

Regional Road Development and Maintenance Project Phase 3

Uliastai - Altai Road

Package CW 2
Construction of new asphalt paved road for
section from
Uliastai to Tsagaankhairkhan (40.1 km)

Volume 2

Specifications

Specifications, Volume2, CW2, Construction of a new asphalt paved road for the section from Uliastai - Tsagaankhairkhan on a new alignment (40km)

SPECIFICATIONS

Part A – Design Specification

Part B – Construction Specification

PART A, DESIGN SPECIFICATION

1.1 Technical Standards and Regulations

The design shall comply with Mongolian national specifications, technical standards, building, construction, and environmental regulations, the EMP provided to the Contractor, and the standards quoted in these Specifications.

1.2 Design Responsibility

The Contractor shall be responsible for updated elements of the design. The original designer shall retain responsibility for the original elements of the design. The duties described in this Part A Design Specification" are the subject of a milestone under the Conditions of Contract."

1.3 Safety rating

Based on an agreement between the Employer and the Asian Development Bank, the design of the road is to achieve a 3-star or better rating the procedure of the International Road Assessment Programme (iRAP). Details of the iRAP rating may be found at <https://irap.org/>.

An iRAP assessment of the existing design was carried out and the recommended principal design changes to achieve the required safety rating include:

- The removal of all hazardous side slopes and/or installation of guardrails
- The removal of all hazardous deep drainage ditches.
- All posts and poles to be non-hazardous (i.e. frangible or <100mm dia.).
- All roadside safety barriers should have end terminals
- All bridge and culvert locations will incorporate adequate safety barrier systems (and connections).
- All significant horizontal curves (with an approximate radius of 800m or less) will be adequately delineated with advanced warning signs
- Audio-tactile line markings to be installed on the road edge
- Installation of adequate road signing
- Ensure 5m clear zone at the roadside.

Further safety compliance of the design will be verified by the Engineer.

1.4 Design approval

The Contractor shall obtain expertise appraisal of the revised design and associated cost estimate in accordance with Mongolian practice and shall bear the cost of obtaining this approval. The Employer will assist in obtaining expertise appraisal in case in case of issues raised by the expertise group relating to the iRAP 3* standard. The Contractor shall assist the Employer to obtain the environmental construction permit.


1.5 Design outputs

Design outputs shall be updated drawings, survey and design reports, quantity calculations, and an updated priced bill of quantities. Design outputs shall be provided in both Mongolian and English versions (or a single bilingual version).


1.6 Survey and design actions

The Contractor shall Implement survey and design actions as shown in the following Table. Some of the design actions will lead to significant increases in pay item quantities compared to the quantities shown in the Drawings which are from the 2022 design. Those design changes having major impact on the design quantities have been identified in the table, and indication is given of the pay item quantities that have been increased, and the new pay items that have been added in the BOQ.

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Item / Chainage	Action by the Contractor	Major impact on 2022 design quantity	Action already taken in the BOQ compared to 2022 design
Pavement design	Amend pavement structure to the following: 30 mm Asphalt concrete surface course (polymer modified bitumen) 40 mm Asphalt concrete binder course (polymer modified bitumen) 200 mm Crushed stone base course 300 mm Granular subbase (laid in two layers) For specification of CS refer to Section 1100 of this Specification. For specification of polymer modified bitumen refer to Section 1200 of this Specification.	Yes	Specification, pay items and quantities revised
Cross Section	Revise embankment side slopes to meet iRAP 3* rating as follows: <ul style="list-style-type: none"> • Embankment height less than 1 m: embankment slope 1:1.5 as in the original design • Embankment height between 1 m and 3 m: embankment slope 1:4 • Embankment height more than 3 m: embankment slope 1:1.5 as in the original design and additional installation of guardrails 	Yes	Embankment fill quantity increased by around 26% Topsoil stripping quantity increased by around 16%.
Ditches	Revise slopes of side ditches to 1V:4H	Yes	Side ditch volume increased by 107%
Culverts	Update culvert designs where required based on the revised embankment slopes.	Yes	Pipe culvert lengths and associated pay items increased by around 35% Box culvert lengths and associated pay items increased by around 20%
Road Permafrost design	Investigate and design sufficient thickness of pavement and non-frost susceptible layers to prevent frost penetration into the subgrade. In permafrost areas, survey and design to preserve the natural base of the earth fill in a frozen state by: Methods based on limiting heat intake underneath the embankment, Methods based on enhancing heat extraction from the embankment, and Methods based on the reinforcement of the embankment to resist permafrost degradation.	No	Remeasure embankment / pavement layers
Guard rails	Provide guardrails along the outside shoulder at culverts, bridge approaches and all other locations where the embankment height is more than 3 meters. The guardrails are to be provided with suitable termination details to ensure that the fence ends are not presented to oncoming traffic. Change to flared non-energy-absorbing terminals  Design transitions between two safety barriers so vehicles slide along the barrier in a smooth way, without any interruption.	No (design already included sufficient quantity)	Technical specification amended.

Specifications, Volume2, CW2, Construction of a new asphalt paved road for the section from Uliastai - Tsagaankhairkhan on a new alignment (40km)

Item / Chainage	Action by the Contractor	Major impact on 2022 design quantity	Action already taken in the BOQ compared to 2022 design
			
Guideposts	Provide frangible guideposts (delineators) equipped with reflectors.	No	Guide post pay item revised
Chevron road signs	Provide Chevron (delineator) road signs at all horizontal curves with radii less than 800m.	Yes	New pay item added
Environmental Impact Assessment	<p>Prepare Environmental Impact Assessment (EIA) in accordance with the Mongolian laws and regulation (methodology approved by the Ministry of Environment and Green Development No. A-117 dated April 10, 2014) and assist MRTD to obtain the environmental construction permit. The EIA should be prepared by a firm having a license to carry out EIA in Mongolia. The EIA should be based on the EIA prepared in 2022 and submitted by the Employer to ADB for its no objection, and should as a minimum retain the mitigation and monitoring measures in that document.</p> <p>Carry out Environmental baseline survey and assessment, including</p> <ul style="list-style-type: none"> i Environmental status assessment within the project area. ii Assessment of the environment in the territory where the project will be implemented, covering areas that may be affected by the project (water environment, climate, geology, hydrogeology, geomorphology, climate conditions, air quality, soil, flora, fauna, etc.). iii Identification of population and social conditions that may be affected by the project. 	Yes	New pay item added for EIA
Animal crossings	<p>Design an animal crossing at km 25+605 based on the study of wildlife migration patterns that is currently being conducted. This location may be adjusted, or additional locations may be added based on the study findings.</p> <p>For details refer to the EMP in Attachment 5 of this Specification.</p>	Yes	Provisional sum added

PART B, CONSTRUCTION SPECIFICATION

The Contractor shall be deemed to have acquainted themselves with the requirements of all current statutes, ordinances, by-laws, rules, regulations or other instruments having the force of law in Mongolia including without limitation those relating to protection of the environment, health and safety, importation of labour and training, taxes, duties, royalties and other levies.

The standards referred to shall be the latest editions approved by the Mongolian State administrative body in charge of standardization and technical regulations at the Base Date. All the conditions and particulars as to standard of materials, workmanship and tests contained in such Standards shall be complied with for various items unless otherwise agreed by the Engineer. Copies, in the English language (as available) of any Standards used in connection with the Works shall be supplied by the Contractor to the Engineer within 14 days of the Engineer's written request stipulating the required standards.

The Contractor may propose that the materials and workmanship be defined in accordance with the requirements of other equivalent national specification than referred in these Specifications and the Contractor may execute the Works in accordance with such other national specifications as may approved by the Engineer. A copy of the proposed national specification together with a translation into English and Mongolian language shall be submitted to the Engineer for approval.

Where codes, certification requirements and materials referred to in these Specifications relate to a particular country or region, other authoritative codes, certifications and materials which ensure a quality equal to or higher than specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 15 days prior to the date when the Contractor desires the Engineer's approval. In the event that the Engineer determines that such proposed alterations to the standards do not ensure equal or higher quality, the Contractor shall comply with the standards set forth in the documents. No additional payment will be made even if higher standards result in additional costs to the Contractor.

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Appendix 4 Furniture for the Engineer’s Accommodation

Appendix 5 Environmental Management Plan

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101 LOCATION AND EXTENT OF SITE

Detailed alignment of the road is shown in drawings. The beginning and end point of each section shown in the drawing and Engineer's instruction shall be taken before the work commencement.

The Site comprises the areas encompassing:

- . Right of way, / road reserve,
- . Borrow pits,
- . Quarries,
- . Sand quarries,
- . Pre-cast yard,
- . Spoil areas,
- . Access roads,
- . Diversions and deviations,
- . Contractor's installations,
- . Storage areas,
- . Camp sites,
- . Site laboratories
- . Engineer's offices and accommodation
- . Plantation of trees

The Employer will give the Contractor right of access to and possession of the parts of the Site on which the Permanent Works are to be constructed. All other parts of the Site shall be arranged at the Contractor's sole responsibility.

102 EXTENT OF CONTRACT

The contract is for construction of the Works shown on the Drawings.

The major items of construction works in the Contract include but are not limited to:

- (a) setting out, taking over the road alignment, refreshing and staking
- (b) site clearance
- (c) investigation and exploration of local material resource, reinstatement of borrow areas
- (d) construction of culverts
- (e) embankment in fill and excavation of cutting
- (f) construction of embankment top layer /formation layer/
- (g) construction of non-frost subgrade layer
- (h) construction of subbase layer
- (i) construction of cement treated base course layer
- (j) construction of gravel shoulder
- (k) applying tack and prime coat
- (l) construction of asphalt base and surface
- (m) construction of bridges
- (n) installation of guideposts
- (o) installation of road signs
- (p) installation of guardrails

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- (q) application of road markings
- (s) installation of curbs
- (t) construction of ditches and side drains and pitching
- (u) construction and maintenance of deviation

103 DRAWINGS

The Contractor shall prepare Detailed Engineering Design (DED) in accordance with Part A of this Specification and obtain expertise approval (Mongolian government procedure) of the DED. The Drawings in the DED are subject to supplementation by way of modifications and additions, that may be instructed by the Engineer from time to time, for the proper execution of the Works.

Additionally, the Contractor shall prepare drawings during construction progress including:

- Shop Drawings (SD)
- Measurement Drawings (MD) that is required for payment approval, and
- As Built Drawings (ABD)

Shop Drawings shall be prepared and submitted for approval by the Engineer so that approval may be obtained no later than 14 days before initiating each given stage of construction. For same types of contract works, several notice to proceed may be requested within the frame of one set of Shop Drawings. Shop drawings shall include, but are not limited to, the following as appropriate: identification and layout of work areas, work schedule and sequencing, methodologies, materials and their transport routes. Construction shall not proceed if the reviewed and confirmed Shop Drawings by the Consultant are not returned back to the Contractor. The Engineer shall review and either approve or reject giving reasons within 7 days of receipt.

104 PROGRAMME OF WORK

The Contractor shall submit a programme of work, and revisions thereto, together with supporting documents in accordance with the Conditions of Contract.

The programming software shall, unless otherwise approved by the Engineer, be Primavera Suretrak or Microsoft Project.

In addition to the supporting documents stated in the Conditions of Contract, the Contractor shall submit a cash-flow estimate.

Regarding the method statement to be submitted in accordance with the Conditions of Contract, the method statement shall include but not be limited to details in respect of:

- Engineering work and housing, field laboratories,
- Organization of temporary facilities,
- Contractor's equipment and its intended production output,
- Location of Contractor's camps and stock yards
- Quarry use, stone crushing, industrial products,
- Production, product, storage and use of other stone materials,
- Borrow area arrangements including access road
- Construction method and staging of works
- Supply, handling and storage of materials required for execution of the Works,
- Concrete plant and equipment,

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- Bituminous mixture plant and equipment,
- Electricity supply and use
- Temporary roads,
- Cut method,
- Organization of water supply,
- Work shift organization,
- Size of the skilled and unskilled labour forces,
- Monitoring progress of work , quality management arrangements, testing methods.

105 ORDER OF WORK

All works, including all bridge and culvert works, will be conducted continuously, and all activities must be carried out in the time specified in the contract, in the order of progress, in such a way that completed Sections of the road may be taken over by the Employer in stages. In general, the contractor shall start the road from one end (section of the road as directed or agreed by the Engineer) and continue towards the other end without leaving any break in between. The work plan (including revised work plan) submitted by the Contractor and approved by the Engineer shall include the length of the section and the sequence of work to be performed by each work component (i.e., earthwork, bridge culvert work, pavement work, etc.).

106 SUBMISSIONS TO THE ENGINEER

Where the Contractor is required by the Contract to make submissions to the Engineer, the Engineer will consider each submission and, if appropriate, reply to the Contractor in accordance with the requirements of the Contract. The Contractor shall make such submissions in accordance with the requirements of the Contract and, in any event, in sufficient time to enable the Engineer properly to examine the submission without delay to the progress of the Works.

The term “submissions” shall include, without limitation, method statements, proposals, details, sub-drawings, drawings, calculations, programmes, progress reports, information, literature, materials, test reports, certificates, requests for approval to cover up the Works and all other items which the Contractor is required by the Contract to submit or the Engineer may reasonably require.

Documents, other than drawings and manufacturers’ literature, shall be submitted in A4 size unless agreed otherwise by the Engineer. All documents shall be in English, except that manufacturers’ literature may be provided in a language other than English providing they are accompanied by an English language translation. All abbreviations shall be fully explained.

All calculations and technical information shall be in units conforming to the Système Internationale (SI). All drawings shall be submitted on A3 size sheets unless agreed otherwise by the Engineer. All notes shall be in English. All dimensions shall be in metres and/or millimetres and all weights in metric units.

All drawings shall include the title of the Contract at the bottom of the drawing followed by the specific drawing title. All drawings shall be uniquely numbered and include the appropriate scales and date. If a drawing is a revision of a previous issue, details of the amendments shall be noted and dated. The Contractor shall obtain the Engineer’s approval regarding the format, titling and numbering of drawing by making sample

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submissions and follow the form of presentation as agreed to by the Engineer for further submission of drawings.

The consent or approval of the Engineer to any submission made by the Contractor shall not relieve the Contractor of any of his responsibilities under the Contract.

The Contractor shall prepare and furnish the Engineer with accurate record (as-built) drawings to full size and scales as otherwise stipulated showing complete Works as executed with existing and finished levels (top, invert and formation levels, plans, cross and longitudinal sections, locations of all functions, manholes, inlets, extent of concrete beds and structures and all things necessary to form a complete record of the finished Works). Also to be shown are the locations of existing utilities. A separate set of contract drawings shall be maintained by the Contractor at the site office. All changes to the original drawings shall be marked on this set of drawings, Accurate coordinates of all underground works shall also be marked on these drawings.

The Contractor shall prepare and submit the Monthly Progress Report not later than the second day of the following month. The report shall provide at least the following information:

- Contract summary of the project,
- Contractor's schedule,
- Monthly progress by work item,
- Construction progress of each work item showing actual vs. planned,
- Invoice summaries for progress payments of amounts requested for the reporting period, amounts requested to date, and actual payments received by the Contractor,
- Future work projections and expenditures,
- Delays of work caused by all events,
- Variations and instructions received from the Engineer during the reporting period
- Contractor's claims,
- Technical and administrative issues or problems identified during the reporting period,
- Summaries of quality control test results, including checking and evaluation of same by the Consultant,
- Construction progress photographs of the works in progress and completed,
- A list of contractor's and sub-contractor's key project management and supervision personnel, including quality control and field engineering,
- A list of Contractor's and sub-contractor's plant and equipment, and equipment usage on the project including downtime,
- A list of Contractor's materials stored on site.

The Contractor shall supply to the Engineer one complete set of marked-up prints of all drawings, including larger scale original drawings where necessary to clearly show adequate detail, and including all utility drawings for which modifications have been performed for or as part of this project.

The Contractor shall furnish three copies of record drawings including electronic versions as AutoCad files. The final certificate of payment will not be issued until all required record drawings have been approved and supplied to the Engineer.

107 TAKING-OVER CERTIFICATES

A Taking Over Certificate will not be issued for the Works or for a Section unless according to the Engineer's recommendation, public transportation can operate comfortably and safely after the opening of the road, and in addition full completion of work on any part of

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the road, except for the works that can be carried out during the warranty repair period listed below:

- restoration of borrow pits and quarries,
- rehabilitation and restoration of temporary roads,
- installation of information signs,
- installation of kilometer indication signs.

The Contractor shall gather the following three set of official documents prior taking-over:

Documentation set 1

- 1) Centerline and topographic points hand over sheet
- 2) Notice to proceed – written notice to begin the contract work
Appointment letters for the Contractor, the supervision consultant, and the Employer's project director.
- 4) Local administrative construction site issuing order
- 5) Construction drawings of Roads and Bridges
- 6) Design Report
- 7) Work Assignment for construction design of Roads and Bridges
- 8) Geological Report of the Construction Site
- 9) Technical Specifications
- 10) National Expertise Evaluation on work drawings
- 11) Construction execution contract
- 12) Fundamental and temporary benchmarks installation, hand over and received sheets
- 13) Meteorological observation report during the construction period
- 14) Red Book (Construction performance of desired work shall be properly noted recorded)

Documentation set 2

The Contractor shall make the following work sheets (appropriately recorded, signed, stamped) approved by relevant organizations and/or officials; further, related photo pictures shall be enclosed in this set of document:

- 1) Borrow excavations visualization sheets, State environmental inspector's review
- 2) Certification of compliance of the completed works by the design firm
- 3) Upper body organizations, local government's enforcement letters, review, and their accomplishments
- 4) Traffic Police's review and approval for opening to traffic, for traffic signs, markings, roadside equipment
- 5) Construction photographs

Documentation set 3

The contractor shall make the following work sheets to be approved (charts, sketches, photo pictures shall be enclosed) by the Engineer and complete this set of documents.

- 1) Work schedule charts
- 2) Site Measurements
- 3) Laboratory testing result reports
- 4) Notices to proceed for covering up the works (related documents, materials to be used in construction work, structure's manufactory certifications, origin, technical certifications, quality control warranty etc. shall be enclosed)
- 5) The Consultant's instruction letters, and evidence of their accomplishments

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- 6) Measurement and material sample testing reports
- 7) Shop Drawings (SD)
- 8) Measurement Drawings (MD)
- 9) As Built Drawings (ABD)

108 METHOD OF CONSTRUCTION AND SEQUENCE OF WORK

Prior to start of the construction activities at Site, the Contractor shall submit to the Engineer for approval, the detailed design and/or working drawings where required and construction methodology including equipment proposed to be used, sequence of various activities and a detailed time program for the Works.

If the Contractor plans to construct the roadworks under traffic, the work shall be planned and constructed in stretches no more than 5 km in length and such length or any shorter length planned by the Contractor shall be progressed continuously and without interruption until completed for the full width of the carriageway including shoulders and edge drains. Compliance with this obligation is deemed to be an obligation pursuant to Sub-Clause 4.14 of the Conditions of Contract.

Without in any way limiting the Contractor's quality system requirements and obligations and responsibilities under the Contract, the Contractor shall furnish, at least 28 days in advance of his program of commencement of each item of work, the method of working intended for various items of work such as investigation, design, site clearance, construction of embankment, sub-base, base, asphaltic concrete, culverts, bridges, retaining walls, cast-in-situ piling, construction of pre-stressed concrete beams, precast concrete, fabrication and construction of bridges, tunnel excavation, and all other items required for the Works. The Contractor shall provide information regarding the details of the method of working and equipment proposed and satisfy the Engineer about the adequacy and safety of the same. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the Engineer.

109 PROJECT QUALITY MANAGEMENT SYSTEM (QM SYSTEM)

The Contractor shall be held solely responsible for the quality of the whole of the Works. The Contractor shall designate a responsible and qualified engineer in his team, as agreed by the Engineer, as the Quality Manager in the Contract, who shall be responsible, under the overall direction and control of the Contractor's Project Manager, for ensuring that the quality control procedures set out in the Project QM System are adhered to. The Quality Manager shall be authorized to control and coordinate all quality control activities and shall be an experienced professional reporting directly to the Contractor's Project Manager. The Contractor shall employ only competent quality control technical staff to carry out testing and other quality control procedures and any staff not meeting this requirement, if so determined by the Engineer, shall be replaced with qualified staff acceptable to the Engineer.

The Contractor's Proposed Project QM System shall demonstrate ability in terms of resources and procedures to control the quality of the Works and shall include but not be limited to:

- general quality control procedures,

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- complete documentation to ensure that all materials that are to be brought to Site comply with the requirements of this Specification and that such compliance shall be maintained throughout the currency of the Contract,
- a complete schedule of sampling and testing procedures including test type, frequency, timing, reporting and signing-off procedures,
- acceptance criteria for payment purposes and procedures in the event of substandard or late test results,
- procedures for the checking, testing and approval of Temporary Works,
- testing, acceptance and monitoring of Contractor's methods and equipment,
- procedures for assurance of acceptable continuity in methodology and workmanship quality correlated with levels of supervision including numbers and type of Contractor's supervisory staff,
- standard report forms for timely submission to the Engineer.

The schedule of testing in the Project QM System shall take cognizance of the key stages of construction so that tests are timely, informative, relevant and do not cause unnecessary delay. The purpose of the Project QM System is for the Contractor to provide records that demonstrate to the Engineer, in the fullness of time, that all the requirements of this Specification have been met.

In preparing the Project QM System the Contractor shall take into consideration that:

- (a) no operation shall be carried out without full and complete written notice having been given to the Engineer by the Contractor sufficiently in advance of the time of the operation to enable the Engineer to make such arrangements as he may deem necessary for its inspection and checking,
- (b) the Contractor shall give the Engineer not less than 48 hours' notice in writing of his intention to set out or give levels for any part of the Works in order that arrangements may be made for checking.

110 UNITS OF MEASUREMENT AND ABBREVIATIONS

a) Units of measurement

Symbols for units of measurement conform to the SI system as set out in BS 5775 (ISO 31/1), of which examples are given below, along with the usual abbreviations.

Where reference is made in the documents to imperial units, the equivalent SI units shall be substituted.

µm	micron = m x 10 ⁻⁶
mm	millimeter
m	meter
km	kilometer
mm ²	square millimeter
m ²	square meter
km ²	square kilometer
ha	hectare
m ³	cubic meter
l	liter
rad	radian
s	second
°C	degrees Celsius
kg	kilogram
g	gram = kg x 10 ⁻³

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mg	milligram = $\text{kg} \times 10^{-6}$
mg/l	milligrams per liter
t	tone = $\text{kg} \times 10^3$
kg/m^3	kilogram per cubic meter
t/m^3	tones per cubic meter
N	Newton
N/m^2	Newton per square meter
Pa	Pascal = $1 \text{ N}/\text{m}^2$
MPa	mega Pascal = $\text{Pa} \times 10^6$
J	Joule
W	Watt
Kw	kilowatt
A	Ampere
V	Volt

b) Abbreviations

The following abbreviations are used:

ACV	Aggregate Crushing Value
ALD	Average Least Dimension
BA	Bitumen Affinity
CBR	California Bearing Ratio
CR	Crushing Ratio
FI	Flakiness Index
HYSD	High Yield Stress Deformed
LAA	Los Angeles Abrasion Value
LL	Liquid Limit
LS	Linear Shrinkage
MC	Moisture Content
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PI	Plasticity Index
PL	Plastic Limit
PM	Plasticity Modulus, $\text{PI} \times (\% \text{ passing } 0.425 \text{ mm sieve})$
PP	Plasticity Product, $\text{PI} \times (\% \text{ passing } 0.075 \text{ mm sieve})$
SE	Sand Equivalent
SG	Specific Gravity
SI	International Standard Units of Measurements
SSS	Sodium Sulphate Soundness Test, loss on 5-cycles
STV	Standard Tar Viscosity
TFOT	Thin Film Oven Test
TS	Tensile Strength
UC	Uniformity Coefficient
UCS	Unconfined Compressive Strength
VMA	Voids in Mineral Aggregates
OPC	Ordinary Portland Cement
no.	Number (units) as in 6 no.
No.	Number (order) as in No. 6
w/c	Water cement (ratio)
wt.	Weight

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%	Percent
max.	Maximum
min.	Minimum
dia.	Diameter
h	Hour
min	Minute
s	Second
wk.	Week

In referring to Standard Specifications the following abbreviations are used:

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society of Testing and Materials
BS	British Standard
BSCP or CP	British Standard Code of Practice
ISO	International Organization for Standardization
MNS	Mongolian National Standard

111 OTHER CONTRACTORS

The Contractor is advised that other contractors employed by the Employer and employees of the Employer may be working in connection with the Project on and around the Site.

Contractor shall not interfere in any way with any works, whether the property of the Employer or of a third party and whether the position of such works is indicated to the Contractor by the Engineer or not. The Contractor shall respect any works executed by others and articles supplied or installed by others and shall be held responsible for any loss or damage thereto if caused by him, his employees or his Subcontractors.

112 TEMPORARY WORKS

After the Contract is signed and before work commences the Contractor shall submit to the Engineer detailed drawings showing his proposed arrangements in respect of Temporary Works (i.e. accommodation, laboratory, parking, storage, hygiene facility, plants, yards, maintenance yard). The Contractor shall submit full supporting details including but not limited to:

- calculations,
- diagrams,
- descriptions of how it is proposed to execute such Temporary Works,
- any other pertinent information.

All Temporary Works shall be subject to the approval of the Engineer. The liability for the whole of the Temporary Works in regard to their construction, safety, maintenance and removal on completion and the equipment and appliances used in their execution shall remain vested in the Contractor. Any approval by the Engineer of the Contractor's or any of his Subcontractors' proposals in respect of Temporary Works shall in no way relieve the Contractor of his duties or responsibilities under the Contract.

113 GENERAL CONSTRUCTION REQUIREMENTS

Notwithstanding the requirements of the Environmental, Health and Safety Management Plan, the following general requirements shall apply:

- (a) The Contractor shall provide adequate lighting whenever work is being executed at night and shall provide and install any additional lighting that the Engineer may require in order to gain access to watch and supervise the Works and carry out any testing and examination of materials.
- (b) Materials available on the Site or materials made available or supplied by the Employer shall be used solely for the execution of the Works.
- (c) The Contractor shall ensure that existing access to all properties adjacent to the Site is maintained for the duration of the Contract.
- (d) The Contractor shall comply with the current Government regulations in respect of the transport, storage and use of explosives and radioactive materials.
- (e) In addition to the requirement of Clause of the Conditions of Contract, the Contractor shall be deemed to be fully conversant with the requirements of all current laws, statutes, ordinances, bye-laws, rules, regulations or other instruments of legal force in Mongolia, including but not limited to those in respect of:
 - addendum to the Specifications,
 - the environment,
 - health and safety,
 - employment including expatriate personnel,
 - training,
 - taxes, duties, royalties and other levies,
 - buildings temporary and permanent,
 - temporary camps,
 - temporary camps,
 - sanitation and water supply.
- (f) All buildings erected by the Contractor upon the Site and camp sites, and the layout of the buildings and the sites, shall comply with laws of Mongolia and all local bye-laws in so far as they are applicable, including, but not limited to, those in respect of health and sanitation.
- (g) Each structure made available for occupancy shall be of sound construction, shall assure adequate protection against weather, and shall include essential facilities to permit maintenance in a clean and operable condition. Comfort and safety of occupants shall be provided for by adequate heating, lighting, ventilation or insulation when necessary.
- (h) Except where otherwise specified, the Contractor shall be responsible for the location of suitable sources of natural materials for the execution of the Works, whether such sources are on the Site or not, and for obtaining all necessary permissions, including certificates of occupancy, quarry licenses and water rights.
- (i) If the Contractor should provide a radio communications network, around the Site, he shall allow the Engineer reasonable use of those facilities. The requirements for the provision of communications facilities for the sole use of the Engineer are stated in Sub-Clause 131 (b) (i) (E) of this Specification.
- (j) The Contractor shall provide, maintain and remove on completion of the Works, all necessary fencing around the Site and provide appropriate security measures but without prejudice to his other obligations including maintenance of free access for the Employer, the Engineer, other contractors and any other persons entitled to such

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- (k) The contractor shall be absolutely and solely responsible for the adequacy, safety and security of Temporary Works and their removal when no longer required, including, but not limited to:
- stores and yards,
 - pilings,
 - staging, gangways, ladders and scaffolding,
 - formwork and false work,
 - dams, cofferdams and caissons,
 - sheet piling, shoring and trenches,
 - fencing,
 - and other associated works,

and for the Contractor's equipment in connection therewith which may be erected or provided for the carrying out of the Contract and for the execution of the Works. This provision shall be applicable to all Temporary Works and Contractor's equipment whenever provided and erected by the Contractor and/or his Subcontractors for the purpose of the execution of or in connection with the Works.

- (l) Examination by the Engineer of the Contractor's and/or his Subcontractors' Temporary Works or of the drawings connected therewith shall not absolve the Contractor from any liabilities or obligations imposed upon him by the provisions of the Contract.
- (m) If the Contractor should temporarily close down his operation for seasonal or other reasons he shall be responsible for maintaining all Site facilities throughout the shutdown period such that they are ready for immediate use upon the resumption of his operations. The Care of Works, pursuant to Sub-Clause 20.1 of the Conditions of Contract, shall remain vested in the Contractor during shutdown periods.
- (n) If fossils, coins, articles of archeological importance are found during the Construction, then the Contractor shall immediately inform the Government of Mongolia and the findings shall be the property of the Government of Mongolia and shall be dealt with provisions of the relevant legislation. The Contractor shall ensure that negative impacts are minimized to the cultural properties / religious structures.

114. PROTECTION FROM WATER, SNOW, ICE AND SAND AND TECHNICAL REQUIREMENTS FOR THE PROTECTION OF CULTURAL HERITAGE

Except where otherwise specified, the Contractor shall be responsible for dealing with water, snow and ice whether from existing drainage systems, water courses, underground springs, precipitation or any other source or cause. In discharging and diverting water he shall avoid flooding or damaging other works or services, causing erosion or polluting water courses.

The Contractor shall keep the whole of the works free from water, snow and, ice and shall provide all dams, cofferdams, pumping, piling, shoring, temporary drains, sumps, snow ploughs, etc. necessary for that purpose.

Well in advance of commencing the Permanent Works the Contractor shall at his own expense cut drains and ditches and carry out any other measures necessary to effectively render the original ground free from water, snow or ice. The Contractor shall at his own expense take all necessary precautions to prevent damage due to erosion, siltation and protect the structures already constructed from being heaped by sand during construction. Such precautions shall include, but not be limited to, temporary drainage

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berms, scour checks, riprap and the like. Spoil material or stockpile material shall be dumped so as not to interfere with streams, watercourses or any of the drainage works detailed by the Engineer. Any damage to the Works or to adjacent properties resulting from the Contractor's failure to take such necessary precautions shall be made good at his own expense.

Cultural heritage protection activities during road construction shall be carried out in accordance with the Law on Cultural Heritage of Mongolia /2001/ and other relevant laws and regulations.

Cultural heritage to be protected during the construction of the road include monuments, human stones, ancient city ruins, ancient settlements, graves, burial mounds, and ritual structures on or near the road route and the quarries.

Taking into account the exposure of highway routes and quarries, protective excavation and transfer measures will be applied to cultural heritage located 25 m from the road centerline, measures to protect against exposure to road construction activities will be applied to cultural heritage located 25-50 m from the road centerline. In addition, cultural heritage located within 50m from a quarry will be included in protective measures.

In accordance with Article 17.10 of Chapter 6 of the Law on Cultural Heritage of Mongolia, the cultural heritage affected by the planned road route shall be excavated and transferred by a professional organization / the Institute of Archeology of the MAS, which previously conducted a survey along the route / before the start of road construction on the basis of a contract. Professional recommendations on the protection of cultural heritage must be taken and implemented.

The contractor must undertake to fully implement cultural heritage protection measures during the construction works, as specified in the Environmental Management Plan.

115 USE OF EXPLOSIVES

The Contractor shall keep in his site office the copies of State laws applying to the supply, transportation, handling, storage and usage of explosives and shall supply one copy of each of those State laws to the Engineer. Explosives shall be used in accordance with the related laws and regulations of Mongolia.

The Contractor shall use explosives for blasting in connection with the Works only at such times and places and in such a manner as the Engineer may approve and in compliance with the License for blasting works always provided that such approval shall not relieve the Contractor from his responsibility for injury, loss, inconvenience and annoyance to persons, damage to the Works and adjoining or adjacent structures, roads, places and things consequent on the use of such explosives.

The Contractor shall be entirely liable for any accident that may occur and shall save the Employer harmless and indemnified from all claims arising there from. Where the possibility exists of loss, inconvenience, injury or accident to persons, animals, works, property, places or objects the Engineer shall have the authority to regulate or proscribe the use of explosives and, in the event of such regulation or proscription the Contractor shall have no claim against the Employer.

The Contractor shall give warning each time of his intention to blast and shall station personnel on the roads and elsewhere with flags, horns and whistles and prevent persons, animals and traffic entering or remaining within the danger zone. He shall arrange for control of traffic on main roads by the local police and traffic police of Mongolia during all blasting operations within 400 m of such main roads.

The Contractor's supervisor in charge of blasting operations shall have a current license held valid by the concerned Authorities of Mongolia for all types of blasting required including restricted blasting, and the license shall be made available to the Engineer for verification.

The Contractor shall provide proper buildings in suitable locations for the storage of explosives to the satisfaction of the Engineer and any statutory regulations in force in Mongolia. Such storage locations shall be clearly marked with "Danger Explosives" sign in bold script in all languages normally spoken on Site.

The Contractor shall take all proper precautions and comply with all laws or other statutory regulations governing the handling and use of explosives including the display on Site of warning notices explaining the procedure to be used in blasting operations, such notices to be displayed in all languages normally spoken by the personnel working on Site.

The Contractor shall select the number, position, orientation, depth and spacing of holes for blasting, the amount and type of explosive to be used per hole and the number and sequence of delays such that fracturing or otherwise damaging the ground below or beyond the required excavation limits is avoided. Final holes shall stop short of the final limits of excavation by the amount required to ensure that, after detonation and the removal of all loose material, the final surface is in the correct position.

In areas where it is necessary to restrict blasting in order to protect installations of significance or whenever he wishes to blast within 400 m of any public road, railway line, overhead power line or telephone line, the contractor shall:

- (a) inform the authority concerned of his intention to carry out blasting within the vicinity of their property and ensure that all conditions imposed by them, including attendance by the representatives of such authority, are met,
- (b) provide cover to the area to be blasted or use other means, to the approval of the Engineer and the authority concerned, to prevent damage by flying debris to such services,
- (c) ensure, by the use of controlled delayed detonations or by limiting the amount of charge used at any blasting site, that the peak particle velocity at any existing building, structure or service does not exceed 50 m/s,
- (d) provide a suitable vibrometer and, whenever called upon to do so by the Engineer, demonstrate by the use of this instrument that the charges he proposes to use comply with this Specification.

Neither the Contractor's compliance with these restrictions nor any approval given by the Engineer shall relieve the Contractor of any of his liabilities or responsibilities in respect of any damage to any building, structure or service resulting from his use of explosives.

The Contractor shall be deemed to have included in his rates for items covering excavation for the supply of all explosives including, but not limited to, their transportation, storage, handling, supervision and compliance with requirements of this Clause of the Specification.

116 PROTECTION OF EXISTING WORKS AND SERVICES

The Contractor shall be held responsible for any injury to existing works, utilities or services (hereinafter referred to as services) , and shall indemnify the Employer against any claims in this respect including consequential damages. The Contractor shall be

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wholly responsible at his own cost for the reinstatement of any services so affected. Before commencing any excavation or other work in the vicinity of existing services or likely to affect otherwise such services, the Contractor shall notify the concerned authority owning and/or operating such services and shall obtain clearance from that authority for the Contractor's work plan for protection and/or reinstatement of such services before proceeding with the works, under intimation to the Engineer.

The Contractor shall be responsible for identifying the precise location and pertinent details of all existing services (visible and concealed) including but not limited to:

- sewers,
- surface water drains,
- cables for electricity telephone and lighting,
- pylons poles and ducts for cables,
- water mains,
- heating water mains.

In those cases where such services are buried, the Contractor shall obtain information about the location and depths of such services from the owning authority. The Contractor shall carry out further investigations by means of hand-dug trial holes and trenches supplemented by electronic or electromagnetic equipment as appropriate. The identification of each service so exposed shall be confirmed in consultation with the Engineer and the authority concerned. Every service at risk shall be fully exposed and such excavations shall be properly shored. Exposed services shall be fully protected and supported in-place prior to the commencement of construction in the vicinity. Installations adjacent to the Works, shall be kept securely in-place until the work is completed and shall then be restored to a safe and permanent condition.

Upon completion of such construction special care must be exercised in filling and compacting the ground under mains, cable, etc., and to leave any water meters, stopcock boxes, manhole covers and similar items accessible. The excavation, refilling and re-installation (where required) shall be done in accordance with applicable regulations and under the direction of the owning authority. Wherever the execution of the Works requires a change in the final level of the road surface, the level of all affected valve covers, manholes, inspection covers and the like and their frames shall be altered to suit in a manner subject to the satisfaction of the Engineer. The Contractor shall immediately inform the Engineer of any services discovered on the Site that are not shown on the Drawings. If, in the opinion of the Engineer, damage to services may occur as a result of the Contractor's operations, the Contractor shall carry out any measures that the Engineer may instruct to prevent such damage.

Because high voltage electricity can cause a short circuit to the ground through cranes and other bulky equipment parts, the Contractor must inform all personnel working near high voltage power lines that they must maintain a safe distance. Tables 1-1 and 1-2 suggest safe distances for high-voltage transmission lines and low-voltage distribution lines. Notwithstanding these suggestions, the Contractor, in consultation with the relevant professional organizations responsible for their activities, shall determine for himself a safe distance to be maintained from power transmission lines of various voltages. The Contractor shall bear the cost of any precautionary measures and and additional work that may be unavoidable due to the proximity of the works to power lines.

Table 1-1: Recommended clearances below high voltage transmission lines

Volt kV	Clearance
138	7.8 m
230	8.4 m

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345	9.4 m
500	10.0 m

Table 1-2: Recommended clearance below low-voltage distribution lines

Volt kV	Clearance
0 - 750	1 m
750 - 38,000	1 m
38,000 - 86,000	1.5 m

Regardless of the above requirements but not reducing their responsibility, the Contractor shall notify the Engineer immediately if they have discovered that any of the engineering facilities are exposed or damaged by them.

Any and all cost related with making changes to the engineering facilities arising in connection with the work plan development, coordination and implementation shall be borne by the Contractor.

117 RELOCATION OF UTILITIES

Regardless of the location and details of the engineering facilities shown on the drawings, the Contractor shall conduct additional exploratory surveys to confirm the information provided and add further details.

In accordance with clause 104 of these technical specifications, while developing the work plan, the Contractor must consider the time necessary to detect, locate, protect, move and notify relevant authorities of the engineering facilities around the Site.

The Contractor shall be responsible for coordination with relevant organizations in case of any engineering facilities are required to be moved or modified. If the contractor requires to receive government support through the Employer, the requirements related to this issue must be reported to the Engineer.

118 PROVISION OF LAND

The Government shall make available free of charge to the Contractor land on which the Permanent Works are to be executed or carried out as indicated on the Drawings or as detailed in this Specification. Such land shall be limited to the actual land area on which construction will be done, including space reasonably required for operating movable construction equipment.

The acquisition of all land required for borrow, stockpile and spoil areas and quarries as defined in Section 600 of this Specification and access roads thereto and land for deviations outside the road reserve, site laboratories, Engineer's offices, houses, inspection huts and land required by the Contractor for his own camps, offices, stores, workshops, houses, Temporary Works or any other purpose shall be the responsibility of the Contractor.

The locations of land to be provided by the Contractor shall be subject to the approval of the Engineer.

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Where it is necessary for the Employer, in fulfilling his obligations, to acquire any land during the Contract, the Contractor shall determine the ownership of and shall pay on instruction from the Engineer, the cost of the land or rent, and/or compensation for demolition or shifting of structures or assets or change in land use required for the Works as valued by the responsible local authorities. The Contractor's obligations in this respect are set out in detail in Clause 603 of this Specification. Although the Contractor may, in the first instance, provide the money for the purchase of the land, all such land shall be the property of the Employer. If the Contractor requires any Governmental facilitation in this matter through the Employer, the requirement in this regard shall be brought to the notice of the Engineer at least 28 days in advance.

In respect of all land required for borrow, stockpile and spoil areas, quarries, access roads thereto, deviations outside the road reserve, the Site laboratories, the Engineer's offices, houses and Inspection huts and land required by the Contractor for his own camps, offices, stores, workshops, houses, Temporary Works or any other purposes, the Contractor shall make all necessary arrangements with the property owners concerned and pay all charges arising there from as per the local laws and regulations. On or before completion of the Works and when so instructed by the Engineer, the Contractor shall, insofar as in the opinion of the Engineer is reasonable and practicable, restore all such land to the same condition that it was in immediately prior to the occupation of that land by the Contractor to the satisfaction of the Engineer.

Should the Contractor request the purchase of land for any purpose and this land is subsequently not used, the Contractor shall be responsible for all costs associated with the compensation

119 MATERIALS AND MANUFACTURED ARTICLES

The Contractor shall be responsible for locating and selecting materials complying with the Specification and for ensuring that materials processed for incorporation into the Works comply with the Specifications. Designated quarries defined in the Materials Report are provided for information only. The location of the source, trial pit logs, results of tests required by the Specification, and representative samples of sufficient size for the Engineer to perform the same tests shall be submitted to the Engineer for acceptance of the source 42 days in advance of transporting to the site and commencement of working with the material. No material shall be used which is not secured from a source licensed by the Government of Mongolia and accepted by the Engineer. Acceptance of a source does not mean that all material from that source will be suitable for incorporation in the works.

Whenever, for separate units, courses, sections, or installations, the material to be incorporated is classified according to size, strength, type, or other design classification, the intent is to specify the minimum acceptable level of compliance, quality, or service. Such designations shall not act to prohibit the furnishing of material of higher class than specified, having better quality, longer service life, or otherwise exceeding the required test characteristics, as the Contractor may elect to provide to facilitate the work. Also, it is not intended that the Contract be so restrictive as to preclude the substitution of similar products or materials that would satisfy the design requirements equal to those specified, even though one or more of the specified test characteristics cannot be met if there is no significant effect on overall performance of the material. Substitutions will be allowed only as authorized by the Engineer, and any revised basis for acceptance shall be as set forth in writing. No extra compensation will be granted for the furnishing of alternate or substitute materials, regardless of any increased costs. Payment for the work will be based on the use of specified materials.

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Such materials shall be tested at and certified by a laboratory acceptable to the Engineer and at the Contractor's expense. Unless provided for elsewhere in the Contract, all goods, materials, transportation, equipment and services for the Works shall be provided by the Contractor. The Contractor shall be solely responsible for the identification of sources of materials and their provision, transportation and storage in accordance with the requirements of this Specification.

Before placing any order for materials and manufactured articles for incorporation in the Works, the Contractor shall submit to the Engineer the names of the firms from whom he proposes to obtain such materials and manufactured articles to be supplied their origin, the manufacturer's specification, quality, weight, strength and any other relevant details. The Contractor shall provide the Engineer with samples of such materials and manufactured articles and, where appropriate shall provide manufacturer's certificates of recent tests carried out on similar materials and manufactured articles.

Should the Engineer at any time determine that any goods or materials intended for use or already incorporated in the Permanent Works do not satisfy the applicable specifications. such goods and materials shall be rejected and replaced by others of acceptable quality.. The costs of any consequential additional or abortive work together with all costs arising from the supply of replacement goods or materials shall be borne by the Contractor.

120 STORAGE OF MATERIALS AND MANUFACTURED ARTICLES

All materials and manufactured articles shall be stored on Site in a manner acceptable to the Engineer. The Contractor shall securely store and protect all work, materials and manufactured articles from the effects of the weather, flooding or vermin.

121 TEST CERTIFICATES

When required by these Specifications or otherwise instructed by the Engineer, the Contractor shall submit test certificates from the suppliers of materials and manufactured articles to be incorporated in the Works. Such test certificates shall certify that the materials and manufactured articles concerned have been tested in accordance with the requirements of this Specification and shall give the results of all the tests carried out. The Contractor shall provide adequate means of identifying the materials and manufactured articles delivered to the Site with the corresponding test certificates.

122 WATER AND POWER SUPPLY

The Contractor shall:

(a) provide at his own risk and cost all water, lighting and electric power required for use in the works and shall pay all costs, fees and charges in connection therewith and allow all sub-contractors use of the same.

(b) make arrangements for requirements of potable water, by providing and maintaining temporary water storage together with any distribution piping which may be necessary and subsequently removing all installations to the approval of the Engineer

The Contractor shall provide a clean, sufficient and continuous supply of fresh water both for construction of the Works and for all houses, offices, Site laboratories, Inspection huts, stores, workshops and labour lines. The Contractor shall undertake all arrangements including pipelines and meters for connecting to local water mains, the provision of pumps, storage tanks and the means of water conveyance where necessary, payment for all fees

Specifications, Volume2, CW2, Construction of a new asphalt paved road for the section from Uliastai - Tsagaankhairkhan on a new alignment (40km) and water charges and the satisfactory removal of all such arrangements and provisions on completion of the Works.

The Contractor may use the natural sources of water subject to local regulations in force and to the provision that any claim arising out of conflicts with other users of the said natural sources shall be dealt entirely by the Contractor. Where natural sources of surface water are not available or not otherwise adequate for whatever reasons, the Contractor shall make arrangements at his own cost for extraction of water from underground sources subject to local regulations.

The water shall be clear of suspended solids and free from any matter in quantities considered by the Engineer to be deleterious to the Works. Water supplied to all the offices, houses, Site laboratories, Inspection huts, stores, workshops and labour lines shall be wholesome and potable to the satisfaction of the Engineer and the public health authorities in the area of the Site.

The drinking water system shall be monitored in accordance with the water quality parameters as prescribed by the Ministry of Environment and Green Development (MOEGD).

123 SIGNBOARDS

The Contractor shall provide, erect and maintain signboards to the layout, colours and dimensions shown on the Drawings or as directed by the Engineer. Signboards shall be erected at locations to be instructed by the Engineer.

The signboards shall be erected within fifty-six days of the date of the letter of Acceptance or within 56 days after receiving the Notice to Proceed, whichever is later. The Contractor shall remove the signboards at the end of the Defects Liability Period.

124 ENGINEER'S FACILITIES

The Contractor shall newly construct or reconstruct existing buildings for Site Laboratories, house and office for use by the Employer, and the Engineer and staff as listed below and/or in the appropriate Appendices to this specification, and provide laboratory equipment, furniture, equipment and vehicles for the Engineer and Employer staff and maintain them at all times. Supervision engineers and personnel must have required workplaces and fully equipped field laboratory.

The location and layout of field laboratories, offices and accommodation is subject to the prior approval of the Engineer.

Quantities of items to be provided for facilities for the Engineer are shown in Appendix 1. Appendix 1 also identifies the ownership of each item, whether purchased for the Employer, or with ownership retained by the Contractor.

(a) Site laboratories and office accommodation

General

The Contractor shall provide, furnish, equip and maintain for the duration of the Contract Site laboratories for the joint use of the Contractor and the Engineer and offices for the sole use of the Engineer's supervisory staff. The offices and laboratories shall be located adjacent to the Contractor's main site offices, as approved by the Engineer.

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The Contractor shall provide the above services in suitable rented buildings including necessary renovations to suit for Site laboratories and Engineer's offices in the nearest town approved by the Engineer.

The terms of any lease for such buildings shall be subject to the Engineer's approval and, shall contain provision for extension of the lease, on terms agreed on beforehand, during any extended time for completion of the Contract, as well as provision for the lease to be taken over by the Engineer in the event of default by or insolvency of the Contractor. Notwithstanding the Engineer's approval of the conditions of the lease, the Contractor shall be solely responsible for providing the accommodation for the full period required and for suitable substitute accommodation should the leased accommodation no longer be available or otherwise found unfit for use.

The Site laboratories and Engineer's offices and their appurtenant services shall be furnished in accordance with these specifications, also taking into account national and local regulations and practices in Mongolia. The Contractor shall prepare and submit for approval the detailed location maps, building plans etc. of his proposals in respect of services for the Site laboratories and Engineer's offices in accordance with the guidelines provided in this Specification.

The location and orientation of the Site laboratories and the Engineer's offices and houses or other accommodation shall be to the Engineer's satisfaction and shall be decided upon in consultation with him and confirmed in writing before furnished.

The Contractor shall provide access roads, fencing and areas of hard standing around the office and laboratory buildings and provide water, central heating and power supplies, security guard, external security lighting, telephone and sewerage services and arrange for the disposal of refuse all to the satisfaction of the Engineer. Drainage ditches shall be provided to prevent standing water in periods of wet weather and surrounding area of Engineer's offices, houses and laboratories should be paved at least 100 mm thick with approved material to the satisfaction of Engineer.

The Site laboratories and Engineer's offices shall be painted with an approved paint and the paintwork shall be maintained during the currency of the Contract and, if so instructed by the Engineer, throughout the Defects Liability Period.

Each door shall be provided with a lock and two keys. 2 no. suitable fire extinguishers and 2 no. fire axes shall be provided for each building.

All accommodations shall be provided with a continuous 24 hour, 220V, 50Hz AC power supply, adequate earthing protection and a continuous fresh, pure, portable water supply.

The clear height of all office and laboratory buildings between floor and ceiling shall be 3.0 m minimum.

The Contractor shall be responsible for regular cleaning and maintenance of the Site laboratory and Engineer's office buildings and of the plots on which they are situated. Clearing of vegetation and cutting of grass inside plot boundary fences and their disposal shall be carried out on a periodic basis to the satisfaction of the Engineer.

The Contractor shall keep all buildings, accesses, services and facilities provided for the use of the Engineer and his staff, in a well maintained, clean and fully habitable condition during the currency of the Contract and, if so instructed by the Engineer, throughout the Defects Liability Period.

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The Contractor shall be responsible for providing all sanitary services necessary to keep water-closets in a clean, odourless and hygienic condition.

The Contractor shall provide the necessary septic tanks for all water-closets. Waste water and septic-tank effluent shall be taken into properly soak ways. The Contractor shall also provide for the remove and proper disposal of all rubbish.

The power available 220 V, 50 Hz shall not be less 20 kVA for each office and 45 kVA for each Site laboratory.

The Contractor shall be responsible for providing sufficient labour, tools, brushes, mops, buckets and the like and cleaning products to comply with the requirements of this Clause. The Contractor shall be deemed to have made allowance elsewhere in his rates for complying with those requirements and no separate payment shall be made in respect of them.

Engineer's offices

The Engineer's office at Contractor's site headquarters or as agreed with the Engineer shall have a total internal floor area as indicated in the summary table. Each shall consist of open plan office, a kitchen and 2 no. WC in a building plan or as directed by the Engineer. Window space shall be a minimum of 15% of the floor area of the office building. All rooms shall be provided with electric fluorescent strip lighting of a minimum power rating of 240 W per room. 2 no. double power points shall be provided in each office and in the kitchen and 1 no. in the corridor.

The Contractor shall provide and install adequate central heating and air conditioning facilities such that ambient temperatures over the range of 18 to 20 °C can be continuously maintained inside the Engineer's offices.

A piped potable water supply shall be provided to toilets, wash hand basins, and to the kitchen which shall contain a sink with suitable built in cupboards and working surfaces. A hot water supply shall be provided to both the kitchen sink and toilet wash hand basins. If there is no existing waterborne sewerage system, sewerage shall connect to a septic tank at least 30 m from the building.

The store shall be fitted with shelving to the approval of the Engineer. Blinds are to be provided for all office windows.

Each office shall be provided with a telephone with PABX facilities, independent of the Contractor's telephone, comprising two external lines, switchboard and extensions to five offices and the Site laboratory. The Contractor shall be deemed to have allowed in his rates and prices for of all telephone and facsimile charges.

The Engineer's office building shall be equipped with the furniture and fittings detailed specified in the Appendices of this Specification.

Site laboratories

The location of the laboratory shall be within the Engineer's office complex, or in another location approved by the Engineer.

The Site laboratory shall have a floor area as indicated in the summary table. The laboratory shall consist of office and laboratory working area or as directed by the Engineer. Window space shall be a minimum of 15% of the office floor areas. All rooms shall be provided with electric fluorescent strip lighting of a minimum power rating of 160 W in the laboratory offices and 480 W in the laboratory working area. One telephone shall be installed in one of the laboratory offices as an extension to the telephone exchange located in the Engineer's office building. A total of 12 no.

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double power points shall be provided in the laboratory office and working area.

The Contractor shall provide and install central heating and air conditioning facilities to both offices and the working area of the laboratory building. These facilities shall be sufficient to continuously maintain ambient temperatures inside the Site laboratory building over the range of 15 to 22 °C.

The floor of the laboratory building shall be constructed of reinforced concrete with a power floated U3 finish. A strengthened reinforced concrete floor panel of size 1.5 m x 1.5 m and of total thickness 0.4 m for use as a compaction area shall be provided. Reinforced concrete plinths are to be provided for the concrete crushing machine, the CBR machine and the Marshall test apparatus.

Sturdy metal surfaced benches with integral cupboards below and sturdy shelving above shall be provided in the laboratory working area and the laboratory store shall be fitted with suitable shelving all to the approval of the Engineer.

Each laboratory building shall be provided with piped potable water and hot water supplies and continuous 24 hour 220 V, 50 Hz AC electricity supply for lighting and running the laboratory equipment.

Blinds are to be provided for all windows.

In addition to the laboratory the Contractor shall provide a separate but adjacent covered drying shed and soaking tank. The drying shed shall have a minimum floor area of approximately 25 m² constructed of raised concrete floor and weatherproof roof but open on all sides. The soaking tank shall be 3 m x 1 m x 0.3 m deep and constructed of water-tight concrete or other materials approved by the Engineer.

The Site laboratories shall be equipped with the furniture and fittings detailed specified in the Appendices of this Specification.

Inspection huts

The Contractor shall provide, furnish and maintain Inspection huts where necessary for the duration of the working months for the sole use of the Engineer's supervisory staff. The Inspection huts shall be of such construction that may be dismantled and transported to other locations and re-erected or they may be 'Ger' or equivalent. The Inspection huts shall be erected on the Site of works or at material processing Site. The sitting of the Inspection huts shall progressively shift as the work Site shifts forward and the Contractor shall be required to dismantle and re-erect these huts or transported them as such as appropriate or as directed by the Engineer.

Each hut shall have a minimum internal floor area of 25 m². These shall have adequate windows, fly-proof net, and well fitted doors fitted with lock. The arrangement shall be made so that ambient temperatures of 18 to 20 °C can be continuously maintained inside the huts in springs and autumns, and electric power of 220V, 50 Hz is supplied for 24 hrs in a day to the huts.

Each hut shall be provided with an overhead tank, faucet and an enclosed toilet and kitchen. Services shall include water supply and sewage disposal system, adequate electric light, all to the satisfaction of the Engineer.

Furniture shall include 1 no. office table 1.8 m x 0.9 m, 4 no. office chairs, 1 no. 4 drawer lockable steel filing cabinet, 1 no. stool together with an electric kettle, a twin burner cooker, a kitchen table, utensils and crockery for the kitchen attached to it, all as approved by the Engineer.

The responsibility for the care of such Inspection huts during shut down periods shall be vested in the Contractor.

Car ports and garages

Garages for Engineer's cars shall be provided near to Engineer's houses, and shall be maintained for the full period of Contract implementation. The design of such garages shall be subject to prior approval of Engineer.

Car ports shall be so provided that vehicles parked under them shall at all times be protected from the direct rays of the sun, rain or snow. They shall have weatherproof roofs and be fully enclosed on three sides with the open side for access. The configuration and layout of car ports to be provided adjacent to the Site laboratories and Engineer's office buildings shall be sufficient to accommodate 10 no. four wheel drive vehicles.

(b) Furniture and equipment for the Engineer's offices

The Contractor shall provide facilities such that regular communication between the various members of the Engineer's supervisory staff on the Site may be ensured at all times during the Contract. The Contractor shall provide the Engineer's office with external telephone connections with full international telephone facilities. The Contractor shall arrange for the offices in the Engineer's office and Site laboratory buildings to be inter-connected by an intercom system. The Engineer's office shall also be connected by telephone or intercom to the Contractor's site offices.

The Contractor shall provide and deliver to the Engineer's offices new office equipment and furniture as listed in the Appendices of this specifications, as approved by the Engineer.

(c) Accommodation for the Engineer's supervisory staff

The Contractor shall provide accommodation as indicated in the summary table of suitable rented houses/flats/apartments for the Engineer's staff near to Engineer's office in accordance with the details given below. The location and orientation of the houses shall be subject to the approval of the Engineer.

The Contractor shall prepare and submit for approval the detailed location maps and apartment plans of his proposals in respect of services for the houses for the Engineer's staff in accordance with the guidelines provided in this Specification.

The Contractor shall provide water, central heating and air conditioning facilities, power, external security lighting, telephone and sewerage services and arrange for the disposal of refuse all as detailed in this Specification and to the satisfaction of the Engineer.

Each accommodation shall have:

- bath, shower, wash basin and internal flush toilet,
- wall-mounted high level type and floor-standing type kitchen units,
- kitchen-sink unit with stainless-steel basin and draining boards,
- built-in wardrobes in the bedrooms,
- linen cupboard,
- piped hot and cold water supply system to the bath shower, wash basins, sink units and toilet,
- four-plate electric stove, complete with grill, oven and splash back,
- combined refrigerator and freezer of minimum volume 300 litres,
- three double power points in both the kitchen and lounge and one double power point in each bedroom and passage way,

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- electric wall-lights and lamp-shades in bedrooms, lounges and dining recesses, fluorescent strip lighting of capacity 80 W in kitchens and electric pendant lamps and lamp-shades in all other rooms and passages,
- external security lighting,
- separate fuse box with mains switch, trip switches and automatic cut-out in the event of a leakage to earth, connected to a continuous 24 hour 220V, 50 Hz AC power supply,
- separate circuits for power ring mains, internal lighting and external security lighting, all with adequate earthing protection,
- external hardwood timber doors fitted with good-quality five lever mortice locks, Yale type locks and internal security chains and bolts,
- windows of the type that can open over the full window area,
- mosquito screens and burglar bars on all outside windows, external kitchen doors to be provided with additional outward opening, self-closing fly screen door,
- a sewerage system, including septic tanks and soakaways if necessary. Such tanks and soakaways shall be deemed to be part and parcel of the accommodation provided and in respect of which no separate payment shall be made,
- finished and varnished hardwood shelving in all lounges and painted timber shelving in store rooms and linen cupboards,
- 2 no. suitable fire extinguishers and 1 no. fire axe,

Houses for the Engineer's staff shall be weatherproof and adequately insulated against the Mongolian climate. Each house shall have a clear height from floor to ceiling of at least 3.0 m.

With the exception of kitchens and toilets, the accommodation shall be fully carpeted throughout. Curtains or blinds shall be provided to all windows.

The Contractor shall provide and install adequate central heating and air conditioning facilities such that ambient temperatures over the range of 18 to 22 °C can be continuously maintained throughout the houses for the Engineer's staff.

Each house shall be properly painted inside and outside with an approved paint or varnish and that paintwork shall be maintained during the currency of the Contract and, if instructed by the Engineer, throughout the Defects Liability Period.

The Contractor shall be responsible for regular maintenance of the Engineer's staff houses including collection of household refuse and its disposal on a daily basis, all to the satisfaction of the Engineer. The Contractor shall be responsible for providing sufficient labour, tools and equipment to comply with the requirements of this Clause. The Contractor shall be deemed to have made allowance elsewhere in his rates for complying with those requirements and no separate payment shall be made in respect thereof.

The Engineer's staff houses shall be equipped with the furniture and fittings detailed specified in the Appendices of this Specification.

Each house/apartment shall have minimum two bedrooms, lounge, dining recess, bathroom, kitchen and store.

(d) Vehicles for the Engineer and Employer

The Contractor shall supply new vehicles approved by the Engineer and maintain them for the exclusive use of the Engineer and the Employer for any purpose whatsoever authorized by the Engineer. Such vehicles shall be specially adapted in

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their place of manufacture, and in accordance with the manufacturer's specifications, to suit the extremes of the Mongolian climate.

Types and description of vehicles shall be as given below:

- Type 1 four-wheel drive vehicle heavy duty station wagon, 5 seats, Toyota land cruiser Prado or equivalent with engine capacity of approximately 2700 cc for the use by the Engineer
- Type 2 four-wheel drive vehicle heavy duty station wagon, 5 seats, Toyota land cruiser 300 or equivalent with engine capacity of approximately 3000 cc for the use by the Employer
- Type 3 double Cab Pick Up 4WD Toyota Hilux or equivalent, direct injection 4 stroke water cooled diesel type for the use by the Engineer
- Type 4 Mitsubishi Delica, 4WD or equivalent, 8-seat minibus, direct injection 4 stroke water cooled diesel type for the use by the Engineer.

All four wheel drive vehicles are to be equipped with Pirelli "Scorpion" 255/75 R15 radial ply tyres or equivalent and alloy wheels to suit.

The vehicles, and any authorized passengers, goods and samples, shall be comprehensively insured by the Contractor and licensed for use within Mongolia by any licensed driver authorized by the Engineer.

The Contractor shall pay all tolls and vehicle licensing costs and provide fuel, lubricants and any repairs or maintenance, including replacing defective or damaged parts or tyres and the like, whenever required in conformity with the vehicle manufacturer's recommendations or as may be deemed necessary by the Engineer. The vehicles shall be fueled, lubricated and maintained as aforementioned until released by the Engineer. The Contractor will continue to comply with these requirements during the Defects Liability Period if so instructed by the Engineer. The ownership of the vehicles on their release shall revert to the Employer.

Each vehicle shall be equipped with a fire extinguisher, first aid kit, tow hook and cable, tool kit (including set of metric spanners, set of screwdrivers, water pump pliers, adjustable wrench and socket set), spare wheel, wheel wrench, jack and handle and front and rear seat belts all of which shall be maintained in working order or replaced by the Contractor as necessary.

The Contractor shall immediately provide a similar replacement for any vehicle out of service for maintenance or through mechanical breakdown or for any vehicle being unavailable owing to theft or accident or through any other cause.

The Contractor shall provide house and working clothes and pay, including all overtime and overnight traveling allowances competent and licensed drivers approved by the Engineer for each of the vehicles indicated. Sufficient drivers shall be available at night and at weekends whenever required by the Engineer.

Vehicles shall remain immobilized on blocks with the wheels removed, batteries disconnected and garaged in heated facilities during seasonal shutdown periods. The responsibility for the care of such vehicles during shut down periods shall be vested in the Contractor. The vehicles shall be fully serviced and made ready for the use of the Engineer's staff prior to the resumption of the construction of the Works in the spring.

All vehicles shall be delivered and handed over to the Engineer no later than 56 days after the Commencement Date. The Contractor shall be responsible for all costs incurred by the Engineer and the Employer due to his inability to meet this

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requirement. From the Commencement Date, the Contractor shall provide rented vehicles of acceptable standard, with drivers, for the Engineer's use, without additional payment, until vehicles designated for the Engineer will be available.

(e) Maintenance of facilities, offices, furniture and vehicles for the Engineer and Employer

The Contractor shall maintain the buildings, furniture and equipment for the Site laboratories and Engineer's offices and accommodation until the issue of Taking-Over Certificate for the complete Works or as instructed by the Engineer. If at any stage the Contractor fails to carry out the required maintenance satisfactorily, the month/months during which, shall not be paid.

If the Contract Works are not completed within the stipulated period or within the granted extended time of completion, maintenance of furniture and equipment shall be carried out at Contractor's expense.

The Contractor shall be responsible for all repairs and maintenance of the buildings, including all fittings, and fixtures, plumbing, lighting, water and electricity supply, etc. and the connection of the services as and when necessary, including replacing broken windows and ventilator glasses and other hardware, and maintenance of internal roads, gardens and lawns.

The Contractor will be responsible for the provision and payment of support staff to clean offices, accommodation and laboratory, washing of sheets, towels, etc. of Engineer's staff, removal and proper disposal of rubbish on a daily basis and for the payment of operating costs for mobile phones, telephone, email, water and electricity etc. including the supply of fuel for back-up generators

Engineer's offices and accommodation

The Contractor shall provide maintenance and running services in a satisfactory manner of all furniture and equipment for the Engineer's offices in a useable condition and in such state of repair as may be considered, in the opinion of the Engineer. The Contractor shall replace promptly any item that becomes unserviceable or is lost.

Site laboratory

The Contractor shall provide maintenance and running services in a satisfactory manner of all furniture and equipment for the Site laboratory in a useable condition and in such state of repair as may be considered, in the opinion of the Engineer. The Contractor shall replace promptly any item that becomes unserviceable or is lost. The Contractor shall provide related supplies, consumables and connected services as and when necessary as may be instructed by the Engineer.

Vehicles

The Contractor shall be responsible for all repairs and services necessary to maintain the vehicles in a good roadworthy condition. The Contractor shall provide all fuel, oil and lubricants in conformity with the vehicle manufacturer's recommendations and all relevant charges incurred concerning the Works. The Contractor shall clean the vehicles inside and outside as frequently as necessary to maintain the vehicles in a "like new" condition at all times.

A suitable replacement vehicle shall be provided for any vehicle out of service for more than 24 hours.

All vehicles will be supplied with a qualified drivers, acceptable to the Engineer. The driver, although employed by the Contractor, shall work entirely under the control and direction of the Engineer. Payment of drivers salaries and allowance shall be deemed to be included in a corresponding item of the Bill of Quantities.

(f) Attendance to the Engineer

As required by the Engineer, the Contractor shall provide supplementary personnel for the Engineer. Supplementary personnel shall include, but not limited to laboratory technicians, surveyors, interpreters. The personnel shall be engaged only after the approval of the Engineer and shall be replaced by the Contractor, at the Contractor's expense, if found unsatisfactory for the tasks for which they were engaged.

- **Engineer's Non-Technical Staff**
The Contractor shall be responsible in respect of wages, salaries, insurance, provident fund and all other costs or charges incurred for non-technical staff including watchmen, chainmen and cleaners, recruited by the Contractor and employed on the Works, in the Engineer's office and in the laboratory.
- **Site Assistance for the Engineer**
The Contractor shall provide at all times during the continuance of the Contract all such soils and survey assistants, workmen, pegs, tools etc., and transport as the Engineer may require for carrying out of his duties in connection with the Contract. The instruments and tools shall in any case be provided for the sole use of the Engineer and once supplied shall not be changed or removed without his consent.

The Contractor shall provide adequate security by day and by night for the Site laboratories, Engineer's office buildings, Inspection huts, vehicles and houses, and for the Engineer's staff. This shall include the provision of full-time attendance of permanent watchmen.

(g) Time for providing Site Laboratories, Engineer's Accommodation and Offices

All houses and offices and Site laboratories to be provided under the Contract shall be handed over to the Engineer in finished and fully habitable condition not later than 90 days after receipt of the Engineer's Notice to Commence the Works.

No construction of the Works shall be permitted until the Engineer's offices and the Site laboratories have been accepted by the Engineer as fully commissioned, finished and able to function efficiently.

If the Contractor should fail to hand over the houses or the offices and Site laboratories within the period specified, the Engineer shall make such alternative arrangements as he considers necessary. These arrangements may include the use of hotels, rented accommodation and the hire or purchase of caravans, trailer mounted cabins, etc. The costs of any such temporary arrangements made by the Engineer, including those of additional transport shall be reimbursed by the Contractor to the Engineer including a 5% addition for administrative overheads.

125 INSURANCE OF FIELD LABORATORY, ITS EQUIPMENT AND ENGINEER WORKPLACES AND THEIR FURNITURE, INSURANCE AND OWNERSHIP

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The Contractor shall insure the field laboratory and its furniture and equipment against accidents, fire, theft, and other possible damage and destruction, including the warranty repair period, during the entire period of the Contract.

126 IMPACT MITIGATION AND MONITORING OF ENVIRONMENTAL QUALITY

The Contractor shall carry out duties assigned to the Contractor in the Environmental Management Plan in Appendix 4 of this specification, and as set out in the Conditions of Contract.

127 HEALTH, SAFETY AND ACCIDENTS

The Contractor shall ensure, so far as is reasonably practicable, the health, safety and welfare at work of his employees including those of his sub-contractors and of all other persons on the Site. The organization of the construction sites and workplaces shall generally be in accordance with national safety rules and the H&S Management Plan to be prepared by the Contractor, including (but not limited to) those listed below.

Responsibilities shall include:

- (a) the provision and maintenance of constructional plant, equipment and systems of work that are lighted, safe and without risks to health.
- (b) the execution of suitable arrangements for ensuring safety and absence of risks to health in connection with the use, handling, storage, transport and disposal of articles and substances.
- (c) the provision of protective clothing and equipment, first aid stations with such personnel and equipment as are necessary and such information, instruction, training and supervision as are necessary to ensure the health and safety at work of all persons employed on the Works.
- (d) the provision of a qualified Safety Officer, to the approval of the Engineer, who has specific knowledge of safety regulations, and experience of safety precautions on similar works and who shall advise on all matters affecting the safety of workmen and on measures to be taken to promote such safety and shall be the first point of contact for the Engineer regarding all health, safety and welfare issues.
- (e) the provision and maintenance of access to all places on the Site in a condition that is safe and without risk of injury.
- (f) the provision of adequate waterborne sanitation, refuse collection and disposal, complying with laws and regulations and to the satisfaction of the Engineer, for all houses, offices, workshops and laboratories erected on the camp site or sites.
- (g) the provision of an adequate number of suitable portable toilets and other sanitary arrangements at sites where work is in progress to the satisfaction of the Medical Officer in the area.
- (h) the execution of appropriate measures in consultation with the appropriate Public Health Authority to control within the Site, including the camp sites, mosquitoes, flies and pests including the application of suitable chemicals to breeding areas.

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- (i) reporting details of any accident to the Engineer and the Police, if appropriate, as soon as possible after its occurrence.

The Contractor shall appoint one responsible member of his staff to act full-time as Safety Officer, and he shall notify the Engineer of such appointment. The Safety Officer shall be experienced in all matters relating to health and safety on Sites and shall be familiar with all relevant safety rules, regulations and legislation. The Safety Officer shall have the power to receive instructions from the Engineer on matters relating to the health and safety of personnel on Site and the safe conduct of site operations.

COVID-19 Prevention Measures

The Contractor shall follow national laws and regulations, as well as occupational and public health, safety and security standards in the event of pandemic outbreak. The Contractor shall ensure that the workplaces, machinery, equipment and processes under their control are safe and without risk to health.

128 INFORMATION FROM EXISTING EXPLANATORY BORING AND TEST PITS

Any information made available by the Engineer to prospective bidders, including the Engineer's report on materials, shall be deemed not to form part of the Contract and only for information purposes. The Contractor shall be held solely responsible for any conclusions that he may reach from any information concerning exploratory borings, test pits and other investigations that have been made by the Engineer on the Site of the Works.

The Engineer may adjust foundation levels and other levels for construction below ground level, in the light of information that becomes available as general excavation proceeds upon the Site.

The Contractor's attention is drawn to his obligations in respect of the inspection and examination of the Site as detailed in the Conditions of Contract.

129 LIAISON WITH GOVERNMENT BODIES

The Contractor shall consult with officials of the local Governments, railway, police and other Government bodies pertaining to the control of traffic and other matters concerning the execution of the Works and shall provide all assistance or facilities that may be required by such officials in the execution of their duties in these respects.

130 PROGRESS PHOTOGRAPHS

Digital coloured photographs showing the progress of the works shall be taken by the Contractor every month. Photographs shall not be less than five megapixels and shall be inscribed with the location, date when taken and a brief description or title. Each set shall be submitted on a CD and two A4 size hard copies.

131 CONTRACTOR'S OFFICE, STORER AND WORKSHOPS

The Contractor shall provide and maintain on approved sites suitable offices, sufficient stores, tanks and workshops for the proper storage of materials, fuel, potable water, plant and equipment. The stores shall be of such size and construction that they provide adequate storage and protection of stocks of materials, fuel, spares, etc. in quantities ensuring uninterrupted progress of the works, and the workshops shall be suitably

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equipped to provide for carrying out major repairs, overhaul or modification by the Contractor of all plant and equipment in or on the works.

The Contractor shall be responsible for the water supply, electricity supply, telephone, sanitary and all other services necessary for constructional and domestic purposes for the duration of the Contract. He shall make all necessary arrangements with the authorities or persons for such electricity supply, telephone and shall make his own arrangements for water supply and sanitary services.

132 MEASUREMENT AND PAYMENT

No separate payment will be made for the work covered by this section and all costs incurred by the Contractor will be deemed to be covered by rates tendered for other work, except where explicit a pay item is stated in the Bill of Quantities.

(a) Contractor's Mobilisation and Demobilisation

Unit: lump sum

This item shall consist of preparatory works and operations, including but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the Project site; for the establishment of all Contractor's offices and buildings or other facilities necessary for work on the project, including removal after completion of the works.

The item for Contractor's mobilisation and site installations shall also include for:

- permits and licences;
- preparing, amending as necessary, and submitting to the Engineer and other interested bodies for approval, details of and drawings showing proposals and programme, including necessary liaison.

The removal of Contractor's site installation, equipment, shelters, facilities and clearing of the area used on completion shall include:

- de-commissioning, loading, transportation, unloading and mothballing of all plant, false work, camp buildings excess materials and equipment;
- removal of all rubbish, surplus materials, discarded materials, temporary structures, equipment, and debris;
- removal of all unneeded, oversized rock left from grading, surfacing, or paving;
- removal of all measures to maintain traffic flows during construction;
- removal of project signboards;
- dismantling and removal from site of all equipment, facilities and instruments for environmental mitigation and monitoring measures during construction; and
- restoration of sites to a condition at least equal to that which existed at the time the works were started.

Payment for Contractor's mobilisation and site installation shall be made in the following way:

- 80% on a pro rata basis according to progress of mobilization and site installations;
- 20% after the Contractor has removed its site installation, equipment, etc. from the site, and has cleared the site following completion of the works.

(b) Project signboard

Unit: number

The unit measurement for project signboards shall be the number instructed and completely installed.

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The items for project signboard shall include for provision and installation of signboards and their cleaning and maintenance.

- (c) Preparation of Detailed Design and Working Drawings
Unit: lump sum

Payment for this item will be made in installments agreed with the Engineer and approved by the Employer for the preparation of detailed designs and working drawings subject to the approval by the Engineer.

The item shall include for:

- required field works, incl. topographical and geotechnical survey and testing;
- preparation of detailed design, calculations, drawings and reports;
- submission to the Engineer and incorporation of changes required by the Engineer;
- obtaining state expertise approval, if required.

- (d) Preparation of Environmental Impact Assessment
Unit: lump sum

Payment for this item will be made in installments agreed with the Engineer and approved by the Employer for the preparation of environmental impact assessment in accordance with the Mongolian law and regulation, subject to the approval by the Engineer.

The item shall include for:

- required surveys and investigations;
- preparation of environmental impact assessment incl. environmental mitigation plan;
- submission to the Engineer and incorporation of changes required by the Engineer and Employer;
- obtaining environmental permit.

- (e) Provision and Servicing of Field Testing Laboratory
Unit: month

The measurement of for provision and maintenance of field laboratory including laboratory equipment shall be each month or part thereof during which is provided. Measurement shall commence upon establishment of a functioning laboratory or laboratories to the Engineer's satisfaction that can undertake the full scope of testing required for the current stage of construction and shall cease at the Date of Completion. During the period of measurement all calendar months including winter shutdown months shall be measured for payment.

The item for field laboratory shall include the cost of providing the laboratory premises and electricity, water, sewage system, and air conditioning in accordance with the requirements of Section 100 of these Technical Specifications, together with laboratory equipment and shall include:

- Erection/rental of the buildings and fixtures complete with all utility services, hard standings, access roads, footways, perimeter fencing, security lighting, landscaping, and all ancillary works;
- specified furniture and equipment;

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- the provision and maintenance of any temporary building, services, and supplies until the permanent facilities are available;
- dismantling and removal
- heating, sanitation, power, lighting and water;
- depreciation and maintenance of buildings, services, fences, notice and direction boards, vehicle access, parking areas, hardstandings and footpaths;
- depreciation, maintenance and replacement of equipment, furnishings, fittings and supplies;
- cleaning;
- replenishment of consumable stores;
- repairing, replacing, calibration of equipment;.
- disposal of waste;
- security for the offices, laboratory, equipment and supplies.

(f) Provision and Servicing of Engineer's Site Office

Unit: month

The measurement of provision and servicing of the Engineer's site office shall be each month or part thereof during which service is provided. Measurement shall commence upon establishment of a functioning office or offices to the Engineer's satisfaction, and shall cease at the Date of Completion. During the period of measurement all calendar months including winter shutdown months shall be measured for payment.

The item shall include the cost of providing the workplace in accordance with the requirements of Section 100 of this technical specifications and the cost of providing and using electricity, air conditioning, water, sewage system, communication equipment such as telephone, fax, etc. and shall include for:

- rental and leasing of Engineer's office;
- heating, sanitation, power, lighting and water;
- depreciation and maintenance of buildings, services, fences, notice and direction boards, vehicle access, parking areas, hardstandings and footpaths;
- depreciation, maintenance and replacement of equipment, furnishings, fittings and supplies;
- cleaning;
- replenishment of consumable stores;
- repairing, replacing, calibration of equipment;.
- disposal of waste;

(g) Provision and Servicing of Engineer's Accommodation

Unit: month

The unit of measurement for provision and accommodation for the Engineers shall be each month or part thereof during which vehicles are provided and maintained. Measurement shall commence upon establishment of a functioning office or offices to the Engineer's satisfaction, and shall cease at the Date of Completion. During the period of measurement all calendar months including winter shutdown months shall be measured for payment

The item for accommodation shall include for provision and maintenance, furniture, necessary tools, equipment, water and sewage systems, light and electricity, air conditioning and central heating systems.

The item for accommodation for the Engineer shall include for:

- Construction, rental or leasing;

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- heating, sanitation, power, lighting and water;
- depreciation and maintenance of buildings, services, fences, notice and direction boards, vehicle access, parking areas, hardstandings and footpaths;
- depreciation, maintenance and replacement of equipment, furnishings, fittings and supplies;
- cleaning accommodation;
- moving and re-establishing portable accommodation as required;
- replenishment of consumable stores;
- repairing, replacing, calibration of equipment;
- disposal of waste.

(h) Vehicles for the Engineer and Employer

Unit: lump sum

The full contract amount shall be paid when the vehicles have been delivered, fully licensed and insured to the satisfaction of the Engineer;

The item shall include for:

- purchase of approved new vehicles;
- delivery in proper working order;
- collecting of the vehicle when no longer required.

(i) Operation and Maintenance of Vehicles for the Engineer

Unit: month

The measurement for supply and maintenance for the vehicles for the Engineer shall be each month or part thereof during which vehicles are provided and maintained.

The item shall include for:

- purchase of an approved new vehicle;
- delivery in proper working order;
- taxing for use on public roads;
- comprehensive insurance, tax;
- suitable replacement including equipment when the regular vehicle is unavailable or unserviceable;
- maintaining in a roadworthy condition and in conformity with the vehicle manufacturer's recommendations;
- fuel, oil and other consumable items;
- keeping clean inside and out;
- driver.

(j) HIV/AIDS and human trafficking awareness training

Unit: provisional sum

Payments for this item shall be made following acceptance of training plans and delivered training. Payments shall be made in one or more instalments during the course of the Contract on an appropriate basis determined by the Engineer.

(k) Design and construction of tollgate, toll building and weigh station

Unit: provisional sum

Subject to the Engineer's prior instructions, design and construction of tollgate, toll building and weigh station shall be paid at rates to be agreed with the Engineer and approved by the Employer.

The item shall include for:

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- preparation of detailed design, design calculations, drawings and reports;
- submission to the Engineer and incorporation of changes required by the Engineer;
- construction of tollgate and toll building;
- provision and installation of weigh bridges and ancillary facilities;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(l) Relocation of utilities

Unit: provisional sum

Subject to the Engineer's prior instructions, the permanent diversion or alternation of existing services that are affected by the Works shall be paid at rates to be agreed with the Engineer and approved by the Employer.

The cost of diversions, temporary or permanent, which are carried out for the Contractor's convenience or to suit the Contractor's methods of working will not be reimbursed.

(m) Design and construction of bus stops and shelters

Unit: provisional sum

Subject to the Engineer's prior instructions, design and construction of bus stops and shelters shall be paid at rates to be agreed with the Engineer and approved by the Employer.

The item shall include for:

- preparation of detailed design, design calculations, drawings and reports;
- submission to the Engineer and incorporation of changes required by the Engineer;
- construction of bus stops and shelters;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(n) Design and construction of additional facilities at rest areas

Unit: provisional sum

Subject to the Engineer's prior instructions, design and construction of additional facilities shall be paid at rates to be agreed with the Engineer and approved by the Employer.

The item shall include for:

- preparation of detailed design, design calculations, drawings and reports;
- submission to the Engineer and incorporation of changes required by the Engineer;
- construction of additional facilities at rest areas;
- provision and installation of ancillary facilities;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(o) Geotechnical investigations due to unexpected discovered soil conditions

Unit: provisional sum

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The item shall include for:

- additional required site investigations, surveys, tests and reports;
- laboratory testing
- verification of designs;
- provision of data, and drawings;
- provision of all required material, labour, equipment, supervision, to carry out geotechnical investigations including, storage and handling of samples,

Subject to the Engineer's prior instructions, additional geotechnical investigations shall be paid at rates to be agreed with the Engineer and approved by the Employer.

(p) Protection of historical and archeological sites

Unit: lump sum

Payments shall be made in one or more instalments during the course of the Contract on an appropriate basis determined by the Engineer.

The item for protection of historical and archeological sites shall include for:

- liaison with relevant government agencies and stakeholders in establishing the position of existing historical and archeological sites including the excavation of trial pits and the use of automatic detective devices;
- complying with local statutes and regulations and the requirements working adjacent to historical and archeological sites;
- protection measures for all historical and archeological sites from damage resulting from the work;
- restoring and leaving historical and archeological sites in a safe and permanent condition on completion of the works adjacent to such sites.

(q) Design and construction of animal crossings

Unit: provisional sum

Subject to the Engineer's prior instructions, design and construction of animal crossings shall be paid at rates to be agreed with the Engineer and approved by the Employer.

The item shall include for:

- preparation of detailed design, design calculations, drawings and reports;
- submission to the Engineer and incorporation of changes required by the Engineer;
- construction of animal crossings;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

SECTION 200 - MATERIALS AND TESTING OF MATERIALS

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200 LIST OF STANDARDS, SPECIFICATIONS AND OTHER PUBLICATION REFERRED

The latest amendments or editions approved by the Mongolian State administrative body in charge of standardization and technical regulations of the following Standards, Specifications and other publications are referred to in, and are to be read in conjunction with, this part of this Technical Specifications:

Name of Standard	Number of Standard
Weighty Concrete. Standard Specifications	MNS1228:1987
Standard Specifications for Concrete Mortar	MNS 1185:1998
Concrete Classification and General Specifications	MNS IEC3173:2002
Concrete and Reinforced Concrete Structures. Concrete Composition	MNS GOST 27006:2010
Roadway and Pavement Material Testing and Sampling, Requirements for Inspection Authority	MNS ASTM D666:2005
Chemical Admixtures for Concrete. Standard Specifications	MNS ASTM C494:2011
Standard Specifications for Air-Entraining Admixtures for Concrete	ASTM C260
Concrete Mixtures. Methods of Testing	MNS 1170-2009
Concrete and Concrete Structures. Concrete Strength Determination by its Composition	MNS 1272-99
Concrete and Reinforced Concrete Structures. Project Basic Regulations.	MNS 3176 -1981
Fiber-Reinforced Polymer Bar for Concrete Reinforcement. General Specifications	MNS GOST 31938 2015
Volume Mass of Concrete. Determination of Water Absorption and Transmission of Moisture and Porosity for Concrete	MNS 2122:1985
Standard Test Method for Frosting Resistance of Concrete	MNS 1918:1985
Standard Test Method for Making and Curing Concrete Test Specimens in the Laboratory	MNS AASHTO T126:2005
Construction Mortar. Methods for Testing	MNS 2120:1999
Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method	MNS ASTM C173:2005
Standard Test Method for Air Content of Freshly Mixed Concrete by The Pressure Method	MNS ASTM C231:2005
Standard Test Method for Temperature of Freshly Mixed Concrete	MNS ASTM C1064-2005
Concrete and Concrete Structures. Method Test for Concrete Strength	MNS 1920:1999
Standard Method of Obtaining Drilled Cores and Sawed Beams	MNS AASHTO 724:2003
Standard Test Method for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials	MNS AASHTO T260:2004
Standard Test Method for Slump of Hydraulic Cement Concrete	MNS ASTM C143-2005
Concrete and Reinforced Concrete Structures. Radioactive Method for Determination of Concrete Protective Covering Thickness, Reinforcement Dimensions and Locations	MNS GOST 17625:2010
Concrete and Reinforced Concrete Structures. Magnetic Method for Determination of Concrete Protective Covering Thickness, Reinforcement Dimensions and Locations	MNS GOST 22904:2010
Precast Reinforced Concrete Structures and Elements. Loading Test Methods. Assessment of Strength, Rigidity and Crack.	MNS 2370:2003

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Name of Standard	Number of Standard
Standard Method of Test for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete	MNS AASHTO T155:2004
Concrete Determination of Strength by Mechanical Methods of nondestructive testing.	MNS 5581:2005
Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete	MNS ASTM C138:2005
Concrete and Concrete Structures. Sulfate Content in Concrete Aggregates. Testing Methods	MNS 4982:2000
Radioisotopes Method for Determination of Volume Mass for Weighty and Lightweight Concrete	MNS 2791:1979
Formworks for Concrete and Reinforced Concrete Structures, Its Classifications and General Specifications.	MNS IEC 3173:2002
Weighty Concrete. Method for Determination of Strength by Reflection and Elasticity	MNS 3323:1991
Weighty Concrete. Method for Determination of Strength by Cashkirov's Hammer.	MNS 4113:1991
Standard Method of Test for Rapid Identification of Alkali-Silica Reaction Products in Concrete	MNS AASHTO 299:2005
Method for Determination of Strength of Concrete by Ultrasonic Methods	MNS 4114:1991
Method for Determination of Strength by Sound Short Proofing for The Weighty and Lightweight Concrete	MNS 2794:1979
Cements. General Specifications	MNS 3091:2008
Portland cement. General Specifications	MNS 0974: 2008
Standard Method of Test for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency	MNS AASHTO T162:2003
Standard Method of Test for Evaluation by Freezing and Thawing of Air Entraining Additions to Hydraulic Cement	MNS AASHTO 188:2011
Standard Method of Test for Fineness of Hydraulic Cement	MNS AASHTO T128:2003
Standard Method of Test for Compressive Strength of Hydraulic Cement Mortar (Using 50-Mm Cube Specimens)	MNS AASHTO T106:2012
Standard Method of Test for Time of Setting of Hydraulic Cement by Vicat Needle	MNS AASHTO T131:2003
Cements. Method of Test Using Multiple Particles Standard Sand	MNS 976:2008
Standard Method of Test for concrete samples. Standard Specifications	MNS 2930:2008
Standard Method of Test for Time of Setting of Hydraulic Cement Paste by Gillmore Needles	MNS AASHTO T154:2003
Standard Method of Test, Chemical Analysis. This standard applies for Portland Cements with/without admixtures, and usage of these cements including, mortars and gravel mixing.	MNS 0975:2002
Standard Specifications for Constriction Gravel and Aggregates	MNS 390:1998
Standard Specifications for Binding Material of Weighty Concrete.	MNS 2803:2004
Construction Aggregates (gravel and crushed stone). General Specifications.	MNS 0346:2000
Mountainous Stone, Aggregates for Road Construction. Methods for Testing.	MNS 2998 (2009)
Standard Specification for Sizes of Aggregate for Highway and Bridge Construction	MNS AASHTO M43:2002
Standard Test Method for rapidly determining soundness of aggregates using sodium sulfate or magnesium sulfate.	MNS ASTM C88:2004
Standard Method of Test for Resistance to Degradation of Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine	MNS ASTM C535:2003

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Name of Standard	Number of Standard
Standard Method of Test for Bulk Density ("Unit Weight") and Voids in Aggregate	MNS AASHTO T19:2003
Standard Method of Test to Determine Lightweight Particles in Aggregate	MNS AASHTO T113:2004
Standard Method of Test to Determine Clay Particles in Aggregate	MNS AASHTO T112:2004
Standard Test Method by washing to Determine aggregate particles smaller than 0.075 mm.	MNS ASTM C117:2004
Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates	MNS AASHTO T27:2003
Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine	MNS ASTM C131:2007
Testing aggregates. Method for determination of aggregate impact value (AIV)	MNS BS 812112:2008
Testing aggregates. Methods for determination of particle shape. Elongation index of coarse aggregate	MNS BS 812 Хэсэг105.2:2003
Testing aggregates. Methods for determination of particle shape. Flakiness index	MNS BS 812 Хэсэг 105.1:2003
Sand for Construction. General Specifications	MNS 0392:2014
Particle-Size Analysis and Determination of Soil Constants	MNS ASTM D421:02
Sand for Construction. Test Methods	MNS 2916-2014
Method to Determine Organic Matter in Fine Aggregates of Concrete	MNS AASHTO T21:2004
Water to be used concrete. Standard Specifications	ГОСТ 23732-2011
Quality of Water to be used in Concrete	MNS AASHTO T26:2005
Water quality. Examination and determination of color	MNS ISO 7887:2000
Water quality. Determination of pH	MNS ISO 105232:2003
Water quality. Determination of the sum of calcium and magnesium - EDTA titrimetric method	MNS ISO 6059:2005
Water quality. Determination of chloride - Silver nitrate titration with chromate indicator (Mohr's method)	MNS ISO 9297:2005
Water quality. Determination of nitrate - Part 3: Spectrometric method using sulfosalicylic acid	MNS ISO 7890:2001
Drinking Water. Determination of nitric content	MNS ISO 4431:2005
Drinking Water. Determination of iron content	MNS ISO 4430:2005
Water quality. Determination of phosphorus - Ammonium molybdate spectrometric method	MNS ISO 6878:2001
Water quality. Rapid Determination of sulfate ion content	MNS ISO 6271:2010
Water quality. Method to determine Fluorine Ion in drinking water	MNS ISO 6272:2001
Drinking water. Method to Determine Dry Particles.	MNS ISO 4423:1997
Cement for Transport Construction. Specifications	ГОСТ P 55224-2012
Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)	ASTM C289
Standard Test Method for Shrinkage Factors of Soils by the Wax Method	ASTM D4943-08
Methods for determination of frost resistance in concrete	ГОСТ 10060-2012
Testing fresh concrete. Flow table test	BS EN 12350 Part 5
Testing concrete. Method for determination of compacting factor	BS 1881: Part 103
Concrete. Determination of strength by mechanical methods of nondestructive testing	ГОСТ 22690-2015
Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, By Nuclear Methods	ASTM C1040
Standard Test Method for Compressive Strength of Hydraulic Cement Mortars	ASTM C109

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Name of Standard	Number of Standard
Standard Method of Test for Sampling and Amount of Testing of Hydraulic Cement	AASHTO T 127-04
Standard Method of Test for Air Content of Cement Mortar	AASHTO T 137-04
Standard Method of Test for Sampling Freshly Mixed Concrete	AASHTO T 141-01
Cements. Methods of Tests Consistency, Times of Setting and of Soundness	ГОСТ310.3-76
Rapid Determination Method of Cement Frost Resistance	MI 2486
Methods of physical tests for hydraulic cement, Part 3: Determination of soundness	IS:4031 (Part 3):1988
Standard Specification for Flow Table for Use in Tests of Hydraulic Cement	ASTM C230 / C230M - 14
Standard Test Methods for Fineness of Hydraulic Cement by Air-Permeability Apparatus	ASTM C204
Standard Test Method for Autoclave Expansion of Hydraulic Cement	ASTM C151 / C151M - 15
Cement strength	BS 4450
Standard Test Method for Measuring Stiffness and Apparent Modulus of Soil and Soil-Aggregate In-Place by Electro-Mechanical Method	ASTM D6758-08
Standard Test Method for Measurement of vehicular to traveled surface roughness	MNS ASTM E1082 (2007)
Standard Test Method for Measuring Road Roughness by Static Level Method	MNS ASTM 1364 (2009)
Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports	MNS ASTM 2940 (2009)
Cements. General specification	MNS 3091 (2008)
Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	MNS ASTM C39/C39M (2007)
Mountainous stone, gravel to be used for road construction. Methods to determine physical and mechanical characteristics	MNS 2998 (2009)
Testing aggregates. Methods for determination of ten per cent fines value (TFV)	MNS BS 812-111 (2010)
Standard Specification for Fly Ash and Other Pozzolans for Use with Lime for Soil Stabilization	MNS ASTM C 593 (2010)
Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate	MNS AASHTO T84-00
Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate	MNS AASHTO T85-91 (2000)
Standard Method of Test for Particle Size Analysis of Soils	MNS AASHTO T88-00
Standard Method of Test for Resistance to Degradation of Fine Aggregate by Abrasion in the Los Angeles Machine	MNS AASHTO T96-02
Soil Sample, Packing, Transporting and Stockpile	MNS 2305-94
Standard Practice for Wet Preparation of Disturbed Soil Samples for Test	AASHTO T146-96 (2000)
Standard Method of Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar	AASHTO T87-2000
Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses	MNS ASTM1241:2002
Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils	MNS ASTM D4318
Standard Method of Test for Specific Gravity of Soils	MNS AASHTO T100-03
Standard Method of Test for Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester	AASHTO T217-02
Standard Method of Test for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency Tester	MNS AASHTO T162-04
Standard Specifications for Transportation Materials Methods of Sampling and Testing Part 1A & 1B Specifications	AASHTO-04
Standard Specifications for Transportation Materials and Methods of Sampling and Testing Part 2A & 2B Tests	AASHTO-04

Specifications, Volume2, CW2, Construction of a new asphalt paved road for the section from Uliastai - Tsagaankhairkhan on a new alignment (40km)

Name of Standard	Number of Standard
Standard Specification for Highway Bridges	AASHTO-04
Fine Aggregate for Portland Cement Concrete	AASHTO M6-03
Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement	AASHTO M31M-03
Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)	AASHTO M33-99 (2003)
Coarse Aggregate for Portland Cement Concrete	AASHTO M80 -87 (2003)
Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes	AASHTO M145- (2004)
Liquid Membrane-Forming Compounds for Curing Concrete	AASHTO M148-01
Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction	AASHTO M153-98 (2002)
Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints	ASTM D5249 - 10 /2016/
Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements	ASTM D6690-15
Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete Pavements	ASTM D 7116-16
Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements	ASTM D 2628-91
Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)	ASTM D 994/D994M 11
Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)	ASTM D 1751-04
Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction	ASTM D 1752-04a
Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material	ASTM C 509-06
Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements	ASTM D3405
Standard Specification for Concrete Joint Sealer, Hot-Applied Elastic Type	ASTM D1190
Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements	ASTM D3405 Mod
Standard Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements	ASTM D3406
Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements	ASTM D2835
Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)	ASTM D1751
Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)	ASTM D994
Air-Entraining Admixtures for Concrete	AASHTO M154-00
Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures	AASHTO M157-97 (2001)
General Requirements for Steel, Plates, Shapes, Sheet Piling, and Bars for Structural Use	AASHTO M160-04
Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)	AASHTO M170M-04
Sheet Materials for Curing Concrete	AASHTO M171-00
Standard Test Method for Water Loss Through Liquid Membrane-Forming Curing Compounds for Concrete	ASTM C 156

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Name of Standard	Number of Standard
Standard Test Method for Determining Relative Humidity	ASTM F2170
Guide to Concrete Curing	ACI 308R-01
Hot Weather Concreting	ACI 305R-91
Cold Weather Concreting	ACI 306R-88
Corrugated Sheet Steel Beams for Highway Guardrail	AASHTO M180-00
Chemical Admixtures for Concrete	AASHTO M194-00
Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)	AASHTO M213-01
Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement	AASHTO M221M-03
Steel Wire, Deformed, for Concrete Reinforcement	AASHTO M225M-03
Blended Hydraulic Cement	AASHTO M240-04
Concrete Made by Volumetric Batching and Continuous Mixing	AASHTO M241-97 (2001)
Glass Beads Used in Traffic	AASHTO M247-02
White and Yellow Reflective Thermoplastic Striping Material (Solid Form)	AASHTO M249-98 (2003)
Retroreflective Sheeting for Traffic Control	AASHTO M268-03
Anti-glare systems for roads. Part 1: Performance and characteristics	BS EN 12676-1: 2000
Anti-glare systems for roads. Part 2: Test methods	BS EN 12676-2: 2000
Recommended Procedures for the Safety Performance Evaluation of Highway Features	NCHRP 350
Road marking materials. Retroreflecting road studs. Road test performance specifications	BS EN 1463-2:2000
Plain and Laminated Elastomeric Bearings	AASHTO M251-04
Carbon and High-Strength Low-Alloy Structural Steel Shapes, Plates, and Bars and Quenched-and-Tempered Alloy Structural Steel Plates for Bridges	AASHTO M270-04
Zinc-Coated (Galvanized) Steel Barbed Wire	AASHTO M280-03
Preformed Polychloroprene Elastomeric Joint Seals for Bridges	AASHTO M297-98 (2002)
Inorganic Zinc-Rich Primer	AASHTO M300-03
Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars	AASHTO M302-00
Selection and Use of Emulsified Asphalts	AASHTO R5-03
Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	AASHTO T24-04
Slump Test of Hydraulic Cement Concrete	AASHTO T119-99
Weight Per Cubic Foot (or Cubic Meter), Yield and Air Content (Gravimetric) of Concrete	AASHTO T121-97 (2001)
Sampling and Amount of Testing of Hydraulic Cement	AASHTO T127-04
Air Content of Hydraulic Cement Mortar	AASHTO T137-04
Sampling Freshly Mixed Concrete	AASHTO T141-01
Air Content of Freshly Mixed Concrete by the Pressure -Method	AASHTO T152-01
Air-Entraining Admixtures for Concrete	AASHTO T157-00
Bleeding of Concrete	AASHTO T158-01
Length Change of Hardened, Hydraulic Cement Mortar and Concrete	AASHTO T160-97 (2001)
Resistance to Concrete to Rapid Freezing and Thawing	AASHTO T161-00
Plastic Fines in Graded Aggregates and Soils by use of the sand Equivalent Test	AASHTO T157-00
Evaluation by Freezing and Thawing of Air-Entraining Additions to Portland Cement	AASHTO T158-01
Density of Soil In-Place by the Sand Cone Method	AASHTO T160-97 (2001)
Air Content of Freshly Mixed Concrete by the Volumetric Method	AASHTO T161-00

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Name of Standard	Number of Standard
Time of Setting of Concrete Mixtures by Penetration Resistance	AASHTO T176-02
Unit Weight and Voids in Aggregate	AASHTO T188-75 (1999)
Density of Soil and Soil-Aggregate in Place by Nuclear Methods	AASHTO T191-02
Test Method for Potential Alkali Reactivity of Cement Aggregate Combinations (Mortar-bar Method)	AASHTO T196-96
Test Method for Potential Reactivity of Aggregates (Chemical Method)	AASHTO T197-00
Residue of Specified Penetration	ASTM C 29-97
Cement Lime Gypsum	AASHTO T238/239
Concrete and Aggregates	ASTM C 227-97
Road and Paving Materials	ASTM C 289-02
Roofing, Waterproofing and Bituminous Materials	ASTM D 243-02
Natural Building Stones, Soils and Rock	ASTM Боть 04.01
BS Colours for Identification, Coding and Special Purposes	ASTM Боть 04.02
Aggregate Flakiness Index, Elongation Index,	ASTM Боть 04.03
Chloride Content of Fine Aggregates	ASTM Боть 04.04
Road Traffic Signs and Internally Illuminated Bollards	ASTM Боть 04.05
Defining density-moisture of a soil by dropping 4.54 kg hammer from 457 mm height	BS 381
Methods of Sampling Fresh Concrete	BS 812
Methods of Testing Fresh Concrete	BS 812
Methods of Making and Curing Test Specimens	BS 873
Methods of Testing Concrete for Strength	MNS ASTM D 1557:2002
Cold Reduced Steel Wire for the Reinforcement of Concrete	BS 1881 хэсэг 1
Structural Carbon Steel Plate Specification	BS 1881 хэсэг 2
Standard Specification for Epoxy Coated Steel Reinforcing Bars	BS 1881 хэсэг 3
Welded steel wire and bar fabrics	BS 1881 хэсэг 4
Steel Fabric for the Reinforcement of Concrete	BS 4482
Steel Bars for Reinforcement of Concrete. Standard Specifications	MNS JIS 3112:2002
British Standard Code of Practice for the Use of Explosives	ASTM A775
Building Code Requirement for Reinforced Concrete	JIS G3551:2005
Recommended Practice for Concrete Formwork	BS 4483
British Standard Code of Practice for the Use of Explosives	BS 5607
Building Code Requirement for Reinforced Concrete	ACI 318
Recommended Practice for Concrete Formwork	ACI 347
Standard for Structural Welding for Reinforcement	AWS D1.4
Technical specifications for the bitumen emulsion activated with the application	MNS AASHTO M208-2002
Standard Specification for Emulsified Asphalt	MNS ASTM D 977:2004
Standard Practice for Selection and Use of Emulsified Asphalts	MNS ASTM D3628:2004
Standard Test Methods and Practices for Emulsified Asphalts	MNS ASTM D 244:2004
Mineral powders used in the asphalt concrete mix. Technical requirements	MNS 4904-1 (2000)
Specification for mineral-bitumen mixture (hot, warm, cold) for road and	MNS 2185 (2002)
Aerodrome Pavement Test method. Mineral filler for asphalt mix	MNS 2795 (2002)
Determination of binding by Marshal test method	MNS ASTM R12 (2002)
Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures	MNS AASHTO T209 (2002)
Determination of bituminous binding features with gravel and stone	MNS AASHTO T182 (2002)
Specification for road cutback bitumen	MNS 5230 (2002)
Obtaining and Testing Drilled Cores and Sawed Beams of Concrete	MNS AASHTO T24 (2003)
Spot Test of Asphalt Materials	MNS AASHTO T102

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Name of Standard	Number of Standard
	(2003)
Asphalt Mixture	MNS AASHTO T195 (2003)
Air Content of Concrete Mixture by Volumetric Method	MNS AASHTO T196 (2003)
Sampling from the pavement prepared with the method of mixing	MNS ASTM D979 (2003)
Manufactured Asphalt mixture sampling	MNS AASHTO T468 (2003)
Defining the bitumen value in the asphalt concrete mix with the atomic method	MNS ASTM D4125 (2004)
Defining the average density of asphalt concrete mix sample by covering with	MNS AASHTO T275 (2004)
Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated	MNS AASHTO T166 (2004)
Surface Percent Air Voids in Compacted Dense -Dry Specimens and Open Bituminous Paving Mixtures	MNS AASHTO T269 (2004)
Method of defining the water resisting property of the compacted asphalt-	MNS AASHTO T283 (2004)
Concrete mix specifications for cold asphalt concrete mix	MNS ASTM D4215 (2004)
Standard Method of Test for Pavement Deflection Measurements	MNS AASHTO T256 (2004)
Surface Texture Depth by Sand Patch Method	MNS ASTM E965 (2004)
Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	MNS AASHTO T245 (2004)
Asphalt concrete plant standard specifications	MNS AASHTO D290 (2004)
Defining the bitumen value of the bitumen mix of the pavement	MNS ASTM D2172 (2004)
Method of defining the volume of the bitumen sprayed by the bitumen sprayer.	MNS ASTM D2995 (2005)
Technical specifications Method of defining the distribution of the rock debris in the surface layer	MNS ASTM D5624 (2005)
Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device	MNS ASTM D4694 (2005)
Standard Test Method for Loss on Heating of Oil and Asphaltic Compounds	MNS ASTM D6 (2006)
Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer	MNS ASTM D2171 (2006)
Standard Test Method for Measurement of Vehicular Response to Traveled Surface Roughness	MNS ASTM E1082 (2007)
Standard Test Method for Measuring Rut - Depth of Pavement Surfaces Using a Straight Edge	MNS ASTM E1703 (2007)
Standard Test Method for Water in Volatile Solvents (Karl Fischer Reagent Titration Method)	MNS ASTM 1364 (2009)
Testing aggregates. Method for determination of aggregate impact value (AIV)	MNS BS 812-112 (2008)
Standard Specification for Graded Aggregate Material for Bases, Subbases for Highways or Airports	MNS ASTM 2940 (2009)
Asphalt-concrete mix. Technical specifications	MNS 1592 (2009)
Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures	MNS ASTM D3515 (2009)
Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous	MNS ASTM D995 (2008)

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Name of Standard	Number of Standard
Paving Mixtures Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures	MNS ASTM D3203 (2007)
Method for random sampling of road, construction material	MNS ASTM 3665 (2010)
Specification for petroleum graded asphalt cement	MNS 6237 (2010)
Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures	MNS AASHTO T209-99 (2004)
Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	MNS AASHTO T245-97 (2001)
Standard Specifications for Transportation Materials Methods of Sampling and Testing Part 1A & 1B Specifications	AASHTO-04
Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis	ASTM D7928-17
Standard Practice for Description of Frozen Soils (Visual-Manual Procedure)	ASTM D4083-16

201 SCOPE OF SECTION

This Section covers specifications, tests and methods of testing that are required for the selection and control of the quality of materials and for control of workmanship, trials and construction control testing.

202 TESTING BY THE CONTRACTOR

The Site laboratories shall be operated under the direction and overall control of the Engineer and shall be used for carrying out contract-related testing by the Engineer or the Contractor or both jointly, with all testing resources including laboratory staff provided by the Contractor.

The Contractor shall provide competent staff (minimum 1 laboratory engineer, 2 laboratory technicians and 4 laboratory helpers for each site laboratory) and sufficient equipment for performing such sampling and tests as may be required for the selection and control of the quality of materials and for the control of workmanship in accordance with this Specification and the Contractor's Project QM System. The frequency of the Contractor's construction control testing shall be in accordance with the Project QM System. The Contractor shall carry out tests on all materials to be incorporated in the Works and on all finished work.

The Contractor shall carry out all tests required and shall provide copies to the Engineer of the results of such tests before submitting materials and finished work to the Engineer for approval. In appropriate circumstances and as required in this Specification, tests on industrially manufactured materials may be carried out at the place of manufacture and, in such cases, the Contractor shall furnish manufacturers' test data in its original form. If it is held by the Engineer that the test data provided by the manufacturer are inconsistent or otherwise unreliable, the Contractor shall arrange for the testing of manufactured materials at an independent test laboratory well equipped for carrying out the required tests, as instructed and approved by the Engineer. Manufactured materials for which the test data have not been accepted by the Engineer shall not be brought to site of work.

The Engineer shall be allowed unrestricted access to the Contractor's sampling operations, testing facilities, equipment, services of laboratory staff and records of test results. The Engineer shall have the rights to witness all tests and to instruct tests forming

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part of or supplementary to the Project QM System to be performed by the Contractor's laboratory staff, including the testing of manufactured products at their place of manufacture.

203 ACCEPTANCE STANDARDS OF MATERIALS

All materials used in or upon the Works shall comply with this Specification and shall be acceptable to the Engineer. Where so specified, the material shall comply with the Standard named or with an alternative Standard in accordance with the requirements. If a material has been specified by manufacturer's trade name, the product of another manufacturer will be acceptable provided that it is demonstrated by the Contractor and agreed by the Engineer to be in all respects of equivalent or higher quality than the named product and the Engineer's prior approval has been obtained.

Samples of all materials proposed for incorporation into the Works shall be submitted to the Engineer and shall, where required by the Project Quality Control Plan or otherwise instructed, be tested and the test results submitted to the Engineer for approval prior to the material being delivered in bulk to the Site.

If it is required in accordance with this Specification certain materials are to be tested at independent external testing laboratories, then the Contractor shall be liable for all costs arising therefrom, including, but not limited to:

- laboratory testing charges,
- provision of samples,
- transportation of samples from the Site to the testing laboratory and, if applicable, back to Site,
- attendance on laboratory personnel.

The Engineer shall be informed one week in advance of the program of testing at the independent laboratory and he shall be entitled to be present at the time and place of testing.

204 GENERAL REQUIREMENTS

(a) Standard Specifications and Methods of Testing

Unless otherwise instructed by the Engineer or indicated elsewhere in this Specification, all materials incorporated in the Works shall comply with "Standard Specifications for Transportation Materials and Methods of Sampling and Testing Part 1A & 1B Specifications, the American Association of State Highway and Transportation Officials (AASHTO). The methods of sampling and testing of materials incorporated in the Works shall be in accordance with Part 2A and 2B, Tests of the aforementioned AASHTO publication.

For tests required to be carried out according to these specifications but not included in AASHTO Test Methods or not indicated otherwise in this Specification, the provision of British Standard Specifications (or other similar internationally used Specifications, as directed or agreed to by the Engineer) shall apply.

(b) Sieves

ASTM E11 sieves shall be used for all tests. The sieve series in mm and μm (microns) is as follows:

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Coarse 100, 75, 63, 50, 37.5, 25.0, 19.0, 16.0, 13.2, 12.5, 9.5, 6.3, 4.75, 4.00 mm
 Fine 2.80, 2.36, 2.00, 1.70, 1.40, 1.18, 1.00 mm, 850, 600, 500, 425, 355, 300, 250, 212, 180, 150, 125,75, 63 μm

(C) Hydrometer

Equipment required to perform ASTM D7928 Hydrometer Analysis

205 SOIL AND GRAVEL

(a) Sampling and sample preparation

Sampling of soil and gravel and their sample preparation shall be carried out in accordance with the following requirements.

- (i) MNS AASHTO T87-86 (2000) - Preparation and analysis of dry samples of disturbed soil and soil rock
- (ii) MNS AASHTO T146-96 (2000) - Preparation of Disturbed Textured Soil Samples by Wet Method or Engineer's Guide

(b) Standard methods of analysis

Soil and gravel analysis shall be performed according to the standard methods given in Table 2-1.

The laboratory density analysis performed according to the standard method of MNS ASTM D 1557:2002 for determining the density-moisture ratio of soil using the method of dropping a 4.54 kg hammer from a height of 457 mm is defined as "MNS ASTM D 1557:2002". In the text of these specifications, if the term "MDD (MNS ASTM D 1557:2002) (Maximum dry density-MDD) is used, it means that the dry density of the compacted material is determined from the density analysis of MNS ASTM D 1557:2002 If the maximum dry density is x%, then the density standard is determined.

Table 2-1: Methods of Soil and Gravel Analysis

Description	Standard number
Standard practice for wet preparation of soil samples for particle analysis and determination of soil constants	ASTM D 2217:2002
Standard practice for soil samples for determination of soil constants	AASHTO T88-2004
Standard test methods for liquid limit, plastic limit and plasticity index of soil	ASTM D 4318:2002
Specific Gravity of Soils	AASHTO T100-2003
Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test	AASHTO T176- 02
Test method for laboratory compaction characteristics of soil using standard effort (600kH-m/m3)	ASTM D 698:2002
Test method for laboratory compaction characteristics of soil using standard effort (2700kH-m/m3)	ASTM D 1557:2002
Standard test method for density and unit weight of soil in place by the sand-cone method	ASTM D 1556:2002

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Description	Standard number
Test method for bearing ration of laboratory compacted soils (CBR)	ASTM D 1883:2002
Standard Test Method for In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge	ASTM D7830 / D7830M - 14
Standard Test Method for Shrinkage Factors of Soils by the Wax Method	ASTM D4943 – 08
Standard Test Method for Measuring Stiffness and Apparent Modulus of Soil and Soil-Aggregate In-Place by Electro-Mechanical Method	ASTM D6758-08
Moisture Content of Soil and Soil- Aggregate In Place by Nuclear Methods	AASHTO T238/239
Laboratory Determination of Moisture Content of Soils	AASHTO T265- 93 (2000)
Surface Moisture during compaction	AASHTO M 180:2004
Test method for organic soil by burn	AASHTOT 267-2004
Classification of Soils and Soil- Aggregate Mixtures for Highway Construction Purposes	AASHTO M145- 2004
Classification of soils for Consulting purposes (United classification system)	ASTM D 2487:2004
Test method for measuring durability of road bed and base by dynamic cone penetration	MNS 5678:2006

If, in the opinion of the Engineer, the compaction operations proposed by the Contractor do not alter the properties of the material during compaction, samples for compaction analysis per **MNS ASTM D 1557:2002** shall be taken prior to the appropriate period of compaction and if the properties of the material change during compaction, samples for analysis should be taken after all compaction has been completed.

A separate new sample is required for density testing of materials likely to crumble during compaction, and this sample is prepared to determine each point on the moisture/density curve.

The site density and moisture content of the soil used in the work and of suitable aggregates, if these are applicable and appropriate in the opinion of the engineer, are determined using nuclear methods, usually in accordance with AASHTO T310. AASHTO T191, Standard Method for In-Situ Sand Cone Density Analysis of Soils, is used to perform initial calibration of density core testing equipment and to conduct in-process inspection/comparison tests as directed by the Engineer.

Laboratory Compaction Tests Using a Tamper Hammer BS 1377 Test 14 as an alternative to AASHTO T180 Compaction Tests for crushed stone materials, non-fine gravel materials, and materials of appropriate particle size composition that may generally be crushed during compaction in accordance with AASHTO T180 tests, Engineer's Guide can be used according to The maximum dry density as defined herein can be derived from

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the appropriate test method. Where AASHTO T180 is mentioned as the test method or test criteria in these specifications, BS 1377 Test 14 may be used as an alternative.

206 STONE, STONE MATERIAL, SAND AND AGGREGATES

(a) Sampling and sample preparation

Sampling and sample preparation shall be performed in accordance with AASHTO T2 /Sampling of Stone Materials/.

(b) Standard methods of analysis

Tests for rock, stone materials, sand and aggregates shall be conducted in accordance with the standard test methods given in Table 2-2.

Table 2-2: Methods of Analysis for Rock, Gravel, Sand, and Aggregate Materials

Indicators	Testing methods
Determination of unit weight and porosity in gravel	MNS 2998:2009
Particle Size Analysis of Soils	AASHTO T88-00
Determining the Liquid Limit of Soils	AASHTO T89-02
Determining the Plastic Limit and Plasticity Index of Soils	AASHTO T90-00
Specific Gravity of Soils	AASHTO T100-03
The Moisture-Density Relations of Soils Using a 4.55 kg Rammer and a 457 mm Drop	AASHTO T176-02
Density Soil In-Place by the Sand-Cone Method	AASHTO T191-02
Analysis of fractions less than 75 µm in mineral material by washing method	MNS ASTM C 117:2004
Organic impurities in small-grained gravel	MNS 2998:2009
Determining the grain composition of fine and coarse gravel	MNS 2998:2009
Determination of specific gravity and water absorption of small-grained gravel	MNS 2998:2009
Determination of specific gravity and water absorption of coarse gravel	MNS 2998:2009
Determination of abrasion resistance of small coarse gravel by Los Angeles machine	MNS ASTM C 535:2003
Determine the strength of gravel using sodium sulfuric acid or magnesium sulfuric acid	MNS ASTM C 88:2004
Determine the index of gravel layering	BS 812
Determination of tensile index	BS 812
Determination of chloride content of fine gravel	BS 812
Moisture Content Determination (Laboratory)	AASHTO T265-93 (2000)
Moisture Content Determination (Field)	AASHTO T217-02

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In addition to the standard test methods detailed in Table 2-2, the following tests are included:

The minimum average size of gravel is determined as follows:

- (i) A sample of at least 200 gravels shall be taken from each fraction of the material to be analyzed and the sample shall be split with a riffler. Sift the sample through a sieve with holes equal to half the normal size of the gravel to be tested, and the particles that pass through the sieve are not used for analysis. Normal-sized gravel is determined by the percentage of at least 85% of the material passing through the smallest sieve.

The minimum size of each particle remaining on the 0.1 mm sieve is determined by measuring using a caliper with a plate of at least 5 mm diameter. Record the number of particles analyzed and the measurements. The sum of the minimum sizes of each particle is divided by the number of measured particles to determine the minimum average size.

- (ii) Test for quick determination of gravel chloride in the field (Quantab test).

The purpose of this testing is to analyze the chloride at the point of shipment by a rapid identification method so that measures can be taken to remove the contaminated cargo quickly.

207 PORTLAND CEMENT

Portland cement shall be sampled in accordance with AASHTO T127 Sampling and Amount of Testing of Hydraulic Cement, and shall comply with all the requirements of AASHTO M85, Portland Cement.

Tests on Portland cement for compliance with AASHTO M85 shall be performed by an independent testing laboratory or as instructed by the Engineer.

Testing in the Site laboratory shall be carried out in accordance with the Standard Methods of Test given in Table 2-3.

Table 2-3: Test Procedures Applicable to Portland Cement

Description	Test Procedure
Compressive Strength of Hydraulic Cement Mortar	AASHTO T106-04
Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency	AASHTO T162-04

208 CONCRETE

Sampling and testing of concrete shall be performed in accordance with the methods given in Table 2-4. It is further specified that the test specimens shall be cured at a temperature of 27 °C ± 2 °C. Water to be used in concrete shall be tested in accordance with AASHTO T26.

Table 2-4: Test procedures Applicable to Concrete

Description	Test Procedure
Potential Alkali Reactivity of Cement Aggregate Combinations	ASTM C227-97

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Slump of Hydraulic Cement Concrete	AASHTO T119-99
Weight Per Cubic Foot (or Cubic Metre), Yield and Air Content (Gravimetric) of Concrete	AASHTO T121-97 (2001)
Air Content of Hydraulic Cement Mortar	AASHTO T137-04
Sampling Freshly Mixed Concrete	AASHTO T141-01
Air-Entraining Admixtures for Concrete	AASHTO T157-00
Bleeding of Concrete	AASHTO T158-01
Resistance of Concrete to Rapid Freezing and Thawing	AASHTO T161-00
Evaluation by Freezing and Thawing of Air-Entraining Additions to Portland Cement	AASHTO T188-75 (1999)
Air Content of Freshly Mixed Concrete by the Volumetric Method	AASHTO T 196-96 (2000)
Methods of Sampling Fresh Concrete	BS 1881 хэсэг 1
Methods of Testing Fresh Concrete	BS 1881 хэсэг 2
Methods of Making and Curing Test Specimens	BS 1881 хэсэг 3
Methods of Testing Concrete for Strength	BS 1881 хэсэг 4

209 BITUMINOUS BINDERS

(i) Tests on straight-run bitumen

Testing of straight-run bitumen shall be performed as instructed by the Engineer in accordance with the methods (taking into account the latest updating as in 2002) as given in Table 2-5.

Table 2-5: Test Procedures Applicable to Straight-Run Bitumen

Description	Test Procedures
Solubility of Bituminous Materials	AASHTO T44-03
Flash and Fire Points by Cleveland Open Cup	AASHTO T48-04
Penetration of Bituminous Materials	AASHTO T49-03
Ductility of Bituminous Materials	AASHTO T51-00
Softening Point of Bitumen (Ring-and-Ball Apparatus)	AASHTO T53-96 (2000)
Water in Petroleum Products and Bituminous Materials by Distillation	AASHTO T55-02
Spot Test of Asphaltic Materials	AASHTO T102-83 (2000)
Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)	AASHTO T179-04
Kinematic Viscosity of Asphalts (Bitumen)	.AASHTO T201-03
Specific Gravity of Semi-Solid Bituminous Materials	AASHTO T202-03
Specific Gravity of Semi-Solid Bituminous Materials	AASHTO T228-04

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Determination of the Breaking Point of Solid of Semi-Solid Bitumen (Fraass method)	DIN 51011
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(ii) Tests on cutback bitumen

Testing of cutback bitumen shall be performed at an independent testing laboratory acceptable to the Engineer in accordance with the methods given in Table 2-6.

Table 2-6: Test Procedures Applicable to Cutback Bitumen

Description	Test Procedure
Residue of Specified Penetration	ASTM D 243-02
Solubility of Bituminous Materials	AASHTO T44-02
Flash and Fire Points by Cleveland Open Cup	AASHTO T48-04
Penetration of Bituminous Materials	AASHTO T49-03
Ductility of Bituminous Materials	AASHTO T51-00
Water in Petroleum Products and Bituminous Materials by Distillation	AASHTO T55-02
Distillation of Cut-Back Asphaltic (Bituminous) Products	AASHTO T78-96 (2000)
Flash Point with Tag Open-Cup Apparatus for Use with Materials Having a Flash Less than 93.3° C	AASHTO T79-96 (2000)
Spot Test of Asphaltic Materials	AASHTO T102-83 (2000)
Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)	AASHTO T179-04
Kinematic Viscosity of Asphalts (Bitumen)	AASHTO T201-03
Specific Gravity of Semi-Solid Bituminous Materials	AASHTO T228-04
Determination of the Breaking Point of Solid of Semi-Solid Bitumen (Fraass method)	DIN 51011

(iii) Tests on polymer modified bitumen

Testing of polymer modified bitumen shall be performed at an independent testing laboratory acceptable to the Engineer in accordance with the methods given in Table 2-7 and shall meet the requirements of AASHTO M 332-14.

Table 2-7: Test Procedures Applicable to Polymer Modified Bitumen

Property	Test method
Penetration of Bituminous Materials	AASHTO T49-03
Softening point	AASHTO T 53
Flash and Fire Points by Cleveland Open Cup	AASHTO T48-04
Solubility	AASHTO T 44
Accelerated Aging (PAV)	AASHTO R 28
Rolling Thin-Film Oven Residue	AASHTO T 240
Elastic Recovery	AASHTO T 301

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Creep Stiffness	AASHTO T 313
Direct tension	AASHTO T 314
Dynamic Shear	AASHTO T 315
Rotational Viscosity	AASHTO T 316
Multiple Stress Creep Recovery Test	AASHTO T 350

(a) Requirements for bituminous binder

(i) General

Before a consignment of bituminous binder is delivered to the Site, the Contactor shall provide the Engineer with a certificate from the manufacturer, along with a sample and relevant test reports, attesting that the material to be supplied complies in all respects with this Specifications. For this purpose each single delivery of 200 tonnes or under shall constitute a consignment. If a single delivery may exceed 200 tonnes, each 200 tonnes or part thereof shall be regarded as a separate consignment.

Any bituminous binder delivered in leaking or damaged containers shall be rejected.

(ii) Straight-run bitumen

Straight-run bitumen when used in asphalt concrete mixes shall be 130/200 penetration grade bitumen and shall comply with the requirements given in Table 2-8.

Table 2-8: Specification for 130/200 Penetration Grade Bitumen

Name of Test	Min	Max.
Penetration at 25°C, (100g, 5sec.), 0.1mm	130	200
Flash Point, Cleveland Open Cup, °C	210	-
Ductility at 25°C, 5cm/min., cm	100	-
Solubility in trichloroethylene, %	99	-
Loss on heating after Thin-Film Oven Test, %	-	0.5
Penetration of residue, percent of original	46	-
Frass breaking point, °C	-21	-
Softening Point (Ring and Ball)° C	35	45
Viscosity requirements	As indicated below	
Spot test with Standard Naphtha Solvent	Negative	
Water content	Nil	
Specific Gravity at 25°C	1.00-1.05	

The straight run 130/200 grade bitumen shall further meet the viscosity requirements indicated below according to the measured penetration of the test sample:

- If the penetration at 25°C is lower than 140, the absolute viscosity at 60°C shall be higher than 900 poises.
- If the penetration at 25°C is between 140 and 160, the absolute viscosity at 60°C shall be higher than 800 poises.
- If the penetration at 25°C is between 160 and 180, the absolute viscosity at 60°C shall be higher than 700 poises.
- If the penetration at 25°C is higher than 180 (180-200), the absolute viscosity

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at 60°C shall be higher than 600 poises.

Further, the bitumen shall be homogeneous, free from water and shall not foam when heated to 175°C.

To the extent straight-run bitumen other than 130/200 penetration grade described above is used for asphalt concrete mixes or in other bituminous work, such bitumen shall comply with the requirements of AASHTO M226 Specifications for viscosity graded asphalt cement.

(iii) Performance Grade (PG) Bitumen (polymer modified bitumen)

Performance grades of bitumen are named due to their level of hardness and consistency, which leads to the classification of bitumen in a range of grades from 30 to 120. Grading designations are related to the average seven-day maximum pavement design temperature and the minimum pavement design temperature. The designation of performance graded bitumen are in accordance with AASHTO M 320-10.

Performance grade bitumen when used in asphalt concrete mixes shall be PG 70-40 grade and shall comply with the requirements given in Table 2-9.

Table 2-9: Performance Specification for PG 70-40

Performance Grade	Unit	PG 70-40
Average 7-day max pavement design temperature ^a	°C	<70
Min Pavement Design Temperature ^a	°C	>-40
Original binder		
Flash point temp, AASHTO T 48, min °C	°C	230
Viscosity, AASHTO T 316: ^b max 3 Pa*s, test temp, °C	°C	135
Dynamic shear, AASHTO T 315: ^c G*/sin δ, ^d min 1.00 kPa test temp @ 10 rad/s, °C	°C	70
Rolling Thin-Film Oven Residue (T 240)		
Mass change, ^e max, percent	%	1.00
Dynamic shear, AASHTO T 315: G*/sin δ, ^d min 2.20 kPa test temp @ 10 rad/s	°C	70
Pressurized Aging Vessel Residue (R 28)		
PAV aging temperature ^f	°C	100 (110)
Dynamic shear, AASHTO T 315: G* sin δ, ^d max 5000 kPa test temp @ 10 rad/s	°C	19
Creep stiffness, AASHTO T 313: ^g S, max 300 MPa m-value, min 0.300 test temp @ 60 s	°C	-30
Direct tension, AASHTO T 314: ^g Failure strain, min 1.0% test temp @ 1.0 mm/min	°C	-30

Notes:

^a Pavement temperatures are estimated from air temperatures using an algorithm contained in the LTPP Bind program, may be provided by the

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- specifying agency, or by following the procedures as outlined in M 323 and R 35.
- b This requirement may be waived at the discretion of the specifying agency if the supplier warrants that the asphalt binder can be adequately pumped and mixed at temperatures that meet all applicable safety standards.
- c For quality control of unmodified asphalt binder production, measurement of the viscosity of the original asphalt binder may be used to supplement dynamic shear measurements of $G^*/\sin\delta$ at test temperatures where the asphalt is a Newtonian fluid.
- d $G^*/\sin\delta$ = high temperature stiffness and $G^* \sin\delta$ = intermediate temperature stiffness.
- e The mass change shall be less than 1.00 percent for either a positive (mass gain) or a negative (mass loss) change.
- f The PAV aging temperature is based on simulated climatic conditions and is one of three temperatures, 90°C, 100°C, or 110°C. Normally the PAV aging temperature is 100°C for PG 58-xx and above. However, in desert climates, the PAV aging temperature for PG 70-xx and above may be specified as 110°C.
- g If the creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

Bitumen shall be homogeneous, free from water and deleterious materials, and shall not foam when heated to 175°C. Bitumen shall be at least 99.0 percent soluble as determined by T 44 or ASTM D5546.

(iv) Cutback bitumen

Rapid-curing cutbacks shall comply with all the requirements of AASHTO Standard Specification M81 Cutback Asphalt (Rapid-Curing Type).

Medium-curing cutbacks shall comply with all the requirements of AASHTO Standard Specification M82 Cutback Asphalt (Medium-Curing Type).

210 BITUMINOUS MIXES

(a) Samples and sampling

Sampling of bituminous mixtures shall be carried out in accordance with AASHTO T168 Sampling Bituminous Paving Mixtures.

(b) Standard methods of testing

Testing of bituminous mixes shall be performed in accordance with the methods given in Table 2-8.

Table 2-8: Test Procedures Applicable to Bituminous Mixes

Description	Test Procedure
Mechanical Analysis of Extracted Aggregate	AASHTO T30-93 (2003)
Quantitative Extraction of Bitumen from Bituminous Paving Mixtures	AASHTO T164-01

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Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens	AASHTO T166-00
Sampling Bituminous Paving Mixtures	AASHTO T168-03
Maximum Specific Gravity of Bituminous Paving Mixtures	AASHTO T209-99 (2004)
Determining Degree of Pavement Compaction of Bituminous-Aggregate Mixtures	AASHTO T230-68 (2000)
Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus	AASHTO T245-97 (2001)
Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures	AASHTO T269-97 (2003)

211 REINFORCING STEEL

Steel for the reinforcement of concrete shall comply with either the AASHTO Standard Specifications or the British Standards set out in Table 2-9. The Contractor shall supply certified mill test reports for all reinforcement. Reinforcing steel shall be tested at an independent testing laboratory acceptable to the Engineer for compliance with and in accordance with the applicable specification.

Table 2-9: Specifications Applicable To Reinforcing Steel

Description	Specification Number
Deformed and Plain Billet-Steel for Concrete Reinforcement	AASHTO M 31M-03
Steel Welded Wire Fabric, Deformed for Concrete Reinforcement	AASHTO M 221M-03
Steel Wire, Deformed for Concrete Reinforcement	AASHTO M 225M-03
Carbon Steel Bars for the Reinforcement of Concrete	BS 4449
Steel Fabric for the Reinforcement of Concrete	BS 4483

212 CONCRETE PIPES AND FITTINGS

Concrete pipes shall comply with the AASHTO Standard Specifications set out in Table 2-10 except that their dimensions and reinforcement details shall be as shown on the Drawings.

Table 2-10: Specifications Applicable to Concrete Pipe and Box Culvert

Description	Specification Number
Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)	AASHTO M 170M-04
Reinforced Concrete Box Culvert, Storm Drain, Sewer Pipe (Metric)	AASHTO M 259M-00 AASHTO M 273M-00

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Concrete for concrete pipes shall comply with the requirements of Section 1300 of this Specification.

Reinforcement for reinforced concrete pipes shall comply with the requirements of AASHTO M 170M.

Reinforcement for reinforced concrete box culvert shall comply with the requirements of AASHTO M 259M-00 AASHTO M 273M-00.

All concrete shall be compacted either by spinning or vibrating.

All concrete pipes shall be cured in accordance with the applicable Standard Specification in Table 2-10. No pipe shall be used in the Works until it is twenty one days old. The date of casting shall be indelibly marked on the barrel.

Concrete pipes shall be tested in accordance with the applicable Standard Specification in Table 2-10.

213 ROAD SIGNS

(a) Paint for road signs

Road signs, posts and fittings shall be prepared, treated and painted in accordance with the requirements of MNS 4597:2014.

(b) Other paints

All other paints used in the Works shall be subject to the approval of the Engineer.

214 ROAD MARKING

Road marking paint shall be reflectorized with glass beads, conforming to the requirements of MNS ASTM D 4956:2005 White and Yellow Reflective Thermoplastic Striping Material (Solid Form) and MNS ASTM D 4956:2005 Glass Beads Used in Traffic Paints.

215 RETROREFLECTIVE MATERIALS FOR ROAD SIGNS

The retroreflective material shall comply with AASHTO M268 Retroreflective Sheeting for Traffic Control.

It is further specified that:

(a) The retroreflective material, when applied to the sign plate, shall give the appearance of a continuous reflecting surface under any angle of observation. It shall consist of a smooth exterior film with spherical lenses embedded beneath the surface, and shall have a protected, precoated adhesive backing which shall be tack-free, heat-activated for mechanical vacuum-heat application. The combination of various elements shall result in a non-exposed lens type optical reflecting system. The retroreflective material shall be applied in accordance with the instructions from the manufacturer of the retroreflective material used.

(b) The retroreflective surface of the sign shall be weather resistant and shall show no appreciable cracking, blistering, crazing or dimensional changes after 2 years unprotected outdoor exposure at 45° upwards inclination to the vertical facing West in Ulaanbaatar

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- (c) When retroreflective surface are laminated to the base materials, the adhesion shall be such that the retroreflective material shall resist peeling, scuffing and marring during normal handling or shocking off when jabbed with a spatula at 20° C. It shall withstand 8 hours of soaking in water at 25° C without any noticeable edge lifting or curling. The adhesive shall have no staining effect on the retroreflective material. The adhesive shall permit the retroreflective material to adhere securely 48 hours after application at temperatures between - 40° C and + 93° C.
- (d) When bent around a 20 mm diameter mandrel at a temperature of 20° C, the retroreflective material applied to an aluminium panel of 0.5 mm thickness shall show no evidence of cracking around the outside of the bend.
- (e) When a 25 mm diameter steel ball is dropped from 2 metres height onto the retroreflective face of the sign specimen at the ambient temperature of 20° C, the retroreflective material around the impact point shall show no evidence of cracking or peeling off.
- (f) After immersion of a specimen of retroreflective sign material for 10 minutes in methyl alcohol, kerosene or turpentine, or for 1 minute in toluene or xylol, the retroreflective material shall show no evidence of dissolving, puckering or blistering. The retroreflective material shall be capable of withstanding washing with a mixture of water and mild detergent, turpentine and methanol.
- (g) The retroreflective surface shall be such as to be readily refurbished by cleaning and recoating in accordance with the manufacturer's recommendations.

216 COLOURS FOR ROAD SIGNS

Standard colours to be used for signs, posts and fittings shall be as described in the relevant British Standard as follows:

Red	BS 381C No. 537
Blue	BS 4800 No. 18 E 53
Yellow	BS 381C No. 537
Green	BS 4800 No. 14 C 39
Grey	BS 4800 No. 10 A 11
Cream	BS 381C No. 352
White	BS 873 Part 1 - Clause 1-3.2
Black	BS 873 Part 1 - Clause 1-3.3

217 GUARDRAIL

Guardrails and associated components shall be Class A with Type 1 finish complying with AASHTO M180 Corrugated Sheet Steel Beams for Highway Guardrail.

218 TRIALS TO CONFIRM EQUIPMENT USE, CONSTRUCTION METHODS AND COMPLIANCE WITH SPECIFICATIONS

a) Laboratory trials

Laboratory trials shall be carried out by the Contractor and in consultation with the Engineer on materials for earthworks and pavement layers that are to be incorporated into the Works in their natural or processed state. Such trials shall be conducted to establish relationships between specified end product requirements of materials and properties that can be readily determined in the field for construction control purposes.

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The laboratory trials on both mixed and natural materials shall be completed and the Contractor's proposals based thereon shall be submitted to the Engineer at least two weeks before the Contractor commences to prove the proposed material in Site trials in accordance this Specification.

b) Site trials

Full-scale laying and compaction Site trials shall be carried out by the Contractor on all earthwork and pavement materials and mixes proposed for incorporation into the Works using the same equipment and methods proposed by the Contractor for the construction of the Works. The Contractor shall ensure the continuity of mix proportions and that materials are thoroughly mixed to achieve a homogeneous state.

The trials shall be carried out to enable the Contractor to demonstrate the adequacy of his equipment and construction methods to place, process and compact the material to the specified density and confirm that the other specified requirements for each completed earthwork or pavement layer can so be met.

Each trial area shall be at least 100 metres long and of the full construction width. The contractor shall allow in his program for conducting Site trials and for carrying out the required tests on them. The trial on each pavement layer shall be undertaken at least 21 days ahead of the Contractor proposing to commence full-scale work on that layer.

The following data shall be recorded for each level of compactive effort at each Site trial:

- the composition and grading of the material before the site trial,
- the composition and grading of the material after compaction,
- the moisture content at the time of compaction and the optimum moisture content for the specified compaction,
- the type, size, tyre pressures, frequency of vibration and the number of passes of the compaction equipment,
- the maximum dry density or target density as appropriate measured on a sample before and at intervals throughout the Site trial,
- the density achieved,
- the compacted thickness of the layer,
- any other relevant information as directed by the Engineer.

The Contractor and the Engineer shall perform at least eight sets of tests on each 100 metre long trial section for each separate earthwork or pavement layer in which the Contractor proposes to incorporate the material. The Site trial shall be deemed to be successful if all eight sets of test results for each layer meet the specified requirements for the material. The data recorded in the Site trial shall provide the basis for determining the method for providing, placing and processing each particular material and selection of construction equipment, as to be proposed by the Contractor and agreed by the Engineer, in order to achieve the requirements of this Specification. When results from one set of trial is found inconclusive by the Engineer, the Contractor shall organize more trials under the direction of the Engineer.

If, during the execution of the Works, the construction control tests should indicate that the specified requirements for a material are not being continually achieved, work on that earthwork or pavement layer shall cease until the cause is investigated and identified by

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the Contractor. Such investigation may include further laboratory tests and Site trials on the material to determine a revised set of data which shall be used to establish a revised method for providing, placing and processing all subsequent material to be incorporated in that layer.

Agreement by the Engineer to a set of data recorded in a Site trial of proposed method of construction shall not relieve the Contractor of any responsibility to comply with the requirements of this Specification.

219 CONSTRUCTION AND PAVEMENT LAYERS AND BACKFILL TO DRAINAGE WORKS AND STRUCTURES

Pursuant to the requirements of this specification and the Project QM System in accordance with this Specification and Quality Assurance testing by the Engineer, all earthwork and pavement layers and backfill to drainage works and structures shall be subject to construction control testing. The Contractor shall be deemed to have allowed in his program and his tender for time required for such control testing in the sequence of his operations

The Contractor shall request in writing the Engineer's approval for each layer of each section of earthworks, pavement construction and backfill to drainage works and structures before starting the construction of the next layer. Such requests shall be made only when the Contractor has satisfied himself that the section of work concerned fully complies with the requirements of this Specification. Such requests shall be accompanied by copies of the Contractor's test results required by Clause 202 and 219 of this Specification.

The Engineer shall thereupon inspect the section for any visible wet spots, laminations, heaving material (visible on proof-rolling), segregation, presence of oversize material and for uniformity of mixing and compaction. Provided that such visual inspection is satisfactory the Engineer shall test the section of the Works submitted for approval. The Engineer shall inform the Contractor in writing of the results of those tests and at the same time shall accept or reject the layer and section concerned.

Works on subsequent layers shall in no circumstances commence until the preceding layer has been approved and accepted by the Engineer in writing. The Contractor is wholly responsible for protecting and maintaining the condition of work which has been submitted for approval.

Should any layer be left unprotected for more than 24 hours subsequent to approval the Contractor shall request re-approval of the layer. The layer shall again be subject to proof-rolling, construction control testing and tolerance checks in accordance with this Specification if so required by the Engineer.

Notwithstanding the Engineer's approval of a layer, the Contractor shall be responsible for making good any subsequent damage due to traffic, ingress of water or any other reason. Should any damage occur, the layer shall again be subject to proof-rolling, construction control testing and tolerance checks in accordance with this Specification.

220 FREQUENCIES OF TESTING

(a) Calibration of nuclear density testing equipment

Generally, a nuclear method for determining field dry density shall be employed. Initial calibration, calibration curve adjustment and daily standardization of the nuclear density

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testing equipment shall comply with the requirements of AASHTO T310, In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth). Adjustment of calibration curves shall be undertaken in parallel with AASHTO T191 Density of Soil In-Place by the Sand-Cone Method.

(b) Test frequency requirements

The frequency of testing shall be in accordance with the Contractor's Project QM System in accordance of this Specification subject to the minimum requirement stated herein being followed:

(i) Applicable Tests

The applicable tests for each type of construction shall be as indicated below:

№	Type of Construction	AASHTO Test	Other Test Designation
1.	Compaction of existing ground	T180-01 T217-02 T265-93 (2000) T310-03	
2.	Embankment Construction	T88-00 T89-02 T90-00 T180-01 T191-02 T217-02 T265-93 (2000) T310-03	
3.	Gravel shoulder and gravel surfacing	T11-97 (2000) T88-00 T90-00 T180-01 T191-02 T193-99 (2003) T217-02 T265-93 (2000) T310-03	
4.	Subbase	T88-00 T89-02 T90-00 T150 T191-02 T193-99 (2003) T265-93 (2000) T265-93 (2000) T310-03	(i) чийгийн тестерээр хийх түргэн арга
5.	Base	T27-99 T84-00 T85-91 (2000) T96-02 T104-99 (2003) T180-01 T191-02	

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		T265-93 (2000) T310-03	
6.	Backfilling of Excavations and Filling for Structures	T27-99 T88-00 T89-02 T90-00 T180-01 T191-01 T193-99 (2003) T217-02 T265-93 (2000) T310-03	

(ii) Test Frequency

For each source of material of type of material used in the works the minimum test frequency shall be as follows:

No.	Type of Construction	Test	Frequency(min)
1	Compaction of existing ground	Moisture-Density Relations	One test per 3000 m ² or 250 m along the alignment
		Moisture Content prior to Compaction	One test per 1000 m ² or 100 m along the alignment
		Field Dry Density	One test per 500 m ² or two tests per section
2	Embankment Construction	Moisture-Density Relations	One test per 2000 m ³
		Particle Size Analysis	One test per 1000 m ³
		Plasticity Index	One test per 1000 m ³
		Liquid Limit	One test per 1000 m ³
		Moisture Content prior to Compaction	One test per 600 m ² of each layer or 3 tests per section
		Field Dry Density	One test per 600 m ² of each layer or 3 tests per section
3	Non-frost subgrade	Moisture-Density Relations	One test per 1000 m ³
		Particle Size Analysis	One test per 500 m ³
		Percent Swell and CBR (set of 3 specimens)	One test per 1000 m ³
		Plasticity Index	One test per 500 m ³
		Liquid Limit	One test per 500 m ³
		Plasticity Product	One test per 500 m ³

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		Moisture Content prior to Compaction	One test per 300 m ² of each layer
		Field Dry Density	One test per 300 m ² or 3 tests per section
4	Gravel shoulder and gravel surfacing	Moisture-Density Relations	One test per 1000 m ³
		Plasticity Index	One test per 500 m ³
		Gradation	One test per 500 m ³
		CBR (Set of 3 specimens)	One test per 500 m ³
		Moisture Content prior to Compaction	One test per 500 m ² of each layer
		Field dry density	One test per 250 m ² of 3 tests per section
5	Subbase	Moisture-Density Relations	One test per 1000 m ³
		Plasticity Index	One test per 250 m ³
		Liquid Limit	One test per 250 m ³
		Uniformity Coefficient	One test per 250 m ³
		Plasticity Modulus	One test per 250 m ³
		CBR (set of 3 specimens)	One test per 250 m ³
		Gradation	One test per 250 m ³
		Moisture Content prior to Compaction	One test per 500 m ² of each layer
		Field dry density	One test per 250 m ² or 3 tests per section
6	Cement Treated Base	Moisture-Density relations	One test per 300 m ³
		Cement Content	One test per 250 m ³
		Compression Strength	Twice a day
7	Backfilling of Excavations and Filling for Structures	Moisture-Density Relations	One test per 250 m ³
		Particle Size Analysis	One test per 500 m ³
		Percent swell and CBR (set of 3 specimens)	One test per 500 m ³
		Plasticity Index	One test per 500 m ³
		Liquid Limit	One test per 500 m ³

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		Moisture Content prior to compaction	Two tests per 300 m ²
		Field dry density	Two tests per 300 m ²

If it is determined by the Engineer that any test or any set of tests done is inconsistent or variable or otherwise inclusive, such tests shall be repeated or the frequency of testing may be increased if so directed by the Engineer.

For each new material encountered as determined by the Engineer, minimum 2 sets of tests as above shall be carried out irrespective of the quantity of the materials.

(i) Existing ground

The AASHTO T180 Maximum Dry Density and Optimum Moisture Content shall be determined for each new material encountered and at intervals of at least once per 3,000 m² of existing ground or at a maximum interval of 250 m along the alignment whichever is more frequent.

Moisture Content test before compaction of materials shall be carried out at least once per 1,000 m². Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests.

The field dry density shall be determined at least once per 500 m² of compacted material or at least one test each 100m length of road, subject to minimum 2 tests per section requested for testing whichever is the more frequent.

The frost classification shall be determined at least once per 500 m² of compacted material at the surface or at least one test each 100m length of road, subject to minimum 2 tests per section requested for testing whichever is the more frequent. Additionally, the frost classification shall be determined at least once per 1000 m² of compacted material at 300 mm below the surface or at least one test each 200m length of road, subject to minimum 2 tests per section requested for testing whichever is the more frequent.

(ii) Earthworks

The AASHTO T180 Maximum Dry Density and Optimum Moisture Content shall be determined for each new material encountered and at intervals of at least once per 2000 m³ of material or whenever the material type changes.

The Particle Size Analysis, Plasticity Index and Liquid Limit for embankment fill material shall be determined at least once per 1000 m³ of material used or for each new material encountered.

Moisture Content test before compaction of each layer of materials shall be carried out at least once per 600 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent. Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests or if compaction operation are resumed after a break.

The frost classification shall be determined at least once per 2500 m² of compacted material at the surface or at least one test each 500m length of road, subject to minimum 2 tests per section requested for testing whichever is the more frequent.

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The field dry density shall be determined at least once per 600 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent.

(iii) Non-frost subgrade

The AASHTO T180 Maximum Dry Density and Optimum Moisture Content, Percent Swell and CBR test (set of 3 specimens) shall be determined for each new material encountered and at intervals of at least once per 1,000 m³ of non-frost subgrade material.

The frost classification shall be determined at least once per 1000 m² of compacted material at the surface or at least one test each 200m length of road, subject to minimum 2 tests per section requested for testing whichever is the more frequent.

The Particle Size Analysis, Plasticity Index, Liquid Limit, for non-frost subgrade shall be determined at least once per 500 m³ of material used or each new material encountered. Moisture Content test before compaction of each layer of materials shall be carried out at least once per 300 m² of each layer of compacted material. Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests or if compaction operations are resumed after a break.

The field dry density shall be determined at least once per 300 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent.

(iv) Backfill, fill and excavated surface to culverts and structures

The Particle Size Analysis, Liquid Limit, Plasticity Index, AASHTO T180 Maximum Dry Density and Optimum Moisture Content shall be determined for every 500m³ of material used or for each new material encountered or for separate location, whichever is more frequent.

The moisture content before compaction and field dry density after compaction shall be determined at least twice per 300 m² or part of each layer of compacted material placed. The minimum number of tests per section for which approval has been requested shall be 3.

(v) Gravel shoulders and gravel surfacing

The AASHTO T180 Maximum Dry Density and Optimum Moisture Content and CBR test (set of 3 specimens) shall be determined on opening up each new source of material and at intervals of at least once per 1,000 m³ of processed material.

The Particle Size Analysis Grading and Plasticity Index for material shall be determined at least once per 500 m³ material used or for each new material encountered.

Moisture Content test before compaction of each layer of materials shall be carried out at least once per 500 m² or part. Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests.

The field dry density shall be determined at least once per 250 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent.

(vi) Subbase

The AASHTO T180 Maximum Dry Density and Optimum Moisture Content and CBR test (set of 3 specimens) shall be determined for each new source of subbase material and at

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intervals of at least once per 1,000 m³ of processed material. The Grading, Plasticity Index, Liquid Limit, Plasticity Modulus and Uniformity Coefficient for subbase material shall be determined at least once per 250 m³.

Moisture Content test before compaction of each layer of materials shall be carried out at least once per 500 m² or part. Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests.

The field dry density shall be determined at least once per 250 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent.

(v) Cement treated base

The Optimum Moisture Content shall be determined for each new source of material and at intervals of at least once per 500 m³ of material produced.

Moisture Content test shall be repeated whenever the moisture content of the material changes due to drying or wetting or if there be uncertainty (e.g. due to variability) in the results of earlier tests.

The Grading of material used for CTB shall be determined at least once per 250 m³.

Cement Content of the mix used for CTB shall be determined at least once per 250 m³.

The Compression Strength shall be determined once per 450 m².

The field dry density shall be determined at least once per 250 m² of each layer of compacted material or at least three tests per section requested for testing whichever is the more frequent.

(viii) Bituminous pavement works

(A) Binder

Tests according to AASHTO T44, T49 and T202 shall be undertaken at least once for each day of work or at least once per 20,000 litres delivered to Site. Tests required for full compliance of Clause 209 shall be carried out at least once for every 200,000 litres delivered at site.

(B) Aggregates

The aggregate properties listed below shall be determined on opening up of each new source of aggregate and whenever the Engineer considers that the aggregate properties may have altered and at least once for every 500 m³ of material produced:

- Grading,
- Los Angeles Abrasion,
- Sodium Sulphate Soundness,
- Flakiness Index.,
- Sand Equivalent,
- Soluble Salts and Deleterious Matter.
- Real and Apparent Specific Gravity and Absorption in the Mixed Aggregate.
- Voids.

(C) Mineral Filler

The grading and bulk density shall be determined once per 50 tonnes of filler used, and when the source of filler is changed.

(D) Bituminous mixture (from the mixing plant)

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The following properties of the bituminous mixture as appropriate to the type of mix specified, shall be determined every 4 hours or part thereof mixing time of samples taken from the mixing plant:

- Bitumen content,
- Grading,
- Marshall stability,
- Flow,
- Absorbed water,
- Voids.

(E) Bituminous mixture (on cores from the compacted layer)

The following properties of the bituminous mixture, as appropriate to the type of mix specified, shall be determined at least once for every 600 m² of mix laid from pairs of core samples cut from the compacted layer:

- Bitumen content,
- Grading,
- Density,
- Voids.

221 MEASUREMENT AND PAYMENT

No separate measurement and payment shall be made for testing of materials, construction trials and construction control testing. The Contractor shall be deemed to have allowed in his rates and prices for the cost of complying with all the requirements of this Section 200 of this Specification.

SECTION 300 - SETTING OUT AND TOLERANCES

Section	CONTENTS
301	BASIC SURVEY AND DETAILED SETTING-OUT
302	TOLERANCES
303	RECTIFICATION OF WORKS OUTSIDE PERMITTED TOLERANCES
304	MEASUREMENT AND PAYMENT

301 BASIC SURVEY AMD DETAILED SETTING-OUT

(a) General

The Employer shall provide, and the Contractor shall develop in its updated design prepared in accordance with Part A of this Specification, sufficient survey information to enable setting out the Works and the Contractor shall be responsible for the setting-out of all necessary reference points and for the maintenance thereof. Setting out shall be considered as the essential work that follows the main works and carried out at the Contractor's expense and no separate payment shall be made. The Contractor shall forthwith satisfy himself as to the accuracy in line, level and dimension upon receipt of the basic survey information and any setting-out details provided.

If the Contractor discovers any error or discrepancy in survey information provided by the Employer, he shall immediately inform the Engineer. If the information is confirmed to be in error, the Engineer shall issue amended drawings or instructions in respect of the correction of the error.

Before commencing construction, the Contractor shall check primary survey reference points, comprising benchmarks and horizontal control points (HIP, start and end points of horizontal alignment etc.) connected to the Mongolian national datum and geodetic coordinate system and accept them from Consultant's Survey Engineer. Primary survey reference points should be located at intervals not exceeding 2 km along the alignment, mostly outside the right-of-way and near HIPs. The Contractor shall further establish and fix secondary benchmarks at intervals not exceeding 200 m along the road, at not less than 50 m from the centerline and in elevated places as possible. Fixing should be done as follows: 250x250x400 concrete block will be cast, in which dia. 22 mm, 200 mm long steel pole shall be fixed. 20 mm of the pole length shall be above the ground from the top surface of the block. After the concrete has been hardened, the block shall be fixed into hard soil at the point of secondary benchmarks and the earth around the block shall be compacted. The top edge of the block should be at the same level as ground level and the number of the block shall be clearly written on the top surface with a indelible paint. 200 mm deep channel shall be dug on all sides of the block at 0,5 m from the block. The earth cut from the channel shall be heaped outside the channel. In one of the corners of the channel, a steel or wooden peg shall be driven into the ground, 400-500 mm above the ground. After fixing the secondary benchmarks, their levels shall be established by connecting them to the primary survey reference points.

All such reference points, benchmarks and horizontal control points shall be of a type acceptable to the Engineer and shall be maintained by the Contractor until the issue of a Taking-Over each road section concerned. The Contractor shall provide the Engineer with a schedule of the location, level and coordinates of all reference points, bench marks and horizontal control points and shall ensure that the Engineer is at all times provided with up to date survey information.

The Contractor shall not remove, damage, alter or destroy plot beacons or national survey beacons. Should the Contractor consider that any beacon will be interfered with by the Works he shall notify the Engineer who shall make the necessary arrangements with the appropriate authorities for the removal and relocation of the beacon. If the Contractor removes or disturbs any beacon without prior instruction from the Engineer, the Contractor

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shall be liable for the full costs of its replacement and any ensuing delays to the Contractor's program.

Any additional setting-out required as a result of erroneous survey work on the part of the Contractor and any abortive works executed arising therefrom shall be rectified at the expense of the Contractor.

(b) Detailed setting-out

After accepting the benchmarks and horizontal control points, the Contractor shall check their coordinates and levels in detail and submit the results to the Engineer for approval. After that levels of secondary benchmarks fixed along the road shall be connected to the levels of primary survey points and the results shall be submitted to the Engineer for approval.

Contractor shall set out the line and level of the Works as shown in the Drawings (taking into account any revisions thereto as instructed by the Engineer) at intervals of not more than 20 m or such lesser intervals as are required to construct the Works to the tolerances.

After setting-out, the Contractor shall check intervals between chainages and additional survey points, ground levels in detail along the centerline and take a longitudinal section and cross-sections over the full roadway width. Similarly the Contractor shall take a longitudinal section and cross-sections along the centerlines of all existing and proposed culverts and structures. When fixing ground level along the centerline of the proposed bridges and culverts, the Contractor shall carry out the survey to the limit and distance from the centerline of the road, specified by the Engineer.

Reference pegs and rails, clearly and indelibly marked with all relevant information (such as number, location and levels etc.), shall be provided perpendicular to the centreline, in such a manner that cut and fill slopes and pavement layer levels can be directly comprehended at any time. These shall be maintained by the Contractor for as long as they are needed to check and monitor the Works.

After completion of the site clearance, the Contractor shall fix 50 x 50 x 1200 mm long timber reference pegs, 400 mm firmly into the ground at 0,5-0,8 m from the each border of the area, from which the top-soil was removed. The interval between reference points fixed along the centerline shall not be more than 20 m. The part above the ground level shall be painted with white. The offset from the centerline shall be indicated by a 25 mm long nail with its head driven flush with the top of the peg. Chainage and offset distance shall be clearly and indelibly indicated on the sides of the peg to the satisfaction of the Engineer. All setting out shall be maintained, rectified and repainted as necessary by the Contractor such that they are kept in a clear and legible condition during the required period.

The surveys should be done using total station survey instruments and data to be compiled in digital medium according to format and standards of accuracy approved by the Engineer. Cross-sections shall be plotted to a natural scale of 1:200 utilizing a suitable computer program and plotter and a draft copy of the plot (along with digital soft copy) shall be submitted to the Engineer for agreement. Longitudinal sections shall be plotted to a scale of 1:2,000 horizontal and 1:200 vertical. The centerline of the alignment shall be plotted to a scale of 1:2000 horizontal. The Contractor shall make any amendments as necessary after the cross-sections have been agreed.

The Engineer shall issue final road, culvert and structure position and levels not more than 28 days after receiving the amended agreed cross-sections and other drawings from the Contractor. Those cross-sections shall be submitted for a minimum length of road of 5 km

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at any one time. The final road, culvert or structure levels instructed by the Engineer may be different from those levels shown on the Drawings. The Contractor shall be deemed to have taken the requirements of this Clause into consideration for the submission of his bid and preparation of his program pursuant to any subsequent program.

On receipt of the final road, culvert and structure levels, the Contractor shall enter the revised data in the program and the revised cross-sections shall be plotted. An original plot and one copy of those cross-sections shall be provided free of charge by the Contractor to the Engineer.

Formation level is defined as the level of the interface between the top of the non-frost subgrade and the bottom of the pavement layers. Before the finishing of the formation layer and prior to the construction of pavement layers, the Contractor shall establish steel pins at a constant offset to the edges of the carriageway shoulders. The offset may be changed due to the conditions in cut and fill areas, in which case pins will be established at the offset approved by the Engineer. Height of the pin above the fill surface shall not be less than 1 m. The steel pins shall be clearly and indelibly marked with all the relevant information necessary to directly establish the centreline and level at any point across the carriageway. The interval between pins shall be no greater than 20 m and the pins shall be maintained by the Contractor until the Engineer no longer requires them to check the work and authorizes their removal.

302 TOLERANCES

(a) Horizontal alignment

The horizontal alignment shall be determined from the centreline of the pavement surface as shown on or calculated from the Drawings. The centreline coordinates of the pavement surface as constructed and offsets therefrom shall be correct within a tolerance of ± 10 mm.

(b) Thickness of pavement layers

The average thickness of any pavement layer measured at five points in any length of 100 m shall not be less than 100% nor more than 120% of the thickness specified or instructed by the Engineer. In addition the thickness of any pavement layer measured at any point shall not be less than 95% nor more than 120% of the thickness specified or instructed by the Engineer.

(c) Surface levels of formation and pavement layers

The level measured at any point on the surface of a finished pavement layer or formation level shall not deviate from the corresponding level calculated from the Drawings by more than the tolerances shown in Table 3-1.

For verification of compliance with Table 3-1, additional measurements of surface levels shall be taken at points to be selected by the Engineer along every 20 m of centerline, at the centerline and at the edge on each side of a particular level and at 1.75 m centers transversely to the road centerline at the base course and pavement of main road and at 1.5 m centers transversely at the base course and pavement of the access road. At the junctions the requisite grid point spacing's to verify compliance shall be determined by the Engineer.

(d) Surface regularity of formation and pavement layers

The surface regularity of a finished pavement layer or formation level shall be tested at points decided by the Engineer with a rigid steel straight-edge, 3 m long, placed parallel or perpendicular to the centerline of the road. The maximum allowable deviation of the surface below the straight-edge shall be as given in Table 3-1.

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In addition the longitudinal slope or transverse cross fall shall not deviate from that shown on the Drawings by more than the tolerances shown in Table 3-1.

Table 3-1: Surface Tolerances for Formation Level and Pavement Layers

Layer	Max. deviation from level	Max. depth below 3 m straight-edge	Max. deviation from slope or cross fall
Asphalt concrete surfacing	± 5 mm	3 mm	± 0.20%
Base course	± 10 mm	8 mm	± 0.25%
Subbase and shoulders	± 15 mm	12 mm	± 0.40%
Subgrade surface	± 25 mm	20 mm	± 0.50%

(e) Embankment slopes

In the final trimmed slope of cuttings and embankments a tolerance of + 0.20 shall be permitted.

(f) Width of embankments

The measured widths from the centerline to the cut toe of slope may have a ±200 mm tolerance, which is a permissible tolerance for bottom widths of cutting. The measured embankment widths from the centerline to top of slope shall not be less than ones shown in the drawings nor greater than by +100 mm.

(g) Depth of side drains

Depth of ditches – the measured difference between ground surface and bottom elevation of ditches – shall not be less than ones shown in the Drawings nor greater than by 100 mm.

(h) Concrete structures

(a) Bridge substructure

Substructure concrete elements shall be constructed within the tolerances set out in the Table 3-2.

Table 3-2: Tolerances in substructure concrete works

Category	Tolerance
Deviation from the specified cross-sectional dimensions	+ 10 mm, - 5 mm
Difference between the specified and relocated location	10 mm
Height variance from the specified top surfaces height	±10mm
Height variance from the specified bearing height	±5mm
Deviation of overall height	10 mm
Deviation from a 3m long straightedge placed on bearing	3 mm
Deviation from a 3m long straightedge placed anywhere on the surface	5 mm

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(b) Bridge superstructure

Superstructure concrete elements shall be constructed within the tolerances set out in the Table 3-3.

Table 3-3: Tolerances in superstructure concrete works

Category	Tolerance
Deviation thickness of T-beam	+ 10 mm, - 5 mm
Deviation thickness of nets	+ 10 mm, - 5 mm
Variance of overall depth or width	+5 mm
Variance of overall length and the length between piers	+10 mm
Deviation from a 3m long straightedge placed anywhere on the surface	5mm

Unless otherwise instructed, values implemented in this Specification are the minimum values which are limited. Further, all testing and analysis done as specified in Quality Assurance/Quality Control Plan or as Technical Specification Section 200, where the data is in tolerance limit (equal or less than) specified in above sections, only then the work shall be counted as completed in terms of measurement.

303 RECTIFICATION OF WORKS OUTSIDE PERMITTED TOLERANCES

Where any tolerances specified in Clause 302 of this Specification are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the surface of the pavement, earthworks or formation layer in the manner prescribed below. The minimum area to be reworked shall be 3 m wide and 30 m long. Rectification on the AC pavement shall be done in full width and length of this area shall be determined by the Engineer.

(a) Earthworks

Wherever the embankment slope is flatter than the specified gradient, the slope shall be trimmed to the specified gradient. Wherever the slope of an embankment is steeper than the specified gradient, the Contractor shall bench the slope and place and compact fill material and trim the slope all in accordance with the requirements of Section 500 of the Specifications.

Where the width of an embankment is greater than the specified width, the Contractor shall trim the embankment to the specified width. Where the width of an embankment is less than the specified width, the Contractor shall bench the slope and place and compact fill material and trim the slope all in accordance with the requirements of Section 500 of this Specification.

Where the results of the construction control tests fail to meet the requirements of this Specification the full depth of the layer shall be reworked such that compliance is achieved. The area to be reworked shall be the whole section submitted for approval or, at the discretion of the Engineer, a length of at least 50 m each side of the test failure location over the full width of the section.

(b) The non-frost subgrade layer below formation level

Where levels or widths are less than tolerance, the full depth of the layer shall be reworked to comply with the requirements of this Specification. The area treated shall be at least 30 m long and 3 m wide or such area to be determined by the Engineer.

Where the results of the construction control tests fail to meet the requirements of this Specification the full depth of the layer shall be reworked such that compliance is achieved. The area to be reworked shall be the whole section submitted for approval or, at the discretion of the Engineer, a length of at least 50 m each side of the test failure location over the full width of the section.

(c) Asphalt concrete and bituminous macadam surfacing

In the event that the tolerances specified in Clause 302 of this Specification are exceeded such that the thickness of the layer is too small, the Contractor shall remove the full depth of the layer and replace it with fresh material laid and compacted to comply with the Specification to be determined by the Engineer. Material shall be laid in one operation. Where the tolerances are exceeded such that the thickness of the layer is too large, the Contractor shall remove the excess material by milling, using equipment and procedures approved by the Engineer.

Where the results of the construction control tests for asphalt concrete surfacing tests fail to meet the requirements of this Specification, the Contractor shall remove the full depth of the layer and replace it in accordance with the Specification to be determined by the Engineer. The area to be treated shall be the whole section submitted for approval or, at the discretion of the Engineer, a length of at least 15 m each side of the test failure location over the full width of the section.

304 MEASUREMENT AND PAYMENT

The Contractor shall be deemed to have allowed elsewhere in his rates and prices for the costs of complying with the requirements of Clauses 302 and 303 of this Specification.

Notwithstanding the provisions of Clauses 302 and 303 of this Specification, measurement and payment for earthworks, pavement layers and gravel wearing course shall be made on the basis of the net cross-section instructed by the Engineer and no additional Payment shall be made in respect of variation within the specified tolerances so long as these tolerances are of random occurrence. Within such tolerances, the average layer thickness achieved in construction for the non-frost subgrade, shoulders and all pavement layers shall not be less than those shown in Drawings.

(a) Basic Survey and detailed Setting Out

Unit: km

The measurement of basic survey and detailed setting out shall be the length along the centre line.

The items for basic survey and detailed setting out shall include for:

- scheduling, coordination and provision of all construction surveying;
- fixing coordinates, levelling and staking;
- tying the points into the national survey network;
- calculations essential to complete the project and properly control the work;
- appropriate traffic control measures for all survey activities;

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- marking of all survey stakes with station and offset reference;
- conducting a detailed cross section survey of the existing road for the purpose of measurement and preparing design and working drawings;
- provision and maintaining of reference stakes;
- renewing of illegible stakes;
- relocation of initial horizontal and vertical control points, if necessary;
- protection of benchmarks;
- cooperation with utility companies and staking of control lines to relocate utilities.

SECTION 400 - SITE CLEARANCE AND TOPSOIL REMOVAL

SECTION	CONTENTS
401	SITE CLEARANCE
402	REMOVAL OF TOPSOIL, STORAGE AND DEPOSITION
403	REMOVAL OF STRUCTURES, FENCES AND OBSTRUCTIONS
404	DIVERSION OF SERVICES
405	MEASUREMENT AND PAYMENT

401 SITE CLEARANCE

Site clearance is defined as the clearing, grubbing, removal and disposal of all obstructions, vegetation, grass, debris, topsoil, scrub, bushes, trees, hedges, undergrowth, stumps, roots, shrubs, plants and the backfilling and treatment of holes ensuring from the removal of stumps and roots.

During the Site clearance and disposal of debris the Contractor shall take full care to ensure that public or private properties are not damaged/affected and the traffic is not interrupted.

The areas over which site clearance is to be carried out shall be as shown on the Drawings or instructed by the Engineer.

The Contractor shall also carry out site clearance over the areas of camps, quarries, borrow areas, stockpile areas and spoil areas, and other working areas as instructed by the Engineer. These areas shall not qualify for payment.

The Engineer may give instructions that specific trees, stumps or objects shall not be removed during the site clearance operation. The Contractor shall take all precautions necessary to ensure that public or private properties are not damaged during Site clearance and if any such damage is caused, the Contractor shall assume full responsibility for making good such damages.

402 REMOVAL OF TOPSOIL, STORAGE AND DEPOSITION

Unless otherwise specified by the Engineer, the Contractor shall remove the topsoil to a thickness of 200 mm in the area to be cleaned, load and transport it to the designated location.

If the Contractor excavates the topsoil to a depth greater than the specified depth, he shall backfill to the appropriate level at his own expense.

Topsoil removed from the roadway earthworks shall be stockpiled in a manner and location satisfactory to the Engineer and, following the completion of cut and fill operations, shall be reinstated on cut and fill slopes in approximately the same thickness as it was removed.

The Contractor will be permitted to attempt to establish grass by top soiling only. Topsoil shall be placed whenever possible at a time of the year that would be favourable for the subsequent establishment of grass. The minimum thickness of topsoil shall be 50 mm and the quality of the topsoil shall be to the approval of the Engineer. After the placing of the topsoil it shall be lightly rolled and well watered. Thereafter, it shall be periodically watered.

403 REMOVAL OF STRUCTURES, FENCES AND OBSTRUCTIONS

The Contractor shall demolish, break up and remove buildings and structures as shown on the drawings and superficial obstructions on the Site in the way of or otherwise affected

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by the Permanent Works. The Contractor shall ensure that individual trees, shrubs and other features and areas, as directed by the Engineer, be preserved, are suitably identified and protected. Should any trees, shrubs and other planting features and planting areas which it is intended to preserve be killed, removed or damaged by the Contractor during the course of the Works, they shall be replaced by the Contractor with plants of the same species and equal in size to those killed, removed or damaged or made good by arboricultural work; or replaced or made good to the satisfaction of the Engineer. Such work shall be carried out at the Contractor's own expense.

Where the line of an existing fence, hedge or wall is cut by the Site boundary the severance shall be made good unless otherwise shown on the drawing; either by the continuation of the fence, hedge or wall in a different direction, or by its termination. In the case of a strained wire or chain link fence a straining post shall be installed and the fence restrained.

Underground structures, chambers and foundations shall be demolished as required, properly cleaned out, and filled. To permit free drainage, holes shall be made at 500 mm centres over the whole area of slabs, basements, etc., which are not removed and which are liable to hold water.

Disused soil and surface water drains, sewers, cables and ducts together with any bed or haunch or surround within one metre of formation level shall be removed and over one metre below formation shall be left unless otherwise instructed by the Engineer. The ends of existing drains and sewers no longer required because of alterations to the drainage layout shall be sealed. All trenches shall be backfilled unless otherwise instructed by the Engineer.

The Contractor, subject to any instructions or contrary directions in accordance with the Contract, shall take all measures required by any Statutory Undertaker, the management of other publicly owned services, or owners of privately owned services or supplies, for disconnection and proper sealing off of all redundant drains, services and supplies.

All materials arising from site clearance which are not required, or unacceptable for use in the Permanent Works shall be disposed by the Contractor.

Materials to be retained arising from site clearance is property of the Employer, and shall be carefully dismantled, taken up or taken down, cleaned and retained for re-use, stacked, labeled and protected or loaded, and transported to store as approved by the Engineer.

When required, voids left by items that have been removed shall be backfilled immediately.

All existing road markings and road studs on carriageways open to traffic shall be removed as soon as they become superfluous or a hazard to traffic and the carriageway reinstated.

Existing tensioned safety barriers shall be detensioned before raising or removing a section of barrier. The post shear bolts shall be slackened between those tensioning assemblies which are at least three beam lengths beyond the ends of the section to be raised or removed. The adjuster bolts at these assemblies and at each intermediate assembly shall then be loosened. Any post shear bolts that are slackened shall be removed and replaced with new bolts.

The treatment of hazardous materials encountered in site clearance shall comply with any specific requirements given by the Ministry of Environment, as well as relevant legislation and any other health and safety measures.

404 DIVERSION OF SERVICES

The Contractor shall be responsible for arranging in liaison with the appropriate Authority, the moving of or alterations to services such as pipelines, power and telephone lines, water mains, sewers and surface water drains which are affected by the Works. The arrangements for such moving or alteration shall be subject to the written agreement of the Engineer and the appropriate Authority.

The positions of all public and privately owned utilities shown on the Drawings have been based on the records of various Utility Authorities and must be regarded as approximate. The Contractor must verify this information and satisfy himself as to the exact nature and position of all such apparatus. The Employer does not guarantee the accuracy of the information given on the Drawings and no warranty is given or implied.

The Contractor shall take into account the current laws regarding the safety of utility lines, together with any amendment or additions thereto.

The Contractor shall prepare drawings showing position, levels and types of each existing utility, including manholes, joint boxes and inspection chambers etc. All drawings shall be prepared using a Computer Aided Drafting program approved by the Engineer. The drawings must show both existing utilities located by trial pits and coordinated by survey, and all proposed new utilities. These drawings are to be used to identify interface problems prior to the production of working (shop) drawings and well in advance of works in such locations of possible conflicts. Diskettes containing the utility drawings data shall be supplied to the Engineer in the approved digital format and shall be incorporated into the As-Built Drawings.

The Contractor shall take any and all measures reasonably required by any Utility Authority for the support and full protection of all mains, pipes, cables and other apparatus during the progress of the Works, and shall construct and provide to the satisfaction of the Utility Authority concerned, all works necessary for the prevention of damage to utilities or interruption of services.

The Contractor shall prepare and furnish all necessary working (shop) drawings etc. of the works required to complete the adjustment of existing and/or new apparatus to finished grades or specified levels. The drawings must be approved by both the concerned Utility Authorities and the Engineer prior to commencement of any work at the Site.

Lifting and moving of communication and electric lines coinciding with the road construction shall be carried out in accordance with the relevant laws and standards in force in Mongolia.

The cost of all utility diversion activities shall be authorized and reimbursed under the appropriate provisional sum.

405 MEASUREMENT AND PAYMENT

(a) Site clearance

Unit: Lump sum

The cost of clearing temporary camps, earth deposits, quarries, reserve materials, waste material points, auxiliary roads leading to them, canals and ditches shall be included in the Contractor's unit price and cost.

The items for site clearance shall include for:

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- removal of objects and obstructions;
- grubbing up and blasting stumps and roots including backfilling and compaction;
- uprooting of bushes and hedges;
- removal of small trees less than 8 cm diameter
- credit value of materials;
- disposal of material;
- making good severed ends of existing fences, hedges and walls;
- cutting back trees, bushes and hedges;
- disconnecting, removing and sealing services and supplies;
- reinstatement and making good;
- preservation of individual or groups of trees, shrubs and the like;
- disposal of hazardous materials at tips, approved by the Engineer;
- application of the site-specific Relocation Action Plan;
- disposal of excess material in areas approved by the Engineer and permitted by local authorities
- meet the requirements of clauses 401, 402, 403 and 404 of these technical specifications.

(b) Removal of Topsoil, Storage and Deposition

Unit: m³

The measurement for removal of topsoil shall be the volume of the void formed by the excavation of topsoil material. Payment shall be made as follows:

- 50% on completion of removal and stockpiling
- 50% on completion of reinstatement of topsoil to cut and fill slopes.

The items for removal of topsoil shall include for:

- excavation, selection and separation of materials;
- loading into transport;
- multiple handling of material;
- keeping earthworks free of water;
- haulage and deposition in temporary stockpiles including the provision of sites for stockpiles;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- grading beds and trimming side slopes of watercourses and the like;
- deposition of topsoil on cut and fill slopes, light rolling, watering;
- replacing acceptable material rendered unacceptable;
- disposal of surplus and unacceptable material;
- grassing, if required.

(c) Removal and disposing concrete culverts

Unit: lump sum

The item for removal and disposal of concrete culverts will be made after removal and disposal of all existing culverts or as agreed with the Engineer.

The items for removal of culverts shall include for:

- total or partial demolition of culverts or other drainage structures; blasting, breaking up and removal;
- cutting and trimming;
- saw cutting;
- cutting through reinforcement, removal, disposal, protecting cut ends with treatment, de-bonding existing reinforcement;

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- excavation of acceptable and unacceptable material;
- excavation in hard material;
- transport and handling;
- working between and behind reinforcement and other obstructions;
- measures in respect of specialist demolition techniques;
- protection of unaffected parts of the structure;
- disposal of material;
- disconnecting, removing and sealing services and supplies;
- disposal of hazardous materials at tips approved by the Engineer;
- filling of all basements and other excavations made;
- replacing items damaged during the foregoing operations.

SECTION 500 – EARTHWORKS

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501 SCOPE OF SECTION

This Section covers all earthworks, placing and compaction of fill material in embankments, ground compaction, and the formation of the non-frost subgrade, and excavation and replacement of unsuitable soils.

502 GENERAL

Site clearance, grubbing and topsoil stripping, as instructed by the Engineer, shall be performed by the Contractor prior to commencing earthworks construction. All earthworks shall be constructed as shown on the Drawings or as directed by the Engineer to the specified slopes, levels, depths, widths, tolerances and heights. Any earthworks not so constructed shall be made good by the Contractor at his own expense.

The Contractor shall excavate cuttings and place fill in embankments in accordance with the Drawings or as directed by the Engineer. Only suitable excavated materials shall be used to form embankments. Any material, that in the opinion of the Engineer is considered undesirable, shall be deemed to be unsuitable for the construction of embankment fills. Unsuitable material shall include but not be limited to:

- material containing more than 2% of organic matter such as topsoil, material from swamps, peat, logs, stumps or any other perishable material,
- Material with a swell of more than 2.5%,
- Material containing clays with a Liquid Limit exceeding 45% or Plasticity Index exceeding 20%.
- boulder, rock fragments and other lumpy material exceeding 75mm in size, weathered rock, volcanic material
- MDD less than 1.75 t/m³ (AASHTO T180)
- fine fraction passing through the 0.075 mm sieve exceeding 45% of the dry weight.

Excess or unsuitable material shall be disposed of only in designated spoil areas which shall be provided by the Contractor in accordance with this Specification.

Where suitable material is available in roadway excavations, the Contractor shall use this material before taking material from a borrow pit, unless he is instructed by the Engineer to take suitable material to spoil. The Contractor shall dispose of unsuitable or excess suitable excavated material in designated spoil areas.

At all times the Contractor shall ensure that earthworks are not damaged by weather or traffic. If such damage should occur the Engineer may withdraw approval from the affected Works until the Contractor has carried out remedial works such that the requirements of this Specification are met., including protection to earth slopes by turfing or other means where so provided for. The expenses of all such remedial works and any consequential additional testing requirements shall be borne by the Contractor.

The Contractor shall provide adequate supervision to ensure that only suitable materials are incorporated in embankment fills. If any unsuitable materials is included in embankment construction, it shall be removed and replaced with suitable material at the expense of the Contractor.

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All trimming of cuttings, embankments, side drains, and shoulders to the specified slopes and shapes shall be carried out concurrently with the earthworks that are being carried out at that particular location and level.

503 CLASSIFICATION OF EXCAVATION MATERIAL

Material from road excavations is classified as follows:

(a) General Excavation

General Excavation includes all excavation activities except hard rock excavation.

Typical excavations also include swampy soils and other unsuitable materials.

(b) Excavation of hard material

Excavation of hard materials shall be considered to include all excavation works that, in the opinion of the Engineer, require blasting, or the use of a hydraulic breaker for their removal, and that cannot be extracted by ripping with a tractor of at least 150 brake horsepower with a single, rear-mounted, heavy-duty ripper.

Excavation of soft soil containing stones larger than 0.75 m³ is classified as hard material excavation. Excavation of solid hard rock with a volume of less than 0.75 m³ is included in normal excavation.

Hard rock material shall not be placed within 900 mm below the surface of the embankment but shall be excavated to a depth of 300 mm below the level shown in the excavation drawings or to such depth as may be directed by the Engineer.

Unless it is determined by the Engineer that the use of blasting is absolutely necessary for excavation of hard material, use of blasting is not permitted. In the event of a dispute as to the classification of materials, the decision of the Engineer shall be final and binding.

504 PREPARATIONS PRIOR TO FORMING EMBANKMENTS

After stripping the topsoil where the cross slope of the surface is greater than 20%, the Contractor shall bench the excavation. Excavate the first level of the bottom edge of the fill sufficiently wide to allow for the operation of the tamping and compaction equipment. After filling and compacting, dig the next level. Excavated material shall be removed from the stepped excavation or shall be used for backfilling as deemed fit by the Engineer. The height of the step shall be 200-300 mm or as directed by the Engineer.

Soil below embankments and for 300mm below cuttings shall be tested on site in accordance with AASHTO T191-93, and if the MDD is less than 95% as defined in (AASHTO T99-94). It needs to be compacted to MDD of 95% (AASHTO T99-94) by digging for the depth of 150 mm or more in the entire width of the construction as directed by the Engineer. Adjust the subsoil moisture under the embankment prior to compaction by evenly watering the soil or drying the material so that the moisture content at the time of compaction is within plus or minus 2% of the ideal moisture content (AASHTO T99-94).

Subsoil in cuttings shall be tested to confirm frost resistance at the test frequency stated in Section 220. If all the parameters match, the base of the cut can be considered as a

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frost-resistant layer. If all other parameters meet the requirements but only the MDD is less than 98% (AASHTO T180), the subsoil shall be thoroughly thinned to a depth of 300 mm and re-compacted until the MDD is 98% (AASHTO T180). If none of these criteria are met, the bottom soil of the excavation should be excavated to a depth of 300 mm and replaced with cold-resistant material of suitable composition. The thickness when compacted must be not more than 150mm.

If the subsoil below the embankment is deemed by the Engineer to be unable to accept fill, the Contractor shall excavate to the depth specified by the Engineer, haul the material to the disposal site, and replace it with suitable material and compact it to a suitable level.

505 EMBANKMENT CONSTRUCTION

(a) Embankment fill material

Soil, gravel, sand, or a mixture of these materials, other than those considered unsuitable, from borrow pits and road excavations, shall be used for the embankment. If the Contractor proves that the volume of material from the cut is not sufficient for the filling of the embankment, and the Engineer approves, the material will be taken from the borrow pits.

A material is not considered unsuitable solely because of its high moisture content. Wet materials are dried by suitable methods until they meet the moisture content specified in the technical specifications.

The materials from borrow pits and road excavations will be classified as suitable and unsuitable for embankment work.

Unless otherwise specified in these specifications, materials with a particle size greater than 75 mm shall not be used for embankment filling. However, if the fill material is not unsuitable material as defined in Clause 502, has particle size of greater than 75mm but less than 250mm, it is defined as hard fill material and, if approved by the Engineer, can be used in accordance with Article 506 for filling up to 1.5 m below the surface of the frost protection layer of the high embankment section. For this work, the Engineer shall take into account the nature of the materials to be used, the capacity of the Contractor's equipment and the working methods demonstrated during the field tests.

The filling material should be carefully selected according to its particle composition so that there is no separation, instability or problems during compaction.

(b) Backfill to structures

When backfilling and compacting the space near structures, fill material with appropriate particle size that meets the following requirements shall be used:

- Plasticity index of clay fraction is less than 7%,
- Liquid limit of clay fraction is less than 30%,
- Fine particles passing through a 0.02 mm sieve are less than 3% of the dry weight.

(c) Frost resistant subgrade

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The top 0.3-meter-thick surface layer of embankment is described as embankment subgrade. Unless otherwise specified by the Consultant or shown on the Drawings, the above-mentioned material shall be placed as embankment subgrade at the Consultant's satisfaction. If soil at the excavation level in cuts does not meet material requirements for embankment subgrade, then it shall be excavated and replaced. Even if soil at the excavation level in cuts meets the material requirement, but the thickness is less than 30 cm, then it shall be excavated and replaced.

In addition to the meeting the material requirements for embankment fill, frost resistant subgrade shall contain less than 3% by dry weight of particles passing through a 0.02 mm sieve.

(d) Construction

The contractor shall organize the work in such a way that the earthworks will be carried out continuously and completed in sequence. Upon completion of any stage of embankment or pavement, the Contractor shall submit a request for approval in writing to the Engineer at least 48 hours before commencing the next stage of work, giving the Engineer sufficient time to carry out his quality assurance responsibilities. The Contractor shall not commence the next layer works on any compacted layer until written approval has been obtained from the Engineer. As soon as the approval of the previous layer is obtained, the material of the next layer shall be laid.

If any layer is left unprotected for more than 24 hours after the Engineer's approval, the Engineer's approval for that period shall be obtained again and the Contractor shall resubmit his application for approval. The compacted thickness of the embankment fill material shall not exceed 150 mm. The Engineer may approve use of thicker layers, provided that the Contractor demonstrates, based on tests using alternative work methods and equipment, that it is possible to spread the fill material in thicker layers than specified herein and to compact it to the required extent. However, the maximum permissible compaction thickness shall be 250 mm. Each embankment layer shall be laid to a sufficient width and compacted in accordance with Section 507 of these specifications.

When constructing the embankment, the Contractor shall comply with the permissible height and width, taking into account the compaction, settlement, compaction and shrinkage of the subsoil under the embankment. During the construction of the embankment, in the case of deformation or movement of the material of the subsoil, the Contractor shall carry out compaction of the approved filling material at the prescribed level and width on each layer at his own expense.

During the construction of the embankment, care should be taken not to allow any vehicle movement over the unprotected surface of the compacted earth. If the Contractor needs to move his working machines and mechanisms over the embankment, he shall organize them so that they do not travel in a single line, but evenly spread across the entire width, and take all necessary steps. If any part of the compacted earth is deformed or damaged due to movement before placing the next layer, the Contractor shall loosen and re-compact the part to meet the conditions of the technical specifications and the requirements set by the Engineer. Fill material shall not be stored in piles on embankments unless specifically authorized by the Engineer.

When the embankment is built up to the level of bridges, culverts or above the drainage pipe, the embankment should be raised at the same level on both sides of the structure. Unless otherwise directed by the Engineer, this work shall be carried out concurrently with the backfilling of the structure. The embankment compaction equipment should be operated as close to the structure as possible, without causing any damage to it. If any damage is caused to the structure, the Contractor shall repair it at his own expense.

(e) Widening of existing embankments

Widening of existing embankments shall include following activities:

1. Remove and stockpile topsoil
2. If slope is steeper than 1:4, bench the excavation
3. The widened part of the embankment and excavation should be compacted in accordance to Clause 507 of this Specifications. The height of the benches should be the same as the layer thickness.
4. During embankment widening ensure that surface water drainage is maintained.

506 ROCK FILLING

If instructed by the Engineer, the Contractor shall excavate swampy soil, transport it to the disposal site, and perform rock filling as follows. Also, the height up to 0.6m below the lower edge of the pavement shall be filled with excavated stone material as instructed by the Engineer or according to the design.

The maximum particle size of hard material to be used for filling the high embankment section is 250 mm. The hard material shall be spread in layers over the total width of the embankment to an uncompacted thickness of not more than 400 mm and the material shall be of suitable grain size. The material is spread and leveled with a crawler tractor weighing not less than 15 tons. It is not allowed to drop stone material on the side slopes of the embankment.

Before laying the next layer, each layer should be filled with fine stones and gravel and filled with suitable grout. Each layer shall be compacted in accordance with Section 507 of these specifications. The Engineer may change the requirements during the filling process of the hard material according to the conditions at the time.

507 COMPACTION OF EARTHWORKS

The moisture content of the material for non-frost material or earthworks fill material shall be adjusted immediately prior to compaction by either uniformly mixing in water or drying out the material such that the range moisture content during compaction is between 1% above and 2% below the Optimum Moisture Content (AASHTO T180). The moisture content shall be kept within these limits until compaction is complete.

Each layer of material shall be compacted at a moisture content within the above limits to a dry density equal to or exceeding those specified below:
all fill material in embankments, except the non-frost subgrade layer shall be compacted to 95% MDD (AASHTO T180),

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- the non-frost subgrade layer on embankment shall be compacted to 98% MDD (AASHTO T180),
- Below the finished formation level in cuttings, if it is proved to be suitable by laboratory testing, shall be compacted to 98% MDD (AASHTO T180) a.

Compaction under and in embankments shall be performed utilizing the methods proposed by the Contractor based on site trials and approved by the Engineer for the non-frost subgrade layer in both cut and fill areas.

The water to be used shall be clean and fresh, free from organic matter, impurities and deleterious substances. Water shall be obtained from a source approved by the Engineer. The Contractor shall, if the Engineer should so require, arrange for the analysis of water supplies to demonstrate compliance with this Specification.

Water shall be evenly sprinkled on the surface of the fill material by machines of a type approved by the Engineer and capable of distributing water at a known, predetermined and constant rate.

508 SPOIL MATERIAL

Spoil material shall be defined as material which, having been obtained from roadway excavations (including from road subgrades and foundations), is unsuitable for use as fill in embankments, or otherwise determined by him as not required for use as fill or non-frost subgrade material, which the Engineer has instructed to be carted to spoil. No excavated material should be carted to spoil except under the specific instructions of the Engineer.

Excavated material initially classified as spoil material but latter on used by the Contractor as fill material, non-frost subgrade, subbase or in any other manner as part of road construction shall be declassified as spoil material and the measurement of spoil material shall be adjusted accordingly.

Spoil material shall only be disposed of by deposition in designated spoil areas located by the Contractor and subject to the prior approval of the Engineer. Land for spoil areas shall be provided in accordance with the provisions of Section 600 of this Specification. The Contractor shall give the Engineer at least 24 hours notice of his intention to commence spoiling operations at a particular location.

509 BORROW AREAS

Fill material that is required in addition to that provided by the excavation, or widening of existing cuttings shall be obtained from borrow areas. Land for borrow areas shall be provided in accordance with the provisions of Section 600 of this Specification. Borrow areas shall be located by the Contractor and shall be subject to the Engineer's approval.

The Engineer may direct that particular materials in borrow areas shall be selected for use in a specific section of the Works. Where such selection is instructed, double handling, stockpiling or excavation in particular areas of a borrow area may be required.

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All borrow material shall be thoroughly mixed in or close to the borrow area and stockpiled for later use to ensure that material from a particular borrow area is homogeneous and uniform in nature throughout.

The Contractor shall construct all accesses to borrow areas and clear and remove all vegetation, boulders and unsuitable, or oversize material from the borrow area. Overburden shall be removed and may be required to be stockpiled for use during the reinstatement of the borrow area in accordance with the provisions of Section 600 of this Specification.

The Contractor shall ensure in every borrow area that suitable material is not contaminated with unsuitable material. Unsuitable material shall be spoiled in accordance with Clause 508 of this Specification or used to reinstate the excavation in accordance with Clause 505 of this Specification.

Borrow areas shall be excavated to regular widths and shape and shall be cleaned up and reinstated on completion. Side slopes of reinstated borrow areas shall have a maximum slope of 6 horizontal to 1 vertical. Borrow area sides shall be neatly trimmed and their bottoms leveled and drained away from the Works all in accordance with applicable contractual, regulatory and legal requirements and the provisions of Section 600 of this Specification.

510. TRIMMING OF SLOPES

The side slopes of embankments shall be trimmed by hand or by approved mechanical means to uniform batters as shown on the Drawings or as instructed by the Engineer. The faces of embankments shall be of properly compacted material in accordance with the requirements of Clause 507 of this Specification and any loose improperly compacted or oversize material shall be trimmed back and removed from embankment faces. Such material shall either be carted to spoil or, if it should be deemed suitable by the Engineer, incorporated elsewhere in the Works. The trimming of cutting and embankment slopes shall be completed within 1 month of completion of earthwork up to formation level.

Any rock, boulder or bitumen-bound/cement-bound pavement appearing in the face of a cutting or embankment shall be trimmed back to within the tolerance specified. If any exposed rock or boulder should be unstable, it shall be completely removed and the resulting void filled with suitable material compacted to the approval of the Engineer.

Trimming the slopes of embankments and cuttings shall be deemed to be part and parcel of the excavation of cuttings and side drains and the construction of embankments and the Contractor shall not be entitled to any separate payment in respect thereof.

511 PREPARATION OF FORMATION

The formation shall, after completion of any subgrade drainage, and immediately before laying sub-base on areas of completed formation, have a surface level tolerance within +20 mm and -30 mm relative to its designed level after completion of the following operations as necessary:

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- (i) Any protection layer shall be removed and any soft or damaged areas shall be rectified by excavating them and replacing with acceptable material having the same characteristics and strength as the surrounding material. The surface of the formation shall be trimmed and immediately cleaned free from mud and slurry.
- (ii) The formation shall immediately be compacted, in addition to the compaction required for the fill. Immediately after the additional compaction the formation shall be trimmed to achieve the tolerances of this sub-Clause.

Where the tolerances of this Clause are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and shall make good the formation as follows:

- (i) if the surface is too high it shall be re-trimmed and re-compacted;
- (ii) if the surface is too low it shall be corrected by the addition of acceptable material having characteristics and strength matching the overlain material, deposited and compacted.

After trimming, or re-trimming if necessary, the formation shall be rolled with one pass of a smooth-wheeled roller having a mass per metre width of roll not less than 2100 kg or a vibratory roller having a mass per metre width of vibrating roll of not less than 700 kg or a vibrating plate compactor having a mass per m² under the base plate of not less than 1,400 kg.

Where the tolerances of this Clause cannot be achieved in the preparation of formation in rock then one of the following shall be carried out so as to achieve the above tolerances:

- (i) the material shall be excavated below formation to the depth shown on drawings. The excavated material shall be processed as described therein and re-deposited and compacted in compacted layers not greater than 250 mm thick; or
- (ii) where the rock surface is tabular it shall be regulated by depositing and compacting cement bound material.

Formation shall be compacted to and end-product specification of a minimum Modulus of Elasticity (EV₂) of 45 MN/m² as determined by a Humboldt stiffness tester or equivalent.

512 MEASUREMENT AND PAYMENT

A suitable computer program and the cross-sections taken in at 20 m intervals shall be used for the computation of earthworks volumes. In irregular ground or tight curvature the Engineer may direct that cross-sections shall be taken at closer intervals.

Earthwork fill shall be measured by the cubic meter of compacted material measured in the completed embankment. No separate measurement or payment shall be made for excavating material to form embankments.

Where fill material is required in addition to that provided by the excavation, including widening, of cuttings and the Engineer instructs the opening of a borrow area, no separate measurement and payment shall be made for:

- provision of land,
- provision of access roads,
- negotiation with owners and authorities,
- royalties, duties and levies on extracted material,

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- removal of topsoil and/or overburden to temporary stockpiles for use upon reinstatement of the borrow area
- transporting
- crushing and/or screening of material to remove oversize material, excess fines or part of any other fraction in order to achieve compliance with this Specification,
- double handling or temporary stockpiling of suitable material in borrow areas.

When instructed by the Engineer, the Contractor shall leave depth indicators during excavations of such shape and size and in such positions as directed so as to indicate the original ground level as accurately as possible. The Contractor shall see that such depth indicators remain intact until final measurements are taken.

Unsuitable or unstable material cut to spoil shall be measured as the volume of the excavation formed.

Material cut to spoil shall be measured, utilizing a suitable computer program for calculation, as the total volume of material removed from cuttings less the volume of unsuitable material cut to spoil as measured above and less the volume of compacted fill in embankments.

- (a) Embankment construction using material from borrow area or roadway excavation
Unit: m³

The measurement shall be the volume of compacted fill in embankments. The item shall include for:

- Excavation, haulage, placement and compaction of embankment from either roadway excavation or borrow pits;
- protection of subgrade;
- multiple handling of material;
- keeping earthworks free of water;
- complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalisation of earth pressures;
- complying with the particular requirements and constraints with regard to soil stabilisation, reinforced earth structures, strengthened embankments, anchored earth structures, corrugated steel buried structures and the like;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- replacing acceptable material rendered unacceptable;
- selection of material of stated Classes and layering or depositing in locations stated in the Contract;
- depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- trimming and shaping to levels and contours;
- trial areas, trials and demonstrations;
- making good after sampling and testing;
- forming and trimming side slopes, benchings and berms in both cut and fill sections;
- treatment of side slopes and berms;
- watering or drying to adjust moisture content;
- compaction of fill;
- blinding;
- special measures for dealing with processed material.

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(b) Excavation in hard rock

Unit: m³

The measurement shall be the volume of excavated hard rock material. The item shall include for:

- surveying the locations where pre-splitting prior to blasting is considered;
- preliminary site trials of blasting;
- blasting, splitting, breaking and the like;
- clearing unstable rocks;
- videotaping at rock blasting locations;
- loosening or breaking up material before or in the process of excavation;
- excavation of material;
- upholding the sides;
- working around and between piles;
- overbreak and making good;
- keeping earthworks free of water;
- selection and separation of materials;
- forming and trimming side slopes, benchings and berms;
- trimming the bottom and sides of foundations;
- grading beds and trimming sides of watercourses and the like;
- protection of subgrade;
- additional excavation the Contractor may require for working space, timbering, formwork or other temporary works and its subsequent backfilling with approved materials and compaction;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- treatment of faces of cuttings which are not to receive topsoil;
- loading into transport;
- haulage and deposition including the provision of sites for deposit;
- multiple handling of material;
- waiting for frozen material to thaw;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like.

(c) Excavation and disposal of unsuitable and surplus material

Unit: m³

The measurement shall be the volume of excavated and disposed unsuitable and surplus material excavated from within the Site.

The items for disposal of unsuitable material shall include for:

- loosening or breaking up material before or in the process of excavation;
- excavation of material;
- upholding the sides;
- working around and between piles;
- overbreak and making good;
- keeping earthworks free of water;
- trimming the bottom and sides of foundations;
- grading beds and trimming sides of watercourses and the like;
- protection of subgrade;
- loading into transport;
- haulage and deposition including the provision of sites for deposit;
- multiple handling of material;
- special measures for dealing with Classes U1B and U2 material;
- waiting for frozen material to thaw;

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- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like.

(d) Levelling and compaction of formation level

Unit: m²

The measurement of completion of formation shall be the area of the layer immediately beneath the sub-base and shall be measured in both cuttings and embankment.

The item for completion of formation shall include for:

- removal of protective layer, mud and slurry;
- compaction;
- cleaning, shaping, trimming, regulating, making good and rolling;
- excavation, processing, compaction of naturally occurring hard material;
- measures to protect formation and sub-formation against deterioration or degradation.

(e) Embankment construction using rock fill

Unit: m³

The measurement shall be the volume of rock material, as shown on the drawings or instructed by the Engineer. The item shall include for:

- Excavation and haulage from borrow, or haulage from roadway excavation, placement and compaction of rock;
- multiple handling of material;
- keeping earthworks free of water;
- provision, placing and compaction of rock material;
- trimming and shaping to levels and contours;
- making good after sampling and testing;
- forming and trimming side slopes, benchings and berms in both cut and fill sections;

(f) Fertile topsoil and greenery

Unit: m²

The measurement shall be the plan area to be topsoiled to the specified thickness.

The item shall include for:

- the removal of debris;
- excavation from stockpile;
- loading into transport;
- haulage, deposition, spreading, levelling and compaction;
- trimming and shaping to levels and contours;
- topsoiling;
- provision and planting of suitable seed mixtures;
- weed control;
- watering including water supply;
- reseedling;
- maintenance of grassed area
- herbicide treatment.

SECTION 600 - QUARRIES, BORROW AREAS, STOCKPILE AREAS AND SPOIL AREAS

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601. GENERAL

The Contractor shall select the sources of aggregate for concrete works, bituminous pavement works, graded crushed stone base, stone masonry, riprap, rockfill to swamps etc. Such sources shall be designated as quarries and are defined in Clause 602 (a) of this Specification.

The Contractor shall select the sources of natural materials for fill material in the construction of embankments and gravel for subbase, wearing course, haul roads and shoulders. Such sources shall be designated as borrow areas and are defined in Clause 602 (b) of this Specification.

The Employer shall not be held liable for the quality and suitability of any material in any of the potential quarries or borrow areas identified in the Engineer's report on materials. The Contractor shall be held solely responsible for investigation and identification of material sources.

602. DEFINITIONS

- (a) A quarry is an open surface working from which stone is removed by drilling and blasting or excavated by any other means for use in the Works.
- (b) A borrow area is a site from which materials, other than stone, are removed for use in the Works.
- (c) A stockpile area is a site upon which material such as topsoil, fill material, gravel or aggregate is temporarily heaped prior to its incorporation in the Works.
- (d) A spoil area is a site upon which surplus or unsuitable materials arising out of the Works are spread and disposed of. Surplus or unsuitable material shall not be placed within the road reserve without the prior written approval of Engineer.

603. PROVISION OF LAND

The Contractor and be responsible for obtaining landowners agreement and any relevant licenses or permits for all land required for borrow areas, quarries, stockpile areas, and spoil areas. In particular, the Contractor is responsible for the acquisition of all land required for:

- quarry and borrow pits
- stockpile and spoil areas
- access roads thereto,
- deviations outside the road reserve
- the Site laboratory,
- the Engineer's residential and office accommodation,
- the Contractor's camps, offices, stores, workshops, houses, etc.,
- Temporary Works, or any other purpose shall be the responsibility of the Contractor.

The Contractor shall ensure that any national or local laws and regulations pertaining to locating and exploiting quarries and borrow areas are satisfied.

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The location and size of quarries, borrow areas, spoil areas and stockpile areas proposed by the Contractor shall be subject to the approval of the Engineer.

If, in the opinion of the Engineer, the location of any proposed quarry, borrow area, spoil area or stockpile area, or access track to them, should:

- have a potentially detrimental effect on the environment,
- be in or too near an urban center,
- require an access road that is excessively long,
- cover too large an area,
- constitute a risk to the safety of the public,
- be more distant than another source of suitable material or area,
- result in the obstruction or disruption of existing watercourses or water supplies,
- the Engineer's approval may be withheld.

The Contractor shall inform the Engineer in writing at least 28 days in advance of any work being undertaken in each particular quarry, borrow area, spoil area or stockpile area.

Prospecting will be done prior to such notification and the Contractor shall inform landowners and get permission from the landowners at least 7 days before prospecting takes place. The Contractor shall complete all necessary negotiations with the owners of the land upon which any quarry, borrow area, spoil area or stockpile area is to be located and shall compensate the owners directly in respect of royalties, buildings to be demolished or loss of crops to which landowners may be entitled in accordance with current ordinances.

The Contractor shall also be liable for any taxes, duties, levies and other statutory payments in respect of land use or the extraction of materials or water.

Prior to the submission of written notice to the Engineer the Contractor shall set out each quarry, borrow area, spoil area and stockpile area with concrete beacons clearly identifying the areas required for working areas, stockpile areas, blasting safety zones and access routes. The Contractor's written notice shall include the following for each quarry, borrow area, stockpile area and spoil area:

- (a) details of the route of the access track proposed,
- (b) a plan at 1:500 scale in ink on a stable transparent material giving details of:
 - plot boundaries, geometric dimensions,
 - owners' names and addresses,
 - local details such as buildings, fences, graves, types and areas of cultivation and services, all agreed with the land owners, and,
 - areas to be used for working areas, stockpile areas, blasting safety zones, etc.
- (c) Authorization from the owner and competent national/local authorities indicating permission to occupy and use the land .

Where a quarry, borrow area, spoil area or stockpile area has insufficient suitable material or area for the use for which it was intended, the Contractor shall propose in writing that either an existing quarry, borrow area, spoil area or stockpile area be extended or that a new quarry, borrow area, spoil area or stockpile area shall be opened.

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The approval and acquisition of such new or extended quarries, borrow areas, spoil areas or stockpile areas shall be in accordance with all the provisions of this Clause 603 of the Specification.

604. ENTRY UPON LAND

The Contractor shall, before entering upon any land satisfy himself that legal rights of entry have been obtained including environmental clearance.

The Contractor shall not enter any area without the Engineer's written approval.

605. SAFETY AND PUBLIC HEALTH REQUIREMENTS

The Contractor shall comply with the bye-laws of the Local Authority regarding public health and safety in respect of the operation of quarries, borrow areas, stockpile areas and spoil areas, and in the absence of, or in addition to such bye-laws, shall comply with the following conditions:

- (a) All areas being worked shall be drained and kept dried. Where a quarry or borrow area has been excavated such that it will not drain naturally, it shall be continually pumped dry while being used. Where instructed by the Engineer, on completion such depressions may be left to form a reservoir for livestock drinking water. In which case slopes shall be graded back to a slope flatter than 1 in 6 to facilitate access by livestock.
- (b) Such areas shall not encompass or be located within or adjacent to watercourses, settlements or urban areas.
- (c) Such areas shall not be located within the boundaries of:
 - Strictly Protected Areas,
 - National Conservation Parks,
 - Peripheral Zones,
 - Nature Reserves,
 - Monuments,
 - Strict Zone Forests,
 - Water Zones.
- (d) Spoil areas shall be located at least 500 m away from the forest areas and it shall not contaminate any water sources like rivers, streams, waterways, drains, watercourses, lakes etc.
- (e) The Contractor shall confine his operations solely to the areas provided and shall demarcate the boundary of the area and erect temporary or permanent boundary fencing as instructed by the Engineer.
- (f) Where the height of any face exceeds 1 metre, the Contractor shall provide, erect and maintain at his own expense temporary livestock-proof fencing and gates to prevent unauthorized access to the top of the working face.
- (g) On completion of work all faces shall be battered back and neatly trimmed to a slope flatter than 1 in 6.
- (h) On completion of work temporary fences and all temporary structures shall be demolished and removed, all latrine pits shall be filled in and drained, topsoil shall be spread and watered and the Site shall be left neat and tidy.

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- (i) The Contractor shall take all necessary steps to prevent the discharge of any operational pollutants, including, but not limited to, suspended sediments, solutes and oils, into ground water or surface drainage systems.
- (j) On completion of work all quarries, borrow areas, spoil and stockpile areas shall be reinstated such that they represent neither a visual intrusion upon the landscape nor a hazard to the public and livestock. Slopes shall be stable and provided with topsoil that shall be regularly watered to promote the growth of covering vegetation. Land drainage, as far as in the opinion of the Engineer is practicable, shall be restored to its original state.

606. ACCESS TRACKS

The Contractor shall provide at his own cost for the construction and maintenance of access tracks and existing roads to quarries, borrow areas, spoil areas and stockpile areas.

607. SITE CLEARANCE AND REMOVAL OF TOPSOIL AND OVERBURDEN

Unless otherwise instructed by the Engineer, the Contractor shall carry out site clearing in accordance with Section 400 of this Specification of all existing quarries, borrow areas, stockpile areas, spoil areas and access tracks thereto, except that measurement and payment will be in accordance with this Section of this Specification.

All existing fences, trees, hedges and other features that the Engineer instructs shall not be removed or disturbed shall be protected in accordance with the requirements of Section 400 of this Specification.

Unless otherwise directed by the Engineer the Contractor shall remove topsoil and/or overburden from quarries, borrow areas, spoil areas, stockpile areas and access tracks thereto. The Engineer shall direct whether topsoil shall be stripped and stockpiled separately or shall be excavated together with the overburden. The Engineer may direct that either topsoil or overburden, if it should prove suitable, be used in the Works.

Topsoil shall be stockpiled in heaps not exceeding 1 m in height. The sides of topsoil heaps shall be fully terraced to prevent surface water run-off and to harvest rainfall. The Contractor shall regularly water topsoil heaps as required to promote the re-establishment of covering vegetation and prevent loss of topsoil by wind erosion.

On completion of work in any quarry, borrow area, spoil area or stockpile area any overburden and/or topsoil that has not been used in the Works shall be pushed back, spread and landscaped over the area of the quarry, borrow area, spoil area, stockpile area or access track thereto. Where topsoil has been stockpiled separately it shall be held back in reserve for spreading over such areas after landscaping.

608. MIXING, SELECTING AND STOCKPILING OF MATERIALS

For attaining the specified grading, the Contractor may be required to mix materials obtained from natural sources using appropriate mechanical equipment such as bulldozer,

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grader, loading shovel, rotavator etc. Such materials shall be thoroughly mixed into a homogeneous composition and formed into stockpiles at least 7 days before intended use.

The Contractor shall ensure that oversize materials and unacceptable material components such as , clay, humus or other inferior or deleterious material encountered in the works is separated from the suitable materials proposed for use in the Works. Such undesirable material shall be removed to spoil. Within each borrow area separate stockpiles shall be used for each type and grading of material.

When removing material from stockpiles, none of the underlying material shall be mixed with it, and generally at least the bottom 100 mm layer shall be left behind.

Should any stockpiles prove surplus to requirements the Contractor shall spread the material over the area of the quarry or borrow area unless directed otherwise by the Engineer.

609. MATERIAL UTILISATION

The requirements for materials from borrow areas for the Construction of the Permanent Works shall take precedence over any requirements the Contractor may have in respect of other works. Where the Contractor requires material from a borrow area, for the construction of access roads, deviations, detours, haul roads, camps, Temporary Works or for any other works not forming part of the Permanent Works he shall require the approval of the Engineer.

610. MEASUREMENT AND PAYMENT

No separate measurement and payment shall be made in respect of this Section 600 of this Specification. The Contractor shall be deemed to have allowed elsewhere in his rates and prices for the cost of complying with all the requirements of Section 600 of this Specification.

Where the Engineer instructs that overburden to be used in the Permanent Works measurement and payment will be in accordance with the corresponding Sections of this Specification.

SECTION 700 – EXCAVATION FOR DRAINAGE STRUCTURES AND PROTECTION WORKS

CHAPTER	CONTENT
701	SCOPE OF THE SECTION
702	CLASIFICTION OF EXCAVATION
703	EXCAVATION FOR CULVERTS AND DRAINAGE WORKS
704	WATER IN EXCAVATION
705	EXCAVATION IN HARD MATERIAL
706	SURPLUS EXCAVATION AND FILLING
707	PROTECTION WORKS
708	EXCAVATION FOR WATER TRAINING AND NEW WATERCOURSES
709	STONE PITCHING
710	RIP RAP
711	MEASUREMENT AND PAYMENT

701 SCOPE OF THE SECTION

This section covers the excavation associated with side ditches, drainage works and the protection of drainage structures. It also includes river training and protection works.

702 CLASSIFICATIONS OF EXCAVATION

All excavation for drainage ditches and river diversion shall be classified as “excavation of hard material” or “general excavation” according to the definition in Section 500 of this Specification. Excavation of hard material includes only excavated materials using explosive method or mechanical stone crusher equipment. Boulders derived from general excavation are more than 0.75m³ shall include in hard materials.

Excavation of basic material shall include suitable or unsuitable materials except hard materials.

703 EXCAVATIONS FOR CULVERTS AND DRAINAGE STRUCTURES

The Contractor shall carry out all excavations for culverts and drainage works to the lines, levels, inclinations, and dimensions shown on the Drawings or instructed by the Engineer. The Contractor shall separately and carefully set aside the various suitable materials encountered so that they may be used for backfilling. If excavated materials are, in the opinion of the Engineer, unsuitable for use as backfill, the Contractor shall spoil such materials upon the instruction of the Engineer.

All excavations shall be kept clean and free from water, snow and ice, and the Contractor shall dig diversion channels, erect cofferdams or otherwise de-water the excavation. Where, in the opinion of the Engineer, the surface of the excavation has become soft or unsuitable due to the Contractor's method of working, the Contractor shall, at his own expense, remove and replace the unsuitable material with non-structural concrete or other approved material as instructed by the Engineer.

The final excavated surface in soft material upon which culverts and all other works specified are to be constructed shall be compacted to a dry density of at least 95% MDD (AASHTO T180) to a depth of 150 mm. For culverts that are to be constructed approximately at existing ground level after the removal of topsoil, the Contractor shall level the existing ground by excavating and/or filling in layers. The ground for 150 mm below invert or underside of bedding material shall be compacted to a dry density of at least 95% MDD (AASHTO T180) such that the foundation for the culvert or bedding is true to grade and of uniform density over the whole length of the culvert.

Where ground conditions, through no fault of his own, are such that a satisfactory foundation cannot be achieved the Contractor shall, upon instruction by the Engineer, remove the unsuitable material either until suitable material is encountered or to the depth and width instructed by the Engineer. This depth should be determined in part by the results of frost classification of the foundation soils. The Contractor shall backfill the resultant excavation with approved material to a dry density of 95% MDD (AASHTO T180).

704 WATER IN EXCAVATION

The Contractor shall make necessary works such as digging drainage, building barriers, pumping water or drying out in order to prevent water enter into foundation pit.

If Engineer requires dewatering well shall be provided outside of foundation layer. Excess squeezing is not allowed for dewatering in cutting due to erosion of fine particles from shrinkage and defects of soils.

Where, in the opinion of the Engineer, the surface of the excavation has become soft or unsuitable due to the Contractor's method of working, the Contractor shall, at his own expense, remove and replace the unsuitable material with non-structural concrete as specified or other approved material as instructed by the Engineer.

The Contractor shall excavate and backfill with his own expenses approved material to a dry density of 95% MDD (AASHTO T180).

705 EXCAVATION IN HARD MATERIAL

(a) Concrete culverts

Where hard material is encountered in trenches for concrete culverts, it shall be excavated so that no hard material protrudes within 50 mm of the underside of the pipe socket. A regulating layer of non-structural concrete of minimum thickness 50 mm shall be placed and compacted on the excavated hard material surface, the top of which shall be at the level of the underside of the pipe barrel. The maximum thickness of regulating layer shall be 150 mm. Where both soft and hard material are encountered in the trench either the soft material shall be removed to a depth of 300 mm or to such depth as instructed by the Engineer and replaced with non structural concrete, or, at the discretion of the Engineer, the hard material shall be removed to a depth of 300 mm or to such depth as instructed by Engineer and backfilled with similar material to that in the remainder of the trench invert and compacted to 95% MDD (AASHTO T180).

(b) Minor structures

Where hard material is encountered in excavations for minor structures it shall be dealt with in accordance with the relevant sections of Clause 703 of this Specification.

706 SURPLUS EXCAVATION AND FILLING

Surplus material of excavation shall be spoiled at the specified place in accordance with Section 500 and 600 of this Specification or shall be used for earthworks at the Engineer's discretion. Only approved material by the Engineer shall be used for retaining wall and backfill.

707 PROTECTION WORKS

The Contractor shall provide and place protection works. Protection work in connection with drainage channels, culvert inlets and outfalls and river training will consist generally of stone pitching or rip-rap. Drawing of water training and temporary works shall be submitted to the engineer for approval prior to starting temporary works in accordance with Section 114

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of this Specification. The Contractor, for placing those structures, shall make effort not to harm or damage to people, animal and property. Unless otherwise directed by the Engineer, the Contractor shall remove cobbles and boulders from stream beds for masonry or other works.

708 EXCAVATION FOR WATER TRAINING AND NEW WATERCOURSES

Excavation for temporary road aside river, widening, deepening or straighten or developing new diversion shall be carried out as per design or instructed by the Engineer. This excavation work shall consist of site clearance, trimming of slope, embankment work and removal of cutting material. If it needed to divert river direction or Engineer has give instruction, plants and grass and soft spoils at original channel shall be removed and filled by suitable material and shall be compacted to a dry density of at least 95% MDD (AASHTO T180). Borrow areas should be far from water channel. Meanwhile construction of bridge, back fill for existing channel shall be carried out simultaneously.

Backfill to existing channels shall be taken in hand alongwith the construction of the bridge. Every effort shall be made to complete the backfill work in one working season. Where there is any doubt about completion of the whole backfill work within one working season, the Contractor shall take suitable measures for protection of the completed work.

River training and protection works shall include stone pitching and rip rap and these are required for ensuring safety of bridge and structure from damages due to flood and ice.

709 STONE PITCHING

The Contractor shall provide stone pitching for drains conforming to Drawings and as further directed by the Engineer. Stone pitching shall consist of sized stones set in sand-cement mortar, laid on the sides and bottom of drains.

The stones used in stone masonry lining shall be hard, sound and unweathered pieces free of seams, laminations, cracks, hollows, inclusions or any other defects. The stones from quarry shall be used. The stones with rounded or triangular face/s or flaky in shape shall not be used.

The stones subject to marked deterioration by water or weather shall not be accepted. The size of stone for flexible boulder apron shall be large as possible. In no case any fragment shall weigh less than 35 kg unless accepted by the Engineer. Minimum acceptable size of stone fragment is 25mm and to be suitable to fill spaces. The apparent specific gravity of stone shall be at least 2.40.

The surface on which the stone apron is to be laid shall be leveled and compacted to a dry density of at least 95% MDD (AASHTO T180). Alongside bottom of stone pitching or at the bottom of river where water runs, channel shall be provided.

The stones shall be laid from bottom of channel and well embedded. Stone pitching shall be settled carefully. Stones shall be tamped well and to be placed keeping minimum distance. Spaced between stones shall be filled by fine aggregates. up section of stone pitching shall be levelled in adjacent layer.

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Where shown on the Drawings the Contractor shall provide stone pitching to the specified thickness and the shape after removing dust and mud.

Where grout is specified, the surfaces of the stones shall be thoroughly cleaned and free from adhering dirt and clay. The grout shall be smoothed off flush with the pitched face and the stones shall be thoroughly brushed such that their top surfaces are exposed.

The cementitious binder for the mortar shall comprise 1:3 part of cement and sand and shall be placed well in between spaces. Mortar shall be broomed and cleaned along with the surface of stone pitching.

The stone masonry lining after being laid should be covered by wet cotton or any other accepted method to be kept in a weather condition for 7 days at least as to ensure initial hardening of mortar.

Drainage layer shall be provided on the ready surface or before doing stone pitching in order to prevent alkaline impact to the road embankment or let run water freely not causing soaking. Under the stone pitching one layer of drainage shall be provided. Drainage aggregates shall be met with the requirements of Section 700 of AASHTO – road construction manual.

Boulder apron: The stone shall be sound, hard, durable and fairly regular in shape. The stones subject to marked deterioration by water or weather shall not be accepted. The size of stones shall be as per design or instructed by the Engineer.

The surface on which the stone apron is to be laid shall be leveled, compacted and prepared for the length and width as shown on the drawings

710 RIP RAP

The stones used in rip rap shall be hard, sound and crushed or natural stones. The individual stone pieces shall be approximately parallelepiped in shape, at least 75mm thick and 23kg weight and 60 percent of stone mass shall be more than 35kg. The stones shall be rough finished and having particle fragments suitable for filling spaces between stones. The apparent specific gravity of stone shall be at least 2.40. The surface on which the riprap is to be laid shall be leveled and compacted to a dry density of at least 95% MDD (AASHTO T180).

To ensure regular and orderly disposition of the full intended quantity of stone, riprap construction shall be bounded by 1m thick dry masonry walls constructed in perimeter trenches 600 mm deep and extending to the full height of the specified thickness of riprap.

Where designated by the Engineer or shown on the Drawings, a granular filter, consisting of one or more thick layers of graded permeable material, shall be placed on the prepared surface to the required thickness and with an even surface finish for each layer placed. The grading requirements of such granular filter material shall be in accordance the Specification Clause 707 or designated by the Engineer.

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The stones shall be laid with close joints from the bottom of the slope of embankment, or existing ground upward, the larger of the stones being laid at the bottom. The surface shall be hand packed, carefully bedded and tightly wedged with suitable spalls to form an even, densely packed surface.

711 MEASUREMENT AND PAYMENT

(a) Side and interceptor ditches

Unit: m³

The volume for side and interceptor ditches shall be measured by cubic metre. Volume shall be calculated as the product of the average end areas of excavation measured at intervals of not greater than 10 m along the centreline of the drain and the length of the drain. The area shall be calculated as the product of the ground level before and after excavation or as instructed by the Engineer.

The rate for channel excavation in soft material shall include for the costs of:

- excavation to any depth and width,
- trimming base and sides to the lines and levels,
- dealing with the flow of water,
- disposal of the excavated material to spoil,
- all necessary hauls, and,
- compliance with the requirements of Clauses 701, 702, 704, 707 and 708 of this Specification.

(b) Excavation for culverts and minor drainage structures

Unit: m³

The unit of measurement for excavation of culverts and minor drainage structures shall be the cubic metre. The volume of excavation shall be calculated as the theoretical void that would be formed if the foundation or structure, including any instructed thickness of blinding concrete, should be lifted vertically out of the ground. No allowance beyond those limits shall be made for working space or overbreak. The calculation of that theoretical void shall be based on the difference between the original ground level as agreed between the Engineer and the Contractor or the formation level, whichever is the lower, and the instructed level of the bottom of the excavation.

The rate shall include for the costs of:

- excavation to any depth instructed by the Engineer or shown on the Drawings,
- shaping and trimming of those faces of the excavation that shall have concrete cast against them,
- compaction of the excavated surfaces upon which foundations shall be placed,
- backfilling with the excavated material or selected material,
- removing the excavated material to spoil if it is unsuitable or surplus to requirements, and,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling etc. for realizing the whole of the works in accordance with the Contract.

(c) Excavation for River Training

Unit: m³

The unit of measurement for excavation for river training shall be the cubic metre. The volume shall be calculated as the product of the average end areas measured

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at intervals of not greater than 10 m along the centreline of the area to be excavated and the length of the excavation. The end areas shall be calculated from existing ground levels or existing river or stream profiles taken prior to commencement of excavation and the cross-section shown on the Drawings or instructed by the Engineer.

The rate for excavate for river training in soft material shall include for the costs of:

- excavation to any depth and to any bed width,
- dealing with water;
- multiple handling of material;
- haulage;
- shaping and trimming the sides and base of the excavation,
- compaction of the excavated surfaces;
- disposal of the excavated material to spoil, and
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling etc. for realizing the whole of the works in accordance with the Contract.

(d) Stone pitching in drains and on slope

Unit: m²

The unit of measurement for stone pitching in drains shall be the square metre. The area shall be calculated from the dimensions given on the Drawings or instructed by the Engineer to be laid.

The item shall include for:

- excavation;
- transportation of excavated soil to spoil area;
- trimming and levelling;
- compacting both side and foundation of cutting
- providing the material and laying and placing stones
- all necessary hauls,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract;

(e) Grouted stone pitching in drains and on slope

Unit: m²

The unit of measurement for grouted stone pitching shall be the square metre. The area shall be calculated as the net area, measured on the slope, instructed by the Engineer to be pitched.

The rate for grouted stone pitching shall include for the costs of:

- excavating,
- disposal of excavated material in a designated spoil area,
- trimming to line and level,
- compacting the sides and base of the excavation,
- construction of toe wall,
- providing and laying filter material,
- providing and laying stone pitching,
- grouting, cleaning, curing,
- all necessary hauls,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(f) Flexible Boulder Apron

Unit: m³

Payment for this item will be at the unit price per cubic metre for the volume of filled and graded stone boulders.

The item shall include for:

- loosening or breaking up material;
- excavation of material;
- working around and between bridge parts;
- overbreak and making good;
- forming and trimming side slopes, benchings and berms;
- grading beds and trimming sides of watercourses and the like;
- treatment of faces of cuttings which are not to receive topsoil;
- loading into transport;
- multiple handling of material;
- disposal of surcharge material where occasioned by the Contractor's method of working;
- disposal of surcharge material rendered unacceptable;
- waiting for frozen material to thaw;
- haulage, deposition and compaction in temporary stockpiles including provision of sites for stockpiles;
- depositing fill to slope away from vertical drainage layers and measures to prevent surface water entering such layers;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like.
- provision of stone boulders/materials;
- trimming and shaping to levels and contours.

(g) Rip Rap

Unit: m³

Rip rap protection works shall be measured as the volume occupied by the protection works.

The item shall include for:

- excavation to any depth in any material, including loosening and breaking up materials;
- disposal of unsuitable and surplus material;
- provision of materials;
- haulage and deposition in culvert inlet and outlet, temporary stockpiles, or if surplus in areas of spoil;
- selection and double handling of materials;
- keeping the earthworks free of water and supporting the earthworks;
- trimming, compacting and preparing the base to receive the protection works;
- laying, bedding, wedging;
- working in and dealing with the flow of water;
- complying with the requirements of Clauses 701, 709 and 710 of these specifications

SECTION 800 - CULVERTS AND DRAINAGE STRUCTURES

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803	REINFORCED CONCRETE PIPE AND BOX CULVERT SECTIONS
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801 SCOPE OF SECTION

This section covers the following:

- a) the provision and installation of circular concrete pipe culverts,
- b) the construction of box culverts
- c) the construction of minor structures including culvert inlet and outlet structures, catchpits, cascades and the like,

Materials and testing of materials shall comply to Section 200 and concrete works shall be carried out in accordance with Section 1300.

802 ORDER OF WORKS

The Contractor shall determine details of length, skew and invert levels and shall provide detailed drawings as construction proceeds. Longitudinal sections, cross-sections and other information shall be submitted to the Engineer for approval.

Before construction or rehabilitation of culverts, the Contractor shall remove debris from existing pipes and adjacent areas to free access water.

All culverts and drainage works shall be carefully programmed. The Contractor shall allow in his program, for the completion of all pipe culverts and drainage works prior to the construction of embankments over or beside them, unless otherwise directed by the Engineer.

803 REINFORCED CONCRETE PIPE AND BOX CULVERT SECTIONS

(a) General

Concrete pipes shall be manufactured and tested in accordance with Clause 212 of this Specification.

Reinforced concrete pipes shall be of precast reinforced concrete and shall conform to AASHTO Specification M 170. Unless otherwise approved by the Engineer or required by the Drawings, the Contractor shall use pipes with tongue and groove joints. Reinforcement in all pipes shall consist of circular bars as shown on the Drawings.

The Engineer may inspect the pipe manufacturing plants at any time to ensure compliance with accepted manufacturing methods. The Contractor will supply material samples for laboratory testing to ensure quality compliance. As part of the Contractor's quality assurance system, the Contractor shall ensure the manufacturer produces precast units in conformity with the Specification and Drawings, verify all conformance data and submit all such conformance data from the manufacturer of the precast elements. The Contractor shall arrange for the Engineer to inspect each reinforced concrete element before laying such pipe or element.

The Contractor shall excavate and prepare trenches and foundations for culverts, in accordance with the provisions of this specification. The Contractor shall be responsible for all dewatering of the trenches and foundations during construction. The Contractor

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shall place supports and/or bedding material in accordance with the Drawings or as required by the Engineer in conformance with applicable Specification sections.

(b) Placing Reinforced Concrete Culverts

The Contractor shall excavate culvert trenches to the required depth. The concrete and/or gravel bed, as shown of the Drawings, shall be constructed to provide a uniform and continuous support under the entire length of the structure. Concrete bedding shall have contraction joints placed at a spacing of not more than 3 m centres.

The trench width shall be a vertical plane 500 mm measured from the outer walls of the structures. The Engineer, at his discretion, may allow extra trench widths, but the Contractor shall receive no additional payment for the wider trench excavation.

The side slopes of the trenches shall be adopted to suit the soil stability. If the Contractor over-excavates the culvert trench, the void shall be filled to the proper level with material approved by the Engineer at the Contractor's own expense.

The Contractor shall lay precast reinforced concrete units carefully. The hubs or socket ends shall be up grade. The spigots or tongued ends shall be fully entered into the adjacent hub or sockets and be true to the required lines and grades.

Before laying succeeding sections of reinforced concrete pipe which do not require cambering, the Contractor shall plaster the lower half of the hub of the preceding sections on the inside with Portland cement mortar. The mortar shall be sufficiently thick to bring the inner surface of the abutting pipes flush and even. The Contractor shall plaster the upper half of the spigot of the succeeding pipe with mortar at the same time.

After laying the reinforced concrete unit, the Contractor shall fill the remainder of the joint with sufficient mortar to form a bead around the joint. The Contractor shall wipe the inside of the joint and finish it to a smooth and even surface. The mortar on the outside shall be cured and remain damp for two days or until the Engineer allows backfilling to proceed.

If the concrete pipes or units do not have spigot and socket flexible joints, the butt joints shall be mortared as specified above and an approved taped band shall be placed around the outside to cover the joint. A mortar band shall be placed over the outside to the extent shown on the Drawings or approved by the Engineer. The band shall be cured for at least 2 days prior to application of bituminous waterproofing.

The Contractor shall not backfill any culvert or appurtenant structure until the Engineer inspects and approves, in writing, the condition of the structure before it is covered. The Contractor shall backfill and compact the material around and over the reinforced concrete culvert pipes as specified on the Drawings using material conforming to the requirements given in these specifications. The granular backfill material shall be free of clay lumps and organic matter. The backfill material shall contain no stones that would be retained on a 25 mm sieve. Oversized material shall be removed at the source of the material.

The Contractor shall place and compact granular backfill to a minimum height of 50 cm above the top of the pipe culvert or to the top of subgrade level, whichever is lower. Unless in a trench, the fill shall extend for a minimum distance of one and a half diameters from the centerline of the pipe on each side of the pipe. The Contractor shall take special care to compact the backfill under the haunches of the pipe properly. The backfill shall be brought up evenly on both sides of the haunches for the entire pipe length. Above the top of the granular backfill, embankment material and/or pavement layers, as applicable to the design, shall be constructed in accordance with the applicable Section of the Specification.

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The Contractor shall place and compact granular backfill to the level of the top slab of box culverts. Above this level embankment and/or pavement layers, as applicable to the design, shall be constructed in accordance with the applicable Sections of the Specification.

Heavy earth moving and compacting equipment shall not operate closer than 1.5 meters from the culvert until the cover above the pipe is at least 50 cm. Light weight equipment may operate within the limitation mentioned above provided the backfill is placed and compacted at least 30 cm above the top of the structure. Notwithstanding these conditions, the Contractor shall be responsible for and shall rectify any damage resulting from his operations.

(c) Extension of Pipes

For extension of pipe culverts, following preparatory works at the existing culvert should be carried out:

1. When connecting the existing pipe to the new pipe, clean the joint and connect the joint for easy assembly and expansion.
2. The joint of the pipe should be well filled with cement mortar with a volume ratio of 1:2.
3. Fill the inside of the joint part of the pipe with mortar, clean and polish the spillage.
4. Use sealants and adhesives (performed joints) for waterproofing of joint sections.
5. Reinforce the new part of the pipe joint with a support beam that prevents it from separating due to settlements.

(d) Waterproofing of Concrete Surfaces

All surfaces of concrete structures including the external surfaces of pipe and box culverts that will be backfilled against or covered below the finished ground level shall be protected with bituminous waterproofing

804 CONCRETING CULVERT BASE

The contractor shall pour a 200 mm thick concrete base along the entire length of the pipe. Concrete class should be B 15.

805 JOINTING CONCRETE PIPES

Jointing of sections of the concrete pipes can be executed in the following ways. These include:

(a) Rigid joints

When installing rigid jointed concrete pipes with integral joints, the contractor shall clean the spigot and the socket of mud, grease and other contaminants before installing the pipe spigot in the sockets. Starting from the top of the pipe, tarred hemp yarn cut to a suitable length to form a joint is wrapped around the spigot to form a butt joint at the top of the pipe, then the spigot is fully inserted into the socket, and the joint is sealed with the gasket. Then, fill the joints with cement-sand mortar in the ratio of 1:2 and grout at an angle of 45 degrees.

Rigid joint sleeves used to join spigots shall be jointed in the same way as integral sockets.

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Before joining all the pipes, the pipes should be soaked and scraped clean, and the joints should be grouted with a cement-sand mortar of 1:2. All joints shall be covered with a covering approved by the Engineer, protected from wind, sun and cold and kept continuously moist for at least 3 days.

After connection, the pipes should not be moved for at least 48 hours.

(b) Flexible joints

Flexible joints between concrete pipes having integral sockets may be formed by a shaped rubber gasket fitted within the socket or by a rubber ring of circular cross section (Oring) placed on the pipe spigot. The type of flexible joint to be used shall be subject to the approval of the Engineer.

Before any joint is installed, all parts of the joint shall be clean and free from mud, oil, grease or other deleterious matter. The Contractor shall lubricate fixed gaskets strictly in accordance with the manufacturer's recommendations. O-ring gaskets shall not be lubricated. Components of flexible joints from different manufacturers shall not be used together.

The spigot of the pipe to be laid shall be entered into the socket of the previous pipe with the two pipes in line, and a firm steady pressure exerted on the end of the pipe being laid. If necessary a jack anchored round the collar of the previous pipe shall be used to pull the subsequent pipe into position. The spigot shall be pulled hard into the socket and then eased back the distance recommended by the manufacturer to provide flexibility in the joint.

After jointing, the Contractor shall test the position of O-rings with a feeler to ensure that they are correctly positioned. If any ring shows a significant departure from a line following a pipe circumference, the joint shall be broken and remade using a new ring.

Where plain ended pipes are connected by a sleeve incorporating flexible joints, the joints shall be made as described for pipes with integral sockets. The joint between the first pipe and the sleeve shall be completed before the second pipe is inserted into the sleeve.

The Contractor d/ shall fill the annular space inside the socket of each pipe or sleeve but outside the gasket with puddled clay, uncaulked yarn or other suitable material approved by the Engineer to prevent the ingress of stones.

(c) Pipe ends

Unless otherwise specified, pipe ends shall be left as straight upright position.

806 CONCRETE BEDS, SURROUNDS AND HAUNCHES

The Contractor shall thoroughly trim, compact and clean the surface of any bed, surround or haunch to the satisfaction of the Engineer before commencing concreting.

Where instructed by the Engineer or shown on the Drawings, the Contractor shall provide 150 mm thick concrete surrounds to concrete pipes. All concrete for beds, surrounds and haunches shall be concrete Grade M 15/20 formed to the dimensions shown on the Drawings or instructed by the Engineer.

807 CAST-IN-PLACE BOX CULVERTS

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Foundation, measuring and markings for the box culverts shall be performed pursuant to the Clauses 804 and 806. On the completed and approved concrete layer, all steel bar related to the retaining walls in both sides, headwalls and wingwalls shall be placed in accordance with the requirement of Clause 1322 of this Specification. Upon a review and acceptance of the Engineer for steel bar works, formwork shall be performed as per the Drawings and inspected and approved by the Engineer. Designing, construction, preparation and dismantling of formwork shall be carried out conformity to the clause 1318 of this Specification. Pouring and curing of cast-in-place box culvert shall be performed by complying with the provisions of the Section 1300 of this Specification. The Contractor shall prepare a method of culvert works in accordance with Clause 108 of this Specification and receive approval by the Engineer prior to the commencement.

808 BACKFILL

Backfill for concrete pipes and drainage structures shall be from excavated material. If insufficient suitable material If the excavated material is not sufficient for backfilling or the culvert is laid close to or on the existing ground, the Contractor shall obtain material from the borrow area for backfilling. All material to be used for backfilling should meet the requirements regardless of the resources i.e. excavation or borrow area.

The selected material shall be placed in layers with thickness not more than 150 mm. The moisture content shall be within the range of $\pm 2\%$ of optimum moisture content. The Contractor shall compact the materials in layers up to the maximum dry density not less than 95 % as per AASHTO T180.

The material must be filled simultaneously on both sides of the pipe to prevent uneven pressure in the pipe during backfilling. The Contractor shall provide suitable compaction equipment to ensure a clearly defined area density around the pipe. The compaction will be done with vibratory equipment under the supervision of an Engineer without any damage to the pipes. If the pipe is damaged, the Contractor will have to remedy at their own expense.

Timbering and sheeting installed for the purposes of providing temporary support to the excavation sides shall be eased up 150 mm at a time in step with the backfill layer and compaction of the backfill shall be achieved under and behind such timber and sheeting.

The material used for filling alongside culverts which are close to the existing ground or above the existing ground shall be compacted in layers with thickness not more than 150 mm and the compaction shall be not less than the material density of adjacent embankment. The width of the material filling along the culvert shall not be less than 2 m. Existing ground underneath backfill shall be compacted to 95% MDD as per AASHTO T180. Filling alongside culverts shall take place at the same time as the layers of the adjacent embankment are brought up and no additional payment will be made other than that provided for the construction of embankments in Section 500 of this Specification. No traffic shall be allowed on the culverts under construction and if required in special condition, the Engineer's approval shall be obtained and protection works shall be carried out in advance.

809 SUBSOIL DRAINS

Regarding to this Technical Specifications, subsoil drains shall include any type of drain designed to collect groundwater that is rising from below, or percolating from the surface above, further, these drains may or may not include pipes. Generally, instruction to place subsoil drains in cuts will not be issued, unless most parts of earthworks in that particular cut are completed. Any designated subsoil drain construction shall be completed before the adjacent formation layer work commences

Coarse aggregate for subsoil drains must be clean hard, crushed rock or gravel with the largest particle passing the 37.5 mm sieve. The aggregate gradation shall be as the Consultant's designated aggregate gradation.

Fine aggregate for subsoil consists of clean hard sand that is obtained from borrow areas.

Table 8-1: Aggregate gradation for subsoil drains

Sieve Size,mm	Mass Percent Passing
50	100
37,5	80-100
19	60-80
9,5	45-65
4,75	30-50
2,36	15-40
0,425	5-25
0,075	0

810 MINOR DRAINAGE STRUCTURES

Minor drainage structures shall include culvert inlet and outlet structures, catchpits, cascades, spillways and the like, as shown on the Drawings.

Concrete for minor drainage structures shall be concrete Grade B20.

811 WATERPROOFING

The main purpose of the waterproofing is to protect the reinforced concrete culvert from getting corroded due to water, mineral and salt. The waterproofing shall be required for headwall of reinforced concrete pipe and box culverts and culvert base section in accordance with details shown on the Drawings and as designated by the Consultant. Penetration grade bitumen BND 90/130 or construction bitumen grade BN 90/10 shall be used for waterproofing.

The Contractor shall provide the Consultant with a certification from the manufacturer, along with relevant test reports, attesting that the bitumen to be used conforms to the Specifications. During the waterproof coating, other object that may get dirtied shall be protected, if an unexpected spread of bitumen dirtied these objects they shall be properly cleaned by a method designated by the. The bituminous coating shall be done on the prepared surface conforming to the Technical Specifications and to the Consultant's satisfaction. The bitumen to use, shall be prepared and heated up in at least 500 liters

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capacity container, conforming to the Technical Specifications. Bituminous coating shall be applied on a prepared surface within 4 hours. Bitumen shall be applied manually or using mechanical equipment; spraying or sprinkling is not acceptable.

The coating shall be performed at air temperature above +10° C, not windy and in fair weather condition, its shall not be applied during humid environment (rain, snow, fog, etc.). Bitumen shall be applied as shown on the drawings - on culvert surfaces, including top and sides of concrete foundation and back of headwall that will be covered by backfill and embankment materials. Two layers of bitumen shall be applied. The Contractor shall ensure that the coating is evenly distributed. A trial coating shall be applied on one culvert. The bitumen application rate shall be adjusted by the Consultant to achieve a satisfactory rate of application.

812 MEASUREMENT AND PAYMENT

(a) Selected granular backfill for culverts and other drainage structures

Unit: m³

The measurement of backfill shall be the volume of compacted backfill for culverts and other minor drainage structures.

The items for backfill shall include for:

- protection of subgrade;
- provision of material;
- multiple handling of material;
- keeping earthworks free of water;
- complying with requirements and constraints on the sequence, timing and rate of deposition and filling, and equalization of earth pressures;
- taking precautions to avoid damage to property, structures, drains, services, instrumentation and the like;
- haulage;
- waiting for frozen material to thaw;
- replacing acceptable material rendered unacceptable;
- placing the backfill layer by layer and correctly compacted.

(b) Granular material for drainage layer and culvert base layer

Unit: m³

The measurement of coarse material for drainage layer and culvert base shall be the volume placed, calculated based on the summation of their areas of placed coarse material and their height as shown on the Drawings.

The items for granular material for drainage layer and culvert base layer shall include for:

- providing the material,
- laying and compaction at any depth,
- all necessary hauls, and,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling etc. for realizing the whole of the works in accordance with the Contract.

(c) Concrete grade B20 for bedding

Unit: m³

Payment for this item will be at the unit price per cubic metre for the volume of concrete placed for bedding.

The item shall include for:

- submission of the concrete mix design;
- trial mixes;
- protecting adjacent surfaces;
- cleaning of concrete surfaces by grit blasting;
- drilling holes for anchor reinforcement;
- formwork;
- provision and fixing anchor reinforcement;
- cleaning and preparation of existing reinforcement;
- reinforcement;
- provision, placing and compacting of concrete;
- filling to overbreak and working space;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives.

(d) Reinforced concrete for use in culverts and minor drainage structures

Unit: m³ for each of concrete grade

The measurement shall be the volume incorporated in the structures, which payment will be compensation in full for all costs of furnishing and installing complete in place. No deduction shall be made for:

- holes, pockets and the like not exceeding 0.15 cubic meters in each in volume;
- cast in components not exceeding 0.15 cubic meters each in volume.

The item shall include for:

- provision of design and static calculation, details and certificates;
- provision of data, drawings and details of reinforcement and fabrications;
- mix design and trial mixes;
- bedding and haunching;
- concrete, mixing, placing in or against any surface, including soil faces, compaction, finishing and unformed surface finishes;
- reinforcement;
- formwork;
- construction joints;
- curing and protection;
- air entrainment;
- admixtures and additives;
- disposal of material;
- movement joints to beds, surrounds and the like;
- reinstatement of unpaved areas;
- checking and cleaning;
- recording, staking and labelling;
- lubricants, packing, grouting and caulking;
- surveys and recordings;
- protective system;
- dealing with existing water flow;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(e) Reinforced concrete pipe culverts

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Unit: m of each diameter

Pipe culverts will be measured by length, as determined by summation of the nominal laying lengths of the individual pipe sections incorporated in each structure. Measurements will be separated as to size, type, kind, and strength class, to the extent indicated in the item name. Elbow, T, and Y sections will be measured for payment as pipe, with the measurements being made along the centreline of the culvert barrel. No length allowance will be made for branch legs, except as included in the measurements for a connecting structure. Transition sections will be measured for payment as pipe of the larger (or more costly) size, except for such special sections as may be designated for measurement as a unit.

Where installation by the jacking method is required or permitted in the absence of a separate bid item, payment will be made on the same basis as if the culvert were installed by the trenching method.

The items for reinforced concrete pipe culverts shall include for:

- provision of design and static calculation, details and certificates;
- provision of data, drawings and details of reinforcement and fabrications;
- pipes and fittings;
- cutting, laying, jointing and bedding;
- building in pipes to headwalls and outfall works;
- hangers, stools and discrete supports;
- bedding, haunching and surrounding;
- formwork, reinforcement, concrete;
- disposal of material;
- movement joints to beds, surrounds and the like;
- reinstatement of unpaved areas;
- checking and cleaning;
- recording, staking and labelling;
- pipe schedules;
- lubricants, packing, grouting and caulking;
- surveys and recordings;
- protective system;
- dealing with existing water flow.

(f) Waterproof coating

Unit: m²

Waterproof coating shall be measured in square meters according to the Specifications. The quantity shall be calculated by multiplying the waterproofed width times the length measured in a horizontal plane. No additional payment beyond the specified areas shall be made.

The following works are included in the unit price of the bituminous waterproofing:

- surface preparation, transferring and coating the material,
- working on steep slopes,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(g) Concrete grade B15 for levelling and filling

Unit: m³

Payment for this item will be at the unit price per cubic metre for the volume of concrete placed for levelling and concrete fill.

The item shall include for:

- submission of the concrete mix design;
- trial mixes;
- protecting adjacent surfaces;
- cleaning of concrete surfaces by grit blasting;
- drilling holes for anchor reinforcement;
- formwork;
- provision and fixing anchor reinforcement;
- cleaning and preparation of existing reinforcement;
- reinforcement;
- provision, placing and compacting of concrete;
- filling to overbreak and working space;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives.

SECTION 900. PASSAGE OF TRAFFIC

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901 GENERAL

The project road consists of formed existing road sections which are used by traffic and also new alignment sections not carrying any traffic or carrying traffic along unformed tracks. Existing road sections carrying traffic (including existing road sections being diverted) shall be maintained at all times during the construction (including during winter breaks in construction) in good trafficable condition allowing vehicles to travel at minimum 50 km/hr speed in flat and steppe terrain and minimum 30 km/hr speed in mountainous terrain.

From the date of commencement of the Contract to the date of issue of Taking-Over Certificate for the whole of Works or Section thereof as provided in the Contract the Contractor shall bear the full responsibility in maintaining the public and vehicular passage along the project road.

Where public traffic using an existing road is likely to be subjected to obstruction or inconvenience due to improvement construction or reconstruction of the road, the Contractor shall carry out proper activities for maintaining the trafficability and riding comfort of the roads/tracks/deviations taking into account the nature of the obstruction caused by construction activities.

Where the existing road is under construction and traffic cannot be routed along a deviation due to local constraints (such as steep mountains and water bodies adjoining the road), the Engineer may allow the Contractor to pass traffic through or over the Works, on being satisfied about the necessity thereof and the Contractor's arrangement for keeping the traffic flowing without damaging the construction in progress. The Contractor shall also provide and maintain temporary signs, barriers and lights along deviations and existing roads adjacent to the works and shall ensure the safe passage of traffic during the Contract. The Contractor shall protect the Works and adjacent public roads from the effects of his own construction traffic.

902 MAINTENANCE OF EXISTING ROADS/TRACKS

The Contractor shall maintain the existing roads/tracks within the limits of the Contract in a safe and trafficable condition from the commencement of the Contract until the adjacent (parallel) section of new road, or deviation where applicable, is opened to public traffic. Existing roads/tracks shall be maintained in a fair trafficable condition. Maintenance shall include, but not be limited to:

- correcting of potholes, ruts, corrugations, depressions or other defects of existing road surfaces and full width grading,
- permanent watering,
- providing the access where crossed the Project road
- unblocking, clearing and maintaining culverts and cutting or deepening outfall drains,
- ensuring the unimpeded flow of water in drainage channels, watercourses and culverts,
- providing, erecting and maintaining temporary traffic signs, barriers and lights,
- assistance to public traffic.

903 CONSTRUCTION OF DEVIATIONS AND MAINTENANCE

(a) General

Where shown on the Drawings or instructed by the Engineer, the Contractor shall construct, operate and maintain deviations in accordance with this Specification. The

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Contractor shall construct deviations only along those parts of the existing road under construction and closed to traffic for that reason. Deviations in those areas where construction has been completed shall be promptly reinstated. Deviations shall follow the shortest practicable route, taking into consideration gradients and obstructions, and their alignment shall be subject to the approval of the Engineer. The Contractor shall submit to the Engineer the detailed drawings showing his proposed arrangements in respect of passing public traffic over and around the Works and the construction of deviations. These proposals shall include but not be limited to details and locations of:

- the extent and alignment of deviations,
- cross-overs,
- two-lane lane traffic operations,
- restricted widths,
- drainage channels,
- drifts,
- culverts,
- gradients in excess of 7%,
- earthworks,
- surfacing,
- dust prevention measures,
- signs, barriers, lights and traffic lights,

The Contractor shall give at least 28 days written notice of his intention to commence construction of deviations along any Section of the Works during which time his proposed arrangements in respect of passing public traffic over and around the Works and the construction of deviations shall be finalized in consultation with the Engineer. In respect of the construction of deviations the Contractor shall be responsible for and held liable for any costs arising from:

- arrangements and payment for the obtaining of land outside the road reserve (if any required),
- diversion of services including telephone lines, power lines, water pipes and the like,

The Contractor shall be held responsible for the protection of telephone poles, power poles or other services which are liable to be disturbed due to the deviations.

(b) Geometry

Deviations shall be constructed to the cross-section shown on the Drawings or instructed by the Engineer. The carriageway width of deviations shall be 7 m having two lanes unless otherwise instructed by the Engineer. The gradient of any deviation shall not exceed 7% except with the approval of the Engineer. Any change of gradient shall be subject to the Engineer's approval.

(c) Construction

Site clearance and any necessary earthworks shall be carried out in accordance with Sections 400 and 500 of this Specification. Generally, deviations will comprise unsurfaced graded tracks. If traffic volume is high or soil conditions poor, the Engineer, may require a gravel surface. Temporary traffic signs, barriers and lights and drainage structures shall be provided on the required section. The minimum depth of drainage shall be 0.6m and the excavated soils from the ditch shall be reserved in the edge of roadside. If, during the operation, watercourse runs over the dike, depth of the ditches and height of the dike shall be increased.

(d) Drainage and drifts

During the construction of deviations, the Contractor shall ensure that the drainage of watercourses crossing the line of deviations remains unimpeded. Temporary ditches,

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culverts, drifts and bridges of adequate size and strength shall be constructed for deviations where considered necessary by the Engineer. The length of drifts shall be such that, other than when the watercourse is in flood, the overlying depth of water is as agreed by the Engineer. The width of intercepting drain shall be not less than 0.6m and excavated soils from drains shall be kept in dike at the edge of road. If, during operation, water of flood or mountain passes over the dike, drains shall be excavated more depth, so as dike shall be elevated.

(e) Reinstatement of deviations

Prior to the commencement of construction of, or the use of land provided for, any deviation the Contractor shall supply to the Engineer 90mm by 125mm colour print of each of a series of photographs taken at a maximum interval of 500 m along the line of the deviation. The photographs should represent a true record of the existing condition of the land including land usage, fences, existing roads and tracks, drainage and other salient features prior to construction. The Contractor shall only commence the construction of any deviation upon written confirmation by the Engineer.

The Contractor shall reinstate the land provided for deviations to a condition similar to that prevailing prior to the commencement of construction. Photographic records may be used by the Engineer to determine if the reinstatement of deviations has been satisfactorily carried out.

(f) Maintenance of deviations

The Contractor shall maintain deviations constructed pursuant to Clause 603 (a) to (e) of this Specification to ensure uninterrupted free flow of traffic and to the standards required for approval by the Engineer at the time of opening deviations to traffic. Deviations shall be maintained for the period from the date of opening to traffic until the adjacent section of new road is opened to public traffic. Maintenance of deviations shall include but not be limited to:

- scarifying, re-shaping and compacting existing road surfaces,
- permanent watering for gravel road,
- full width grading,
- correcting of potholes, ruts, corrugations, depressions or other defects and compacting,
- ensuring the unimpeded flow of water in drainage channels, watercourses and culverts,
- elevating dikes
- minor repairs to culverts and bridges,
- signs, barriers, lights and traffic lights,
- assistance to public traffic.

904 PASSAGE OF TRAFFIC THROUGH THE WORKS

Generally, public traffic apart from the equipment, machinery and vehicles for the Engineer's and Contractor's use is prohibited throughout the Work area. Where it is proposed by the Contractor and agreed by the Engineer, that traffic is to be passed through, over or across the Works, the Contractor shall order his work in half widths or in short lengths to facilitate the safe passage of traffic. The frequency and duration of delays to traffic whilst passing through, over or across the Works, shall be kept to a minimum.

Delays shall not exceed 30 minutes without prior agreement of the Engineer and should normally be less than 10 minutes. If any proposed method of working should require an anticipated road closure in excess of 30 minutes, the Contractor shall give the Engineer, 48 hours prior written notice. In default of such notice, the Engineer, may refuse to allow

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such closure or may require such closure to be rescheduled. Where traffic passes through, over or across the Works, the Constructor shall ensure that excavations and other hazards are protected with barriers and are clearly illuminated at night. Any damage caused to the Works by the passage of public traffic through, over or across the Works shall be made good at the expense of the Contractor.

905 SIGNS, BARRIERS AND LIGHTS

The Contractor shall provide, erect and maintain temporary signs, barriers, lights and traffic lights along existing roads and deviations constructed in accordance with MNS 4596:2014. Warning signs, regulatory signs, prohibitory signs, mandatory signs and priority signs used for temporary signing shall comply with the requirements of the Mongolian Standard MNS 4597-2014. Signs shall be kept clean and maintained in a good condition. The Contractor shall prepare a traffic control plan at a suitable scale for the direction and control of traffic. The plan shall be submitted to the Engineer, for his approval at least 14 days prior to the commencement of any Works affecting traffic. The plan shall take into consideration the relocation and updating of traffic control measures as construction progresses. Barriers shall be painted with in red and white stripes and shall be provided with strips of retroreflective film or provided with alternating red and white reflectors.

906 CLOSURE OR DIVERSION OF ROADS

Where, as a result of the Works, an existing public or private road is to be permanently closed, or temporarily diverted or re-opened to public traffic, the Contractor shall give the Engineer, at least 28 days written notice. The Engineer, may negotiate with the appropriate Authority or owner in respect the method, order and time for the execution of the work and shall issue instructions to the Contractor accordingly. Where the amount of work involved is small, the Engineer, may instruct the Contractor to make his own arrangements with the appropriate Authority or owner. In all cases, the Contractor shall obtain the Engineer,'s instructions and no road shall be interfered with in any way until the appropriate Authority's or owner's consent to the work has been obtained.

907 ASSISTANCE TO THE PUBLIC

The Contractor shall render such assistance to the public as shall be necessary to allow the safe and convenient passage of traffic at all times.

908 ACCESS ROADS

(a) Access to the Site

The Contractor shall be responsible for providing and maintaining, at his own expense, access to all parts of the Site for his equipment, labour and materials and local public traffic where no alternative access is available. Where there is no existing access to or along the new alignment, the Contractor shall construct and maintain his own access and haul roads as required, all at his own expense. All such accesses shall be made available for the use of the Employer and the Engineer's staff.

(b) New access roads

Access roads to quarries and stockpile, borrow and spoil areas shall follow the shortest practicable routes between them and the nearest point on the new alignment. Access road shall be provided with drainage channels and culverts of adequate size and strength and the permanently and adequately maintained ensuring uninterrupted progress of the Works.

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(g) Reinstatement of access roads

The Contractor shall reinstate all access roads in the same manner as that specified for the reinstatement of deviations pursuant to Clause 604(e) of this Specification.

(h) Costs

The Contractor shall be wholly liable for all financial arrangements associated with the construction of access roads and for all costs arising out of them including, but not limited to:

- all land use arrangements;
- payment for land use, if applicable;
- negotiation with land owner, occupiers and appropriate Authorities,
- diversion of services including telephone lines, power lines, water pipes and the like,
- compensation
- payment for using natural resource etc.

909 CONTRACTOR'S CONSTRUCTION TRAFFIC

The Contractor shall not use subgrade and pavement layers under construction for the plying of construction equipment or trucks carrying construction materials. For this purpose, subgrade and pavement layers shall be treated under construction until the pavement construction has been completed up to the surfacing stage. The use by the Contractor of completed sections of the road or completed pavement layers shall be prohibited when, in the opinion of the Engineer, damage to structures, the subgrade, the formation, pavement layers or surfacing could ensue.

Notwithstanding the completion of the pavement work, the public traffic shall not be allowed in any section of the Road without the Engineer's consent. Any damage to the completed formation, completed pavement layer or surfacing layer caused by any of the Contractor's vehicles, regardless of their axle loading, shall be repaired as instructed by the Engineer and at the Contractor's expense.

910 MEASUREMENT AND PAYMENT

No separate measurement or payment shall be made for the costs of complying with Section 900 of this Specification and the Contractor shall be deemed to have allowed elsewhere in his rates and prices for all such costs.

SECTION 1000 – GRAVEL SHOULDERS

CHAPTER	CONTENT
1001	GENERAL
1002	MATERIAL REQUIREMENTS
1003	CONSTRUCTION OF GRAVEL SHOULDERS
1004	TOLERANCE
1005	MEASUREMENT AND PAYMENT

1001 GENERAL

(a) Description

Gravel refers to naturally occurring fine-grained material, including regular gravel, crushed gravel, or crushed stone.

Gravel shoulder is a surface course of appropriate grain size laid to protect the surface of the pavement and the two edges of the base.

Gravel materials may be materials extracted directly from nature, or materials that have been crushed or sifted and washed and re-mixed in specific proportions.

The Contractor shall comply with the relevant laws of Mongolia and the requirements specified in Chapter 600 of these Technical Specifications when performing work related to the opening, reclamation, rehabilitation, and establishment of temporary roads leading to gravel quarries, as well as places where materials are removed or stockpiled.

(b) Source of Materials

Materials for granular shoulders are obtained from the following sources:

- (i) Quarries or borrow areas,
- (ii) Excavation material.

The Contractor shall determine the location of the materials to be used and obtain the approval of the Engineer.

1002 MATERIAL REQUIREMENTS

The particle size ratio of the compacted material is a gradual curve that approaches or parallels the particle size range shown in Table 10-1. "B" grade gravel will be used in the upper part of the gravel embankment at 100mm thickness, and "A" grade will be used in the remaining lower part. The thickness of the top and bottom sections shall be determined by the Engineer. However, the Engineer may decide not to use Grade "A" where the thickness of the gravel bank is 200 mm or less.

Table 10 – 1. Gradation Requirements for Gravel Shoulders and Gravel Surfacing

Sieve Size	Mass Percent Passing	
	Grading	
	A	B
37.5 mm	100	
19.0 mm	95-100	100
9.5 mm		80-100
4.75 mm	40 – 70	60-75
2.36 mm	25 - 50	35-55

0.425 mm	15 - 35	18-27
0.075 mm	5 - 20	

Material for gravel shoulders or surfacing shall have a minimum CBR of 20% at 98% MDD (AASHTO T180) and 4 days soaking. The plasticity index of the material is between 3-7%.

1003 GRAVEL SHOULDER CONSTRUCTION

(a) DESCRIPTION

"Shoulder" is a part of the construction work that is placed at the bottom of the foundation, outside the edge of the pavement, as shown in the drawing.

(b) MATERIALS

The material brought to the construction site to be used for shoulder must fully meet the parameters of granularity, CBR and plasticity mentioned in Clause 1002, and must not be mixed with black dirt or other foreign materials. In addition, it is forbidden to bring the materials used for the embankment and mix them on the field.

(c) SHOULDER CONSTRUCTION WORKS

The equipment to be used for gravel shoulder works and their work methods shall be selected and determined by field testing as directed by the Engineer.

The contractor shall make the gravel shoulder at the same time as the pavement, and in doing so, he shall choose and adhere to such a method as to ensure the constant discharge of surface water at any time.

Therefore, it is not allowed to make the asphalt pavement, crushed stone base and side road pavement shoulders mentioned in this Contract before or after the construction of parallel sections.

Gravel material shall be distributed uniformly over the entire width of the shoulder and shall be laid to a thickness after compaction not less than that shown on the drawings or as directed by the Engineer.

The gravel material shall be deposited in sufficient quantity and spread in a uniform layer across the full width required such that the final compacted thickness is nowhere less than shown upon the Drawings or instructed by the Engineer. Every reasonable effort shall be made to prevent segregation of gravel material during the loading, hauling, placing, processing and compacting operations.

The compacted thickness of any layer laid processed and compacted at one time shall not exceed 200 mm. Where a greater compacted thickness is required, the material shall be laid and processed in two or more layers. The minimum layer thickness shall be 140 mm.

The moisture content of the gravel shall be adjusted by either uniformly mixing in water or drying out the material such that the moisture content during compaction is between 1% above and 2% below the Optimum Moisture Content (AASHTO T180). To do this, adjust the humidity by mixing or drying the material evenly. It is forbidden to moisten or moisten the shoulders at a temperature below 0°C.

After bringing the gravel material to the specified width and leveling the cross slope, measure with surveying equipment to adjust the level and use a 3m rake or other approved tool to check the level of the surface and level the necessary areas. Light compaction may

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be done before final compaction. If the surface has already received 25% of the total compaction, the Contractor shall not perform scraping or leveling of the surface. It is prohibited to water or moisten the soil to any extent when the ambient temperature drops below 0 when performing the work of the soil.

Following the final trimming, the material shall be compacted to a dry density of at least 98% MDD (AASHTO T180). During the grading, trimming and compaction of the material the Contractor shall ensure that the surface and/or the material does not dry out by applying fog sprays of water or other approved means sufficient to maintain the surface and/or material within the specified limits of moisture content.

On completion of compaction, the surface shall be well closed, free from movement under compaction planes, ridges, cracks and loose or segregated material.

If the surface does not meet the requirements specified herein, the Contractor shall take the same measures as for subgrade specified in Section 300 of these Specifications or any other measures required or approved by the Engineer. If necessary, the Engineer may instruct the removal and replacement of the pavement in that area, and the Contractor shall be responsible for the entire cost of this work.

In addition, it will be performed in accordance with the requirements of Section 200 of these technical specifications.

1004 TOLERANCE

The tolerances for gravel shoulders shall in accordance with the tolerances for the subbase or adjacent pavement layers specified in Chapter 300 of this Technical Specification.

1005 MEASUREMENT AND PAYMENT

(a) Gravel shoulders

Unit: m³

The unit of measurement for gravel shoulders shall be the cubic metre placed and compacted upon the subbase as shoulders to pavement. The volume shall be calculated as the product of the width and the compacted instructed thickness multiplied by the length instructed to be laid.

There will be no separate measurement or payment for repair works.

The rate for gravel shoulders shall include for:

- provision of materials;
- trial areas and trials;
- making good after sampling and testing;
- protection of material in transit and while awaiting tipping;
- grading, measuring, mixing and depositing materials;
- spreading and compaction;
- cleaning, preparing and working on or up to existing surfaces and features;
- edge support;
- maintenance of surface;
- taking measures to protect the capping layer and sub-base from deterioration due to the ingress of water and the use of constructional plant;

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- taking measures to protect the base, sub-base, capping layer and subgrade from damage due to the Contractor's method of construction and choice of constructional plant;
- shaping to cambers, falls and crowns;
- complying with the provisions of Chapters 100, 200, 300, 600, 900 and 1000 of these Technical Specifications.

SECTION 1100 – BASE AND SUBBASE

CHAPTER	CONTENT
1101	GENERAL
1102	MATERIAL CATEGORIES

SUBSECTION 1100 (A) – GRANULAR SUBBASE

1103	SUBBASE MATERIAL REQUIREMENTS
1104	LAYING AND COMPACTING OF SUBBASE
1105	TEST COMPACTION
1106	SETTING OUT AND TOLERANCE
1107	DRAINAGE FROM SUBGRADE AND SUB-BASE SURFACES
1108	MEASUREMENT AND PAYMENT – SUBSECTION (A)

SUBSECTION 1100 (B) – CEMENT TREATED BASE

1109	GENERAL CEMENT TREATED BASE
1110	MATERIAL
1111	EQUIPMENT
1112	CONSTRUCTION WORKS
1113	QUALITY CONTROL
1114	SEQUENCE OF CONSTRUCTION WORKS
1115	MEASUREMENT AND PAYMENT – SUBSECTION (B)

SUBSECTION 1100 (C) – CEMENT TREATED CRUSHED STONE BASE

1116	GENERAL CEMENT TRATED CRUSHED STONE BASE
1117	MATERIALS FOR CEMENT TREATED CRUSHED STONE BASE
1118	PLANTS AND EQUIPMENT
1119	CONSTRUCTION WORKS
1120	QUALITY CONTROL
1121	SEQUENCE OF CONSTRUCTION WORKS
1122	MEASUREMENT AND PAYMENT – SUBSECTION (C)

SUBSECTION 1100 (D) – CRUSHED STONE BASE

1123	GENERAL CRUSHED STONE BASE
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- 1124 MATERIALS FOR CRUSHED STONE BASE
- 1125 PLANTS AND EQUIPMENT
- 1126 CONSTRUCTION WORKS
- 1127 QUALITY CONTROL
- 1128 SEQUENCE OF CONSTRUCTION WORKS
- 1129 MEASUREMENT AND PAYMENT – SUBSECTION (D)

1101 GENERAL

(a) Description

The term "natural material" shall include but not be limited to gravel, soft stone, rocks, sandy soils or a combination of any of these aggregates. A natural material is also referred to as "gravel" as a generalized term.

"Crushed stone of appropriate composition" refers to a mixture of crushed natural large or quarried stone, blended in a certain proportion, with a gradual curve within the specified grain size limits.

Crushed natural rock or cobblestone shall be produced from stone with a particle size of at least 100mm. A two-stage crushing system shall be employed.

(b) Source of Materials

Subbase and Base materials can be obtained from the following sources:

- (i) stone quarry,
- (ii) borrow pit
- (iii) excavated material,

The Contractor shall be fully responsible for the selection and determination of the source of materials at his own expense. In either case, the source of materials to be used shall be approved by the Engineer.

(c) Inspecting the work area

During the site inspection conducted at the bidding stage, the contractor shall carefully study the materials that can be extracted from nature surrounding the work site, and determine following items (not limited by these) for the materials that are available and have adequate resources:

- amount of required removal of soil stripping,
- difficulty of removal,
- material quality and hardness,
- physical and chemical parameters of materials,
- degree of required selection of sources,
- ratio of bulk materials,
- extraction method,
- processing method,
- path or road to the material source.

(d) Stone quarries and borrow locations

The contractor shall comply with and abide by relevant laws of Mongolia and the requirements specified in Chapter 600 of these Technical Specifications when performing work related to stone quarries and borrow areas, as well as places where materials are removed or stockpiled. follow.

1102 CLASSIFICATION OF MATERIALS

The natural materials used in the subgrade layer are materials that can be excavated from stone quarries and borrow areas or from road excavations without blasting.

Crushed stone with appropriate grain size is material extracted from a stone quarry and crushed and processed in at least two stages. The type of stone shall be selected as specified or instructed by the Engineer, and the crushing material shall be natural rock or cobblestone with a particle size of at least 100mm.

CHAPTER 1100 (A) – GRANULAR SUBBASE

1103 SUBBASE MATERIAL REQUIREMENTS

(a) General

Aggregates for subbase may be obtained directly from natural material sources or otherwise modified by crushing and/or screening, washing and recombining in appropriate compositions in order to meet the specified material properties.

Subbase materials shall not contain the items listed below:

- organic matter,
- weathered or brittle material,
- secondary (clay) minerals,
- flat or flaky material (mica),
- soft stone,
- expandable minerals,
- materials that are easily affected by chemicals,
- soluble salt.

(b) Material properties

The particle size ratio of the subgrade material after compaction is in the form of a gradual curve that is close to or parallel to the particle size range shown in Table 11-1.

Table 11-1: Particle size requirements for subbase materials

Sieve size	Percentage by weight of material passing through the sieve
63 mm	100
37.5 mm	90-100
25.0 mm	80-100
19.0 mm	60-90
9.5 mm	30 – 65
4.75 mm	25 - 55
2.36 mm	15 – 40
0.425 mm	8 – 20
0.075 mm	2 – 8
0.02 mm	< 3

The physical properties of the material shall meet following requirements:

- Uniformity coefficient $\leq 50\%$,

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- Liquid limit $\leq 25\%$,
- Plasticity index $\leq 6\%$,
- CBR $\geq 30\%$ after 4 days of immersion in water at 98% MDD as determined by AASHTO T180-93
- The coarse portion, retained on a 2.00 mm (No.10) sieve, shall have a mass percent of wear not exceeding 50 by the Los Angeles Abrasion Tests as determined by AASHTO T96.

1104 LAYING AND COMPACTING OF SUBBASE

The thickness of any layer laid and compacted in one operation is not more than 200mm. In areas where the thickness of the compacted layer is required to be greater than this, the material shall be compacted in two or more stages. The minimum thickness when compacted is 100mm.

The particle size ratio of the material shall be as specified in Chapter 1203. Pick up and remove any uncrushed stones larger than the specified size.

The method of work such as laying and compacting, as well as the selection of equipment, is determined by preliminary tests by the Contractor with directions from the Engineer. Above tests shall be repeated if the source of materials or equipment is changed at the beginning of the construction work, or if the Engineer deems it necessary to ensure the quality of the work.

The material shall be spread uniformly over the total width indicated on the drawing or as specified by the Engineer, and after compaction, the thickness shall not be less than that indicated on the drawing or as directed by the Engineer. All possible measures should be taken to prevent separation of gravel particles during loading, transporting, unloading, spreading and compacting of materials.

In any case, the compacted thickness of the subbase should be 2 times the largest size of the used material, and the compacted thickness of the base should be 3 times the largest size of the used material.

The Contractor shall mix the material uniformly with water and the moisture shall be initially adjusted before paving. Measures should be taken to adjust the moisture to the required level during the process of laying and compaction. Unless otherwise directed by the Engineer, the moisture content of the material at the time of compaction may be 0.5% greater or 1% less than the Adequate Moisture Content (AASHTO T180-93). After laying the base and subbase, the level should be adjusted using a surveying equipment, and the flatness of the surface should be checked using a 3m rake or an approved tool, and the necessary areas should be leveled. Light compaction may be done prior to final compaction, but if the surface has already received 25% of the total compaction, the Contractor shall not scrape or level the surface.

After final shaping, the subgrade is compacted until the MDD (maximum dry density) is at least 98% (AASHTO T180-93) and the base material is at least 100% MDD. The contractor shall compact each layer immediately after laying.

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In all areas except for the turning curves, compaction shall be done axially from the outer edge of the pavement towards the center. In the curved part, it is also done along the axis, but from the low edge to the raised edge.

When spreading, leveling, or compacting materials, the contractor shall use water spray or other approved methods to prevent drying of the surface and materials, and maintain the specified moisture content at an appropriate level.

After compaction, the surface should be well compacted, without cracks, no slips or waves caused by the roller, and without stone separation. If the surface does not meet the requirements specified herein, the Contractor shall take any other measures required by the Engineer, including taking or redoing the measures specified in chapter 300 of this Technical Specification. The Contractor shall bear the cost of repairs and rework.

1105 TEST COMPACTION

The contractor shall test the subbase and base layers by applying a load of not less than 5 tons per 1 m of the width of the roller with a roller approved by the Engineer. During the test compaction, the layers must remain visibly motionless. Approval will be granted if the test compaction is deemed sufficient. Test compaction and any necessary post-test repairs shall be carried out by the Contractor at his own expense.

1106 RED LINE SETTING AND TOLERANCE

Laying of the subbase shall be carried out taking into account the tolerance specified in Section 300 of these Specifications.

1107 DRAINAGE FROM SUBGRADE AND SUBBASE SURFACES

The Contractor shall take protective measures by constantly removing water from the subgrade and the subbase and any damage caused by standing or flowing water on the surface shall be repaired by the Contractor at his own expense. Among others, the drainage requirements specified in Chapters 100 and 1100 of these Technical Specifications shall apply.

If, due to standing water in any part of the subgrade, sub-base and base courses the material is soaked or because of this the material cannot obtain the required density, the Contractor shall remove these materials at his own expense and replace them with materials that comply with these Specifications.

1108 MEASUREMENT AND PAYMENT - SUBSECTION (A)

(a) Subbase

Unit: m³

The measurement of sub-base shall be the volume measured to the outlines stated in the Contract.

The items for sub-base shall include for:

- provision of materials;
- trial areas and trials;
- making good after sampling and testing;
- loading into transport, haulage;

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- protection of material in transit and while awaiting tipping;
- grading, measuring, mixing and depositing materials;
- providing and mixing water or drying out the material;
- processing and modifying materials for compliance with the specifications;
- removal and disposal of oversized material in a manner approved by the Engineer;
- mixing and processing;
- spreading and compaction;
- maintenance of surface;
- taking measures to protect the capping layer, sub-base and base from deterioration due to the ingress of water and the use of constructional plant;
- taking measures to protect the subgrade, sub-base and base from damage due to the Contractor's method of construction and choice of construction plant;
- shaping to cambers, falls and crowns.

SUBSECTION 1100 (B) – CEMENT TREATED BASE

1109 GENERAL CEMENT TREATED BASE

This chapter describes the requirements for cement-treated base (CTB) construction. Asphalt concrete layer is placed on the CTB layer.

CTB refers to a mixture of natural gravel, crushed stone material, cement and water in the appropriate ratio. The mixture is mixed in a dedicated centralized plant.

Depending on the conditions, the base is laid on the subbase, frost protection layer, compacted embankment, and the surface of the excavation. CTB shall be installed in accordance with the procedures specified in this chapter.

In addition, how to make and maintain waterproof protective bituminous or emulsified film (coating) is described.

1110 MATERIAL REQUIREMENTS

a) Cement The cement to be used in CTB shall be regular or portland cement and shall meet the requirements of AASHTO M-8507, MNS 974:99 and other international standards. It is preferable to have cement with a strength of 100 MPa.

b) Gravel material The materials to be used in the CTB shall be a mixture of sand and gravel, soil and crushed stone, and meet the particle size and physical properties shown in Table 11-2 below.

Table 11-2: Base material specifications

Control parameters Sieve size mm	Base layer Weight percentage of material passing through the sieve %
53	100
37.5	85-100
19	60-90
4.75	30 - 65
2.36	20-50
0.425	10-30

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0.075	5 - 10
0.425 sieved PI	< 5
Linear shrinkage	<3
10% Minimum number of fine particles (TFV)*	110 kN
Minimum % of wet to dry TFV ratio	60
Water absorption % **	< 2

By weight

* As per BS-812-Part 111 standard

** If water absorption is greater than 2%, a cold resistance test is required.

c) Water

The water should be drinkable and the alkalinity or pH of the water should be between 6 and 8.5 according to AASHTO T-26.

d) Curing Membrane

A bituminous curing membrane shall be used for curing and shall meet the requirements of AASHTO M 82 – 75 (2004).

e) Sand blotter

Sand to be used when required to prevent pick up of the curing membrane by trucks must not contain any deleterious chemicals.

f) Mixing ratio

Mix composition will be determined to meet the strength parameters, and currently (for tender purposes) the water and cement input as a percentage of soil and gravel material is given as follows:

Base layer: cement \pm 6%, water \pm 8%

The input rate is determined in the laboratory by a 7-day UCS (unconfined compressive strength) test. Wet and dry tolerances are also used to determine input rates. The parameters given in the table below will be used to determine the input rate.

Table 11-3: Indicators for control of input norms

Name	Base layer
7-day UCS* (MPa) in the laboratory	3.75 - 6.0
7-day UCS* (MPa) in the field	2.5 – 4.0
Wet and dry resistance	20 – 30 %
AASHTO T-135-97 (2005)	
Resistance to freezing and thawing AASHTO T-136-97 (2005)	20 – 30 %

Note: * Cylinder cubes specified in AASHTO T-180

1111 EQUIPMENT

Mixing equipment

Equipment capable of producing a mixture of not less than 80 tons per hour shall be used for continuous cycle or batch mixing of gravel, soil, water, and cement. The mixture production plant shall meet following requirements:

- (i) Dry materials are measured by weight in batch plants.
- (ii) Dry materials can be measured by volume in continuous cycle plants. (Bags of cement can be unpacked in the volumetric hopper)
- (iii) A cement transfer nozzle shall be used to speed up the flow of cement from the main channel to the sample weighing scale. The tap should be constructed in such a way that the setting time of the cement can be controlled.
- (iv) In batch plants, the cement weighing scale is separate from the aggregate weighing scale. If the cement hopper is separate from the gravel hopper and the cement is weighed before the gravel is weighed, both cement and gravel can be weighed on the same scale.
- (v) Mix the cement into the mixer with the gravel material to mix the cement evenly with the gravel.
- (vi) If mixing in a continuous cycle plant, cement, water and gravel shall be weighed and conveyed by approved equipment. To this end, the conveyor and weight are coordinated to maintain the correct cement-to-gravel ratio throughout the entire mixing process. A continuous cycle plant should have an alarm system that indicates overcapacity and undercapacity of the mixer. Enclosures for configuration and maintenance shall conform to the Engineer's requirements.
- (vii) Batch plants and continuous cycle plant throughputs (units) should not exceed those required to ensure uniformity of the mix.
- (viii) Any area in the mixer where the material does not touch or does not mix is corrected by adjusting the conveyor.
- (ix) Water can be measured by weight or volume. The amount of water to be added to the mixture and the time will be verified by the Engineer.
- (x) Cement, water and gravel shall be mixed uniformly and the mixing time of one ingredient shall not be less than 30 seconds.

Transportation equipment

Dump trucks and specialized cement concrete transportation trucks shall be used.

a) Auto grader

The auto grader is equipped with a cutting device and has a blade and capacity long enough to shape the entire width of the road in one pass. The leveling autograder has an automatic control that controls the level and form.

b) Paver

CTB is laid with a paver with a capacity of 8.5 m width, with the option of attaching additional equipment for wider spreading. The paver shall be equipped with following equipment:

- (i) Loading hopper and spreading mechanism
- (ii) Screed with tamping and vibrating arrangement to ensure smooth spreading and initial compaction of the mixture without any ridges or indentations
- (iii) Sensors for slope and grade control

c) Compaction equipment

For compaction a steel wheeled roller and rubber tired roller is required. The weight of the vibrating roller shall not be less than 8 - 10 tons. For micro-cracking, a 12-ton steel wheel roller should be used. The rubber tire roller shall weigh 20-30 tons and the tire pressure shall be 0.7 MPa.

d) Bitumen and water spraying equipment

- (i) The equipment to be used during water maintenance shall be a pressure distributor installed in the vehicle and shall maintain the surface by generating water mist and spray without directly affecting the road surface.
- (ii) A self-propelled bitumen spreader shall be used for application of the curing membrane.

e) Stiffness testing tool

After construction of the CTB, its stiffness is tested using a special Humboldt Stiffness Gauge (HSG) instrument. This tool determines the amount of force applied to the CTB to cause it to deform.

1112 CONSTRUCTION WORKS

a) General

When laying the CTB, the construction work shall be carried out in such a way that the cement is evenly distributed to prevent any separation or agglomeration. The density and moisture content of the CTB shall be evenly distributed throughout the thickness. In order to determine the number of compacting rolling, the density and moisture content, the amount of settlement of the mixture, and to determine the flatness of the surface, a test layer of 100-300 meters shall be laid first. After the testing layer is approved, the main work can begin.

b) Surface preparation

The surface of the preceding layer must be thoroughly compacted to achieve a minimum of 98% proctor density per AASHTO T180 prior to placing the CTB. The tolerance of the surface along and across the road should not exceed 15 mm under the 3m rake. Keep the surface moist (not wet) before laying the CTB.

Clean the surface of the layer below the CTB thoroughly from waste and excess material.

c) Weather conditions

- (i) Air temperature: If the air temperature falls below 5°C, the work of the CTB must not be started and the CTB work should not be started again until the air temperature rises above 5°C.
- (ii) Snow and Rain: Do not carry out CTB works when it is raining or snowing. Once the CTB surface has been laid, measures should be taken to protect it from precipitation until it is sufficiently strengthened. Also, the above work should not be started during strong wind.

d) Timing

The mixture should be spread on a pre-prepared surface within 45 minutes after adding water in the batching plant. In addition, the compaction, compaction and leveling of the mixture must be completed within 2 hours after the water is poured into the mixer.

e) Compaction

The dry density of compacted CTB shall not be less than 98% of the maximum dry density according to AASHTO T-180.

f) Transportation

When transporting the mix, it shall be thoroughly covered as directed by the Engineer.

g) Construction debris

Transverse: If the laying operation is temporarily stopped for more than 2 hours or continues the next day, the thickness of the laid mixture shall be gradually thinned (at a distance of 6m along the axis) and leveled by half of the total thickness of the laid material. The next day, when starting work, spread new mixture on the thin part and fill it to the required thickness.

h) Spread the mixture and make the first compaction

The surfaces are spread using a spreader with an additional cutting device, with a control system for controlling the longitudinal and transverse moldings in order to produce the required slopes and forms. The paver is followed by vibrating and regular rollers to perform the first preliminary compaction.

i) Surface measurements

After the first compaction is completed, measure along and across the surface using a measuring tool and a 3 m rake.

j) Leveling, fixing and final compaction of the surface

Finally, remove loose material from the surface and, if necessary, lightly dampen the surface and roll with tire roller. Measure the flatness of the surface of the finished CTB with a 3 m long flat rake. The distance between the rake and the surface where the rake is placed on any part of the road should not exceed 10 mm.

k) Initial maintenance

During and after the completion of the CTB work, the surface should be watered with a fine nozzle sprayer or moistened with water mist so that the moisture content is not less than that specified in the input norm. Never spray the surface with high pressure water. The first maintenance should be done within 24 hours after the completion of compaction.

l) Micro cracking

After 24 hours of water spray treatment, the stiffness of the CTB should be checked using a Humboldt Stiffness Gauge (HSG) or equivalent. If the instrument reading is between 50 – 60 MN/m or kN/mm, microcrack compaction should be initiated. If the reading of the instrument is less than this, continue the maintenance by sprinkling water for another 24 hours until the surface hardness is 50-60 MN/m. Checking the stiffness should be done every 30m along the axis of the road, and after compaction of micro-cracks, marks are placed on the tested places for re-checking the stiffness.

Micro-crack compaction of the finished CTB is performed with a 12-ton vibrating roller operated at maximum power at a speed of approximately 3 km per hour. Compaction shall be carried out in the total width of the road except for 0.3m of the edges on both sides of

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the road. After 1-2 passes of the roller on the marked areas, if the reading decreases by 40% from the previous measurement, the compaction of microcracks is considered complete. The stiffness is measured after each pass of the roller and rolling is stopped when the stiffness decreases by 40% of the previous one. This will determine how many passes of roller are required to reduce the stiffness by 40%.

l) Final care

After the compaction of micro-cracks is completed, the area shall be moisturized for 48 hours. (During the maintenance period, cover the surface with felt, straw and polyethylene plastic paper). After that, spray bitumen emulsion, similar to the bitumen emulsion that is sprayed prior to asphalt laying, to form a waterproof curing membrane. Bitumen should be spread at the rate of 0.8-1.2 kg per square meter. If large cracks appear after bitumen spraying, fill the cracks with bituminous material of appropriate grade. For 3 days after bituminous spraying, the film is protected from perforation and peeling, moistened and cared for. Where such damage occurs, partial repair and maintenance shall be carried out.

m) Movement restrictions

Within 7 days after the laying of the CTB or until the maintenance is completed, the movement of any vehicle, such as heavy-duty vehicles used in construction work, is prohibited.

n) Time of commencement of paving work

Asphalt concrete paving can be started after 7 days of maintenance of the cement-reinforced base and movement restrictions.

o) Shoulder

The shoulder shall be made after placement of the curing membrane.

1113 QUALITY CONTROL

a) Compressive strength

The compressive strength is tested by taking cylinder samples according to the AASHTO T-180 standard 2 times every day that the mixed material is laid. For each sampling, 2 sets of cylindrical molds with 3 samples each are taken. The sample taken in the field is compacted in the form shown above and treated with moisture according to the field conditions. It is more convenient to leave sample molds in the field and maintain them in the same way as the base surface. In this case, it is necessary to protect the molded samples from damage or loss. For greater reliability, it is advisable to keep the same number of samples in the laboratory. Two samples from each set shall be tested for 7-day strength test and the third shall be tested as directed by the Engineer.

b) Micro cracks

After paving the CTB layer, road workers will check for micro-cracks every 30 m.

c) Area moisture and density

Moisture: Site moisture during compaction may be equal to $\pm 2\%$ of the appropriate moisture content determined under laboratory conditions in accordance with AASHTO T-180. Every 300m of the total length of the CTB, the moisture content and density of the area will be checked according to the AASHTO T-318-02 standard.

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Density: Tested in accordance with AASHTO T-180 and AASHTO T-191 standards.

1114 SEQUENCE OF CONSTRUCTION WORKS

The main construction works of CTB shall be carried out in the following order:

- Prepare the layer below the CTB
- Mix and prepare the CTB mixture in the factory.
- Transport CTB mix from plant to the field
- Drop off at site
- Spread the CTB mixture with a spreader
- Perform initial compaction
- Measure elevation and cross-section
- Perform final compaction
- Perform initial care
- Micro-crack compaction
- Perform final care
- Apply bituminous spraying and create a curing membrane
- Restrict movement of vehicles
- 2 weeks after final care on the base layer, lay the asphalt concrete layer

1115 MEASUREMENT AND PAYMENT - SUBSECTION (B)

(a) Cement Treated Base

Unit: m³

The measurement of cement treated base shall be the volume measured to the outlines stated in the Contract.

The items cement treated base shall include for:

- provision of gravel and crushed stone materials;
- adding cement as required;
- variations in cement content;
- trial areas and trials;
- making good after sampling and testing;
- loading into transport, haulage;
- protection of material in transit and while awaiting tipping;
- grading, measuring, mixing and depositing materials;
- providing and mixing water or drying out the material;
- processing and modifying materials for compliance with the specifications;
- removal and disposal of oversized material in a manner approved by the Engineer;
- mixing and processing;
- spreading and compaction;
- cleaning, preparing and working on or up to existing surfaces and features;
- edge support;
- maintenance of surface;
- taking measures to protect the capping layer, sub-base and base from deterioration due to the ingress of water and the use of constructional plant;
- taking measures to improve the sub-base and base to protect the base, sub-base, capping layer and subgrade from damage due to the Contractor's method of construction and choice of constructional plant;
- shaping to cambers, falls and crowns;
- check the compaction strength using the Humboldt Stiffness Gauge (HSG) and provide this instrument;
- provision of soundness test certificate.

SUBSECTION 1100 (C) – CEMENT TREATED CRUSHED STONE BASE

1116 GENERAL CEMENT TREATED CRUSHED STONE BASE

This section covers the specifications for construction of cement treated crushed stone (CTCS) base layer.

CTCS base is a composition of aggregates which includes ideal particle size of crushed stone, mixed with appropriate proportions of cement and water. This composition aggregate shall be produced using mixer plants, considering factors such as its methodology features and cement stabilized base work quantities.

1117 MATERIALS FOR CEMENT TREATED CRUSHED STONE BASE

a) Cement

The Cement to use in the CTCS base shall be OPC 32.5; PC 32.5 classification Portland Cement which conforms to the MNS 974:2008 standard specifications. Prior to transporting the cement to the construction site, its physical, mechanic and chemical characteristics shall be tested and approved. Routine test shall be carried out at every 200 ton arrived at construction site. Cement quality shall be determined as per construction rules and regulation of "Technical Specifications for Cement Treated Crushed Stone Base".

b) Crushed stone aggregate

The Crushed stone aggregate shall consist of crushed stone that does not contain flat or scaly particles (such as mica), clay, clay loam, organic matter and other toxic substances. Stone that crushes easily and cracks, breaks apart as flat particles, and has a smooth surface when it gets cracked shall not be used. Physical characteristics of crushed stone aggregate shall conform to the following:

Table 11-4: Test Methods for Particle Size Analysis (MNS AASHTO T88:2004)

Aggregate Particles specifications, %			
Sieve size, mm	CTCS base aggregates and technical specifications		
	No. 1	No. 2	No. 3
53 mm	100	-	-
37.5 mm	70-100	100	-
25 mm	45-80	60-40	100
12.5 mm	30-60	30-65	40-70
4.75 mm	20-50	20-50	20-50
2.36 mm	15-40	15-40	15-40
0.425 mm	5-25	5-25	5-25
0.075 mm	0-5	5-10	5-10

Note: * Cement-based crushed stone mixes shall be selected as shown in Table 11-4 depending on thickness of base, reinforced by road, meteorological zone and cement. In the IIIA, IIIV region, or the Grade1 and Grade2 in the Gobi region, select the Grade 2 and Grade 3 in other regions (IA, IB, IIA, IIB)

Table 11-5 Aggregate specifications of CTCS base

No.	Standard	Test Method	Unit	Technical Specification
1	MNS ASTM C 535:2003	Degradation	%	< 50
2	MNS ASTM D4318:2006)	Liquid Limit	%	≤ 25
3	MNS ASTM D4318:2006	Percent passing 0.425 sieve PI	-	< 5
4	MNS 2998-2001	Water Absorption	%	< 2

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5	MNS ASTM C 88 : 2004	Frost Resistance	%	< 12
6	MNS 2998 : 2009	*Coarse aggregate crushing test	%	≥ 80
7	MNS BS 812 хэсэг 105.1, 105.2 : 2003	*Elongated and angular flat particles	%	≥ 30

Note: * Conforming to the BS-812

** If the water absorption is more than 2.5%, frosting resistance test is required.

c) Water

CTCS base water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other deleterious substances. The water shall have a pH value between 6.0 and 8.5 and shall subject to the approval of the Engineer and tested in accordance with AASHTO T26. Water quality shall be determined as per construction rules and regulation of "Technical Specifications for Cement Treated Crushed Stone Base".

d) Curing membrane

The curing membrane shall conform to the requirements of AASHTO M148.

e) Sand cover

During curing, the sand cover to protect the fresh based CTCS base course, shall not contain any chemical substances

f) CTCS base course composition

CTCS base aggregate mixing shall conform to the following specifications: The project road is classified as "1B main highway" strength mark of Cement treated crushed stone base is set as M60-M75.

g) Mix proportions

The composition shall be determined in the laboratory by complying with an ideal strength parameters. The above mentioned specifications shall also refer to the composition mixing work. The composition shall be determined in a laboratory by 7-day UCS (unconfined compressive strength) test method. Further, the base course strength shall be monitored by the following parameters:

Table 11-6: Compressive and Tensile of bending strength testing

Parameters of Composition of CTCS Base	Strength Limits, МПа (кгс/см ²), барарүй	
	Tensile strength of bending (R _{гүл})	Unconfined Compressive Strength data of the Base Course Composition (R _{шax})
M 60	> 1.2	> 6.0
M 75	> 1.5	> 7.5

Table 11-7: Mix compressive testing

Type	Compressive Strength Limits, МПа-аас барарүй	
	(7хоног) R _{шax}	(28хоног) R _{шax}
M 60	4.2	6.0
M 75	5.25	7.5

1118 PLANT AND EQUIPMENT

a) Plant

Well configured, mechanically operated stone crushing and mixing plants, that conforms to the quality of the final production, shall be implemented for crushing, sieving, and mixing the aggregates. Depending on the length of project road, the capacity of stone crusher

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shall be 25-100 ton per hour and shall be equipped to crush stone by four types of particle sizes. Mixer plant with continuous cycle shall be equipped with automatic weight hence the speed of conveying stone material and cement material shall constantly be supervised.

Stockpiled aggregates with different size which extracted from various sources, shall be mixed according to the sample conducted by the Contractor and by methodology satisfied by the Consultant, using mechanically operated equipment that is installed at the stockpile area. In order to prevent aggregate segregating, during mixing, production, transferring the aggregate shall be moistened, further, it shall be stockpiled at up to 5m of height, consisting layers up to 25 cm. If the Contractor needs to extract aggregates from another accepted source, and mix them with designated composition, in order to satisfy the designated particles size, the following shall be complied:

- The Contractor shall perform the aggregate extraction and mixing at his own cost.
- In order to ensure stability of the base /strengthen the compaction/, additional sand which does not contain organic and plastic matter and may be added to the mixture.
- Additional sand proportion shall be determined by lab-testing regarding the Consultant's satisfaction, particularly, not more than 15% of the weight of the mixture.
-
- A mixing plant either of the batch type or continuous type capable of mixing granular material/soil, cement and water producing not less than 180 t/hour shall be implemented. The following requirement shall meet for mixture production:
 - For batch type plant, the dry aggregates shall be measured by weight.
 - Continuous type plant mixer, all the materials adjustable calibrated to measure by weight, Gravel and cement flowing through the continuous feeder with adjustable speed which should be always under control.

A cement diversion chute shall be used to effect supply of cement diverted from the main belt to a sampling weighing scale. The cement diversion chute shall be constructed such as to provide control over the cement test time.

At batch mixing plant cement shall be weighed on separate scales than that of aggregate batching scales. If the cement compartment is separate in the aggregate hopper and cement is weighed before weighing the aggregates, cement may be weighed on the same scales of weighing aggregates.

Cement shall be added steadily to the granular material to ensure its uniform distribution to the aggregates during the mixing process.

Approved feeder and metering devices shall be used for measuring cement, water, and aggregates in case of continuous type mixing plant. To ensure this feeder and metering devices shall have to be interlocked and synchronized so that constant ratio of cement and aggregate is followed throughout the mixing operation. The continuous batch type plant shall be equipped with a proper signal system capable of indicating bins strike off capacity and minimum metering level. The gate opening calibration and functioning of the plant must be to the satisfaction of the Engineer.

The charge mass in batch type, and rate of feed in the continuous type shall not exceed their uniform mixing capacity. The dead areas in the mixer where aggregates are neither agitated nor move shall be corrected by controlling the rate of feed.

Water may be measured either by mass or volume. The quantity, rate and time of adding water to the mix shall be as approved by the Engineer.

Mixing shall ensure uniform distribution of cement and water in the entire granular mix. In no case shall the mixing period be less than 30 sec once all the materials are fed in the mixer

b) Transport

Ready mixes shall be properly loaded and transferred by dedicated trucks/dump trucks.

c) Placing

The laying of CTCS Base shall be done by using paver finisher capable of laying and paving a width of at least one lane, having extension provisions to cover the additional width. Grader and paver both may be used as series. The paver finisher shall be powered with the following features:

- Loading hoppers and suitable distribution mechanism
- The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread smoothly and uniformly
- The paver shall have provision of sensor for slope and grade control.
- The paver shall be equipped with necessary control mechanism

d) Compaction

Compaction shall be performed smooth wheeled rollers and rubber tired rollers. Vibrating rollers shall weigh in static condition not less than 9-12 t. For microcracking stage 12 t smooth wheeled rollers shall be used. The rubber tired roller shall have 20–30 t weight with tire pressure of 0.7 MPa.

e) Curing

Water curing: The pressure distributors shall be truck mounted and capable of applying a fog or fine mist of water to the road surface without direct impact.

If Bituminous curing membrane needs to be used, self-propelled bitumen sprayer having appropriate features shall be used, as approved by the Engineer.

Plastic sheet may be used. Plastic sheet shall be white in color which protects from light, and with not less than 0.10 mm thick. The plastic sheet shall be water proof.

1019 CONSTRUCTION

a) General

The CTCS base construction shall be carried out as uniformly distributed cement, free from loose or segregated areas. The layers shall be of uniform density and moisture content in its full depth with a smooth surface. Prior the main work, a trial compaction of not less 100m length shall be performed to ascertain the extent of compaction rolling, control on density and moisture, slump of the mix and final surface finishes. The main work shall follow once the trial compaction is approved.

b) Surface preparation

Before laying CTCS base course, subbase layer surface shall be proof rolled and checked for minimum 98 % heavy proctor compaction conforming to the AASHTO T-180. The surface tolerance shall not exceed by more than 15 mm from the specified grade and cross section at verification by 3m-straightedge. The surface shall be kept moist but not too wet before laying the CTCS base. The surface of subbase layer shall be cleaned of unacceptable materials and shall be kept moist before receiving the CTCS base aggregates.

Setting out should be carried out in such a manner that surface level is closely monitored.

Reference pegs should be parallel fixed along the edge points of a road and monitored by using string-method and others. In case stabilized base is constructed on sharp curved section, transition section of sufficient length should be provided therein. An abrupt change

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and any changes that may breach classification requirements of a road should not be allowed to be incorporated in surface of base course.

c) Weather restrictions

Air temperature: The construction of CTCS base shall not commence if the falling air temperature reaches 5°C or the work shall not resume until rising air temperature have reached 5°C.

Rain and snowing: CTCS base shall not be placed if it is raining/snowing or likely to rain/snow. Already placed surface shall be protected against precipitation until it is sufficiently strengthened. Also, the work shall not resume when there is wind storm, which is one of the contract conditions for restrictions for the work to continue.

d) Timing

The mixed material shall be placed on the prepared surface within 45 min of adding of water to the cement in the mixer. The placing, compacting, and finishing of the CTCS base shall be completed within a period of 2 hours from the time of adding of water.

e) Laying the mixture

Immediately after the surface has been prepared and approved, the mixture shall be spread to line and level by the laying plant without segregation or dragging. The line and level of laying shall be checked and identified by theodolite to the both sides from centerline. Use of hand tools with low accuracy such as ordinary rulers for the fixing the level wire will be prohibited.

In case a mix is laid in parallel lanes, two pavers and more should be used depending on width of a road. In case one paver is used for two-lane width, laying duration should be determined in such a manner that construction joints are not created. If laying of the second lane follows the first within 30 minutes, joints should not be provided. Construction joints should be provided in other cases. Where additional lanes are required, upon completion of mix lying, an edge of base course should be cut toward longitudinal direction of base for removal. When spreading a base mix, a care should be taken to prevent from extreme dryness and loss of moisture.

f) Compaction

The compacted dry unit mass of the finished CTCS course shall not be less than 98 % of the maximum dry density conforming to AASHTO T-180 heavy proctor compaction.

Care should be taken not to damage the edge of a road during compaction, because of traffic and prevent from damage due to weather affect. Compacted surface should achieve full compaction and be regular. Thickness of compacted one layer should be less than that specified in the drawing. If thickness of compacted base is specified to be more than 225 mm, compaction should be carried out in two layers. Base mix should be immediately compacted upon completion of spreading; and compacted surface should achieve required level, cross-sectional pattern and uniform thickness. Base should be uniformly compacted within timeframe and to required density. Loose stones appeared on base surface should be removed from time to time. Moisture content of layers to be compacted might be in the range of $\pm 2\%$ of optimum moisture content. Where a roller is not applicable, a manual roller should be used for compaction. In order to avoid damage in base elevated points, auto grader or similar equipment shall be used for leveling. Surplus materials should be, as directed by the Engineer, placed onto shoulders and adjacent embankment. No loose materials should be left on surface of cement treated crushed stone base. Laying additional mix onto compacted base in order to achieve design level is strictly prohibited. If it becomes obvious that level was reduced after compaction, additional materials should be added after inevitable scarification.

g) Transport

The ready mixed aggregates shall be covered upon transferring. A dump body shall be equipped with a waterproof and windproof cover.

h) Construction joints

Longitudinal: In case subsequent mix is placed over parallel lane adjacent to a compacted layer which is laid more than 30 minutes ago, an edge of the compacted layer shall be cut to the full thickness forming vertical surface. Such cutting shall be done with the same day.

Transverse: In case paving shall be stopped to take up next day, thickness of mix being placed on a day in question shall be reduced gradually slopping up to the half of original thickness of mix (6 m along centerline). When the work takes up next day, fresh mix shall be placed on and filled in thinner parts achieving the full thickness.

When laying asphalt concrete mix on base surface, pavement and base joints should be overlapped. Gap between joints should not be less than 30 cm.

i) Initial compaction

For laying the mixture it is necessary to use an asphalt paver with a base mounted additional saw and a sensor that controls the surface slope of the coating.

Following the asphalt pavers, the rollers, which operate in the normal and vibrating mode, perform the first pre-compaction.

A crew consisting of roller operators and other required workers should carry out rolling and compaction. The sequence of the work is as follows:

- The first two proof rolling should be carried by a tandem roller in a static regime.
- Second stage compaction shall be carried out by 30Hz roller with highest amplitude at 3-4 km/h, 3 times in total.
- The consecutive compaction shall be carried out by 9-12 ton 45 Hz roller with lowest amplitude at 4-6 km/h speed, totally 2-3 times.
- Compaction shall be carried out by pneumatic roller 4-6 times at 6-10 km/h speed.
- Compaction shall be completed and checked after compacting 2 times at 6-8 km/ h speed by tandem roller in a static regime.

Compaction shall be commenced after laying of section with length of 20-30 m and optimum length of single compaction shall be 100-150 m.

Amount of area under single work is named as section or length of single work. When the length of section is short causes multiple longitudinal joints, further results in uneven thickness.

j) Slope measurement

Upon completion of first compaction, longitudinal and transfer to surface slope shall be verified with 3m-straightedge or other appropriate instruments

k) Grading and leveling the surface, and final compaction

Any loose particles on the surface shall be disposed, and surface moistening and compaction by tire rollers may performed where necessary.

The finished surface of CTCS Base shall be checked with a 3m-straightedge which when placed anywhere on the surface in any direction shall not show a gap more than 8 mm between straight edge and the finished surface.

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When the requirements such as clearing of the undulation before rolling and disappearing of tyre marks of rollers are fulfilled it is considered that compacting is done finally with satisfaction.

Switching on and off vibration of the rollers is permitted only during the movement of the rollers but it is not allowed when they are stop. Saturating tyres of pneumatic rollers is not allowed. Stopping the roller during the process of compaction is not allowed at the location where the activity of the compaction is in the process.

l) Initial curing

During finishing the surface shall be kept moist, by applying a fine spray or fog of water as such intervals as may be required to maintain the surface at not less than its optimum moisture content as specified in the mix design. The surface shall not be moisten with High compressive water at any time. The initial curing shall be done for a period of 24 hours after completion of the compaction.

m) Microcracking

After first 24 hours of water spray curing, the stiffness of the CTCS base shall be measured by an appropriate device such as Humboldt Stiffness Gauge (HSG) or equivalent. If the stiffness reading is in the range of 50 – 60 MN/m, the microcracking rolling shall commence. If the stiffness reading is less than the stated value range, further curing of water spray shall continue till another 24 hours or so unless the desired stiffness of 50-60 MN/m is observed. The stiffness reading shall be taken at every 30 m spacing along the road axis and the reading spots shall be duly marked to be identified for subsequent readings after microcracking rolling. The microcracking of the finished CTCS base shall be accomplished by active rolling using a 12 ton vibratory steel wheeled roller in vibratory mode with full amplitude approximately at a speed of 3 km/h. The rolling shall cover full width except 0.3 m edge strips on either side. The microcracking shall be deemed to be completed if the stiffness reading at the marked spots where initial reading were taken have reduced by 40 % compared to the initial reading after one or more passes of the rolling. The reading shall be taken after every single pass of rolling and when the target of 40 % reduction is observed the rolling shall stop. Such regular stiffness reading shall determine the number of passes required to achieve the 40 % reduction in the stiffness.

In addition, keeping the capacity of allowing the load covering wider areas or with shape of a plate is preferred. Therefore, in order to avoid from the irregular alligator cracks that can be appeared on the surface of the base it is possible to use the method of forming cracks in advance and cutting to reduce the cracks and coefficient decreasing limited condition.

n) Final Curing

After completion of the microcracking, the section shall be moist cured for another 48 hours. Afterwards, prior placing the concrete pavement, bitumen spraying shall be performed in accordance with the Technical Specifications Subsection 1006. After placing the bitumen coating, the surface shall be kept moisture cured for 3 days

o) Traffic restriction

Vehicle traffic including construction equipment traffic shall be restricted traveling on the paved CTCS base or until the curing work completes.

The materials of the base are not allowed to be placed in following conditions in the case that any actions are not taken for non- frost.

- - When the temperature becomes down or is below 5°C;
- - When the temperature becomes up or is below 3°C

p) Start date of the pavement work

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Upon completion of the curing that lasts for 7 days, the concrete pavement construction may commence.

q) Shoulders

Construction of shoulders shall be started immediately, upon completion of paving and compacting CTCS Base and development of protection film. If any loose aggregates of the shoulders appear on the CTCS Base, it shall be removed under by the Consultant satisfied method, without damaging the surface.

1120 QUALITY CONTROL

a) Compressive Strength

The compressive strength shall be verified during construction by obtaining field samples in the cylinder size conforming to AASHTO T-180 of the mixed material from the site twice each day of placing of the CTCS.

In accordance with the requirements of the standards MNS 1272:1999 and MNS 1557:2002 taken mix shall be compacted with a hummer with 4.54 kg from the height of 45.7 cm in 300 mm high mould to prepare the sample for testing bending strength in the laboratory with 5 layers in cylinder mould with 150 mm dia.

For each time two sets of 3 samples shall be molded. The material shall be compacted in the above designated molds at the site and shall be moist cured as is being done at the site for surface curing. Preferably the cubes shall be kept at the surface and shall be cured as the main surface is being cured and should be protected from any damage or loss. To be on safer side similar number of samples shall be maintained in the laboratory also. Two of the three samples of each set of collected cubes and cured shall be tested at 7 days and the third one shall be tested as directed by the Consultant.

b) Density of the base course

Moisture: While compacting, field moisture may be ± 2 % of optimum moisture content determined in the laboratory, according to AASHTO T-180. The field moisture and density shall be immediately measured, for each 300 m length of the CTCS base conforming to the ASTM D7830 /D7830M-14, using a SDG- 200 gauge. This gauge indicates the result of 1 location in less than a minute. Therefore, implementing this instrumentation, prevents the CTCS Base to get over or less strengthened. Additionally, conforming to the AASHTO T- 318-02 standard specifications is necessary.

Density: If the gauge is not available, the density shall be verified according to the AASHTO T-191 standard.

c) Stiffness

Upon completion of compaction and initial curing of CTCS base, the base stiffness shall be verified with a Humboldt Stiffness Gauge (HSG). This gauge indicates required strength for base settlement. If the base is sufficiently hardened, microcracking compaction may be started, further, the gauge reading helps to determine the required number of roller passes.

d) Surface smoothness

The surface smoothness shall be within the tolerance limits stated in the Table 9-5. The roughness of the surface shall be checked referring the surface of the top layer of the base if the base has 2 layers.

Table 11-8: Permissible Surface Tolerances for CTCS

Layer	Surface Elevation	Max. hollow space below a 3m-straight edge	Cross Slope
CTCS base layer	±10 mm	8 mm	±0.30%

e) Measuring the thickness of the base

The equipment with 100 mm dia. shall be used to measure the thickness of the base. After completion of the compaction sample shall be taken from each 3000 m square for the measurement. The holes remained due to taking sample shall be filled with the same mix design of cement treated base.

f) Testing of crushed stone materials

Crushed stone materials shall be tested for each 3000 m³ for their particle size, Los A

g) Cement

The cement shall be used in the mix of the materials to be used for the construction of cement treated crushed stone base only after ensuring the requirements indicated in the sub- clause 902.1 of this Technical Specification. Each 200tns of arrived cement at the site shall be tested frequently. If there is the cement that is more than 42 required test shall be conducted and it can be used only after confirming the test result of that. The content of the cement shall be identified as per the requirements of MNS AASHTO T 211-90:2016 taking sample from the cement treated mix after producing the mix or mixing at the site. This method is very suitable to identify the content of the cement within very short time at the site. In addition, it can be used for checking uniformity of mixing at site and laying the mix. This method can be used to measure the content of cement before strengthening and also required tests should be conducted after mixing materials and cement before strengthening.

h) Water

The quality of the water shall be identified as per the MNS AASHTO T 26: 2005 and it should be as per the requirements of the Clause 1117 of this Specification.

1121 SEQUENCE OF CONSTRUCTION

Main construction work for CTCS Base shall be executed in the following sequence:

- Grading and compacting the subbase finished surface
- Crushing the aggregates, prepare and produce CTCS Base aggregates at designated composition
- Trial spreading as designated by the Engineer
- After grading and compacting the subbase course, spread CTCS base layers with a paver finisher
- Base course compaction
- Initial curing
- CTCS microcracking
- Final curing
- Prepare for commencing asphalt concrete pavement construction

1122 MEASUREMENT AND PAYEMENT – SUBSECTION (C)

(a) Cement Treated Crushed Stone Base (CTCS)

Unit: m³

The measurement of cement treated crushed stone base shall be the volume measured to the outlines stated in the Drawings.

The items cement treated crushed stone base shall include for:

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- provision of crushed stone materials;
- adding cement as required;
- variations in cement content;
- trial areas and trials;
- making good after sampling and testing;
- loading into transport, haulage;
- protection of material in transit and while awaiting tipping;
- grading, measuring, mixing and depositing materials;
- providing and mixing water or drying out the material;
- processing and modifying materials for compliance with the specifications;
- removal and disposal of oversized material in a manner approved by the Engineer;
- mixing and processing;
- spreading and compaction;
- cleaning, preparing and working on or up to existing surfaces and features;
- edge support;
- maintenance of surface;
- taking measures to protect the capping layer, sub-base and base from deterioration due to the ingress of water and the use of constructional plant;
- taking measures to improve the sub-base and base to protect the base, sub-base, capping layer and subgrade from damage due to the Contractor's method of construction and choice of constructional plant;
- shaping to cambers, falls and crowns;
- check the compaction strength using the Humboldt Stiffness Gauge (HSG) and provide this instrument;
- provision of soundness test certificate.

CHAPTER 1100 (C) – CRUSHED STONE BASE

1123 GENERAL

This section covers the specifications for construction of crushed stone (CS) base layer.

CS base is a composition of aggregates which includes ideal particle size of crushed stone. This composition of aggregate shall be produced using mixer plants, considering factors such as its methodology features and work quantities.

1124 MATERIALS FOR CRUSHED STONE BASE

Coarse aggregate shall consist of crushed angular stone free from weathered matter, inclusions, air bubbles, plate-like substances (e.g. mica), clay, silt, organic matter and other deleterious substances. Rocks which are highly jointed or fissured in-situ or breaks into platy fragments or have a polished appearance along the fracture planes shall not be used as aggregate sources. The minimum size of the stone to be crushed to produce the chippings shall be at least 4 times the nominal size of the chippings. At least 75% by weight of the coarse aggregate shall have two or more faces split by the crushing. The percentage passing the 75 µm sieve shall not exceed 0.5% by weight. The physical characteristics of the aggregate shall comply with the following requirements.

The grading of graded crushed stone base material after placing and compaction shall be a smooth curve within and approximately parallel to the envelope shown in Table 11-9.

Table 11-9: Gradation Requirements for Graded Crushed Stone Base Material

Sieve Size	Mass Percent Passing
50 mm	100
37.5 mm	90 – 100
25.0 mm	80 – 95
19.0 mm	60 – 80
9.5 mm	40 – 60
4.75 mm	25 – 40
2.00 mm	15 – 30
425 µm	7 – 19
75 µm	2 – 8

The contractor may use the natural fine material passable through 6.3 mm sieve from secondary approved source by the Engineer if the amount of fine aggregate produced during crushing is insufficient. The percentage of such fine material shall be not more than 20% of total weight of mixture and PI shall be maximum 4%.

The physical characteristics of graded crushed stone base material shall comply with the following requirements:

- Sodium Sulphate Soundness (AASHTO T104) max. 12%,
- Los Angeles Abrasion Value (AASHTO T96) max. 30%,
- Flakiness Index (BS 812) max. 35% and,
- Water absorption max. 2%.

The crushing, screening and proportioning of materials and their subsequent blending shall be carried out using well-matched mechanical equipment and working procedure which ensure adequate capacity and consistently acceptable product quality. The blending of materials of different sizes or sources shall be carried out at a stackyard using mechanical equipment and work procedure demonstrated through trials by the Contractor and found acceptable by the Engineer. To avoid segregation, graded crushed stone shall be moistened when being handled and transported and shall not be stockpiled in heaps greater than 5 m in height.

1126 CONSTRUCTION WORKS

The compacted thickness of any layer laid, processed and compacted at one time shall not exceed 200 mm. Where a greater thickness is required, the material shall be laid in two or more layers. The minimum layer thickness shall be 100 mm compacted.

Any oversize material which cannot be broken down to the required size shall be removed and disposed of.

The procedure of laying and compacting, including selection of equipment, shall be determined from construction trials carried out as instructed by the Engineer. In principle laying of the base course shall be carried out with a paver finisher in order to reliably achieve the required tolerances. Such trials shall be repeated when materials sources or equipment selection are changed at the start of each construction season or when determined otherwise by the Engineer to maintain quality of work.

Base shall be at or near the optimum moisture content at the time of placing, and shall be uniformly blended. Material shall be deposited in sufficient quantity and spread in a uniform layer across the full pavement width, such that the final compacted thickness is nowhere less than shown on the Drawings or instructed by the Engineer. Spreading may be carried out by using a motor grader or using a paving machine, but a paving machine is preferred. Every reasonable effort shall be made to prevent segregation after mixing and during the loading, hauling, placing, processing and compacting operations. After laying all areas of segregated coarse or fine material shall be corrected, or removed and

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replaced with material, which conforms to the Specification. Where the material for shoulders is the same as that used for the base course, the material shall be evenly spread in layers, as herein specified, for the full width of the base course and the shoulders simultaneously. Where the shoulders are not of the same material as the base course, then the base shall be spread to give the required compacted depth and the edge detail shown in the Drawings.

The moisture content shall be adjusted by either uniformly mixing in water or drying out the material such that the moisture content during compaction is maintained between 5% above and 1% below the Optimum Moisture Content (AASHTO T180). Base layers shall be graded and trimmed to final line and level. Light compaction may be applied before the final trim is carried out provided that the Contractor shall not carry out further trimming or correction of surface irregularities once 25% of the compactive effort has been applied.

The final trim shall be in cut and the Contractor shall ensure that material from the trim is neither deposited in low areas nor spread across the section but graded clear of the works.

The Contractor shall compact each layer immediately after it has been placed.

All rolling shall be longitudinal and shall commence at the outer edges of the pavement and progress towards the center, except that rolling of superelevated curves shall progress from the lower edge to the higher edge.

During the grading, trimming and compaction of the material the Contractor shall ensure that neither the surface nor the material itself dries out by applying fog sprays of water or other approved means sufficient to maintain the surface and/or material within the specified limits of moisture content.

The Contractor shall proof-roll all completed CS base with a steel three wheeled roller applying a load of not less than 5 tonnes per metre width of roll. Layers shall be free from visible movement under proof-rolling. Approval of a layer shall only be given after the satisfactory completion of the proof-rolling. Proof-rolling and any necessary remedial works identified as a result of proof-rolling shall be carried out at the expense of the Contractor.

1127 QUALITY CONTROL

Base material shall achieve a dry density of at least 100% MDD (AASHTO T180).

Base course shall be set out and constructed to the appropriate tolerances specified in Section 300 of this Specification.

On completion of compaction, the surface shall be well closed, free from movement under compaction planes, ridges, cracks, loose or segregated material. If the surface fails achieved to meet the requirements of this Specification, the Contractor shall take the necessary action brought out in Section 300 of the Specification or any other such action as the Engineer may require thereon.

1129 MEASUREMENT AND PAYMENT – SUBSECTION (D)

Crushed Stone Base

Unit: m³

The measurement of crushed stone base shall be the volume measured to the outlines stated in the Contract.

The items for crushed stone base shall include for:

- provision of materials;
- trial areas and trials;
- making good after sampling and testing;

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- loading into transport, haulage;
- protection of material in transit and while awaiting tipping;
- grading, measuring, mixing and depositing materials;
- providing and mixing water or drying out the material;
- processing and modifying materials for compliance with the specifications;
- removal and disposal of oversized material in a manner approved by the Engineer;
- mixing and processing;
- spreading and compaction;
- maintenance of surface;
- taking measures to protect the sub-base and base from deterioration due to the ingress of water and the use of construction plant or use by the public;
- shaping to cambers, falls and crowns.

SECTION 1200 – PAVEMENT WORKS

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SUBSECTION (A) – GENERAL

1201 CONTENTS OF SUBSECTION (A)

Subsection A describes all requirements for bituminous binders and crushed stone.

1202 REQUIREMENTS FOR BITUMEN BINDERS

All bitumen binders shall meet the requirements of chapter 200 of these Technical Specifications.

1203 STORAGE AND MAINTENANCE OF BITUMEN BINDERS

If the Contractor transports binders in bulk, the temperature and quantity of binder shall be recorded as approved by the Engineer. Any binder material that does not meet the requirements of chapter 1205 of these specifications shall not be permitted by the Engineer to be used in construction.

The Contractor shall keep the bitumen storage unit and heating station clean at all times, and the grass around these facilities shall be mowed. To prevent the risk of fire, the barrels should be placed at a sufficient distance from each other.

The bitumen carrier and bitumen pot shall be kept clean at all times. If the brand of bitumen changes, it is not allowed to mix and store and use other types of bitumen. In order to receive the new brand of bitumen, the drums are prepared and all work pans and bitumen carriers are thoroughly washed with an approved solution. Waste from cleaning of bitumen pot and bitumen carrier should be disposed of in designated sewage wells. In doing so, the Contractor has to take all possible measures to prevent pollution of the surface of the land, the flow of running water, and soil water veins. The contractor shall empty the sewage well as approved by the Engineer and remove sewage within a certain period of time. Upon completion of construction, the Contractor shall remove these sewage wells and canals and rehabilitate the surrounding area to the extent required by the Engineer.

The Contractor shall keep all pans, preheat wells, tools and equipment absolutely clean.

When bitumen is poured from the pot or the warehouse into the bitumen carrier, it is filtered through a mesh filter made of fine wire.

If bitumen is transported by rail, measures shall be taken to ensure road safety, not to pollute road rails, sleepers and other equipment, and to keep them clean at all times.

1204 HEATING THE BITUMEN BINDERS

During storage, the temperature of the bitumen binder should be kept as low as possible, but at a level where the binder can be pumped.

The contractor shall heat the bitumen binder only in pans or tanks of sufficient capacity equipped with suitable pumps and thermometers with detailed readings. The binder shall

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not be heated in a container with faulty thermometer or a thermometer that does not have detailed readings.

For streaming pressure sprayers, spray viscosity ranges from 70 to 100 centistokes, and spraying pressure sprayers from 35 to 65 centistokes.

Any brand of bitumen used in construction work should not be heated above 170°C. Superheated bitumen shall be removed from the site by the Contractor.

The volume of the binder shall be measured at 15° C or based on the volume adjusted at 15° C using the Petroleum Standard Measurement Table (ASTM D 1250) and shall be applied to the binder at the input norm specified or determined by the Engineer.

Polymer modified bitumen shall be kept at 160 – 170° C and mixed continually.

1205 ADDITIVES

Appropriate additives approved by the Engineer shall be used to increase the binding properties of the bitumen used for surface treatment. Additives shall be applied in the manner prescribed by the Engineer and in accordance with the manufacturer's instructions for use.

1206 LIMITATIONS ON CONSTRUCTION WORKS

The Contractor shall not carry out construction work involving bitumen in adverse weather conditions or under conditions of prior warning by the Engineer.

Bituminous materials shall not be placed on wet or frozen surfaces, or in adverse weather conditions for compaction of the mixture, and unless the manpower, machinery, and equipment set specified in the Engineer's approved work methods are provided. The Engineer may instruct the surface to be moistened prior to application of bituminous emulsion and certain types of liquid spraying.

The contractor shall spread the bitumen mixture on the surface when the air and road surface temperature is +10°C or higher and the wind speed is less than 36km/h.

1207 ENSURING SAFETY

The contractor shall take all necessary measures to prevent fire. The contractor's procedures for working with bitumen shall meet conditions that do not harm the health and safety of the public or its employees. In particular, the Contractor shall:

- a) heat bitumen only to the extent required for the operation,
- b) prevent water from reaching hot bitumen,
- c) provide suitable protective clothing, shoes and gloves for working with hot bitumen
- d) reduce dust to a minimum level,
- e) measures must be taken to keep the lids of working pots and bitumen storage barrels closed, and if there is an open storage area, prevent livestock and animals from entering.

1208 MEASUREMENT OF WORKS AND PAYMENT – SUBSECTION (A)

No separate measurement or payment shall be made for the fulfillment of Chapters 1201 – 1208 of these Technical Specifications. The costs incurred in complying with the requirements of Chapter 1200 Subchapter "A" shall be considered as included by the Contractor in the unit assessment of Chapter 1200 Subchapter B and C.

SUBSECTION (B) – PRIME COAT AND TACK COAT

1209 DESCRIPTION

Prime Coat refers to the use of bitumen binders with low viscosity on absorbent, unpaved surfaces.

Tack Coat is the application of a bitumen binder in a thin layer to an asphalt concrete or concrete surface.

1210 MATERIALS FOR PRIME COAT AND TACK COAT

The binder used for prime coat is MC30 and MC-70 liquefied bitumen that meets the requirements of AASHTO M82. Unless otherwise specified by the Engineer, cutback bitumen shall be sprayed at the rate of 0.8-1.4 l/m².

After prime coat application, the surface must dry within 24 hours and the depth of penetration into the sprayed surface should be 3 - 10mm. If the Contractor is going to pass his vehicles or public transport through the sprayed surface, he must protect the area by spreading blinding material.

Blinding material for spraying on bituminous surfaces should not contain organic matter, clay and other unsuitable substances, and fine crushed stone, sand, stone dust from the crusher should be used. The grain size of the material shall be AASHTO M43, size 110 or as directed by the Engineer.

The binder used in tack coat is:

- (i) hot spraying of 0.3 l/m² bitumen of penetration grade just before paving the asphalt concrete;
- (ii) a medium curing cutback bitumen, applied at sufficient time before laying the bituminous layer to allow the evaporation of the diluent, sprayed at a rate sufficient to give 0.2 l/m² of residual bitumen;

Diesel fuel may be used as a diluent unless otherwise directed by the Engineer.

The appropriate ratio of binder and diluent to be used in bituminous spraying and coating shall be determined by the Contractor in advance in the laboratory and reviewed by the Engineer, after which the work shall be carried out after a certain number of field tests and the approval of the Engineer.

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The Contractor shall regularly maintain a table showing the temperature of the binder to be used, the ratio of the components, and the location of the place where the bituminous spraying and coating will be carried out, and it shall be signed by the relevant personnel of the Contractor and the Engineer.

1211 SURFACE PREPARATION

The contractor shall thoroughly clean the surface to be sprayed and coated by sweeping with a mechanical broom, blowing with a gas pump/compressor, washing with water spray, or by other suitable means, and remove loosened soil and other foreign materials.

The surface to be bitumen sprayed and coated shall be completely cleaned over the entire width.

Check the direction, cross section and level of the surface to be sprayed and coated, and level the surface to the extent approved by the Engineer before starting the work. The Contractor shall apply to the Engineer for permission to spray immediately before commencing bituminous spraying.

Upon receipt of the Engineer's permission to commence work, the Contractor shall sprinkle a small amount of water evenly over the entire surface width prior to spraying, avoiding standing water or soaking the layer. Add the amount of water little by little to ensure the right conditions. If the surfaces are waterlogged, measures should be taken to remove the water and dry it to an appropriate level before spraying.

1212 PRIME COAT AND TACK COAT APPLICATION

After the surface has been prepared to the Engineer's approval in accordance with Chapter 1211 of the Technical Specifications, prime coat or tack coat shall be applied in accordance with the appropriate input rate. After the Engineer's approval of the surface preparation, the spraying and coating must be completed within 4 hours.

Spread the binder slightly beyond the total width of the surface. If the application rate is incorrect, the Contractor shall immediately stop the work and notify the Engineer, so that the Engineer gives instructions to change the rate.

Mark the edge of the spraying and coating area with a thread or a wire at intervals not exceeding 15m on the straight sections of the road and no more than 7.5m on turn sections.

The bitumen shall be applied using a uniform pressure sprayer with a minimum capacity of 7,000 liters. Hand spraying may be done with Engineer's approval for repair of small areas or poorly sprayed areas due to clogged sprinkler nozzles.

Adjust the nozzle of the sprayer for uniform spraying and coating, and test it by spraying it on a suitable material (such as paper or sheet metal) or in a designated flat tray before starting the work. The test should not be carried out on the road surface and any bitumen spilled on the ground should be cleaned.

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If the sprayer nozzle becomes clogged or damaged during spraying, stop spraying immediately. Finish by manually spraying the under- sprayed area. The sprayer machine shall be repaired before starting the next spray.

At the time of starting and stopping of spraying and coating, in order to make the beginning and end edges of the field clear and clean, paper or metal sheet with a width of at least 2m is laid across the entire width of the area being sprayed.

The metal sheet should be thoroughly cleaned after each operation, and the test tray should be cleaned after each day's work.

During spraying, the curbs, road furniture, culvert head- and wingwalls, trees and bushes should be protected and if they are accidentally contaminated by bitumen, they should be thoroughly cleaned by a suitable method approved by the Engineer.

1213 TEMPERATURE AT SPRAYING

Table 12-1 shows the minimum pumping temperature, spray temperature limits, and maximum permitted temperature limit.

Table 12-1 Injection, Spraying and Heating Temperatures for Medium Rate Thickening Liquefied Bitumen

Binder	Temperature (°C)*			
	Minimum temperature for pumping	Spraying		Heating limit
		Slot jets	Atomizing jets	
MC30	10	40 - 50	50 – 60	65
MC70	25	55 - 70	65 – 80	85

* *These figures are given for guidance only. The appropriate temperature at that time, depending on weather and road conditions, bitumen temperature and viscosity ratio, must be determined by the Contractor and approved by the Engineer.*

1214 CURING AND BLINDING OF PRIME COAT

After prime coat application, if the binder has not penetrated within the specified time, or if it is necessary to introduce vehicular traffic in this area, crushed stone material shall be sprinkled in the necessary amount to absorb the excess bitumen and protect the sprayed surface. Crushed stone material is evenly distributed over the entire area so that the wheels of the car do not go over the uncovered bituminous material.

Remove crushed stone and all loose material from the sprayed surface before applying the next coat.

1215 TOLERANCES

The amount of binder to be sprayed at one time in the total width should not deviate by more than + 10% from the specified norm. The average amount of bitumen sprayer to spray in one trip is at least equal to the established norm. In order to check the correctness

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of the calculation based on the capacity of the bitumen sprayer, the level of bitumen in the bitumen tank shall be checked at least once a day during bitumen spraying.

The ratio of bitumen and diluent is checked once every time spraying is done.

1216 MEASUREMENT AND PAYMENT – SUBSECTION (B)

(a) Prime Coat

Unit: m²

The measurement of prime coat shall be calculated using the width of the top surface of the course.

The items for prime coat shall include for:

- provision of materials;
- trial areas and trials;
- designing and verifying mixes;
- spreading;
- cleaning surfaces;
- protection and masking and unmasking of kerbs, drainage channels, chamber covers, gully gratings, expansion joints, road studs, road markings and the like and obtaining clean markings;
- cutting back, preparing and working on or up to adjacent faces, surfaces and features;
- admixtures and additives.

(b) Tack Coat

Unit: m²

The measurement of tack coat shall be calculated using the width of the top surface of the course.

The items that tack coat shall include for are as for Prime coat.

SUBSECTION (C) - ASPHALT CONCRETE PAVING

1217 DESCRIPTION

Asphalt concrete work shall consist of a surfacing of dense grade hot mixed hot-laid asphalt concrete, constructed on a primed base course in accordance with these Specifications and the lines, grade, dimensions and cross sections shown in the Drawings. This Section of Specification shall be used for all types of asphalt concrete pavement.

1218 MATERIAL

(a) Bitumen

Bitumen grade shall be performance-graded PG 70-40 in accordance with AASHTO M320-10 conforming to chapter 209 of the Technical Specifications and/or as approved by the Engineer.

(b) Aggregates

Coarse stone (remaining on the 4.75 mm sieve) is crushed pointed stone and does not contain weathered, flat or flaky material (micnite), clay, loam, organic material or other

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harmful substances. Stone that crumbles or cracks easily on the ground and that break apart in flat flakes or have a smooth surface along the fractured grain should not be used for crushed stone materials. The minimum size of crushed stone should be 4 times the size of fine crushed stone or larger. More than 75% of the total weight of the crushed stone must be cracked in two or more directions during the crushing process. The amount of stones passing through the 0.075 mm sieve does not exceed 0.5% by weight. The physical properties of the material shall meet the following requirements:

- Los Angeles abrasion loss $\leq 20\%$
- Sodium sulfate strength $\leq 12\%$
- Water absorption $\leq 2\%$
- Flakiness index $\leq 20\%$

Fine aggregate consists of coarse sand (passed through a 4.75 mm sieve) and crushed stone or crushed gravel. The stone is strong and coarse-grained, and does not contain clay, loam, mica or other harmful substances. Fine-grained aggregate sand equivalent (AASHTO T176) value is not less than 50, the plasticity index passing through a 0.425mm sieve is not more than 4, and the weight loss is not more than 15% after 5 sodium sulfate strength tests according to the AASHTO T104 standard.

The contractor shall take measures to prevent separation of material particles when collecting stones in stockpiles. The stones are built up in horizontal layers, so that the height of the each layer does not exceed 1.5 m.

(c) Mineral powder

Mineral powder shall consist of stone dust, hydrated lime, Portland cement and other minerals approved by the Engineer.

When using mineral powder, the powder should be dry and free of any lumps.

The composition of mineral grains shall be in the following range:

Sieve size	Percentage of weight that passes through the sieve
600 μm	100
300 μm	95 - 100
75 μm	70 - 100

Mineral powder obtained from stone dust and similar materials shall not contain mica, organic materials or other impurities, and the plasticity index shall not exceed 4%.

(d) Sand

Mixed group M_{kp} 2,1-3,1 – natural and crushed sand conforming to MNS 392 : 2014 standard, shall be used for asphalt concrete mix. Crushed coarse sand may be added to fine sand. Crushed sand shall be extracted from stones that is strength properties is not less than in ones used for aggregates. Crushed stone particles smaller than 0.075mm may be 5% of the weight in which clay content shall not exceed 5%.

1219 PHYSICAL CHARACTERISTICS AND GRADING REQUIREMENTS

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Unless otherwise specified by the Engineer, after mixing the coarse and fine stone or mineral powder according to the reference standard, the grain size distribution shall be equal to or close to the limits given in Table 12-5.

Based on the results of laboratory tests and field tests, the grain size limit may be changed if approved by the Engineer.

Table 12-5: Grain size limits for asphalt concrete

Size of the sieve	Percentage of weight that passes through the sieve	
	Type A-11	Type A-5
25 mm	100	100
19 mm	95 - 100	95 - 100
12.5 mm	70 - 90	-
9.5 mm	33 - 55	55 - 65
4.75 mm	45 - 65	32 - 45
2.36 mm	20 - 35	27 - 37
1.18 mm	-	19 - 27
600 µm	11 - 23	13 - 20
300 µm	5 - 16	9 - 15
150 µm	4 - 12	7 - 12
75 µm	2 - 7	4 - 7

Asphalt concrete mixtures shall meet the requirements of Table 12-6.

Table 12-6: Physical Properties of Asphalt Concrete

Parameter	Type A-11	Type A-5
Marshall stability (kg)	>900	>900
Flexibility (mm)	20 - 40	20 - 40
Porosity (% voids in the mix)	3 - 5	3 - 5
Loss of stability in Effect of Water on Compressive Strength at temperature of 60 °C	75 %	75%
Bitumen content (%)	5 - 5.5	5.5 - 6.5
Compaction of the sample	50:50	75:75

The binder content in the reference ingredient rate originally proposed by the Contractor may be changed based on the results of laboratory tests and field tests with the approval of the Engineer.

1220 CONTRACTOR'S EQUIPMENT

(a) General

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In accordance with Chapter 100 of these Technical Specifications, the Contractor shall clearly develop and present to the Engineer the equipment and work methods to be used in the execution of the construction work.

The Engineer reserves the right to inspect the Contractor's equipment at any time. In the presence of the Engineer, the Contractor will make regular adjustments to the equipment and repair any malfunctions.

All equipment used for mixing, laying and compacting the asphalt concrete mixture shall be of adequate capacity and in good serviceability and approved by the Engineer. Old or worn equipment shall not be permitted.

(b) Asphalt mixing equipment

The bituminous material will be mixed in an asphalt plant conforming to the AASHTO M156 standard, and the plant will be located in the field. Asphalt concrete plant must have at least 3 tanks for storing heated rock material, 1 tank for storing mineral powder, the necessary number of bitumen storage. All containers have a moisture-proof lid.

The asphalt plant shall be of batch type with automatic control, and sufficient capacity for continuous construction work, connected to a reliable source of power, capable of adjusting the mix composition to within the tolerances specified in chapter 1242 of this specification, and, have a software that produces, upon request by the Engineer, copies of asphalt concrete batching information. It shall also be equipped with a hot bunker with a capacity of at least 100 tons to store the ready hot mixture.

The bitumen storage tank shall be equipped with a thermostat capable of maintaining the working temperature of bitumen within ± 5 degrees of the specified value, and maintaining the temperature of bitumen without exceeding 170°C, and the thermostat shall be installed in such a way that it is easy to see from the outside. Bitumen heated above 170°C or burnt due to long exposure should be taken out and removed.

(c) Asphalt paving equipment

The asphalt paver is a self-propelled paver equipped with a vibrating screed and conveyor auger with a hopper and heater. Asphalt paver must be able to pave the asphalt mix without creating any stains, defects, material separation or clumping on the surface within the specified level and tolerance. It shall be equipped with a dedicated device (screed) to ensure the smoothness of the surface during paving, has an electronic /laser/ sensor, and is capable of paving 8m wide strips. Paver should be equipped with a precision control system that adjusts the screed by sensing the slope and cross fall along the surface. The control system is capable of operating the screed with an accuracy of $\pm 1\%$ in the specified cross fall. The paver should have a manual control system as well as an automatic control system.

(d) Compaction equipment

The contractor shall provide the number, approved type and weight of rollers to compact the asphalt mixture as required. The rollers shall be self-propelled devices with steel rollers, tires or vibratory type or a combination of these, and shall not disturb the paved mixture as they change direction. Before commencing the paving of the asphalt mixture, the Contractor shall demonstrate that the equipment can meet the requirements of the work through field tests in accordance with chapter 200 of these Specifications, and shall determine the most suitable method of operation, the number of passes, and the sequence of work.

1221 SURFACE PREPARATION

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Before laying the bituminous mixture, all loose and excess material shall be removed from the surface by mechanical sweep, high pressure gas nozzle or other approved method. Any defects found in the surfaces shall be rectified and no bituminous mixture shall be laid until the approval of the Engineer is obtained.

Unless otherwise directed by the Engineer, the Contractor shall apply prime coat or tack coat as applicable to the non-bituminous base surface or old surface in accordance with chapter 1200, Subchapter "B" of the Technical Specifications before laying the bituminous mixture.

The prime coat or tack coat must be cured before the mixture is applied. However, the tack coat should be applied only as far ahead of placing mix as necessary to obtain the minimum curing period.

Before laying the bituminous mixture, the Contractor shall repair the defects of the prime coat or tack coat, and if there are other road structures in contact with the bituminous mixture, apply tack coat to their surface. Repair the unevenness of the old pavement or foundation. Holes, dents, bumps, and other damaged parts of the foundation should be dug out cleanly and filled with new material.

Before applying bituminous mixture to the old surface, the Contractor shall seal the joints and crack across and along the surface with an approved material. In either case, the Contractor shall obtain permission to commence work from the Engineer prior to commencing work.

If the work is delayed due to the Contractor's method of work, and as a result, the Engineer deems it necessary to apply tack coat on top of the previously applied tack coat or between layers, the Contractor shall be responsible for the cost of the additional tack coat.

1222 MIX DESIGN OF ASPHALT CONCRETE

Asphalt concrete consists of a mixture of crushed stone, bitumen and mineral powder with the specified input norm. The Contractor shall determine the design mix and have it approved by the Engineer. The design mix comprises the following:

- (a) a single percentage of stone passing each sieve size,
- (b) a single percentage of bitumen and mineral powder in the mixture,
- (c) upper and lower temperature limits during mixing,
- (d) upper and lower temperature limits during paving of the mixture.

Not less than 56 days before the start of production of asphalt concrete mixture, the Contractor shall submit an official letter to the Engineer, attaching the design mix, the results of laboratory tests, the source of each sample and material, and the viscosity / temperature relationship of the binder. The Engineer has the right to require the Contractor to carry out additional tests necessary to verify and approve input standards. The Contractor shall follow only the standard ingredients approved by the Engineer while producing the bituminous mixture. If the Contractor has a proposal to change the standard input norms or to change the type or source of materials, he shall notify the Engineer in advance, explain his proposal in detail and present the relevant documents to the Engineer in writing. The Contractor shall not make any of the above changes until approved by the Engineer.

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If the Engineer deems the mix design submitted by the Contractor to be insufficient, the Contractor shall re-determine the mix design before producing the mixture and presenting it to the Engineer for approval along with relevant documents.

The Engineer reserves the right to temporarily approve or disapprove crushed stone material stored near the asphalt plant and mix from the asphalt plant. After the asphalt concrete is placed on the site, before compaction, samples of the mixture are taken and analyzed to ensure that it conforms to the mix design.

If additives are to be added to the mix in accordance with standard input norm, the source of additives shall be approved by the Engineer. The amount of additives shall be determined by the Contractor and approved based on the analysis of the Engineer's laboratory and the laboratory's procedure for setting the standard input norm. Also, the amount of additives will be verified in the field laboratory during the production process. Additives are added during the production of the mixture or mixed by other approved methods.

The above-mentioned procedures shall be followed whenever the mix design is updated.

1223 SITE TRIALS

The contractor shall compact the pavement material using the planned machinery and equipment and perform the test according to his planned method. The test shall be carried out in consultation with and in the presence of the Engineer at a location specified by the Engineer.

The contractor will conduct tests to demonstrate that his planned work methods, work sequence, machinery, plant, activities of its personnel and that the asphalt concrete pavement and compaction are done to the required level and meet requirements.

The test shall be performed on a length of at least 100 m, on the total width of the road, and with the appropriate thickness of the material. If the test section meets the technical requirements and is approved by the Engineer, it will be considered as a permanent construction part, but if it does not meet the requirements, it will be scrapped and removed.

In accordance with Sub-clause 14.1 of the terms of the contract, the contractor shall include in his schedule of work the time for the field tests and appropriate analysis. The contractor shall carry out the test 14 days before the start of the main paving work of the area.

In each test section, the contractor compacts each phase to the required level and records the following information:

- a) material composition and degree of grain size, bitumen content, type and brand of bitumen;
- b) moisture content of stone in hot bunker of asphalt plant,
- c) Temperature of stone and bitumen before entering the mixer, temperature of the mixture at the time of leaving the mixer, at the time of paving, at the start of compaction, and at the end of compaction

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- d) Roller width, weight, type, number of wheels, tire load, tire pressure, vibration frequency, number of trips for each type of iron
- e) Planned permeability and other planned parameters of the mixture with laboratory test results
- f) Density and permeability
- g) Fully compacted thickness with layer tolerances
- h) Any other relevant information required by the Engineer;

In the presence of the Engineer, the contractor shall take and analyze samples for each compaction type at least 8 points per 100m. If all 8 samples meet the requirements, the test section is considered successful. The above information recorded during testing will serve as the basic material to be used in further development of detailed requirements.

If during the construction work it is determined that the material does not meet the requirements through quality control analysis, the Contractor shall stop the work and determine the reason. In this, laboratory analysis and field tests will be conducted to determine the comprehensive parameters of material properties.

Acceptance by the Engineer of the data recorded by the field test shall not relieve the Contractor of any responsibility for meeting this specification.

1224 MIXING OF ASPHALT CONCRETE MIXTURE

The asphalt plant shall meet following requirements in accordance with AASHTO M156:

- (a) Minimum capacity 120 tph
- (b) a cylindrical dryer capable of heating the crushed stone to the temperature specified in this Specification,
- (c) heating the bitumen to a suitable temperature in a vessel approved by the Engineer to the mixing plant through insulated pipes where heat loss is minimized,
- (d) dry mixing of the plant for at least 10 seconds and mixing with bitumen for at least 30 seconds,
- (e) does not exceed 60 seconds of mixing time with bitumen in normal batching,
- (f) shall have an automatic control system to control the amount of aggregate material, mixing time and the release action of the mixer.

The contractor shall heat the bitumen until it flows smoothly and avoid overheating. The temperature of heated bitumen should not exceed 170 °C. If bitumen is to be stored hot for more than 24 hours, the temperature of bitumen should not exceed 125 °C. Heat and dry so that the temperature during mixing of aggregate is 125-165°C. The temperature of bitumen when mixed with rock material is between 140 °C and 160 °C. The temperature difference between the binder and the aggregate should never exceed 14°C.

The contractor will add the dried aggregate to the mixer in the specified amount for each fraction, and then give the bitumen in the specified amount. Mix the mixture until the stone material is evenly coated with bitumen.

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The contractor shall provide sufficient number of vehicles to carry out the asphalt paving work continuously during the planned period. Truck bodies shall be insulated or equipped with a reheater if required.

Contamination of the asphalt mixture and the release of particles during transportation must be prevented. Each load shall be made up of well-fastened canvas or similar coverings, and the coverings shall be of such size as to hang over each side of the crate. The product must be securely fastened so that it does not flap or fall apart during transportation. If the cover is torn or punctured, it should be replaced immediately. In addition, the bottom of the trucks for transporting asphalt mixture should be clean and smooth, and it should not be contaminated with oil, solvents or other materials that can adversely affect the mixture.

The contractor is responsible for supplying hot mix that meets the design mix.

1225 LAYING THE MIXTURE

Immediately after the surface has been prepared and approved, the mixture shall be spread to line and level by the paver without segregation or dragging. The line and level of laying shall be checked and identified by theodolite to the both sides from centerline. Use of hand tools with low accuracy such as ordinary rulers for fixing the level wire shall be prohibited unless otherwise instructed by the Engineer.

The Contractor shall place the mixture in full widths of carriageway. The compacted thickness of asphaltic concrete layer shall be in accordance with the requirements of Section 300 of this Specification. The compacted thickness shall be at least 2.5 times more than maximum size of aggregate. Minimum compacted thickness shall be 50mm.

Self-propelled asphalt pavers shall be used for laying. Pavers shall be capable of spreading and finishing the asphalt plant-mix material in widths applicable to the typical section and thickness, elevations, grades and camber shown on the Drawings or instructed by the Engineer. Prior to start paving operations the screed assembly shall be heated and receiving hopper and delivery augers are cleaned. If the screed is not heated as required or is not vibrating, the operation of the paver shall not be permitted.

The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. If any defects such as failure of thickness and gradient; development of crack, unevenness or rutting in the surface, the work shall be stopped immediately and correction shall be made to the satisfaction of the Engineer. Laying shall be re-started only after the Engineer's approval. The Contractor shall appoint a competent person to supervise all paving operations, operation mixing plants correlations between them. The Contractor shall not operate the paver in a continual stop and start fashion and shall minimize a number of cross joints.

Automatic controls in the paver shall be backed by manual controls that can be optionally activated. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided that the specified requirements are met.

If the Contractor fails to obtain and maintain the specified surface tolerance, the paving operations shall be suspended until satisfactory corrections, repairs or equipment replacement are made to the satisfaction of the Engineer.

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If during the paving operations unqualified mixture such as overheated, with high content of bitumen, segregated, with below etc. such mixture shall be removed from the site and disposed. Hand laying and hand raking of any bituminous material shall generally not be permitted.

Handwork will be allowed in the immediate vicinity of joints and at difficult corners where the finisher screed cannot reach. The Contractor remains responsible for the quality of finish in any area which has been hand raked and may be required to remove the laid asphalt and relay it if the quality of surface is, in the opinion of the Engineer, markedly inferior to adjacent, acceptable, machine laid surfaces. The Contractor shall bear any cost for the repeated work. Laying shall be started from the lowest point where longitudinal gradient is HIGH. Care of preventing water under the surface shall be taken in elevated section.

1226 COMPACTION OF THE MIXTURE

Immediately after spreading the bituminous mixture, the Contractor shall compact it thoroughly and uniformly by rolling. The minimum temperature of the mixture at the commencement of compaction shall be 125°C. The minimum temperature at completion of compaction shall be 90-110°C. The number, weight and type of rollers supplied by the Contractor shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The equipment to be used, sequence of rolling operations and number of passes shall be proven during Site trials and agreed with the Engineer.

Rolling, in compliance with the general procedures outlined below, shall continue until the layer under compaction has attained the specified requirements.

Prior to commencement of rolling, the fuel delivering system of the roller shall be properly checked, and repaired if any leakage of the fuel is observed. Also, drum watering system shall be in working condition.

Initial rolling with a vibratory steel tandem roller with 6 to 8 tons weight shall follow the laying plant as closely as possible. The roller shall roll every first pass there without vibration and every other pass back shall be vibrated.

Intermediate rolling with a pneumatic tyred roller with 12 to 16 tons width shall follow immediately upon initial rolling. Final rolling with a 3 steel wheels roller shall be used to eliminate marks from previous rolling. The rollers shall be operated with the drive roll nearest the laying plant, at a uniform speed not exceeding 5 km/h.

Rolling shall normally commence from the outer edge and proceed longitudinally parallel to the centreline, each pass overlapping the previous pass by one half of the roller width. On superelevated curves, rolling shall begin at the low side and progress to the high side. The rollers should not make sharp turns to the sides especially during initial and intermediate rollings. For the short stops the rollers should move to the compacted area.

When rolling the edge of the pavement, the wheel should protrude 50-100 mm more than the edge of the tread. Do not stop the rolling or other equipment on the pavement that has not been fully compacted, and if the roller breaks or stops for any other reason during the work, take immediate action to remove it from the compacted area or outside the area. If the compaction rollers are to be stopped, they must be moved to the previously compacted area.

The field density of asphalt concrete layer shall be checked from the average density of pairs of cores cut through the full thickness of the layer at the frequency indicated in the Project Quality Control Plan subject to a minimum of 1 pair of cores for each calendar day

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that asphaltic concrete work take place. Asphalt concrete layer shall be compacted to an average field density which shall be equal to or greater than the specified density and not more than 2 in any consecutive 10 results shall be more than 2% below the specified density.

The specified minimum density of compaction shall be 98% of the density of Marshall specimens compacted from the approved standard mix. Where the average density of compaction of such an area is greater than 1% below the specified minimum density, the Contractor shall forthwith remove the asphaltic concrete and replace it with asphaltic concrete complying with the specified requirements. It is strictly prohibited to charge construction equipment with fuel in any area of asphalt concrete pavement. Sharp turn of the roller shall be prohibited on any rolling operations.

The Contractor shall keep roller wheels and drums lightly moistened with water to prevent adhesion of the mixture to the rollers. The water shall not contain any chemicals neither using the diesel fuel instead of water will not be permitted. In areas too small for rollers, a vibrating plate compactor may be used to achieve the specified compaction.

1227 FINISHING, JOINTS AND EDGES

If cracks, damage, or defects occur on the paved asphalt pavement surface, it will be excavated, filled with fresh hot mix, leveled, and compacted to the same extent as the surrounding surface.

Joints in asphalt should be heated such that the old and new material is at approximately the same temperature. Rolling should overlap the joint.

Where the mixture is to be placed against previously placed bituminous material he shall form transverse joints by cutting neatly in a straight line across the previous face to expose the full depth of the course. Hand tools (i.e. crowbar or axe) are prohibited. Cutting face shall be heated and covered by bitumen, then the mix spread immediately. The paver shall be positioned to spread material overlapping the joint face by 20 to 30 mm.

After positioning the paver, the hot mixture pulled out by delivering augers shall be left on the edge of previously placed bituminous surface for 5 to 10 minutes and then the paver shall start paving. The excess mixture on joint area shall be raked off and discarded. The joints shall be spread by the mixture with fine aggregate and carefully leveled by hand and immediately compacted by a roller.

The finish at joints shall comply with the surface requirements and shall present the same uniformity of finish, texture and density as other sections of the surface. If during paving operations segregation of aggregate occurred The Contractor shall take hot mixture and sift it through a small sized sieve on the segregated surface, then level it with wooden plate and compact it by a roller.

1228 SAMPLING AND TESTING OF ASPHALT MIXTURES

The Contractor shall take sampling of asphalt mixtures in accordance with AASHTO T168.

1229 QUALITY CONTROL TESTING

During mixing and laying of bituminous materials the Contractor shall carry out control tests on the constituents and on the mixed material in accordance with his Project Quality Control Plan, Clause 1239 and Section 200 of this Specification.

If the results of any tests show a trend towards the constituent materials failing to comply with the Specification, the Contractor shall identify whatever changes are necessary to the materials and work procedure to ensure compliance, and obtain the Engineer’s approval before implementing such changes. If more than one test result for every 10 successful tests of a mixture or material does not meet the Specifications, the Contractor shall immediately cease laying operations until he has identified and corrected the reason for the failure. The Contractor shall at his own cost remove all faulty material and replace it with material complying with this Specification.

1230 TOLERANCES

The Contractor shall construct surfacing courses within the geometric tolerances specified in Section 300 of this Specification. The Contractor shall maintain the composition of the mixture as determined from the standard mix and Site trials within the tolerances, per single test, set out in Table 12-4.

Table 12-4: Tolerances for Asphalt Mixes

Constituent	Tolerance
Bitumen content	± 0.3% by total weight of total mix
Passing 4.75 mm and larger sieves	± 6% by total weight of dry aggregate including mineral filler
Passing 2.36 mm to 0.15 mm sieves	± 4% by total weight of dry aggregate including mineral filler
Passing 75 µm sieves	± 2% by total weight of dry aggregate including mineral filler
Temperature of the mix	± 10 °C

The average amount of bitumen in any length of the layer, calculated as the product of the bitumen contents obtained from single test and the weight of mixture represented by each test, shall not be less than the amount instructed.

The average amount of bitumen for each day’s production calculated from the check weights of mixes shall not be less than the amount instructed. The final average overall width of the upper surface of a bituminous mix layer measured at six equidistant points over a length of 100 m shall be not less than the width specified. At no point shall the distance between the centreline of the road and the edge of the upper surface of a bituminous mix layer be narrower than that specified by more than 10 mm.

1231 MEASUREMENT AND PAYMENT-- SUBSECTION©)

(a) Asphalt concrete surface course

Unit: m3

The measurement of asphalt surface course shall be calculated using the width of the top surface of the course and the thickness of the course.

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Note: The width of "the "top surface" of the course shall be the width required by the Contract and shall exclude sloping sides or edges. No deductions shall be made for openings of 1 square metre or less.

The item shall include for:

- provision of materials;
- trial areas and trials;
- making good after sampling and testing;
- protection of material in transit and while awaiting tipping;
- designing and verifying mixes;
- grading, measuring, reclaiming, mixing and depositing materials;
- air entrainment;
- spreading and compaction;
- cutting back, saw cutting, cleaning, preparing and working on or up to existing surfaces and features;
- edge support;
- forming or sawing grooves, cleaning, grit blasting, priming, caulking, temporary and permanent sealing of joints;
- shaping to cambers, falls and crowns;
- forming sockets, recesses, openings, and bays;
- protection and masking and unmasking of kerbs, drainage channels, chamber covers, gully gratings, expansion joints, and the like;
- maintenance of surface;
- taking measures to protect and maintain the pavement from deterioration by the use of constructional plant and the ingress of water and other materials;
- measures required for aftercare and opening the road to traffic;
- admixtures, additives and modifiers;
- saw cutting and sealing bituminous layers;
- bond-breaker tape;
- variations in the quantities of aggregates, bitumen, filler, and additives.

(b) Asphalt binder course

Unit: m³

The measurement of asphalt binder shall be calculated using the width of the top surface of the course and the thickness of the course.

Note: The width of the "top surface" of the course shall be the width required by the Contract and shall exclude sloping sides or edges. No deductions shall be made for openings of 1 square metre or less.

The item shall include for:

- provision of materials;
- trial areas and trials;
- making good after sampling and testing;
- protection of material in transit and while awaiting tipping;
- designing and verifying mixes;
- grading, measuring, reclaiming, mixing and depositing materials;
- air entrainment;
- spreading and compaction;
- cutting back, saw cutting, cleaning, preparing and working on or up to existing surfaces and features;
- edge support;
- shaping to cambers, falls and crowns;
- forming sockets, recesses, openings, and bays;

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- protection and masking and unmasking of kerbs, drainage channels, chamber covers, gully gratings, expansion joints, and the like;
- maintenance of surface;
- taking measures to protect and maintain the pavement from deterioration by the use of constructional plant and the ingress of water and other materials;
- measures required for aftercare and opening the road to traffic;
- admixtures, additives and modifiers;
- retarders, brushing and other measures necessary to provide exposed aggregate textured surface including disposal of surplus mortar arising;
- bond-breaker tape;
- variations in the quantities of aggregates, bitumen, filler, and additives.

SECTION 1300 - CONCRETE WORKS

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1301 SCOPE OF SECTION

This section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete and mortar required in the Works. It also covers formwork and reinforcement for concrete.

1302 DEFINITIONS

Structural concrete is any class of concrete, which is used, in reinforced or non-reinforced concrete construction, that is subject to stress.

Non-structural concrete is composed of materials complying with this Specification and is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

A formed surface is a face that has been cast against formwork.

An unformed surface is a horizontal or nearly horizontal surface produced by screeding or trowelling to the level and finish required.

A pour refers to the operation of placing concrete into any mould, bay or formwork, etc., and also to the volume that has to be filled. Pours in vertical succession are referred to as lifts.

Falsework comprises the structural elements that initially support both the formwork and the placed concrete.

Formwork is a structure, either temporary or permanent, provided to contain fresh concrete and support it in the required shape until it has hardened.

Consistence refers to fresh conc'ete's resistance to flow and is most commonly measured by the slump test. Other methods of measuring consistence include the compacting factor apparatus and the Vebe consistometer.

1303 MATERIALS FOR CONCRETE

(a) General

The Contractor shall submit to the Engineer full details of all materials that he proposes to use for making concrete. Concrete shall not be placed in the Works until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

(b) Cement

Cement shall comply with the requirements of Type II AASHTO M85 Specification for Portland cement or MNS974:20088 MNS 3091:2008, MNS EN 197:2018 standard, PC 42.5-62.5 or CEM 42.5 grade Portland cement, as approved by the Engineer. Only PC grade concrete shall be used for girders and beams.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufact'rer's

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sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles provided with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in suitably equipped purpose-built vehicles or containers.

Cement in bags shall be stored in a suitable weatherproof structure the interior of which shall be kept dry and well ventilated at all times. The floor shall be raised above the surrounding ground level and shall be constructed so that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed 3 m in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks. Cement from broken bags shall not be used in the Works.

Bulk cement shall be stored in weatherproof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on Site to ensure that his anticipated program of work is not disrupted as a result of lack of cement, taking due cognisance of factors such as transport, climatic conditions, holidays and breakdowns.

Cement, which has become hardened or lumpy or fails to comply with this Specification in any way, shall be removed from the Site. All cement for any one structure shall be from the same source. All cement used in the Works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. The tests to be performed shall be those set out in Section 200 of this Specification. The Contractor shall supply two copies of each test certificate to the Engineer. The Contractor shall not deliver any cement to Site until such results and analyses have been submitted to and approved in writing by the Engineer.

Each set of tests carried out by the manufacturer or Contractor shall relate to not more than one day's output of each cement plant, and shall be made on samples taken from cement which is subsequently delivered to the Site. Alternatively, subject to the discretion of the Engineer, the frequency of testing shall be one set of tests for every 200 tonnes of cement delivered to Site from each cement plant.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Engineer with two copies thereof.

Cement, which is stored on Site for longer than 42 days, shall be re-tested in an approved laboratory as directed by the Engineer.

Cement, which does not comply with this Specification shall not be used in the Works and it shall be disposed of by the Contractor.

(c) General requirements for aggregates

The sources of all aggregates shall be subject to the approval of the Engineer.

The Contractor shall immediately remove from the Site any aggregates that are, in the opinion of the Engineer, unsuitable for incorporation into the Works.

Aggregates shall be delivered to Site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in the same load.

Washing of aggregates may only be carried out using fresh clean water from a source approved by the Engineer. The Contractor shall make his own arrangements in respect of water procurement and storage facilities. Water used for washing aggregate shall not be directly discharged into water courses or surface water drains.

Silty water shall only be disposed of in one of the following ways and subject to the approval of the Engineer:

- pump and spread over grassland
- pump to excavated soakaway
- pump to sewer
- pump to settling lagoon
- pass through a filtration system with or without flocculating agents

Each type or size of aggregate shall be stored in a separate bin or compartment with gently sloping concrete base. Dividing walls between compartments shall be substantial, continuous and of sufficient dimensions to ensure that no mixing of types or sizes of aggregates occurs. The Contractor shall take such measures necessary to prevent the segregation of aggregates in storage heaps. Stockpiles shall be built up in horizontal layers and shall not exceed 1.5 m in height.

Storage heaps shall be capable of draining freely in order to avoid sudden fluctuations in the moisture content of the aggregates during batching. The Contractor shall not use wet aggregates until, in the opinion of the Engineer, they have completely drained. The Contractor shall measure the moisture content of fine aggregates continually and adjust the amounts of aggregates and water in each batch of concrete mixed to make allowance for the water content of the aggregates. The Contractor shall protect the aggregate storage heaps from inclement weather as necessary.

(d) Fine aggregate

Fine aggregate shall be clean hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with AASHTO M6. All the material shall pass through the 9.5 mm sieve and the grading shall be in accordance with and approximately parallel to the grading envelopes in Table 15-1. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source.

The fine aggregate shall not contain iron pyrites or iron oxides It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on the strength of mortar in accordance with AASHTO T71, that the presence of such materials does not reduce the relative strength at 7 days to lower than 98%.

Table 13-1: Grading Requirements for Fine Aggregate for Portland Cement Concrete

Sieve Size	Mass Percent Passing	
	Non-structural concrete	Structural concrete
9.5 mm	100	100
4.75 mm	95 – 100	95 - 100
1.18 mm	45 – 80	45 – 80
300 µm	10 – 30	5 – 30
150 µm	2 – 10	0 – 10

The amount of fine aggregate retained between any pair of successive sieves shall not exceed 45 %.

Other properties of fine aggregate shall be as set out below:

- (i) the fineness modulus shall be between 2.3 and 3.1,
- (ii) the content passing the 75 µm sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand,
- (iii) the chloride content when tested with a Quantab chloride titrator shall not exceed 0.03 per cent by weight,
- (iv) after five cycles of the test in AASHTO T104 using sodium sulphate the weight loss shall be less than 10 per cent,
- (v) the aggregate shall non-reactive when tested in accordance with ASTM C 289 for alkali silica reaction.

(e) Coarse aggregate

Coarse aggregate shall be clean hard and durable crushed rock, crushed gravel, natural gravel or a combination thereof, conforming to the requirements of AASHTO M 80. The material shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coal or other soft or porous material, or organic matter in sufficient quantity to adversely affect the properties of the Concrete. The shape of the coarse aggregate shall be angular, rounded or irregular with a flakiness index of less than 30%.

The maximum nominal size of coarse aggregate shall be 20 mm for structural concrete and 40 mm for non-structural concrete.

Grading of nominal sized coarse aggregate shall be in accordance with and approximately parallel to the grading envelopes in Table 13-2

Table 13-2: Grading Requirements for Coarse Aggregate for Portland Cement Concrete

Sieve Size	Mass Percent Passing		
	Nominal Size Aggregate		
	10mm	20 mm	40 mm

50 mm	-	-	100
37.5 mm	-	-	95 -100
25.0 mm	-	100 -65 - 85	
19.0 mm	--90 - 100 -35 - 70		
12.5 mm	100-55 - 80 -25 - 50		
9.5 mm	85-100-20 - 55 - 10 - 30		
4.75 mm	10-3-	0 - 10-	0 - 5
2.36 mm	0-1-	0 - 5	
1.18 mm	0-5		

The amount of coarse aggregate retained between any pair of successive sieves shall not exceed 45%.

- (13) Other properties of course aggregate shall be as set out below (i) the proportion of clay, silt and other impurities passing a 75 µm sieve shall be not more than one per cent by weight,
- (ii) The total shell content of aggregate shall not be more than the following:
- 40 mm nominal size and above 2% of dry weight
- (14) 20 mm nominal size and lower 5% of dry weight (iii) the chloride content shall not exceed 0.05 per cent by weight when tested with a Quantab chloride titrator,
- (15) (iv) after five cycles of the test in AASHTO T104 using sodium sulphate the weight loss shall be less than 10 per cent (v) the aggregate shall non-reactive when tested in accordance with ASTM C 289 for alkali silica reaction,
- (16) (vi) the aggregate shall have a water absorption of less than 2.5 percent when tested in accordance with AASHTO T102 (vii) the aggregate shall have an Aggregate Crushing Value (ACV) in accordance with BS 812 of less than 30%,
- (viii) the aggregate shall have a Los Angeles Abrasion (LAA) in accordance with AASHTO T96 of less than 35%.

(f) Testing aggregates

(i) Acceptance testing

Before casting any concrete, the Contractor shall deliver to the Engineer sample loads of all aggregates that he proposes to use in the Works. Representative samples of each proposed source of aggregate shall be prepared by the Contractor in accordance with AASHTO T2, of minimum mass 50 kg for fine aggregate and 100 kg for coarse aggregate, and forwarded to the Engineer together with such further samples as the Engineer may require. Each, sample shall be clearly labeled to show its origin and shall be accompanied by all the information called for in AASHTO T2.

If at any time tests reveal that previously accepted materials fail to comply with the Specification, their use in the Works shall forthwith be suspended pending further tests that shall be made in the presence of the Contractor and the

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Engineer. Thereafter acceptance or rejection of the material shall be based on such tests.

- (17) A material shall be accepted if not less than three consecutive sets of test results show compliance with the Specificationii) Compliance testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification and Project Quality Control Plan during the period that concrete is being produced for the Works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to Site provided that no set of tests shall represent more than 250 tonnes of fine aggregates nor more than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

- Grading AASHTO T27
- Flakiness Index BS 812
- Plastic fines AASHTO T176
- Moisture content "Sp"edy" Apparatus
- Check on organic impurities AASHTO T21

In addition to the above routine tests, the Contractor shall carry out the following tests at the intervals stated:

- Moisture content: as frequently as may be required in order to control the water content of the concrete as required by the Specification.
- Chloride content: as frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in Sub-Clauses 1503 (d) and (e) of this Specification.

The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load in order to prevent excessive amounts of chloride contaminating the concrete. For this purpose the Contractor may elect to use a rapid field test such as the Quantab test. In the event of disagreement regarding the results of such rapid field tests, the chloride content of the aggregate shall be determined in the laboratory as described in BS 812 (the Volhard test).

(g) Water for concrete and mortar

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other deleterious substances. The water shall have a pH value between 6.0 and 8.5 and shall be subject to the approval of the Engineer and tested in accordance with AASHTO T26.

Water with following properties shall not be used for mixing or curing concrete:

- saline or brackish water,
- containing more than 500 mg/l chloride ion,
- containing more than 1000 mg/l sulphate ion,
- containing more than 1000 mg/l alkali carbonates and bicarbonates, or,
- containing more than 2000 mg/l total suspended matter.

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In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by carrying out tests for compressive strength and time of set as specified in Table 1 of AASHTO M157.

The Engineer may at his discretion allow use of water having pH exceeding 8.5, but otherwise satisfying the criteria given above subject to the following additional criteria being satisfied.

First establish the source of alkali i.e. from carbonates of calcium and magnesium or from sodium and potassium oxides (Na₂O and K₂O).

1. In case the source of alkalinity is from sodium and potassium oxides (Na₂O and K₂O), the water may be allowed for mixing and curing provided it satisfies the following criteria:
 - total contents of alkali from all the possible sources should not exceed more than 3 kg/m³ of freshly mixed concrete,
 - both coarse and fine aggregates are not reactive
2. In case the source of alkalinity is from the carbonates of calcium and potassium, the water can be used, even if the aggregates are reactive provided the total contents of alkali from all the possible sources should not exceed more than 3 kg/m³ of freshly mixed concrete.

(h) Admixtures and cementitious extenders

The use of admixtures in concrete may be proposed by the Contractor to assist him in compliance with the Specification or in placing the fresh concrete. Admixtures shall be subject to the approval of the Engineer. Air-entraining agents shall be used to increase the durability of concrete subject to frost action unless otherwise directed by the Engineer.

The Contractor shall submit to the Engineer full details of any admixture he proposes to use and the manner in which he proposes to add it to the mix. The information provided shall include but not be limited to:

- (i) the typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage,
- (ii) the chemical names of the main active ingredients in the admixture,
- (iii) the chloride ion content, if any, expressed as a percentage by weight of admixture,
- (iv) the extent, if any, that the admixture causes air-entraining when used at the manufacturer's recommended dosage,
- (v) details of any previous uses of the admixture in Mongolia.

Chemical admixtures used in concrete shall comply with the requirements of AASHTO M194. Air-entraining admixtures shall comply with AASHTO M154. The Contractor shall have all proposed air-entraining admixtures tested, at a laboratory acceptable to the Engineer, in accordance with AASHTO T157.

In addition to the general requirements, air-entraining agents shall be capable of producing an air content in concrete mixes within the limits stated in the Specification or on the Drawings without any tendency to produce excessive air content in the event of prolonged mixing times.

The effects of a proposed air-entraining agent shall be tested by the Contractor in trial

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mixes produced in the plant which he proposes to use for the Permanent Works.

Workability agents shall not have any adverse effect on the properties of the concrete.

The chloride ion content of any admixture shall not exceed 2 per cent by weight of the admixture nor 0.03 per cent by weight of the cement in the mix.

Calcium chloride or admixtures containing calcium chloride shall not be used.

Admixtures shall not be mixed together without the consent of the Engineer.

The use of pozzolanic admixtures, whether as a separate material or incorporated in the cement before delivery to Site, may be permitted subject to the agreement of the Engineer. The proportion of pozzolanic material used shall not exceed 50 percent by weight of the cement in the mix except in the case of ground iron blast furnace slag when the proportion shall be subject to the agreement of the Engineer. When ground iron blast furnace slag is incorporated during concrete batching the mixture shall comply with AASHTO M302. When ground iron blast furnace slag is blended with cement the mixture shall comply with AASHTO M240.

Fly ash shall have a carbon content not exceeding seven percent by weight. The maximum sulphate content expressed as SO₃ shall be 2.0 percent by weight. The fineness shall be in accordance with that Specified in Table 2 of AASHTO M295. Fly ash shall only be used in conjunction with cement complying with ASTM C150 and the total sulphate content of the mix from all sources, expressed as SO₃ shall not exceed four percent of the weight of cement.

1304 THE DESIGN OF CONCRETE MIXES

(a) Grades of Concrete and relationship between cube and cylinder compressive strengths. The Grades of concrete are designated herein in terms of characteristic compressive strength at 28 days of cylinder specimens (150 mm diameter x 300 mm long) as shown in Table 133

Table 13-3: Grades of Concrete Designated According to—28 - day Compressive Strengths of Cylinder and Cube Specimens

Concrete Grade	Characteristic Strength of Cylinder Specimens	Characteristic Strength of Cube Specimens
B15	15 MPa	19 MPa
B20	20 MPa	25 MPa
B25	25 MPa	32 MPa
B30	30 MPa	38 MPa
B35	35 MPa	45 MPa
B40	40 MPa	51 MPa
B50	50 MPa	64 MPa

(b) Maximum water/cement ratio

The concrete grade is directly related to the water-cement ratio. The following Table 13-4

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shows concrete strength regarding the water-cement ratio. The higher concrete class the lower water-cement ratio is preferred, in order to do so, concrete admixtures may be used.

Table 13-4: Concrete strength and Water/Cement Ratio

Water/cement ratio	Concrete strength ratio (days after)					
	1	3	7	28	90	360
0.4	0.24	0.48	0.70	1	1.15	1.38
0.5	0.17	0.43	0.66	1	1.19	1.47
0.6	0.11	0.37	0.64	1	1.21	1.55
0.6	0.08	0.33	0.64	1	1.31	1.67

(c) Design of proposed mixes

The Contractor shall design all concrete mixes called for in the Specification, using only those constituents that have been approved by the Engineer for use in the Works and in compliance with the following requirements:

- (i) the aggregate portion shall be well graded from the nominal maximum size of stone down to the 150 µm size,
- (ii) the cement content shall be such as to achieve the target strengths called for in Table 13-4
- (iii) for durability and low permeability the minimum cement content shall be as shown in Table 13-5. The degree of exposure applicable to individual structural elements shall be designated by the Engineer.

Table 13-5: Minimum Cement Content for Durability and low Permeability

Structural Member	Minimum Cement Content (in kg/m ³ of Compacted Concrete)
Plain Concrete	360
Reinforced Concrete	400

- (iv) workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions,
- (v) air-entraining agents shall be added to the Concrete in sufficient quantity to produce the air contents set out in Table 13-6.

Table 13-6: Air Content for Frost Resistance

Nominal maximum size of aggregate	Entrained air content
40 mm	5.5 %
20 mm	6.0 %
10 mm	7.5 %

- (i) the water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than that shown in Table 15-4 taking cognizance of any water contained in the aggregates,
- (ii) the length change of hardened concrete determined in accordance with AASHTO T160 shall not be greater than 0.05 per cent,

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- (iii) the total chloride content, expressed as chloride ion, arising from all constituents in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weight of cement in the mix:
 - for steam cured concrete or concrete containing sulphate resisting cement: 0.05 percent by weight,
 - for any other reinforced concrete: 0.3 per cent in 95 per cent of all test results provided no result is more than 0.5 per cent,
- (iv) the total sulphate content, expressed as SO_3 , of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4% by weight of the aggregate or 4.0% of the weight of cement in the mix, whichever is the lesser.

At least 56 days before commencing placement of concrete in the Permanent Works, the Contractor shall supply the Engineer with concrete mix designs for each proposed class of concrete and specific consistence requirement.

The proposed concrete mix designs shall include details of:

- the cement type,
- the cement content in kg/m^3 ,
- designated sizes and grading of aggregates,
- the weights, in the saturated surface-dry condition, of aggregates in kg/m^3 ,
- the water content in kg/m^3 , which shall be taken to mean the mixing water, the water in any admixtures and any water in the aggregates in excess of the saturated surface-dry condition,
- the design slump, measured in accordance with AASHTO T119,
- the manufacturer of the air-entraining agent and the required dose per m^3 ,
- the limits for air content,
- the manufacturers of any plasticisers, dispersing agents or other proposed admixtures and their required doses per m^3 .

1305 SITE TRIAL MIXES

After the Engineer has approved the concrete mix designs, the Contractor shall prepare Site trial mixes for each class of concrete specified and for each consistence requirement envisaged.

For each Site trial mix of concrete the Contractor shall prepare three separate batches of concrete using materials that have been approved for use in the Works and the mixing plant proposed for the execution of the Works. The volumes of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the following tests carried out:

- (a) the slump of the concrete shall be determined in accordance with AASHTO T119,
- (b) from each batch six test cubes shall be cast, cured and tested in accordance with BS 1881,
- (c) three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at twenty eight days,

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- (d) the density of all the cubes shall be determined before the strength tests are carried out,
- (e) the length change of hardened concrete shall be determined in accordance with AASHTO T160 shall not be greater than 0.05 percent.

Subject to the agreement of the Engineer, the compacting factor apparatus may be used in place of a slump cone. In this case the correlation between slump and compacting factor shall be established during preparation of the trial mixes.

The average strength of the nine cubes tested at 28 days shall be not less than the applicable target mean strength shown in Table 15-4 and no single cube shall have a strength of less than 3 MPa lower than the applicable characteristic strength shown in Table 15-4.

After Site trials have confirmed it's full compliance with the requirements of this Specification, a design mix for a particular class and consistence of concrete shall be designated the approved mix for that class and consistence of concrete. The Contractor shall only use approved mixes in the Works and shall not depart therefrom without the prior written permission of the Engineer. If the Contractor intends to make a change to a mix in the source of materials or their proportions, he shall prepare further Site trial mixes, conduct the corresponding tests and seek the Engineer's approval before any such changes are put into effect.

The Contractor shall allow in his Program, pursuant to Sub-Clause 15.1 of the Conditions of Contract, for designing concrete mixes, conducting Site trial mixes and for the preparation and testing of test specimen as required.

1305 QUALITY CONTROL OF CONCRETE PRODUCTION

(a) Sampling

For each consistence and class of concrete in production at each plant, samples of concrete for use in the Works shall be taken at the point of mixing or of deposition as required by the Project Quality Control Plan or as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the further requirements set out in this Specification.

Six 150 mm size cubes shall be made from each sample and shall be cured and tested all in accordance with BS 1881 Part 3, three at seven days and three at 28 days.

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than 50 m³ of concrete.

Until compliance with the Specification has been established the frequency of sampling shall be such that each sample represents not more than 20 m³ of concrete or as otherwise instructed by the Engineer.

The Contractor shall arrange for the Engineer to be present during the sampling of the concrete and the manufacture, storing and curing of the test cubes. Should the Contractor fail to arrange for the Engineer to be present the test cubes shall not be deemed

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acceptable for quality control purposes.

(b) Testing

(i) Consistence

The slump or compacting factor of the concrete shall be determined for all batches at the frequency instructed by the Engineer.

The slump of the concrete in any batch shall not differ from the value established by the Site trial mixes by more than 20 mm or one third of the value, whichever is the greater.

The variation in value of the compacting factor, if used in place of a slump value, shall be within the following limits:

- for a value of 0.9 or more ± 0.03
- for a value of between 0.8 and 0.9 ± 0.04
- for a value of 0.8 or less ± 0.05

(ii) Water/cement ratio

The water/cement ratio as estimated from the results of (i) above, determined by samples from any batch, shall not vary by more than five per cent from the value established during Site trial mixes.

(iii) Air content

The air content of air-entrained concrete in any batch shall be within 1.5 percentage points of the values specified in Table 13-6 in Sub-Clause 1304 (c) (v) and the averaged value of four consecutive measurements shall be within 1.0 percentage points of the specified value, expressed as a percentage of the volume of freshly mixed concrete. Testing shall be in accordance with AASHTO T196.

(iii) Flakiness Index

If the Flakiness Index of the coarse aggregate should vary by more than five units from the average value of the aggregate used in the approved mix and if the workability of the mixes should be adversely affected by such variation, a new set of Site trial mixes and corresponding tests shall be carried out.

(v) Crushing concrete cubes

The compressive strength of test cubes shall be determined in accordance with BS 1881 Part 4.

The results of all cube tests shall be shown on an approved form that shall include, but not be limited to, the following information:

- the cube reference number,
- the cube size and weight,
- the date the cube was made,
- the grade of concrete from which the cube was made,
- the location in the structure at which the concrete sample was taken,
- the slump of the concrete,
- the date on which the cube was tested,
- the total load at failure, and,
- the stress in MPa at failure.

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Two copies of each test certificate, containing all the information mentioned above, shall be forwarded to the Engineer for his retention and a third copy retained in the Site laboratory.

(c) Valid cube results

A result is defined as the average 28 day compressive strength from testing a set of three cubes from one batch of concrete. The testing of a set of three cubes shall be deemed valid only if the range in compressive strength of the three cubes tested is less than 15% of their average compressive strength.

Until such time as sufficient valid test results are available to apply the method of control described in Sub-Clause 1506 (d) of this Specification the compressive strength of the concrete at 28 days shall be such that no single result is less than the characteristic strength minus 3 MPa and the average value of any three consecutive results shall be greater than the characteristic strength plus 2 MPa.

If the average of any three consecutive results is less than the characteristic strength plus 2 MPa but at least equal to the characteristic strength, the concrete shall be considered acceptable but the Contractor shall adjust the mix design and the standard of control.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

(d) Acceptance criteria for characteristic strength concrete

When valid cube results are available for at least 30 consecutive batches of any class of concrete of the same consistence mixed in any one plant, the mean compressive strength shall be greater or equal to the characteristic strength plus 1.7 times their standard deviation and each individual cube tested shall be greater than 85 per cent of the characteristic strength.

(e) Non-compliant test results

If any one test cube result in a group of three consecutive results is less than 85 per cent of the characteristic strength but the average of the group of three results of which it is part satisfies the strength requirements of Sub-Clauses 1506 (c) or (d) of this Specification, then only the batch from which the failed cube was taken shall be deemed not to comply with the Specification.

If more than one test cube result in a group of three consecutive results is less than 85 per cent of the characteristic strength or if the average strength of the group of three results fails to satisfy the specified strength requirements then all the batches between those represented by the first and last cubes in the group of three results shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the mix design, subject to the approval of the Engineer, to restore compliance with the Specification. After adjustment of the mix design the Contractor shall again comply with the requirements of Clause 1505 of this Specification.

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but is not limited to:

- increasing the frequency of sampling until control is again established,
- cutting test cores from the concrete and testing in accordance with AASHTO T24,
- carrying out strengthening or other remedial work to the concrete,
- carrying out non-destructive testing such as load tests on beams,
- removing and replacing the concrete.

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If the mean compressive strength of three test cores is more than 85 % of the characteristic strength and no single test core has a compressive strength of less than 75 % of the characteristic strength, the Engineer may, at his discretion, consider leaving the defective concrete in place.

1307 MIXING CONCRETE

The Contractor shall submit to the Engineer full details, including drawings, of all the equipment for batching, mixing, transporting, placing, compacting and finishing concrete that he proposes to use and the arrangements he proposes to make before any equipment is ordered or delivered to Site.

Concrete shall not be mixed by hand. Concrete for the Works shall be batched and mixed in one or more central plants unless the Engineer agrees to some other arrangement. If the Contractor should propose to use ready mixed concrete, he shall submit to the Engineer for approval full details and test results of the concrete mixes proposed. The Engineer may approve the use of ready mixed concrete provided that:

- (a) the proposed mixes, the materials to be used and the methods of storage and mixing comply with the requirements of this Specification,
- (b) adequate control is exercised during mixing,
- (c) the ready mixed concrete complies with the requirements of AASHTO M157.

Approval for the use of ready mixed concrete shall be revoked if the Engineer should be dissatisfied with the control exercised in respect of the materials being used or during mixing.

Batching and mixing plants shall be modern efficient equipment and capable of producing thoroughly homogeneous concrete complying with the uniformity requirements of AASHTO M241. Truck mixers shall comply with the requirements of BS 4251 and shall only be used with the prior agreement of the Engineer.

All mixing operations shall be controlled by an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged such that drainage water is not discharged into the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt removed.

Cement and aggregates shall be batched by weight. Water may be measured by weight or volume. Liquid admixtures shall be dispensed by an electrically controlled flowmeter.

The weighing and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in AASHTO M241 and checked against accurate weights and volumes when required by the Engineer.

The weights of cement, water, admixtures and of each size of aggregate as indicated by the mechanisms employed shall be within the tolerance shown in Table 13-8.

Table 13-8: Allowable Tolerances in the Proportioning of Concrete Mixes

Allowable tolerance in proportioning	Percent by weight
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Mass of cement	0 to + 4
Mass of fine aggregate	-2 to + 2
Mass of coarse aggregate	-2 to + 2
Admixtures	-2 to + 3
Water	-1 to + 1

The Contractor shall provide standard test weights at least equivalent to the maximum working load used on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device.

Tests shall be made by the Contractor at least once a week or at intervals to be determined by the Engineer and shall be carried out in his presence. For the purpose of carrying out these tests, there shall be easy access for personnel to the weigh hoppers. The Contractor shall furnish the Engineer with copies of the complete results of all check tests.

The Contractor shall make any adjustments, repairs or replacements necessary to ensure the continuous satisfactory performance of weighing and water dispensing mechanisms and their compliance with this Specification.

The measured materials shall be batched and charged into the mixer by means that prevent loss of any materials due to effects of wind or other causes. The Contractor shall conduct Site trials to determine the most suitable method and order in which materials are to be fed into the mixer to consistently produce a uniform concrete mix. Once the optimum combination for the particular plant arrangement has been established, it shall be adhered to.

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or pan. Mixing shall continue until there is a thorough distribution of the materials, and the mass is of a uniform colour and consistency.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour during concreting and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently. The Contractor shall ensure that all specified moisture adjustments are accurately made in order to obtain the desired slump within the tolerances set out in Sub-Clause 1506 (b) (i) of this Specification.

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After mixing for the required time, each batch shall be discharged completely from the mixer before any materials for the succeeding batch are introduced.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed and thereafter the first batch of concrete through the mixers shall contain only half the normal quantity of coarse aggregate. This batch shall be mixed for one minute longer than the time applicable to a normal batch.

Mixers shall be thoroughly cleaned out before changing from one type of cement to another.

Water that has been used for washing out mixers shall not be allowed to drain directly into streams or surface water drains but shall be disposed of in accordance with one of the methods outlined in Sub-Clause 1503 (c) of this Specification and in a manner that is acceptable to the Engineer.

1308 TRANSPORT OF CONCRETE

Concrete shall be discharged from the mixer and transported to the Works by means which shall prevent adulteration, segregation or loss of ingredients, and which shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the mixer and placing shall not exceed 25 mm.

The time elapsing between mixing and placing a batch of concrete shall be as short as practicable and in no case longer than shall permit completion of placing and compaction before the onset of initial set. Concrete shall not be incorporated in the Works after the onset of initial set has occurred. The rate of delivery of concrete shall be such that the interval between batches shall not exceed 20 minutes and shall be sufficient to produce a monolithic unit and preclude the formation of cold joints within a structure. During transportation the concrete shall be protected from any adverse effects of sun, rain and wind. Concrete shall not be transported over or near to recent work that has not fully hardened.

1309 PLACING OF CONCRETE

(a) Consent for placing

Concrete shall not be placed in any part of the Works until the Engineer's consent has been given in writing. The Contractor shall give the Engineer at least 24 hours notice of his intention to place concrete.

All mortar from previous concreting, debris and foreign material shall be removed from the forms and steel prior to commencing the placing of concrete.

Concrete placing shall commence within 24 hours of the Engineer's consent. If the Contractor should fail to commence placing concrete within this period the Engineer's consent shall be deemed to be withdrawn and the Contractor shall again request consent as specified above.

(b) Preparation of surface to receive concrete

Excavated surfaces against which concrete is to be cast shall be prepared as set out by this Specification.

Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other suitable methods. The Contractor shall ensure that the freshly deposited concrete or any of its constituents are not washed away by any such flow. Any under-drains constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

The treatment for existing concrete surfaces against which fresh concrete is to be cast shall be as follows:

- whilst the existing concrete is still green surface aggregate shall be exposed by washing and brushing with a stiff bristled brush,
- fresh concrete shall be cast against the dry exposed aggregate surface,
- surfaces shall be clean, hard, dry and sound.

If any fissures have been cleaned out as described in Section 700 of this Specification they shall be filled with mortar or with concrete as instructed by the Engineer. The amount of mortar placed at any one time shall be limited so that it does not dry out or set before being covered with concrete.

(c) Placing procedures

Whenever a concrete placement plan or schedule is specified or approved, the sequence of placement shall conform to that plan.

All equipment used to place concrete shall be of adequate design and capacity and operated so as to prevent segregation of the mix or loss of mortar. Such equipment shall not cause vibrations that might damage the freshly placed concrete. Equipment shall not have any aluminium parts that come in contact with the concrete. The Contractor shall ensure that any mortar coating on placing equipment that sets or dries out between the placing of successive batches of concrete is cleaned from the equipment before placing is resumed.

When discharged above its place of final deposition, the Contractor shall ensure that concrete shall in no circumstances fall freely through a height exceeding 1.5 m. Elephant trunking shall be used to reduce the free fall height to less than 1.5 m. The use of chutes, other than those forming standard accessories to truck mixers, shall not be permitted.

Forms for walls, columns and other thin sections of significant height shall be provided with openings or other devices that prevent segregation and accumulation of hardened concrete on the formwork or reinforcement above the level of the placed concrete.

The first batch of any fresh concrete to be placed shall contain only half the normal quantity of coarse aggregate.

Concrete shall be placed and consolidated prior to initial set and in no case more than 2 hours after cement has been added to the mix. The Contractor shall not retemper any concrete by adding water to the mix.

It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork.

The Contractor shall move fresh concrete within formwork by shoveling and not with mechanical vibrators. Separate gangs of workers shall be employed by the Contractor for placing and compacting concrete.

Concrete shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 500 mm in compacted thickness unless otherwise permitted or

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directed by the Engineer. Such layers shall not be thinner than four times the maximum nominal size of aggregate.

Layers shall be placed such that the formation of feather edges is avoided. The Contractor shall place concrete in each section of the structure continuously and without interruption between the construction or expansion joints indicated on the Drawings. The delivery rate, placing sequence and methods shall be such that formation of cold joints is precluded and in no circumstances shall fresh concrete be cast against previously placed material in which the initial set has occurred.

All the concrete in a single bay or pour shall be placed as a continuous operation and each unit shall form a monolith without joints. Concrete shall be carefully worked round all obstructions, irregularities in the foundations and the like such that all parts are completely full of compacted concrete with no segregation or honeycombing. Concrete shall be carefully worked round and between waterstops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour.

All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard.

During and after placement of concrete, care shall be taken not to injure the concrete or break the bond with reinforcing steel. Workmen shall not walk through fresh concrete. Platforms for workmen and equipment shall not be supported on reinforcement. Once the concrete has set, no forces shall be applied to the forms or to reinforcing bars projecting from the concrete, until the concrete is sufficiently hardened to resist damage.

These people are responsible for ensuring that the formworks satisfied the technical requirements, to properly install the joints of the temporary works, and that the reinforced steel and fasteners are placed correctly.

(d) Placing concrete under water

When it is necessary to place concrete under mineral slurry or water the Contractor shall submit to the Engineer his proposals for the method and equipment to be employed. Concrete shall be deposited either through funnel-shaped tremies which shall have discharging bottom fitted with a trapdoor or by concrete pumps fitted with a device at the end of the discharge tube to prevent the ingress of water whilst the tube fills with concrete.

A tremie shall consist of a water-tight tube, constructed in sections joined by flange couplings and watertight gaskets, having a diameter of not less than 250 mm and fitted with a hopper at the top. Tremies shall be supported so as to permit both free movement of the discharge end over the entire top surface of the work and to allow rapid lowering to retard or stop the flow of concrete.

The discharge end shall be sealed closed at the start of work so as to prevent water from entering the tremie before it fills with concrete. Tremies shall be kept continuously full of concrete up to the level of the bottom of their hopper and shall be kept immersed in the concrete in order to reduce to a minimum the contact area of the concrete with the water, if water enters the tube after placing has started, the tremie shall be withdrawn and emptied, the discharge end resealed and the tremie refilled with fresh concrete before placing is resumed. The flow shall be continuous until the work is completed.

During pumping, once the delivery of concrete has started, the end of the discharge tube shall be kept full of concrete and below the surface of the deposited concrete until placement is completed.

In both circumstances, special care, shall be taken to avoid segregation. The cement content of concrete that is to be placed under water shall be 10 per cent more than the standard mix for the corresponding grade and workability to compensate for loss due to washing.

Concrete that is to be placed under mineral slurry or water by tremie shall be compacted before placing as follows:

- (i) a poker vibrator shall be lowered to the bottom of the tremie pipe prior to filling it with concrete,
- (ii) the gate at the base of the tremie shall be shut,
- (iii) as concrete is fed into the hopper and the tremie begins to fill, the poker vibrator shall be gradually withdrawn in such a manner that all the air is removed from the fresh concrete in the tremie pipe,
- (iv) the poker vibrator shall then be fixed in position where the hopper discharges into the tremie pipe in such a way that air shall be removed from the fresh concrete without transmitting vibration to the sides of the tremie,
- (v) as placing proceeds, the poker vibrator shall be switched on and off as necessary to avoid over vibration of the concrete in the hopper between batches as the placing of Concrete proceeds.

Concrete to be placed underwater by pump shall be similarly compacted in the hopper that discharges into the pump. Concrete shall be placed under mineral slurry or water in one continuous operation and the surface of the concrete during placement shall be kept as near to horizontal as practicable. Still water shall be maintained at the discharge point of pumps and tremies. To ensure thorough bonding, each successive layer of concrete shall be placed before the initial set of the preceding layer has taken place. The Contractor shall have sufficient equipment available to fulfill this requirement when placing large pours.

During and after concreting under water, pumping or de-watering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete. Cofferdams shall be vented during the placing and curing of concrete to equalize the hydrostatic pressure and thus prevent flow of water through the concrete. In addition to the testing requirements outlined in Clause 1306 of this Specification, 7 days after the completion of the pour the Contractor shall take two continuous test cores from separate locations in each pile or pier at locations to be instructed by the Engineer.

The cores shall be taken vertically through the full depth of concrete placed underwater and complete recovery of the cores shall be required. The minimum diameter of the cores shall be 50 mm. Each pile or pier shall be investigated utilizing an ultrasonic cross-hole pile integrity testing system. In the event that concrete placed underwater proves to be unsound the Engineer may require further test cores be taken to establish the condition of the entire pour. The Contractor shall then correct the unsound condition by pressure grouting the entire mass, removing the unsound concrete or by other methods that meet with, the approval of the Engineer. All expenses incurred in testing and correcting unsound concrete placed underwater and grouting holes left by test coring shall be at the Contractor's expense.

(e) Interruptions to placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces. Any concrete already placed shall be thoroughly

compacted in accordance with Clause 1311 of this Specification. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it has hardened enough to resist damage. Equipment and materials to comply with these requirements shall be readily available at all times during concrete placing. Before concreting is resumed after such an interruption the Contractor shall cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and shall leave a clean, sound surface prepared in accordance with Sub-Clause 1309 (b) of this Specification against which fresh concrete may be placed.

The Contractor shall ensure that a competent shuttering joiner and a competent steel fixer are in attendance during all concreting operations. They shall be responsible for ensuring that the formwork is maintained in accordance with this Specification, temporary construction joints are inserted as necessary, and steel reinforcement and fittings are maintained in place as placing proceeds. If it should become possible to resume concrete placing without contravening this Specification and with the Engineer's consent, new concrete shall be thoroughly worked into the existing concrete and compacted so as to eliminate any cold joints.

(f) Dimensions of pours

Unless otherwise agreed by the Engineer, pours shall be no more than two metres high. Pours shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of the pour. The Contractor shall plan the dimensions and sequence of pours in such a way that cracking of the concrete due to thermal or shrinkage stresses is eliminated.

(g) Placing sequence

The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Works are of equal duration. This duration shall normally be not less than three or more than seven days under temperate weather conditions unless otherwise agreed by the Engineer. Where required by the Engineer to limit the opening of construction joints due to shrinkage, fresh concrete shall not be placed against concrete which is less than 21 days old. When the Drawings call for contraction gaps in concrete, these shall be of the widths and in the locations shown on the Drawings and they shall not be filled until the full time interval shown on the Drawings has elapsed.

1310 PROTECTION OF CONCRETE FROM THE ENVIRONMENT

(a) General

The Contractor shall take all necessary precautions to protect concrete from damage due to climatic or other environmental conditions during placing and curing operations. Concrete that has been frozen or otherwise damaged by climatic conditions shall be either repaired to a condition acceptable to the Engineer or removed and replaced.

The temperature of the concrete immediately before placing shall be between 10° C and 32° C, except as provided elsewhere in this Specification. The maximum temperature of the concrete at time of placement for bridge decks shall be 27° C.

(b) Protection from rain

If, in the opinion of the Engineer, rain is sufficiently heavy or prolonged to wash mortar from coarse aggregate on the exposed faces of fresh concrete, the Contractor shall suspend the placing of concrete unless adequate protection and means to remove any water accumulating on the surface of the placed concrete are provided. Concrete shall not be deposited into such accumulations of water.

(c) Hot weather precautions

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When ambient temperatures are above 32° C, formwork, steel reinforcement, steel beam flanges and other surfaces that will come into contact with the fresh concrete shall be cooled to below 32° C by means of water sprays or other approved methods.

The temperature of the concrete at time of placement shall be maintained within the specified temperature range by any combination of the following:

- shading the materials storage areas,
- shading the production equipment,
- cooling the aggregates by sprinkling with water,
- cooling the aggregates or water by refrigeration or replacing a portion or all the mix water with ice that is flaked or crushed to the extent that the ice will completely melt during mixing of the concrete,
- liquid nitrogen injection.

In drying weather and whenever instructed by the Engineer, all fresh concrete surfaces shall be protected from evaporation by a combination of:

- suitable covers
- sun shades
- wind breaks

or be wet-cured with a fine mist spray that maintains a sheen of water on the exposed surface.

The Engineer may require that the placing of concrete be rescheduled to take advantage of the cooler parts of the day.

(d) Cold weather precautions

(1) Mixing and placing

When requested by the Engineer, the Contractor shall provide and install two maximum-minimum type thermometers at each structure site. Concrete shall not be placed without heating and protection from freezing if either:

- the ambient air temperature is falling and falls below 7° C
- the ambient air temperature is rising and is below 3° C

When the ambient air temperature is below 5° C, the temperature of the concrete at the time of placement in sections less than 300 mm thick shall be not less than 15° C. Irrespective of air temperature, aggregates shall be free of ice, frost and frozen lumps when batched and concrete shall not be placed against any material whose temperature is 0° C or less.

If concrete is to be placed when, in the opinion of the Engineer, sub-zero ambient temperatures are likely the Contractor shall make provision for heating water and aggregates. The newly placed concrete shall be protected against freezing for 8 full days after the completion of the pour.

Aggregates shall be heated to a temperature of between 20° C and 65° C and water shall be heated to a temperature of between 55° C and 65° C. The temperature of the mixed concrete shall be between 15° C and 25° C when placed in the formwork. The apparatus for heating aggregated shall heat them uniformly without the occurrence of hot spots. The heating apparatus and housing shall be sufficient to enclose and protect the structure such that the air surrounding the fresh concrete is kept at a temperature of between 20° C and 30° C for 5 full days after the completion of the pour.

Over the next three days the concrete shall be allowed to cool to a temperature of not less than 5° C. The heating apparatus shall be positioned so that there is no direct discharge

of heat on either the formwork or concrete surfaces. When the outside ambient temperature is below -15°C , the housing shall be constructed so as to allow the concrete to be placed without the housing having to be opened. If mixing is to take place externally, the concrete shall be placed via hoppers installed through the housing, such hoppers shall be plugged when not in use. When the outside ambient temperatures are above 15°C , the Contractor may open small areas in the housing for short periods to facilitate the placing of concrete. Before any concrete is placed in sub-zero outside ambient temperatures, the Contractor shall demonstrate the adequacies of his heating arrangements by bringing up the temperature to the 20°C specified herein and maintaining it for a continuous 24 hour period prior to concreting. The Contractor shall supply all heating apparatus and fuel necessary.

(2) Initial curing

When dry heat is proposed for heating the housing, the Contractor shall propose measures, to the approval of the Engineer, for maintaining the atmospheric humidity and preventing the concrete from drying out. If heated by apparatus that releases smoke or gas fumes, the housing shall be adequately ventilated in such a way as to carry away all such fumes. The housing shall be of sufficient dimensions to enable the unimpeded placing of fresh concrete and the subsequent removal of formwork such that any required rub finishing of the exposed concrete can be completed 3 days before the heating of the housing is discontinued. The Contractor shall provide around the clock supervision and monitoring of heating operations. Sufficient fuel and stand-by heating apparatus shall be available to allow for any sudden drop in outside temperature and any breakdowns of equipment that may occur.

Placing concrete under water

Where concrete is to be placed under water in sub-zero ambient outside temperatures, the Contractor shall heat water inside cofferdams to a minimum temperature of 5°C before placing any concrete. After placing the concrete, and before dewatering the Contractor shall maintain the temperature of the water above the concrete in the cofferdam above 5°C .

(e) Protection from soil or water with high sulphate content

The Contractor's attention is drawn to the high sulphate content of water and/or soil areas. All concrete for piles, pile caps and sub-structure shall be made with Portland cement complying with the requirements of AASHTO M85 Type II. Water from such locations shall not be used for making or curing concrete. The water content of the mix shall be carefully controlled and regulated so as to produce concrete of minimum permeability. The concrete shall be thoroughly compacted to maximum density. The concrete matrix shall be without rock pockets. The depth of cover from the face of the concrete to the reinforcing steel shall be not less than 60 mm. Formwork shall be left in place for a minimum of 7 days after casting to protect newly formed concrete surfaces from attack. Except for the repair of any surface cavities and the plugging of form tie holes, the original formed surface of the concrete shall be left undisturbed. Special handling shall be provided for pre-cast members to avoid even slight deformation cracks.

1311 COMPACTION OF CONCRETE

Concrete shall be fully compacted throughout the full extent of the placed layer. Concrete shall be thoroughly worked against the formwork and around any reinforcement and other embedded items, without displacing them. Particular care shall be taken at arises and

other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall generally be compacted with the assistance of mechanical poker (immersion) vibrators. The Contractor may, for the compaction of slabs and bridge decks, use supplementary twin beam vibrators at the surface in the event that a satisfactory surface finish cannot be produced by poker vibrators alone.

Poker vibrators shall operate at a frequency of between 7,000 and 10,000 impulses per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compactive effort is not reduced. Table 13-9 shows a range of poker vibrator sizes and applications

Table 13-9: Poker Vibrator Sizes and Applications

Diameter in mm	Radius of Effective Action in mm	Rate of Compaction in m³/h	Application
20 - 30	80 - 150	0.8 - 2	slumps of 50 mm and above in very thin sections and highly confined or congested places
35 - 40	150 - 250	2 - 4	slumps of 50 mm and above in thin columns and walls or moderately confined places
50 - 75	180 - 350	3 - 8	slumps of 25 mm and above general construction in places free from restrictions

The Contractor shall provide, in accordance with Table 13-9 above, sufficient number and sizes of poker vibrators to enable the entire quantity of concrete being placed to be vibrated for the period necessary to achieve full compaction. Stand-by poker vibrators shall be available for instant use at each place where concrete is being placed.

Where the concrete contains aggregate with a nominal size of 75 mm or more, vibrators with a diameter of 100 mm or more shall be used.

Compaction of fresh concrete shall take place at the point it is placed in the works. Vibrators shall not be used to move concrete laterally. The poker shall be inserted vertically into the concrete under its own weight. The poker vibrator shall penetrate the layer of concrete placed previously to avoid the formation of laminated strata. Vibration shall be continued at each point for a short period until the concrete ceases to contract, a thin layer of mortar appears on the surface and the formation of air bubbles stops. The poker shall be withdrawn slowly to fully close the void that would otherwise ensue.

Vibration shall be of a sufficient duration and intensity to thoroughly compact the concrete, but shall not continue long enough to cause segregation. Vibration shall not be continued at any one point to the extent that localized pools of grout are formed. Application of

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vibrators shall be at points uniformly spaced and not farther apart than 1.5 times the radius over which vibration is visibly effective.

Vibration shall not be applied directly to, or through the reinforcement nor shall vibrators be allowed to touch reinforcement, the formwork or other embedded items.

Vibrators of small diameter shall be supplemented by such tamping as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners.

Concrete for columns, substructure and culvert walls, and other similar vertical members shall be placed and allowed to settle for a period of time and then re-vibrated after 1 to 2 hours to reduce plastic settlement cracking before concrete for integral horizontal members is placed.

The Engineer may also instruct that concrete be re-vibrated to improve the surface finish of the concrete by reducing blowholes or to eliminate plastic shrinkage cracks. Concrete may be re-vibrated provided that it is still in a plastic state, the vibrator can penetrate the concrete under its own weight and the concrete closes behind it upon its removal. The Contractor shall conduct Site trials to determine the optimum waiting period for various grades and consistencies of concrete.

1312 CURING OF CONCRETE

(a) General

Concrete shall be protected during hardening from loss of moisture and from the development of temperature differentials within the concrete sufficient to cause thermal cracking.

The methods used for curing shall not cause damage of any kind to the concrete. Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case for at least seven days or until the concrete is covered by later construction.

The curing process shall commence as soon as the concrete is hard enough to resist damage from the process, and in the case of large areas or continuous pours, shall commence on the completed sections of the pour before the rest of the pour is finished.

All newly placed concrete shall be cured so as to prevent loss of water by use of one or more of the methods specified herein. If the surface of the concrete begins to dry before the selected cure method can be applied, the surface of the concrete shall be kept moist by a fog spray applied so as not to damage the surface.

Curing by other than steam or radiant heat methods shall continue uninterrupted for the periods shown in Table 13-10.

Table 13-10: Minimum Curing Periods

Cement Type	Average Ambient Temperature Greater than 15° C	Average Ambient Temperature 5° C to 15° C	Average Ambient Temperature Less than 5° C
Portland Cement with less than 10% added pozzolans	7 days	10 days	14 days

Portland Cement with more than 10% added pozzolans	10 days	15 days	20 days
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When deemed necessary by the Engineer during periods of hot weather, water shall be applied to concrete surfaces being cured by the liquid membrane method or by the forms-in-place method, until the Engineer determines that a cooling effect is no longer required. If, instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out below, provide suitable sunshades and windshields to prevent the direct rays of the sun or drying winds from reaching concrete surfaces.

(b) Materials

(i) Water

Water shall conform to the requirements of Sub-Clause 1303 (g).

(ii) Liquid membranes

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of AASHTO M148.

(iii) Waterproof sheet materials

Waterproof paper, polyethylene film and white burlap polyethylene sheet shall conform to the requirements of AASHTO M171.

(c) Methods of curing concrete

(i) Formwork in-place method

Formed surfaces of concrete may be cured by retaining the formwork in-place, without loosening, for the required duration.

(ii) Water method

Concrete surfaces shall be kept continuously wet by ponding, spraying or covering with materials that are kept continuously and thoroughly wet. Such materials may consist of cotton mats, multiple layers of burlap or other approved materials that do not discolor or otherwise damage the concrete.

(iii) Liquid membrane curing compound method

The liquid membrane method shall not be used on surfaces where a rubbed finish is required or on surfaces of construction joints unless it is removed by sand blasting prior to placement of concrete against the joint. Type 2, white pigmented, liquid membranes may be used only on the surfaces of bridge decks, on surfaces that will not be exposed to view in the completed work or on surfaces where their use has been approved by the Engineer. When membrane curing is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. Formed surfaces shall be sealed immediately after the formwork is removed and necessary finishing has been carried out. The solution shall be applied by power-operated atomizing spray equipment in one or two separate applications. Hand-operated sprayers may only be used for coating small areas at the discretion of the Engineer.

Membrane solutions containing pigments shall be thoroughly mixed prior to use and agitated during application. If the solution is applied in two increments, the second application shall follow the first application within 30 minutes. Equipment shall be subject to the approval of the Engineer. The curing compound shall be applied to the concrete surface, in such a manner that provides a uniform coverage, at the rate of 0.2 l/m² (litres

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per square metre) on smooth surfaces. The rate of application on textured shall be 0.5 l/m² or as otherwise instructed by the Engineer.

If rain should fall on newly applied concrete curing membrane before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner during the curing period, a new coat shall be applied to the affected areas at the same rates of application specified above.

(iv) Waterproof cover method

This method shall consist of covering the surface with a waterproof sheet material so as to prevent moisture loss from the concrete. This method may be used only when, in the opinion of the Engineer, the covering can be adequately secured to prevent moisture loss. The concrete surface shall be wet when the cover is placed. Sheets shall be of the widest practicable width. Adjacent sheets shall overlap by a minimum of 300 mm and shall be tightly sealed with pressure sensitive tape, mastic, glue, or other approved methods to form a complete waterproof cover of the entire concrete surface.

Covers shall be secured against displacement by the wind. Any part of the cover that becomes defective before expiration of the curing period shall be immediately repaired. Sheeting that has lost its waterproof property shall not be used.

(v) Heated housing method

Concrete placed in cold weather shall be cured in accordance with the requirements of Sub-Clause 1310 (d) of this Specification.

(vi) Accelerated curing by steam or radiant heat

These methods shall be used only for pre-cast concrete elements manufactured in established plants.

Steam curing or radiant heat curing shall be done inside a suitable enclosure to contain the live steam or the heat. Only low pressure, saturated steam shall be utilized. Temperature recording devices shall be employed as necessary to verify that temperatures are uniform throughout the enclosure and within the limits specified.

There shall be a delay period of 35 hours before the initial application of steam or heat after the final placing of concrete to allow its initial set to take place. If retarding agents are used, the delay period shall be increased in accordance with the instructions of the Engineer. If the time of initial set is determined in accordance with AASHTO T197 delay period shall be adjusted accordingly.

During the delay period, the temperature within the curing chamber shall be maintained at not be less than 10° C and live steam or radiant heat may be employed to do so. During this period the surface of the concrete shall be kept wet.

Application of live steam shall not be directed on the concrete or on the forms so as to cause localized high temperatures. During accelerated curing by steam or radiant heat the rate of increase of ambient temperature within the curing enclosure shall not exceed 20° C per hour and the maximum ambient temperature shall not exceed 71° C.

The maximum temperature shall be held until the concrete has reached the specified strength, and the cubes used to determine the concrete strength shall be cured alongside and under the same conditions as the pre-stressed concrete.

An ambient temperature recording device of a type approved by the Engineer shall be placed on top of the element after the placing of concrete is complete. The thermometer shall not be moved until after accelerated curing is complete. A graph of ambient

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temperature against time shall be submitted to the Engineer upon completion of accelerated curing for each element. The graph shall indicate:

- element identification no.,
- hour, day, month and year,
- time of completion of concrete placing,
- start of heating
- end of heating,
- end of accelerated curing

Once accelerated curing has been completed, the ambient temperature shall not be allowed to fall at a rate exceeding 20° C per hour until a temperature of 6° C above the temperature of the air to which the concrete will be exposed has been reached.

Elements shall not be subjected to freezing temperatures before reaching their specified design strength.

Radiant heat may be applied by means of pipes circulating steam, hot oil or hot water, or by electric heating elements. Radiant heat curing shall be done under a suitable enclosure to contain the heat, and moisture loss shall be minimized by covering all exposed concrete surfaces with a plastic sheeting or by applying an approved liquid membrane curing compound to all exposed concrete surfaces.

Top surfaces of concrete members to be used in composite construction and surfaces to which other material is to be bonded in the finished structure shall be thoroughly cleaned of concrete curing membrane residue so as to enable bond 7 design limits to be met. Details of the Contractor's proposals for curing concrete shall be submitted to the Engineer for approval prior to any placing of concrete in the Works.

(vii) Limiting temperature differentials in newly placed concrete

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

- limiting concrete temperatures at placing as set out in Sub-Clause 1310 (c),
- use of low heat cement, subject to the agreement of the Engineer,
- insulation of exposed concrete surfaces,
- insulated formwork left in-place,
- preventing rapid dissipation of heat from surfaces by shielding from wind,
- avoiding the use of ponding or sprayed water when such use would cause rapid cooling of the surface.

1313 CONSTRUCTION JOINTS

Whenever concrete is to be bonded to other concrete that has hardened, the surface of contact between the sections shall be deemed a construction joint.

Where construction joints are shown on the Drawings, the Contractor shall form such joints in those positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the agreement of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the Drawings require a different arrangement.

The Contractor shall form construction joints in all classes of work as tongue and groove joints against which concrete can subsequently be properly compacted. There shall be no construction joints in pre-cast members nor in reinforced concrete deck slabs of minor spans.

Construction joints shall be so arranged as to reduce to a minimum the effects of shrinkage in the concrete after placing, and shall be placed in the most advantageous positions with regard to stresses in the structures and the desirability of staggering joints.

Feather edges of concrete at joints shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.

The intersections of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high pressure water and air jets and/or by washing and brushing the surface with a bristle brush shortly after casting but when the concrete is hard enough to withstand the treatment without the leaching of cement.

The surface of vertical or near vertical joints shall be similarly treated if circumstances permit the removal of formwork at a suitable time. At vertical joints a retarding agent may be painted onto the form face provided that the formwork is removed within 72 hours of casting and the concrete surface cleaned by washing and brushing to expose the aggregate.

The treatment for forming construction joints shall be as follows:

- whilst the existing concrete is still green surface aggregate shall be exposed by washing and brushing with a stiff bristled brush,
- fresh concrete shall be cast against the dry exposed aggregate surface.
- surfaces shall be clean, hard, dry and sound.

Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free is to be thoroughly scabbled by mechanical means or wet sand blasted or prepared by air-driven needle guns. The indentations produced by scabbling shall be not less than 10 mm deep and shall not extend closer than 40 mm to a finished face. The surfaces so formed shall be washed clean and left to dry before concreting and any grit or other deleterious or loose material removed from the vicinity.

The Contractor shall clean and remove all concrete or other matter adhering to fittings or reinforcement that project from the existing concrete surface taking care not to break the bond between the steel and the existing concrete.

The amount of coarse aggregate in the first layer of concrete to be cast against hardened concrete surfaces shall be reduced by 50% to allow for the effective loss of mortar required to initially coat placing equipment, the joint, reinforcement and formwork. Pre-placed grouts or mortars shall not be used unless otherwise instructed by the Engineer.

No concrete shall be placed in position or against a construction joint until the joint has been inspected and approved by the Engineer.

Epoxy resins especially designed for bonding old concrete to new shall be used at construction joints where directed by the Engineer. The preparation of the construction joint surface and the application of the epoxy resin shall be in accordance with the manufacturer's recommendations and the Engineer's instructions. The brand and type of resin used shall be subject to the Engineer's approval.

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Where a joint is to be formed to prevent bonding between contiguous structural elements, the Contractor shall place two intermediate layers of approved waterproof building paper at the location specified. The paper shall be cut to fit the surfaces accurately without creases or wrinkles. Overlapping edges shall be covered with adhesive tape on both faces of the overlap. There shall be not less than two layers of approved waterproof building paper over the full area of the joint. When carrying out concreting operations the Contractor shall ensure that the paper remains undamaged.

1314 EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints are discontinuities in concrete designed to allow for thermal or other movements in the concrete. Expansion joints are formed with a gap between the concrete faces to permit both subsequent expansion and contraction of the concrete. Contraction joints are formed to accommodate the contraction of adjacent concrete and may include provision for subsequent filling. Expansion and contraction joints shall be formed in the positions and in accordance with the details shown on the Drawings or elsewhere in the Specifications. When forming joints by saw-cutting, the cut shall be made as soon as the concrete can be cut without spalling or raveling of the edges and before any cracks form in the concrete.

1315 WATERSTOPS

All references to waterstops include grout stops. Waterstops shall be of the material and form shown on the Drawings. No waterstop material shall be brought onto site until the Contractor has submitted full details of the materials he proposes to use, including samples, and these have been approved by the Engineer. All samples shall be of adequate length for testing.

Poly vinyl chloride (PVC) waterstops shall be extruded from an unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC waterstops shall have an elongation at breaking stress of at least 500 per cent at 25° C and shall allow a joint movement of at least 50 mm.

Low modulus waterstops shall be of rubber or PVC as described above but shall have an elongation of at least 200 per cent at 25° C under a tensile stress of 6 N/mm² and shall allow a joint movement of at least 50 mm. Waterstops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements. In rubber or plastic material joints other than butt joints shall be supplied ready made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for the purpose by the manufacturer.

Waterstop material shall be stored carefully on Site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic waterstops shall be stored in cool well ventilated places away from direct sunlight. Rubber and plastic waterstops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side, shall be protected from the sun. Waterstops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc. before placing concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be the only means whereby the waterstop is fixed. In no circumstances shall a waterstop be punctured with nails, etc. as a means of fixing. Concrete shall be placed carefully round waterstops so as to avoid distortion or displacement and shall be fully compacted. Where waterstops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the waterstop. Formwork adjoining waterstops shall be carefully removed to avoid damage. If waterstops suffer any damage which cannot be properly repaired in

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situ the Engineer may require a section of concrete to be removed and the waterstop replaced.

1316 FINISHES ON UNFORMED SURFACES

Horizontal or nearly horizontal surfaces, which are not cast against formwork shall be finished to the class shown on the Drawings and defined hereunder :

(a) UF 1 finish

All surfaces on which no higher class of finish is called for on the Drawings or instructed by the Engineer shall be given a UF 1 finish.

The concrete shall be leveled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

(b) UF 2 finish

This is a floated finish for roof or floor slabs and other surfaces where a hard trowelled surface is not required. The surface shall first be treated as a Class UF 1 finish and after the concrete has hardened sufficiently, it shall be floated with a wooden or cork surfaced hand or power float sufficient only to produce a uniform surface free from screed marks.

(c) UF 3 finish

This is a hard trowelled surface for use on bearing areas, where weather resistance or appearance is important, or on areas subject to high velocity water flow. The surface shall be floated as for a UF 2 finish but to the tolerance slated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be power floated to produce a dense, smooth uniform surface free from trowel marks.

(d) Roadway surface finish

The surfaces of bridge decks and approach slabs shall be struck-off by screed equipment traveling on rails. The equipment shall be constructed to span the full deck width. The rails shall be of sufficient strength and supported and fixed at such intervals to prevent deflection during screeding operations. Equipment and rails shall be adjusted so that the concrete surface after strike-off conforms to the specified profile and cross section.

The rails shall be fully in place and firmly secured for the entire scheduled length before placing of concrete commences. Rails shall extend beyond both ends of the scheduled length for a distance sufficient to permit the screed equipment to clear the concrete to be placed. The elevation of rails shall be adjusted and set to allow for anticipated settlement, camber, and deflection of falsework, as necessary. The screed equipment shall have the capability of uninterrupted operation over the entire surface to be struck-off. Rails shall have the capacity to be adjusted as necessary to correct for unanticipated settlement or deflection that may occur during the operation of screed equipment.

Rail supports located within the area to be concreted shall be cut back to at least 50 mm below the screeded surface and removed as soon as they are no longer needed and the resulting voids made good with fresh concrete.

The Contractor shall provide a movable work bridge normal to the centreline of the roadway in order to facilitate inspection of the concrete surface, remedial works, making good holes left by rail supports, power floating, texturing and the application of curing compound. After the surface has been screeded all further work that may be required shall be carried out from the work bridge. The Contractor shall install a sturdy and robust walkway with safety railing on each side of the work area to provide access to the work bridge. The Contractor shall operate the screed equipment over the entire area to be concreted to check rail deflections, deck thickness and depth of cover to reinforcing steel,

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and to verify the satisfactory operation of all equipment before the delivery of concrete begins. Any necessary adjustments shall be made before concrete placing commences.

The Contractor shall not use any recently poured parts of the bridge deck or approach slabs as an access for light equipment until a minimum period of 48 hours has elapsed after completion of the pour. This minimum period shall be extended if, in the opinion of the Engineer, the deck has not attained sufficient strength. No heavy equipment shall travel on the bridge deck or approaches until the concrete has gained 80% of the design strength. The screed equipment shall go over the surface as many times as necessary to obtain the required profile and cross section. A slight excess of concrete shall be kept in front of the screed equipment at all times. This excess of concrete shall be carried through to the edge of the pour and disposed of. It shall not be worked into the placed concrete.

During finishing operations, excess water, laitance or foreign materials brought to the surface shall not be reworked into the slab, but shall be removed by means of a "squeegee" or straightedge drawn from the centre of the slab towards either edge. The addition of water to the surface of the concrete to assist in finishing operations will not be permitted.

After the surface has been struck-off it shall be finished with a power float to give a UF 3 surface finish as detailed in Sub-Clause 1316 (c) above.

After finishing the entire surface shall be checked by the Contractor with 3 m metal straightedge placed parallel to the centreline of the bridge. Lines along the edges, the centreline and the mid points in between the centreline and edges shall all be checked. For deck surfaces that are to be overlaid by 25 mm or more of another material the deviation from the straight edge shall not exceed 10 mm. Deviations in excess of this requirement shall be corrected before the concrete sets. The checking operation shall progress by overlapping half of the preceding check. All other unformed concrete surfaces shall be in the positions shown on the Drawings within the tolerances set out in Table 13-10 and there shall be no sudden change of level in the surface. Provided that where dimensional tolerances are given on the Drawings they shall take precedence over those given in Table 13-10.

Table 13-11: Allowable Tolerances of Unformed Concrete Surfaces.

Class of Finish	Maximum Gap between the Surface and a 3 m Straight Edge or Correctly Shaped Template Placed on the Surface	Maximum Difference in Level or Position between a 3 m Straight Edge or Correctly Shaped Template Placed on the Surface and the Specified Level or Position
UF1	5 mm	+ 10 mm or - 10 mm
UF2	5 mm	+ 10 mm or - 10 mm
UF3	3 mm	+ 5 mm or - 5 mm

1317 FINISHES ON FORMED SURFACES

The classes of surface finish to be achieved on formed concrete surfaces shall be as shown on the Drawings and defined hereunder:

(a) Ordinary surface finish

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All exposed concrete surfaces shall receive an ordinary surface finish unless otherwise indicated on the Drawings or instructed by the Engineer. This finish shall be a smooth even concrete surface free of honeycombing, objectionable fins, projections, bulges, offsets, streaks, surface discolouration or other surface imperfections. The formwork shall be faced with plywood complying with the National Institute of Standards and Technology Product Standard PS1 for Exterior B-B Class I Plywood or BS 1088 Plywood for Marine Craft or equivalent material in large sheets. The sheets shall be arranged in an approved uniform pattern. Wherever possible, joints between sheets shall be arranged to coincide with an architectural feature or a change in direction of the surface. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed.

A satisfactory ordinary surface finish shall be defined as one that, in the opinion of the Engineer, requires no remedial measures, such as general filling of surface pitting, other than the filling of holes or cavities caused by the removal of ties and tie rods. All objectionable fins, projections, bulges, offsets, streaks, surface discolouration and other surface imperfections shall be remedied by methods agreed by the Engineer. Cement washes and plasters shall not be used.

Immediately after the removal of formwork, all defects in concrete surfaces shall be brought to the attention of the Engineer. Defects shall be repaired in accordance with this Specification or as directed by the Engineer. Cavities or holes shall be filled carefully and to their full depth, with a cement-sand grout of the same quality and mix as that used in the surrounding concrete but with the fraction remaining on the 2.36 mm sieve discarded. Grout used for pointing shall be not more than 1 hour old. Patched areas shall be rubbed flush with the surrounding surface after the cement grout has hardened.

Honeycombed concrete and localized poorly bonded rock pockets shall be removed and replaced with sound concrete or packed mortar in accordance with Clause 1321 of this Specification.

If, in the opinion of the Engineer, the concrete surface does not conform to the requirements for ordinary surface finish described herein, the Contractor shall, at his own expense, and as may be directed by the Engineer, provide the entire surface or designated areas thereof with a rubbed finish in accordance with Sub-Clause 1317 (b) of this Specification.

(b) Rubbed surface finish

Unless otherwise indicated on the Drawings, this finish shall only apply as a corrective measure at the expense of the Contractor. The rubbed finish shall be provided as soon as formwork is removed. The concrete shall first be given an ordinary surface finish in accordance with Sub-Clause 1317 (a) of this Specification. After the grout for pointing has sufficiently set the entire surface shall be thoroughly wetted with clean water using a brush. The surface shall be rubbed with a power operated stone to bring the surface to a paste. Rubbing shall be continued sufficiently to remove all formwork marks, projections and other surface irregularities to produce a smooth dense surface free from blemishes or pits. Material which has been ground to a paste during rubbing shall be spread uniformly over the entire surface and allowed to take a set. The final finish shall be obtained through a second rubbing with a fine carborundum stone that shall continue until the entire surface is of a smooth even texture and a uniform colour. After the final rubbing has been completed and the surface has dried it shall be rubbed with burlap to remove loose powder. The final surface shall be free from unsound patches, paste, powder and objectionable marks. Under no circumstances shall a cement wash or plaster be applied.

1318 FALSEWORK AND FORMWORK

(a) Falsework

Falsework shall be designed by a structural engineering firm experienced in the design of formwork and falsework and acceptable to the Engineer. At least 21 days before he proposes to commence concreting, the Contractor shall submit to the Engineer design calculations and detailed working drawings showing details of the proposed formwork and falsework. The drawings and calculations shall be certified by the designing structural engineering firm. The calculations shall take into consideration the sequence and rate of placing and the equipment proposed for placing, compacting and finishing the concrete.

Notwithstanding any approval given by the Engineer for the drawings and calculations submitted by the Contractor for the falsework and formwork and the acceptance of the falsework and formwork as constructed, the Contractor shall be held solely responsible for the safety and adequacy of the falsework and formwork. The Contractor shall indemnify the Employer and the Engineer and keep them indemnified against any losses, claims or damages whatsoever to persons or property which may arise out of or in consequence of the design, construction or maintenance of the falsework or formwork.

Formwork and falsework shall be designed and constructed so that they support the loads imposed on them, including but not limited to, those imposed by the fresh concrete, by the rate of placing concrete and by the methods of placing and compacting concrete such that, after the concrete has hardened, the formed faces shall be in the positions shown on the Drawings within the tolerances set out in Clause 1321 of this Specification.

After the drawings have been approved by the Engineer, the Contractor shall construct the falsework in accordance with the submitted drawings. Variations to the construction of falsework from that show on the drawings shall not be permitted without the approval of the designer and the submission to the Engineer of revised drawings.

Loads

The design loads for falsework shall consist of the sum of dead and live vertical loads and any horizontal loads. Dead loads shall include the weight of the falsework and all construction material to be supported. The combined weight of concrete, reinforcing and pre-stressing steel and formwork shall be assumed to be not less than 2.60 t/m^3 of normal weight concrete. Live loads shall consist of the operating weight of any equipment to be supported applied as concentrated loads at the points of contact and a uniform loads of not less than 98 kg/m^2 applied over the area supported, plus 112 kg/m applied at the outside edge of deck overhangs. The horizontal load for the design of the falsework bracing system shall be taken as the sum of the horizontal loads due to equipment, construction sequence, including unbalanced hydrostatic forces from fluid concrete, stream flow when applicable and an allowance for wind. However, the minimum horizontal load in any direction shall be taken as 2 percent of the total dead load. Loads imposed by falsework onto existing, new or partially completed structures shall not exceed those permitted Clause 8.15, "Application of Loads", of Division II, AASHTO Specifications for highway bridges.

Foundations

Falsework shall be supported on solid footings designed to prevent settlement and properly founded on material capable of supporting the loads imposed on it. Due consideration shall be given to the effects on the foundation material if it should become wet. When instructed by the Engineer, the Contractor shall conduct suitable load tests to demonstrate that the soil bearing values assumed for the design of the falsework footings do not exceed the supporting capacity of the soil. If falsework cannot be founded on

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satisfactory footings it shall be supported on piling that shall be spaced, driven, tested and removed to the satisfaction of the Engineer.

Deflections

Falsework shall be constructed and set, utilizing variable depth camber strips between falsework beams and soffit forms if so instructed by the Engineer, to impart the specified camber and profile to the completed structure. The Contractor shall make necessary allowances for dead load deflection and any other deformations caused by the placing of concrete.

For cast-in-place concrete structures, the calculated deflection of falsework flexural members shall not exceed 1/240 of their span irrespective of the fact that the deflection may be compensated for by camber strips.

Clearances

Unless otherwise provided for or instructed by the Engineer, the minimum dimensions of clear openings to be provided through falsework for roadways that are to remain open to traffic during construction shall be at least 1.5 m greater than the width of the approach travelled way and 4.5 m high.

Construction

Falsework shall be constructed from structural steel sections. Structural steel tubes shall have a minimum wall thickness of 4 mm. Screw jacks, pairs of wedges or other approved devices shall be employed at each post to set falsework to grade, to facilitate minor adjustments during the placing of concrete and to allow for the gradual release of the falsework. The Contractor shall provide tell-tales attached to the formwork and extending to fixed reference points, or other approved means for the accurate measurement of falsework settlement during the placing of the concrete.

(b) Formwork

(i) General

Formwork shall of an approved construction surfaced with wood, steel or other approved sheet material.

Formwork for concrete shall be constructed to withstand, without distortion, all the forces to which it will be subjected.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete, it shall also incorporate provisions for making minor adjustments in position, if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for any movement, deflection or settlement under the weight of fresh concrete.

The inner surfaces of the forms shall produce a smooth surface of uniform texture and colour substantially equal, in the opinion of the Engineer, to that which would be obtained using of plywood conforming to the National Institute of Standards and Technology Product Standard PS1 for Exterior B-B Class I Plywood or BS 1088 Plywood for Marine Craft.

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced horizontally and vertically and shall be continuous or form a regular pattern. The same type of formwork surfacing material shall be used throughout each element of a structure.

Where overhangs in formwork occur, means shall be provided to permit the escape of air and to ensure that the space is filled completely with fully compacted concrete.

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Formwork shall be provided for concrete surfaces at slopes of 30° to the horizontal or steeper. Surfaces at slopes less than 20° may be formed by screeding. Surfaces at slopes between 20° and 30° shall generally be formed unless the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the hydraulic pressure of fresh concrete. Formwork for voids within the body of the concrete shall be secured against floatation.

Formwork shall not be re-used after it has suffered damage, which is sufficient to impair the finished surfaces of the concrete.

Where pre-cast concrete elements are specified or proposed by the Contractor and agreed by the Engineer for use as permanent formwork, they shall comply with the requirements of this Specification. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish in Clause 1321 and fixed so that they cannot move when concrete is placed against them.

All formwork surfaces that are to make contact with the concrete shall be thoroughly cleaned and treated with an approved chemical or wax emulsion release agent before the reinforcing steel is placed. Neat mineral oils and water-soluble emulsions shall not be used. The Contractor shall construct trial panels to demonstrate the suitability of any release agents proposed. Release agents shall not be approved if their use causes any of the following properties:

- inhibited adhesion of any material to be subsequently applied to the formed surface,
- the retarded set of the formed surface,
- poor surface durability,
- blowholes,
- staining,
- efflorescence,
- colour variation.

(ii) Design

The structural design of formwork shall conform to ACI Standard, "Recommended Practice for Concrete Formwork" (ACI 347) or some other internationally recognized standard acceptable to the Engineer. In selecting the hydrostatic pressure to be used in the design of formwork, factors to be taken into consideration shall include, but not be limited to:

- the maximum proposed rate of placing concrete,
- the workability and consistence of the proposed mix,
- the effects of vibration,
- the temperature of the concrete,
- ambient temperatures,
- any proposed use of retarding agents, plasticisers or pozzolanic materials in the concrete mix.

(iii) Construction

Prior to reuse, forms shall be cleaned with power driven mechanical equipment, inspected for damage and repaired as necessary. When forms appear to be defective in any manner, either before or during the placement of concrete, the Engineer may suspend operations pending the correction of defects.

The Contractor shall construct formwork in such a manner that the sides can be removed without disturbing the soffit forms and, if props are to be left in place when the soffit forms are removed, these props remain undisturbed during striking. The Contractor shall not

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remove supports temporarily for the purpose of stripping formwork and subsequently replace them.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 60 mm from the face without injury to the concrete. Fittings for metal ties shall be of such design that, upon their removal, the cavities that are left will be of the smallest possible size. The cavities shall be filled with cement mortar and the surface left sound in accordance with Sub-Clause 1317 (a) of this Specification.

Supports for formwork may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete should be used in conjunction with bolts, the metal left in place shall not be closer than 60 mm from the face of the concrete.

Where circumstances prevent easy access within the form for cleaning and inspection, temporary openings for this purpose shall be provided through the formwork.

The internal and external angles on concrete surfaces shall be formed to a chamfer utilizing 20 mm x 20 mm hardwood timber fillets of new material. New 25 mm square hardwood timber shall be incorporated in the formwork to form a clean, level horizontal joint on exposed concrete surfaces at the top of each lift unless otherwise instructed by the Engineer.

Formwork shall be constructed such that it is mortar tight and the dimensions and alignment of the concrete enclosed by the formwork complies in every respect to the particulars indicated on the Drawings. Where reinforcement projects through formwork the form shall fit closely round the bars.

(iv) Preparation of formwork before placing concrete

After construction of the falsework and formwork and prior to the placing of any reinforcing steel, the Contractor shall thoroughly inspect the falsework and formwork. Dimensions shall be controlled, unevenness of surface shall be corrected and special attention shall be paid to the adequacy and tightness of bolts, ties, bracings and ledgings and to the soundness of foundations.

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. In order to avoid colour differences on adjacent concrete surfaces, only one type of release agent shall be used on any one structure.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into its final position. Reinforcement shall not be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from the placement space.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs.

After construction of the falsework and formwork and the fixing of reinforcing steel the Contractor shall give the Engineer written notice at least 24 hours in advance of his intention to place concrete. The Contractor shall satisfy himself that the work complies with the requirements of this Specification in all respects prior to giving such notification to

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the Engineer. The Contractor shall not commence the placing of concrete without the written authorization by the Engineer to do so.

(c) Removal of falsework and forms

(i) General

The Contractor shall not remove falsework or formwork without the prior written consent of the Engineer. In the determination of the time for the removal of falsework and forms, consideration shall be given to the location and character of the structure, climatic conditions, the materials used in the mix and other factors influencing the early strength of the concrete.

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected. Methods of removal likely to cause overstressing of the concrete or damage to its surface shall not be used. Supports shall be removed in such a manner so as to permit the structure to uniformly and gradually assume the stresses due to its own weight.

Unless otherwise instructed falsework shall be released before bridge railings, copings or barriers are constructed.

(ii) Striking times

The minimum periods which shall elapse between completion of placing concrete and removal of formwork and falsework are given in Table 13-12 and apply to ambient temperatures of between 0° C - 25° C. At lower temperatures or if cement other than ordinary or sulphate-resisting Portland cement is used, the Engineer may instruct different periods.

Table 13-12: Minimum Period Before Striking Formwork (Ordinary or Sulphate Resisting Portland Cement Concrete)

FORMWORK TYPE	Average Ambient Temperature					
	Minimum Period Before Striking					
	25° C	25° C	25° C	25° C	25° C	25° C
Vertical formwork to columns, walls and large beams	9 hours	10 hours	12 hours	15 hours	20 hours	30 hours
Soffit formwork to slabs	3 days	3 days	4 days	5 days	7 days	10 days
Soffit formwork to beams and props to slabs	7 days	8 days	10 days	15 days	17 days	25 days
Props to beams	10 days	12 days	14 days	18 days	24 days	36 days

Alternatively, formwork and falsework may be removed when the concrete has attained the strength set out in Table 13-13, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Table 13-13: Minimum Concrete Cube Crushing Strengths to be Attained Before Striking Formwork (Ordinary or Sulphate Resisting Portland Cement Concrete)

Type of Formwork/Falsework	Percentage of Characteristic 28 day Compressive Cube Strength to be Attained Before Striking Formwork
Vertical formwork to columns, walls and large beams	30
Soffit formwork to slabs	35
Soffit formwork to beams and props to Slabs	40
Props to beams	50

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork and falsework until removal can be completed without damage to the concrete.

As soon as the formwork has been removed, bolt holes in concrete faces that are not required for subsequent operations shall be completely filled with mortar and made good.

(iii) Extent of removal

All falsework and forms shall be removed except:

- elements of driven falsework piles more than 0.30 m below non-frost subgrade within roadbeds, or 0.6 m below the original ground or finished grade outside of roadbeds, or 0.6 m below the established limits of any navigation channel,
- footing forms where their removal would endanger the safety of cofferdams or other work,
- forms from enclosed cells where access is not provided,
- deck forms in the cells of box girder bridges that do not interfere with the future installation of utilities shown on the plans.

1319 MORTAR AND GROUT

(a) General

This Section covers the making and placing of mortar and grout for use in concrete structures. Such uses include mortar for filling under masonry plates, mortar used to fill voids and repair surface defects, grout used to fill sleeves for anchor bolts, and mortar and grout for other such uses as necessary.

Surfaces to receive mortar or grout shall be cleaned from all loose or foreign material that would inhibit bonding with the mortar. They shall then be flushed with water and allowed to dry to a surface dry condition immediately prior to placing the mortar or grout.

Small quantities of mortar or grout may be hand-mixed but for amounts over 0.5 m³ a mechanical mixer shall be used. Once mixed, mortar or grout shall not be retempered by the addition of water and shall be placed within one hour.

After placing, all surfaces of mortar or grout shall be cured by the water method in accordance with Sub-Clause 1312 (c) (ii) of this Specification for a period of not less than five days.

(b) Mortar for general purposes

Mortar shall be composed of fine aggregate complying with Sub-Clause 1303 (d) of this Specification and Portland cement Type IA complying with AASHTO M85. The mix proportions shall be as stated on the Drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine aggregate by weight.

The water content of the mortar shall be as low as possible consistent with the use for which it is required but in any case the water/cement ratio shall not be more than 0.5. Mortar which is specified as "dry pack" shall be mixed with sufficient water for the mix to become cohesive but not plastic when squeezed in the hand. Dry pack mortar shall be rammed into the cavity it is required to fill, using a hand rammer with sufficient force to ensure full compaction.

(c) Grouting of pockets and holes

Pockets and holding-down bolt holes shall be thoroughly cleaned out using compressed air and water jets. Holes drilled by diamond bit shall be roughened. Pockets and holes shall be filled with grout consisting of cement and clean fresh water mixed in proportion of two parts by weight of cement to one part by weight of water. The pouring of liquid grout shall cease as soon as each hole is filled and any excess grout on the surface of the concrete foundation shall be completely removed and the surface dried off before the next operation proceeds.

(d) Underpinning of baseplates

The space between the top surface of foundation concrete and the underside of baseplates shall be filled with a special mortar made up of materials in the proportions of one part Portland cement to one part fine aggregate. An additive to counteract shrinkage, acceptable to the Engineer and in accordance with ASTM C845, shall be added in the proportions recommended by the manufacturer. The special mortar shall have the minimum water-cement ratio compatible with sufficient workability to enable maximum compaction to be achieved. The special mortar shall be well rammed in horizontally below the baseplate from one edge only, until it is extruded from the other three sides. The mortar which has extruded shall then be rammed back to ensure complete support without voids.

1320 RECORDS OF CONCRETE PLACING

Records, in a form agreed by the Engineer, shall be kept by the Contractor of the details of every pour of concrete placed in the Works. These records shall include, but not be limited to:

- class of concrete,
- slump,
- location of pour,
- date of pour,
- ambient temperature and concrete temperature at time of placing,
- moisture contents of aggregates,
- details of mixes,
- batch numbers,
- cement batch number,
- ambient temperatures during curing,
- results of all tests undertaken,
- location of test cube sample points, and,
- details of any cores taken.

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The Contractor shall supply to the Engineer four copies of these records each week covering work carried out during the preceding week. In addition he shall supply to the Engineer monthly histograms of all 28 day cube strengths together with cumulative and monthly standard deviations and any other information that the Engineer may require concerning the concrete placed in the Works.

1321 REMEDIAL WORK TO DEFECTIVE CONCRETE

If, on stripping any formwork, the exposed concrete should be found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions, which the Engineer may give.

Defective surfaces shall not be made good by plastering. Remedial works to surface defects shall be carried out in accordance with Sub-Clause 1317 (b) of this Specification.

Areas of honeycombing that the Engineer agrees may be repaired shall be cut back to sound concrete or to 75 mm whichever is the greater distance. In case of reinforced concrete, the area shall be cut back to at least 25 mm clear distance behind the reinforcement or to 75 mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air the cavity shall be coated with an approved epoxy resin and then be filled immediately with concrete of the same class as the main body but with aggregate larger than 10 mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth. Surface irregularities which are outside the limits of tolerance shall be ground down to achieve transition slopes of less than 1 in 50 between adjacent surfaces in the manner and to the extent instructed by the Engineer.

Defects other than those mentioned above shall be dealt with as instructed by the Engineer.

1322 REINFORCEMENT FOR CONCRETE

(a) General

This Clause covers deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works.

All reinforcing bars shall be high yield stress deformed. Reinforcement shall comply with either of the following British Standards or AASHTO Specifications:

BS 4449 Carbon Steel Bars for the Reinforcement of Concrete

BS 4482 Cold Reduced Steel Wire for the Reinforcement of Concrete

BS 4483 Steel Fabric for the Reinforcement of Concrete

AASHTO M 31 M Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

AASHTO M 221 M Steel Welded Wire Fabric, Deformed for Concrete Reinforcement

AASHTO M 225 M Steel wire, Deformed, for Concrete Reinforcement

(b) Testing requirements

The Contractor shall obtain reinforcement from an approved manufacturer and shall submit manufacturer's test certificates to the Engineer.

The Contractor shall test all reinforcement intended for use in the Works for compliance with the applicable AASHTO Standard in a laboratory acceptable to the Engineer, and supply two copies of each test certificate to the Engineer. The frequency of testing shall be as set out in the appropriate AASHTO Standard.

In addition to the testing requirements described above, the Contractor shall be required to carry out such additional tests as may be instructed by the Engineer.

The Contractor, shall promptly remove from Site any reinforcement that does not comply with this Specification.

(c) Delivery and storage of reinforcement

Reinforcement shall be delivered to Site either in straight lengths, or cut and bent in accordance with the requirements of the Contract. Reinforcement shall be rejected if it should be delivered to Site in long lengths which have been bent over double for ease of transportation.

Reinforcement shall be stored on site on racks or on skids on a hard impermeable base such that it remains straight and free from mechanical injury or contamination. Any reinforcement, which is likely to remain in storage for a long period, shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will adversely affect its properties shall either be removed from Site or may be tested for compliance with the applicable AASHTO Standard in accordance with Sub-Clause 1322 (b) of this Specification at the Contractor's cost.

(d) Bar bending schedules

When not included on the Drawings, the Contractor shall submit bar bending schedules to the Engineer for review and approval. Bar bending schedules shall include the following information :

- bar location and placing details,
- reference mark,
- grade of steel,
- size designation,
- number of bars,
- length of bars,
- shape code of bars,
- comments.

Fabrication of reinforcement shall only commence after such lists have been approved by the Engineer. The approval of bar bending schedules shall in no way relieve the Contractor of the responsibility for their accuracy. Any costs incident to the revision of material furnished in accordance with such bending schedules to achieve compliance with the Drawings shall be at the expense of the Contractor.

(e) Fabrication

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(i) **Cutting and bending**

Unless otherwise shown on the Drawings, cutting and bending shall comply with ACI 318 building code requirement for reinforced concrete.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules and shall be responsible for cutting and bending the reinforcement in accordance with the Drawings. The Contractor shall immediately notify the Engineer if there should be a discrepancy between a schedule and the Drawing to which it relates.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5° C the rate of bending shall be reduced if necessary to prevent fracture of the steel. Fabrication tolerances shall be in accordance with ACI 315.

After bending, the Contractor shall tie bars together securely in bundles or groups, legibly labelled as set out in ACI 318.

Heating and bending of high yield bars shall not be permitted.

(ii) **Identification**

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute".

(f) Handling and surface condition of reinforcement

When placed in the work, reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other materials that would reduce bond. Reinforcement shall be free from injurious defects such as cracks and laminations. Bonded rust, surface seams, surface irregularities, or mill scale shall not be deemed just cause for rejection provided that the surface is thoroughly cleaned prior to fixing in the works. Provided also that the minimum dimensions, cross-sectional area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel specified.

(g) Placing and fastening

(i) **General**

Steel reinforcement shall be accurately placed as shown on the Drawings and held firmly in position prior to and during the placing of concrete. Reinforcement shall be rigidly fixed so that no movement can occur during concrete placing. Unless otherwise permitted by the Engineer, all intersecting bars shall be tied together with annealed galvanized iron wire of not less than 1.25 mm diameter with the ends of the tying wire turned back into the main body of the concrete.

The Contractor shall ensure that reinforcement left exposed in the Works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened before concrete placing continues, without leaving residual kinks or damaging the concrete round them.

(ii) **Support systems**

Reinforcing steel shall be supported in its proper position by use of mortar blocks, wire bar supports, supplementary bars or other approved devices. Such devices shall be of such height and placed at intervals sufficient to maintain the distance between the

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reinforcement and the formed surface or the top surface of deck slabs within 5 mm of that indicated on the Drawings.

Platforms for the support of men and equipment during the placing of concrete shall not be supported on the reinforcement.

(iii) Mortar blocks

Mortar blocks shall have a compressive strength of not less than that of the concrete in which they are to be embedded. The face of blocks in contact with forms for exposed surfaces shall not exceed 50 mm by 50 mm in size and shall have a colour and texture that will match the concrete surface. Mortar blocks shall have an embedded annealed galvanized iron wire of diameter 1.25 mm for securing the block to the reinforcement. An alternative type of spacer block may be used subject to the approval of the Engineer.

(iv) Stools and high chairs

Such supports shall conform to industry practice as described in the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute". Chairs or stools that bear against forms for exposed surfaces shall be either Class 1 - Maximum Protection (Plastic Protected) or Class 2. Type B-Moderate Protection (Stainless Steel Tipped) for which the stainless steel conforms to ASTM A493, Type 430.

(v) Welding of reinforcement

Reinforcement in structures may only be welded with the prior written approval of the Engineer. Welding shall conform to the Structural Welding Code, Reinforcing Steel, AWS D1.4 of the American Welding Society and applicable special provisions.

(vi) Splicing of Bars

All reinforcement shall be fabricated in the full length indicated on the plans unless otherwise permitted. Except where shown on the Drawings splicing of bars shall be subject to the written approval of the Engineer. Splices shall be staggered as far as possible.

Lapped splices shall be of the lengths shown on the Drawings. If not dimensioned on the Drawings, the length of lapped splices shall be in accordance with Division I, Clause 8.32 of AASHTO Standard Specifications for Highway Bridges or as instructed by the Engineer. Bars in lapped splices shall be placed and wired in such a manner that their minimum depth of cover complies with that indicated on the Drawings and the requirements of Sub-Clause 1310 (e) of this Specification.

Welded splices, in accordance with the provisions of Sub-Clause 1322 (g) (v), may be allowed at the discretion of the Engineer.

The Contractor shall not use mechanical couplings for splicing reinforcement without the prior written approval of the Engineer. Mechanical couplings shall develop both in tension and compression at least 125% of the specific yield strength of the bar.

Two field splices out of each 100, or portion thereof, placed in the work, shall be selected by the Engineer, removed by the Contractor and tested to 125% of the specified yield strength.

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Sheets of welded mesh reinforcement shall be spliced by a lap of one and a half times the spacing of the mesh with all ends and edges securely tied.

1323 SUBSTITUTION BY BARS OF DIFFERENT SIZES

Substitution of the bars indicated on the Drawings with bars of different sizes or yield strengths will be permitted at the discretion of the Engineer and only with his prior written authorization. The product of the area and yield strength of the substituted bars shall be at least equal to that of the bars indicated on the Drawings and shall conform to the requirements of Division I, Clause 8.16.8.4 of AASHTO Standard Specification for Highway Bridges.

1324 PRE-CAST REINFORCED CONCRETE

(a) General

This includes all pre-cast reinforced concrete mentioned in the Contract document or the Contractor intends to use.

(b) Formwork

Formwork for pre-cast reinforced concrete structure shall comply with the requirements of Clause 1318 of this Technical Specification. The formwork shall be constructed and set such that the alignment and dimensions are not changed and fine grained concrete and concrete slurry are not leaked while using it.

Formwork for concrete shall be constructed on hard base to withstand, all the forces to which it will be subjected. Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. The Contractor shall use the removal substances which meets the requirements of Sub-Clause 1318 (b) (i).

(c) Reinforcement for pre-cast concrete

Reinforcement for pre-cast concrete should comply with the requirements of Clauses 1322 and 1323 of this Specifications. If ready made formwork is to be used, it shall be rigidly fixed on the jig for replacing the reinforcement steel in order to provide the accuracy, and supported with forms so that no movement can occur during concrete placing.

Concrete cover shall be of the type mentioned in the Working Drawing and if it is not mentioned shall be not less than 50mm or reinforcement diameter. Reinforcement shall be placed such that the net space between them shall be equal to the nominal size of the stone plus 5mm or not less than the reinforcement diameter in any case.

(d) Fabrication

Concrete to be used for pre-cast reinforced concrete structure shall be of Grade as shown in the Working Drawing and meet the requirements of 1303 to 1310 of this Technical Specification. Lightweight aggregate shall comply with the Requirements of AASHTO M195. The fabrication yard shall be properly protected from the water, rain, sun, and wind. The structures shall be fabricated and formed in as per the dimensions and tolerances given in the Working Drawings.

(e) Surface finish

Unless otherwise mentioned in the Working Drawing, the unformed surface of the structure shall be finished in accordance with the Sub-Clause 1317 (a) to produce a uniform plain surface. Unless otherwise mentioned in the Working Drawing, the unformed surface of the pre-cast structure shall be finished in accordance with the Sub-Clause 1316 (c) to produce

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UF3 surface. If the special surface is required the Contractor shall construct trial panel and store at the manufactured site for testing after the Engineer's approval. Pre-cast structures to be further manufactured shall be of same as trial panel.

The area that contacts with other structures or cast-in-place concrete shall be screed with steel brush and thoroughly washed with water before concrete is hardened. If the concrete requires hardening the surface shall be screed with sand and cement mix.

(f) Delivery and storage

Precast structures shall be delivered in a manner preventing them from any damages and shall be stored on a hard, water-proof base. During storage of pre-cast structures and large size cast-in-place structures, reinforced in an ordinary way, they shall be placed such that they shall not have any additional load, exceeding that which shall be given to them in their final position in the works. As shown in the working drawings, the structures shall be provided with proper hooks, loops and openings, which shall be used for handling the structures. If it is impossible to provide hooks or openings, the place suitable for handling, shall be indicated on the structure with oil paint. The number of the structure and date of casting shall be indelibly marked on precast structures. Structures shall be piled on suitable slabs or cushions so that any damage is not caused to the concrete or surface. Slabs under every structure should be not more than two. They shall be firmly supported and be placed in the position, in which the structures shall have a minimum load on them.

1325 MEASUREMENT AND PAYMENT

a) Not used

(b) Reinforced concrete excluding the cost of reinforcing steel

Unit : m³ of each concrete grade

Payment for this item will be at the unit price per cubic metre for the volume of concrete incorporated in the permanent structure. No deduction shall be made for:

- holes, pockets and the like not exceeding 0.15 cubic meters in each in volume;
- reinforcement;
- cast in components not exceeding 0.15 cubic meters each in volume.

The item includes for:

- design calculation and execution drawing, to be submitted to the Engineer for approval;
- submission of the concrete formulation showing the grain quality, grain mixture with sieve curb, type of cement and cement content, and if foreseen concrete additives;
- trial mixes and plant trials;
- formwork;
- forming holes, ducts, pockets, sockets, mortices and the like, and casting-in items as required;
- placing of the service girders and the formwork according to drawings;
- provision and placing of the reinforcement bars;
- preparation, transport, placing and compaction of concrete;
- curing and protection;
- matching members as required for side by side construction;
- marking members for identification, date of casting and lifting points and delivery in matching sequence;
- lifting devices, bearing plates and removal;
- erection and fixing in final position;
- temporary supports and connections to prevent displacement;

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- bedding, jointing and pointing, including cramps, dowels or other fixing devices;
- caulking and sealing between and under units and members;
- cutting and trimming;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives;
- in the case of the precast prestressed members and the like, ducts, tendons and stressing (including partially stressing) and grouting internal tendons;
- in the case of precast and precast prestressed members and the like, for incorporation in in-situ post tensioned prestressed construction, forming and installing tendon ducts to profile and sealing, forming recesses in the concrete for anchorages and jack seatings, bearing lates, reinforcing helices, grout inlets, vents and other components, including casting in;
- working in the river;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(c) Reinforcing steel

Unit: ton or kilogram

The measurement of reinforcement shall include the reinforcement specified to be cast into the element and required to bond into the substructure.

The weight of plain bar reinforcement shall be calculated on the basis that steel weighs 0.00785 kilogram per square millimetre of cross sectional area per linear metre. The weight of deformed bar reinforcement shall be calculated from the nominal rolling mass of the reinforcement. Steel bar supports to reinforcement shall be measured as reinforcement.

The items for reinforcement shall include for:

- cleaning, cutting and bending;
- reinforcement;
- tying with tying wire, tying devices or clips;
- welding;
- supports and spacers (except for steel bar supports to reinforcement);
- reinforcement connectors;
- extra fabric reinforcement at laps;
- protection of projecting reinforcement;
- lifting bars, supporting steel or lifting yokes for prefabricated reinforcement cages;
- repairing damage to protective coatings on, and patching cut ends of, reinforcement;
- preparing bending schedule;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(d) Reinforced Concrete for Structural Members

Unit: m³ of each concrete grade

Payment for these items will be at the unit price per cubic metre for the volume of reinforced concrete members. No deduction shall be made for:

- holes, pockets and the like not exceeding 0.15 cubic meters in each in volume;
- reinforcement;
- cast in components not exceeding 0.15 cubic meters each in volume.

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The items for concrete for structural members shall include for:

- design calculation and construction drawings, to be submitted to the Engineer;
- submission of the concrete mix design;
- trial mixes and plant trials;
- all materials;
- falls, cambers and shaped profiles;
- construction joints, skewbacks, stunt ends, steppings, bonding chases and the like;
- holes, pockets, mortices casting in items and the like;
- ducts and sockets
- concrete to fill over-break and working space;
- filling of tie bar holes;
- underlay and sliding layers;
- formwork;
- reinforcement;
- provision, placing and compacting of concrete;
- filling to overbreak and working space;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(e) Plain concrete without reinforcement

Unit: m³ of each concrete grade

The unit of measurement for plain concrete without reinforcement shall be the cubic meter of concrete at locations shown on the Drawings or as directed by the Engineer. The volume shall be calculated from the dimensions given on the Drawings or instructed by the Engineer. This item includes concrete placed in leveling courses and approach slabs, concrete footpaths and blinding concrete. Blinding concrete upon hard material shall be measured as the volume placed provided that the maximum thickness of 150 mm allowed for overbreak is not exceeded. Any concrete placed in excess of this limit shall be to the Contractor's expense.

The items for plain concrete shall include for:

- design calculation and construction drawings, to be submitted to the Engineer;
- submission of the concrete mix design;
- trial mixes and plant trials;
- falls, cambers and shaped profiles;
- construction joints, skewbacks, stunt ends, steppings, bonding chases and the like;
- holes, pockets, mortices casting in items and the like;
- ducts and sockets
- concrete to fill over-break and working space;
- filling of tie bar holes;
- underlay and sliding layers;
- formwork;
- provision, placing and compacting of concrete;
- filling to overbreak and working space;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;

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- admixtures and additives;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(f) Assembly and placing of bridge superstructure girders

Unit: number

Payment for this item will be at the contract unit price per complete installed girder.

The item includes for:

- placing of the service girders and the formwork according to drawings;
- matching members as required for side by side construction;
- marking members for identification, date of casting and lifting points and delivery in matching sequence;
- lifting devices, bearing plates and removal;
- erection and fixing in final position;
- temporary supports and connections to prevent displacement;
- bedding, jointing and pointing, including cramps, dowels or other fixing devices;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(g) Precast Elements

Unit: number for different types

Pre-cast elements shall be measured as numbers for different types. The rate for pre-cast elements shall include for the costs of all material, molding and fabrication of the structure and complying with the requirements of this technical Specifications.

No separate measurement and payment shall be done for prestressed reinforcement or steel to be incorporated in pre-cast concrete structure.

(h) Cement mortar

Unit: m³ of each concrete mortar type

The unit of measurement for cement mortar shall be the cubic meter of mortar at locations shown on the Drawings or as directed by the Engineer. The volume shall be calculated from the dimensions given on the Drawings or instructed by the Engineer.

The items for mortar shall include for:

- submission of the mortar mix design;
- trial mixes and plant trials;
- construction joints, skewbacks, stunt ends, steppings, bonding chases and the like;
- formwork;
- provision, placing and compacting of mortar;
- filling to overbreak and working space;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

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(i) Concrete blocks

Unit: m² of each block type

Payment for this item will be at the unit price per square metre for the area of installed concrete block elements as shown on the drawings or as directed by the Engineer

The item shall include for:

- mix design and trial mixes;
- excavation;
- provision of materials;
- preparation, transport and placing of concrete;
- placing of the formwork and reinforcement bars;
- provision, mixing, transport, placing and compaction of concrete;
- curing and protection;
- measures to control alkali-silica reaction;
- air entrainment;
- admixtures and additives;
- removal of formwork;
- backfill and compaction.
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

SECTION 1400 - BRIDGE WORKS

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EXCAVATION AND BACKFILLING, WATER TRAINING EMBANKMENT AND BRIDGE PROTECTION WORKS

1401 SCOPE OF SECTION

This section covers excavation and backfilling works for bridges, river training, and bridge protection works.

1402 CLASSIFICATION OF STRUCTURAL EXCAVATION

Material shall be classified as either “hard” or “soft” material as defined below: Hard material shall comprise material which can be excavated only after blasting with explosives or barring and wedging or the use of a pneumatic or hydraulic mechanical breaker fitted with a rock point in good condition and operated correctly. Isolated boulders or more than 0.75 m³ occurring in soft material shall be classified as hard material. Soft material is all material other than hard material, including that which is suitable or unsuitable for re-use.

1403 STRUCTURAL EXCAVATION OF FOUNDATIONS FOR STRUCTURES

The excavation of foundations for structures shall be kept to the minimum. The sides of the excavation shall be kept vertical and shall be properly timbered or sheet piled, shored and strutted as necessary to prevent subsidence/slippage or collapse of the surrounding soil.

All excavated surfaces, in material other than hard material, on which foundation for structures are to be placed shall be compacted to 95% MDD (MNS ASTM D1557:2002) immediately before foundations are constructed.

Excavated surfaces in hard material shall provide for a minimum thickness of 50 mm of blinding concrete.

Where a combination of hard and soft materials exist in the excavated surfaces then, dependent on the proportions of existing materials, the Contractor shall, at the instruction of the Engineer, either remove a minimum of 300 mm of soft material from below the level of the underside of the foundation and replace it with non-structural concrete to the top of blinding level or removal a minimum of 300 mm of hard material from below the level of the underside of the foundation and replace it with soft material compacted to 95% MDD (MNS ASTM D1557:2002).

Where ground conditions are such that a satisfactory foundation cannot be achieved at the specified foundation base level Contractor shall, if instructed by the Engineer, remove the unsuitable material either until a suitable founding material is encountered or to the depth and width instructed by the Engineer. The Contractor shall backfill the resultant additional excavation to the specified level of the underside of blinding concrete with approved material compacted to 95% MDD (MNS ASTM D1557:2002). The Engineer's approval of any excavation shall be obtained prior to any construction thereon.

1404 EXCAVATIONS TO BE KEPT DRY

All excavations shall be kept dry and the Contractor shall take all necessary measures to maintain excavations free from water, snow and ice. Where required by the Engineer, the sumps from which dewatering pumps operate shall be constructed outside the area of the foundation base. Excessive pumping from the excavation that is liable to cause

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settlement, disturbance, or washing out of fine particles from the neighbouring ground shall not be permitted. Where, in the opinion of the Engineer, the foundation has become soft or unstable and additional excavation is required due solely to the Contractor's method of working, the resulting backfill shall be with approved material compacted to 95% MDD (AA MNS ASTM D1557:2002) or concrete as instructed by the Engineer. All such excavation and backfill shall be at the Contractor's expense.

1405 CAST-IN-SITU PILE FOUNDATIONS

Construction of cast-in-situ pile foundation is included in the Section 1500.

1406 SURPLUS EXCAVATED AND BACKFILLING MATERIALS

Surplus excavated material shall be disposed of in designated spoil areas in accordance with Sections 500 and 600 of this Specification or may be used in earthworks if considered suitable by the Engineer.

Backfilling and filling behind and around structures shall only be carried out using materials that have been approved by the Engineer.

1407 BACKFILLING OF EXCAVATIONS AND FILLING FOR STRUCTURES

The Contractor shall obtain the Engineer's approval prior to commencing any filling around a structure or backfilling a trench or excavation, or to loading any structure.

The Contractor shall obtain the Engineer's approval to his proposed sequence of filling and backfilling behind and around a structure and to the height of fill at any time between fill levels.

The Contractor shall carry out filling and backfilling operations with selected materials approved by the Engineer in horizontal layers not exceeding 150 mm compacted thickness. Each layer shall be thoroughly mixed, watered or dried as necessary, and compacted to a minimum dry density of 95% MDD (MNS ASTM D 1557:2002).

Timbering and sheeting left in for the purpose of supporting the sides of the excavation shall be eased up 150 mm at a time in steps with the backfill layer. Where instructed by the Engineer, timbering or sheeting shall be left permanently in place. Where shown on the Drawings or instructed by the Engineer the Contractor shall place selected granular fill materials conforming to the grading in accordance with AASHTO M6/AASHTO M43 for size No. 89 /9.5-1.18mm/ and granular filter materials conforming to the grading in accordance with AASHTO M43 for size No. 467 /37.5-4.75mm/ approved by the Engineer.

The Contractor shall use a sliding form or other means approved by the Engineer during backfilling such that the filter layer is brought up and compacted at least 150 mm ahead of the selected granular fill materials, and that the selected granular fill materials is brought up and compacted at least 150 mm ahead of the adjacent earthworks fill. The interface between selected granular fill materials to this Section 500 and the adjacent earthworks carried out in accordance with Section 500 of the Specification shall be as shown on the Drawings or as instructed by the Engineer. Above ground level the Contractor shall use the same material as that being used for the adjacent embankment.

1408 PROTECTION OF STRUCTURES

The Contractor shall furnish, construct and maintain all necessary cofferdams, caissons, cribs, channels, flumes and other diversions and protection works and shall furnish install,

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operate and maintain all necessary pumping and other equipment for the exclusion or removal of water from various parts of the Works.

Drawings for cofferdams and other proposed temporary installations shall be submitted to the Engineer before commencement of the Temporary. The Contractor shall avoid any measures in the proposed installations that may cause flooding or endanger the safety of persons or property on upstream or downstream of the Site. All such Temporary Works shall be removed on completion of the Works unless otherwise instructed by the Engineer.

1409 STONE PITCHING FOR BRIDGE PROTECTION

Where shown on the Drawings or directed by the Engineer the Contractor shall excavate for, trim to line and level, provide and lay stone pitching. Stone pitching shall be formed of stone which is sound, hard, durable and fairly regular in shape. Quarry stone shall be used. Rounded boulders shall not be allowed. The stones subject to marked deterioration by water or weather shall not be accepted.

The largest stones shall be used and in no case shall any fragment weigh less than 35 kg unless otherwise permitted by the Engineer. The sizes of spalls shall be minimum 25 mm and shall be suitable to fill the voids in the pitching. The apparent specific gravity for stone pitching shall be at least 2.40.

The area to be pitched shall be prepared by excavating, shaping and trimming to accommodate the stonework and shall be compacted to 95% MDD (MNS ASTM D 1557:2002).

A trench shall be excavated along the toe of any slope to be pitched or along the unprotected edge of the pitching in the beds of watercourses. Commencing at the bottom of the trench stones shall be laid and firmly bedded into the slope and against adjoining stones.

The stones shall be set on edge with their largest dimension at right angles to the slope unless such dimension exceeds that of the instructed thickness of the stone pitching. The stones shall be securely rammed into the surface to be protected. The stones shall be fitted closely together so as to leave only a minimum of interstices which shall be filled with suitably shaped and tightly wedged spalls. The top of the pitching shall be finished flush with the adjacent material.

Where grout is specified, the surfaces of the stones shall be thoroughly cleaned and free from adhering dirt and clay. Grout, composed of one part cement to three parts sand, shall be rammed into the wetted interstices between the stones so as to ensure all voids are completely filled, provided that the Engineer may instruct that 20% of vertical joints be left open as weep holes.

The grout shall be smoothed off flush with the pitched face and the stones shall be thoroughly brushed such that their top surfaces are exposed. The grouted stone pitching shall be cured with wet sacking or other approved method and protected from the effects of the climate for a period of not less than seven days after grouting.

Filter media shall be placed on the prepared slope or area before placement of slope pitching to prevent leaching of the embankment through the voids of stone pitching as well as to allow free movement of water without creating any uplift on the pitching. One layer of graded filter media of specified thickness shall be provided underneath the pitching.

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Flexible Boulder Apron: Stones used in apron shall be sound, hard, durable and fairly regular in shape. Stones subject to deterioration by water or weather shall not be used. Angular shape stones shall be preferred to rounded boulders. The size of stone should be as indicated in the drawings or as approved by the Engineer. The surface on which the apron is to be laid shall be leveled and prepared for the length and width as shown in the drawings.

1410 RETAINING WALLS

The Contractor shall furnish and placing structural concrete and incidental construction of retaining walls in conformity with the lines, grades and dimensions, as shown in details on the Drawings or as directed by the Engineer. All materials shall conform to Section 1300, "Concrete Works." of this Specification. The concrete shall be Grade B30. Filter media/granular filter materials shall be in accordance with Clause 1307 /g/ of this Specification.

Weep holes shall be 50 mm dia and shall extend through the full width of the walls with slope of about 1 vertical to 20 horizontal towards the draining face. The spacing of weep holes shall not exceeding 1.0 m in either direction and shall be staggered or as directed by the Engineer.

BEARINGS

1411 GENERAL

Bearings shall comply with the requirements of AASHTO M251 and shall be designed in accordance with AASHTO Standard Specifications for Highway Bridges.

Bearings shall be manufactured and installed in accordance with the details shown on the Drawings or as described in this Specification. They shall adequately provide for the thermal expansion and contraction, rotation, tilting, creep and shrinkage of the structural elements that they support.

Bearing surfaces of bearings shall be kept free from contamination and after the deck has been completed, each bearing and the area around it shall be left clean. All bearings shall be indelibly marked with their appropriate type and identification numbers that shall be visible after installation.

Bearings shall not be dispatched to the Site until they have been tested in accordance with the requirements of this Specification and the certified results of such tests approved by the Engineer.

1412 PROPERTIES OF THE ELASTOMER

The raw elastomer shall be virgin Neoprene (polychloroprene). The elastomer compound shall be classified as being of low temperature grade 0, 2, 3, 4, or 5. The grades are defined by the testing requirements in Table 14-1. A higher grade of elastomer may be substituted for a lower one.

The elastomer compound shall meet the minimum requirements of Tables 14-1 except as otherwise specified by the Engineer. Test requirements may be interpolated for intermediate hardness. If the material is specified by its shear modulus, its measured shear modulus shall lie within 15 percent of the specified value. A consistent value of hardness shall also be supplied for the purpose of defining limits for the tests in Table 14-1.

If the hardness is specified, the measured shear modulus must fall within the range of Table 14-2. When test specimens are cut from the finished product, the physical properties shall be permitted to vary from those specified in Table 15-1 by 10 percent.

All material tests shall be carried out at 23° C ± 2° C unless otherwise noted. Shear modulus tests shall be carried out using the apparatus and procedure described in annex A of ASTM D4014.

1413 STEEL LAMINATES

Steel laminates used for reinforcement shall be made from rolled mild steel conforming to ASTM A 36/A 36M, ASTM A 570M or equivalent, unless otherwise specified by the Engineer. Holes in plates for manufacturing purposes will not be permitted unless they have been accounted for in the design, as shown on the plans.

1414 BOND

The vulcanized bond between fabric and reinforcement shall have a minimum peel strength of 5.2 KN/m. Steel laminated bearings shall develop a minimum peel strength of 6.9 KN/m. Peel strength tests shall be performed by ASTM D429 Method B.

Table 14-1: Neoprene Quality Control Test

PHYSICAL PROPERTIES				
ASTM D 2240	Hardness	50 ± 5	60 ± 5	70 ± 5
D 412	Tensile Strength, Minimum MPa	15.50	15.50	15.50
	Ultimate Elongation, Minimum %	400	350	300
HEAT RESISTANCE				
ASTM D 573 70 Hours at 100°C	Change in Durometer Hardness, Maximum Points	15	15	15
	Change in Tensile Strength, Maximum %	-15	-15	-15
	Change in Ultimate Elongation, Maximum %	-40	-40	-40
COMPRESSION SET				
ASTM D 395 Method B	22 Hours @ 100°C, Maximum %	35	35	35
OZONE ASTM D 1149	100 Hours mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
LOW-TEMPERATURE BRITTLINESS				
ASTM D 746 Procedure B	Grades 0 & 2 – No Test Required			
	Grade 3 Brittleness at 40°C	No Failure	No Failure	No Failure
	Grade 4 Brittleness at 48°C	No Failure	No Failure	No Failure

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	Grade 5 Brittleness at 57°C	-	No Failure	No Failure	No Failure
INSTANTANEOUS THERMAL STIFFENING					
D1043	Grade 0 & 2 – Tested @ 31°C	-	Stiffness at test temperature shall not exceed 4 times the stiffness measured at 23°C		
	Grade 3 – Tested @ -40°C		Stiffness at test temperature shall not exceed 4 times the stiffness measured at 23°C		
	Grade 4 – Tested @ -45°C				
	Grade 5 – Tested @ -54°C				
LOW-TEMPERATURE CRYSTALLIZATION					
Quad Shear Test as Described	Grade 0 – No test required		Stiffness at test time and temperature shall not exceed 4 times the stiffness measured at 23°C with no time delay. The stiffness shall be measured with a quad shear test rig in an enclosed freezer unit. The test specimens shall be taken from a randomly selected bearing. A $\pm 25\%$ strain cycle shall be used, and a complete cycle of strain shall be applied with a period of 100 seconds. The first $\frac{3}{4}$ cycle of strain shall be discarded and the stiffness shall be determined by the slope of the force deflection curve for the next $\frac{1}{2}$ cycle of loading.		
	Grade 2 – 7 days @ -18°C				
	Grade 3 – 14 days @ 26°C	-			
	Grade 4-21 days @ -37°C				
	Grade 5 – 28 days @ 37°C	-			

Remark - Refers to "Modulus of Rigidity," while ASTM D4014 Refers to "Shear Modulus Stiffness." The Word "Stiffness" is used here to Cover Both Terms

Table 14-2: Elastomer Properties at Different Harnesses

Hardness (Shore 'A')	50	60	70
Shear Modulus (G) (psi)	95-130	130-200	200-300
At 73 degrees F (MPa)	0.68-0.93	0.93-1.43	1.43-2.14
Creep deflection at 25 years	25%	35%	45%
Instantaneous deflection			
k	-	0.75	0.6
			0.55

1415 FABRICATION

Bearings with steel laminates shall be cast as a single unit in a mould and vulcanised under heat and pressure.

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Casting of elements in separate units and subsequent bonding shall not be permitted, nor shall cutting from large size cast be permitted.

Bearings of similar size to be used in particular bridge shall be produced by identical process and in one lot.

The moulds used shall have standard surface finish adequate to produce bearings free from any surface blemishes.

Steel plates for laminates shall be sand blasted, clean of all mill scales and shall be free from all contaminants prior to bonding by vulcanisation. Rusted plates with pitting shall not be used. All edges of plates shall be rounded.

Spacers used in mould to ensure cover and location of laminates shall be of maximum size and number practicable. Any hole at surface or in edge cover shall be filled in subsequently.

Table 14-3: Tolerances

Items		Tolerances
1	Overall vertical dimensions:	
	Design thickness 32mm or less	-0, +3
	Design thickness over 32mm	-0, +6
2	Overall horizontal dimensions:	
	For measurements 914mm and less	-0, +6
	For measurements over 914mm	-0, +12
3	Thickness of individual layers of elastomer (laminated bearings only) at any point within the bearings	± 20 percent of design value but no more than ± 3 mm
4	Variation from a plane parallel to the theoretical surface: (as determined by measurement at the edge of the bearings):	
	Top	Slope relative to the bottom of no more than 0.005 radians
	Slides	6
5	Position of exposed connection members	± 3
6	Edge cover of embedded laminates of connection members	-0, +3
7	Size of holes, slots, or inserts	± 3
8	Position of holes, slots, or inserts	± 3

1416 ACCEPTANCE SPECIFICATION

The manufacturer shall have all the test facilities required for the process and acceptance control tests installed at his plant to the complete satisfaction of the Engineer. The test facilities and their operation shall be open to inspection by the Engineer on demand.

All acceptance and process control tests shall be conducted at the manufacturer's plant or at an independent testing laboratory acceptable to the Engineer. The Contractor shall be liable for all costs arising therefrom, including:

- laboratory testing charges,
- provision of samples,
- transportation of samples

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- attendance on laboratory personnel.

Acceptance testing shall be commenced with the prior submittal of testing program by the manufacturer to the Engineer and after obtaining his approval.

Any acceptance testing delayed beyond 180 days of production shall require special approval of the Engineer and modified acceptance specification, if deemed necessary by him.

All acceptance testing shall be conducted by the Inspector with aid of the personnel having adequate expertise and experience in rubber testing provided by the manufacturer, working under the supervision of the Inspector and to his complete satisfaction.

1417 QUALITY CONTROL CERTIFICATE

The manufacturer shall certify for each lot of bearing under acceptance:

- That the entire process remained in control during the production of the lot of bearings under acceptance as verified from the quality control records/charts which shall be open to inspection of Engineer/Inspector on demand.
- A certified copy of results of process control testing done on samples of elastomer used in the production of the lot shall be appended and shall include at least the following information:
- Composition of compound – raw elastomer and ash content, the grade of raw elastomer used (including name, source, age on shelf), test results of hardness, tensile strength, elongation at break, compression set, accelerated ageing, etc.
- Certification and marking

Bearings shall be transported to bridge site after final acceptance by Engineer and shall be accompanied by an authenticated copy of the certificate to that effect.

An information card giving the following details for the bearings, duly certified by the manufacturer shall also be appended:

- name of manufacturer,
- date of manufacture
- elastomer grade used,
- bearing dimensions,
- production batch no.,
- acceptance lot no.,
- date of testing,
- specific bridge location, if any
- explanation of markings used on the bearing.

All bearings shall have suitable index markings identifying the information. The markings shall be made in indelible ink or flexible paint and if practicable should be visible after installation. The top of the bearing and direction of installation shall be indicated.

1418 STORAGE AND HANDLING

Each elastomeric bearing shall be clearly labelled or marked. The bearing shall be wrapped in a cover. They shall be packed in timber crates with suitable arrangement to prevent movement and to protect corners and edges.

Care shall be taken to avoid mechanical damage, contamination with oil, grease and dirt, undue exposure to sunlight and weather to the bearings during transport and handing prior to and during installation.

1419 INSTALLATION

Bearings shall be installed in accordance with the manufacturer's instructions and under the supervision of the manufacturer's representative.

Installation of multiple bearings one behind the other on a single line of support shall be identical dimensions.

Bearings must be placed between true horizontal surfaces (maximum tolerance 0.2 percent perpendicular to the load) and at true plan position of their control lines marked on receiving surfaces (maximum tolerance ± 3 mm).

Concrete surfaces shall be free from local irregularities (maximum tolerance ± 1 mm in height).

For cast-in-place concrete construction of superstructure, where bearings are installed prior to its concreting, the forms around the bearings shall be soft enough for easy removal. Forms shall also fit the bearings snugly and prevent any leakage of mortar grout. Any mortar contaminating the bearings during concreting shall be completely removed before setting.

For precast concrete superstructure elements, fixing of bearing to them may be done by application of epoxy resin adhesive to interface, after specified surface preparation. The specifications for adhesive material, workmanship and control shall be approved by the Engineer. Care shall be taken to guard against faulty application and consequent behaviour of the adhesive layer as a lubricant. The bonding by the adhesive shall be deemed effective only as a device for installation and shall not be deemed to secure bearings against displacement for the purpose of design.

1420 MAINTENANCE

The bearing shall be subject to planned maintenance care.

The exposed bearing surface shall be maintained clean and free from contamination with grease, oil etc.

After installation routine maintenance inspection of all bearings shall be made till the expiry of the Defects Liability Period to check for any surface cracking or signs of damage, deterioration or distress.

Damaged bearings shall be replaced immediately. To avoid difference in stiffness, all adjacent bearings on the same line of support shall also be replaced.

1421 TAR PAPER BEARING

Where shown on the Drawings or as instructed by the Engineer. The Contractor shall provide tar paper bearings. The product shall consist of preformed sheets or strips made of clean granulated cork securely bound together by a suitable asphalt binder and encased between two layers of felt, conforming to the requirements of AASHTO M213.

EXPANSION JOINTS

1422 STRIP SEAL EXPANSION JOINTS

(a) Components

Strip seal expansion joints shall comprise the following components:

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- claw leg profiled edge beams of extruded rolled steel of good weldability and high notch toughness,
- vulcanized polychloroprene strip seal of high tear strength, a high resistance to aging and insert to oil, gasoline, and ozone,
- rigid anchor plates welded to the edge beams at staggered intervals, and,
- weldable steel anchor loops to connect the rigid anchor plates to the top reinforcement of the bridge superstructure.

(b) Materials

Steel for edge beams shall conform to German Standard grade Rst 37-2 or equivalent approved standard specification. All steel elements shall have an integral corrosion protection system. Polychloroprene strip seal shall conform to the requirements of AASHTO M297. Properties of polychloroprene shall conform to Table 18.2.3.1 A and 18.2.3.1 B of Division II of AASHTO Standard Specifications for Highway Bridges. Steel anchor plates and anchor loops shall comply with AASHTO M270.

(c) Fabrication

Rolled steel sections for edge beams shall be supplied in lengths sufficient to provide for the finished dimensions and profiles shown on the Drawings. Edge beams shall be cut by means of a miter box saw to fit the finished bridge cross-section and camber. The profile of the bridge cross-section shall be accurately marked on workshop benches. After the steel sections are correctly aligned to that profile they will be clamped securely to the bench, and continuously welded.

Anchor plates shall be flame cut to size and welded to the edge beams at the intervals shown on the Drawings. Anchor loops shall be bent to the required shape and welded to the anchor plates.

The manufacturer shall supply all the appurtenant materials for the installation of strip seal joints including sealants and waterproofing membranes.

Auxiliary brackets shall be provided to secure the joint assembly during transportation and storage. Expansion joint assemblies shall be handled with care and stored off the ground in storage sheds or containers on wooden pallets.

(d) Installation

The width of the gap shown on the Drawings to allow for movements due to thermal variations, shrinkage, creep, superstructure deformations and sub-structure deformations shall be confirmed by the Contractor and conveyed by him to the manufacturer. The gap dimension shall be preset according to the temperature at fabrication and the likely temperature at installation.

The dimensions of the recess in the bridge deck required for expansion joint installation shall be as indicated on the Drawings or modified in accordance with the manufacturer's recommendations. The recess shall be thoroughly cleaned and free from any dirt or debris. The exposed reinforcement shall be adjusted as necessary to permit unobstructed lowering of the joint into the recess.

The gap between existing formed concrete surfaces and the formwork for the concrete in which expansions joints are to be set shall be thoroughly sealed against the leakage of mortar from freshly placed concrete.

The size of the gap shall be compatible with the mean structure temperature at the time of installation. This temperature shall be determined in accordance with a prior arrangement agreed between the Contractor and the Engineer. Should temperatures

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vary from the those anticipated for presetting the gap, the necessary adjustment shall be made prior to placing the concrete.

The joint shall be lowered to its pre-determined position in the prepared recess, levelled and finally aligned before the anchor loops on one side of the joint are welded, in accordance with the Specification, to the exposed reinforcement bars of the structure. Upon completion, the same procedure shall be followed for the other side of the joint. When the expansion joint is finally held in position on both sides, the temporary auxiliary brackets shall immediately be released and removed.

The recess shall then be filled with low shrinkage concrete of the same strength as that of the contiguous superstructure element and in compliance with Section 1300 of this Specification. During the placing and hardening of concrete under expansion joint components, relative movement shall be prevented between them and the supports to which they are being fixed. In particular where strong backs or templates are used to locate the two sides or a joint, they shall not be fixed simultaneously to both sides. Screw threads shall be kept clean and free from rust.

Polychloroprene strip seal shall be cut to length by the Contractor and carefully inserted into the grooves of the steel edge beams without damaging the strip seal. After the concrete has sufficiently hardened, sturdy ramps shall be provided and maintained to protect all expansion joints from vehicular loading. Vehicles shall cross the joints only by means of such ramps until the Engineer permits their removal after the carriageway surfacing is placed.

Carriageway surfacing shall be finished flush with the top of the steel edge beams. The interface between the surfacing and the steel edge beam shall be a wedge-shaped seal of approved sealing compound. The external surface of the exposed steel edge beam shall be thoroughly cleaned before sealing.

(e) Acceptance testing

The acceptance testing of polychloroprene shall be carried out and certified by an approved laboratory in accordance with the requirements stipulated in Tables 18.2.3.1A and 18.2.3.1B of Division II of AASHTO Standard Specifications for Highway Bridges. The Contractor shall submit test certificates to the Engineer for verification.

The manufacturer shall provide certificates from laboratories or authorities approved by the Engineer that confirm compliance with the following criteria:

- the fatigue strength of steel edge beams and anchorages is sufficient to withstand a minimum of 2×10^6 load change cycles without discernible damage,
- the joint is watertight under a water pressure of 4 bars,
- the proprietary joint has performed satisfactorily in conditions similar to those that may be anticipated to prevail at the Site of the Works.

1423 FILLER-TYPE EXPANSION JOINTS

This type of joint shall be constructed from the following materials:

- profiled copper strip of minimum thickness 2 mm,
- 20 mm thick compressible bitumen-impregnated fibre board or other approved expansion joint filler,
- 20 mm thick approved pre-moulded joint filler, and,
- approved joint sealing compound.

Pre-moulded joint fillers shall conform to one of the following specifications:

- (a) AASHTO M33 Prefomed Expansion Joint Filler for Concrete,
- (b) AASHTO M153 Prefomed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction,

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(c) AASHTO M213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

Compressible bitumen-impregnated fibre board or other approved expansion joint filler shall be cut to shape from full size sheets of material. The use of small off-cuts to fill the joint shall not be allowed.

Expansion joint materials shall be handled with care by the Contractor and stored off the ground in storage sheds or containers to prevent damage.

Joint gaps shall be constructed to the dimensions shown on the Drawings. Surfaces of joint gaps shall be thoroughly cleaned to remove all loose materials, dirt and debris, then washed or jetted out.

No joint shall be sealed without inspection and prior approval by the Engineer. Pre-moulded expansion joint filler shall only be positioned immediately prior to the placing of the contiguous material. If opposite surfaces of the same joint are to be placed at different times, joint filler shall not be positioned until the material forming the second face is about to be placed. Sealants and joint primers shall be applied in accordance with their manufacturer's recommendations. A 100 mm wide by 10 mm deep recess shall be formed in the asphaltic concrete wearing course above the centerline of filler-type expansion joints. This recess shall be filled with a compacted coarse sand and bitumen mix containing 6 % bitumen.

All traces of joint materials spilt or splashed on to finished bridge surfaces shall be removed and the surfaces made good to the Engineer's approval.

BRIDGE ACCESSORIES

1424 GENERAL

Bridge railings shall include that part of the structure erected on and above the footpath for the protection of pedestrians and traffic.

Railings shall not be constructed until falsework has been removed and the element is self-supporting. Concrete shall be complied with the requirements of Section 1300 of this Specification.

Railings shall be constructed in accordance with the details and dimensions shown on the Drawings and erected true to line and level. In particular, the Contractor shall ensure that expansion joints in the railings are constructed correctly. Posts shall be vertical within a tolerance of 2 mm in 1 metre. Railing materials shall be handled and stored above ground on platforms or skids such that they are kept free from damage or contamination by grease or dirt.

1425 CAST-IN-PLACE CONCRETE RAILINGS

Cast-in-place concrete handrails shall be constructed from concrete Grade B30 using maximum nominal size of aggregate in the mix 10 mm in accordance with the requirements of Section 1300 of this Specification. Forms for cast-in-place concrete railings shall either be of single width boards or shall be lined with suitable material approved by the Engineer. Form joints shall not be situated on plane surfaces.

All mouldings, panel work, bevels and chamfers shall be constructed in accordance with the details shown on the Drawings. All corners in the finished work shall be true, sharp

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and clean-cut and shall be free from cracks, spalls or other defects. Posts shall be cast in a single pour.

1426 PRE-CAST CONCRETE HANDRAILS

Pre-cast concrete handrails shall be constructed from concrete Grade B30 using maximum nominal size of aggregates in the mix 10 mm in accordance with the requirements of Section 1300 of this Specification.

1427 DRAINAGE SPOUTS

This work consists of providing and installing spouts and pipes for bridge deck drainage. Drainage spouts shall be fabricated from mild steel, complying with AASHTO M160, to the dimensions shown on the Drawings. The drainage assembly shall be seam welded for water tightness and then hot dipped galvanized after fabrication to produce a minimum thickness of galvanized coating of 75 μm in accordance with AASHTO M111. Drainage spouts shall be provided at the intervals shown on the Drawings.

Before placing concrete, the galvanized assemblies shall be given two coats of bituminous paint and secured firmly in the positions shown on the Drawings. The gap between drainage spouts and their corresponding cut-outs in the deck slab formwork shall be thoroughly sealed against the leakage of mortar from freshly placed concrete. After the concrete has hardened, any shrinkage cracks in the vicinity of drainage spouts shall be thoroughly sealed with an approved material to the satisfaction of the Engineer. The discharge from drainage spouts shall be kept away from the deck structure by providing extensions to the spouts as necessary.

1428 BRIDGE DECK WATERPROOFING

The contractor shall carry out the waterproofing layer in accordance with a working drawing complying with the Engineer's instruction.

MEASUREMENT AND PAYMENT

1429 MEASUREMENT AND PAYMENT

- (a) Structural Excavation for Bridge Foundation
Unit: m³

The unit of measurement for structural excavation shall be the cubic metre. The volume of excavation shall be calculated as the theoretical void that would be formed if the foundation or structure, including any instructed thickness of blinding concrete, should be lifted vertically out of the ground. No allowance beyond those limits shall be made for working space or overbreak. The calculation of that theoretical void shall be based on the difference between the original ground level as agreed between the Engineer and the Contractor or the formation level, whichever is the lower, and the instructed level of the bottom of the excavation.

The rate for excavate for structures in soft material shall include for the costs of:

- excavation to any depth instructed by the Engineer or shown on the Drawings,
- shaping and trimming of those faces of the excavation that shall have concrete cast against them,
- compaction of the excavated surfaces upon which foundations shall be placed,
- backfilling with the excavated material or selected material,
- removing the excavated material to spoil if it is unsuitable or surplus to requirements, and,

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- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling etc. for realizing the whole of the works in accordance with the Contract.

(b) Selected Granular Backfill Material

Unit: m³

The unit of measurement for selected granular fill materials shall be the cubic metre. The volume of material shall be calculated as the product of the plan area instructed to be backfilled with selected granular fill materials and the average depth of selected granular fill material instructed.

The rate for selected granular fill materials shall include for the costs of:

- providing the material,
- backfilling at any depth,
- all necessary hauls, and,
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling etc. for realizing the whole of the works in accordance with the Contract.

(c) Elastomeric Bearings

Unit: number of each size

Payment for this item will be at the unit price for each elastomer bearing complete installed.

The items for elastomeric bearings shall include for:

- delivery of the original certificates for the elastomeric bearings;
- submission of bearing design calculation for approval;
- provision of data and drawings;
- nuts, bolts, washers, dowels, protective caps, dust covers, wrapping, adhesives and lubricants;
- provision, transport and placing of the bearing pads;
- preparation of the support layer according to the instruction on drawings (the seating layer must be made out of an appropriate epoxy mortar);
- accurate installation of the bearing pads to line and level in accordance with the details shown on drawings.
- complying with the requirements of section 1400 of this Specification and Clause 18.2 of Division II of AASHTO Standard Specifications for Highway Bridges.

(d) Tar Paper Bearings

Unit: m²

The unit for tar paper bearings shall be the square meter. The area of tar bearing shall be calculated from the dimensions shown on the Drawings or instructed by the Engineer.

The rate for tar paper bearings shall include for the costs of:

- materials,
- transportation, handling and storage,
- testing,
- all labour, equipment and incidentals required for the installation of tar paper bearings,
- any protective measures required, and,
- complying with the requirements of Clause 1425 of this Specification.

(e) Expansion/Deformation Joints

Unit: m

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Payment for this item will be at the unit price per linear metre for the installation of filler type expansion joints and shall include for:

- design, provision of data and drawings;
- delivery of the original certificate of the manufacturer for all expansion joint material;
- execution of all work;
- removal of the concrete to limits shown in detail given by the manufacturer without cutting the existing reinforcement bars;
- cleaning and drying of the surface by air blasting;
- provision and installations of the joint system according to manufacturer's instructions;
- apply bonding grout prior to concrete placement;
- adhesives and the like;
- forming, cutting and sealing grooves and edges in surfacings and bridge deck waterproofing;
- protective system;
- measures to protect the joint against damage or displacement;
- drilling or forming holes and pockets and casting in bolts, sockets, base plates and anchorage assemblies;
- preparation and supply of data sheets;
- complying with the requirements of Clause 1427 of this Specification;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(f) Bridge Railings

Unit: m

Payment for reinforced concrete bridge railings will be at the unit price per linear metre for the complete installation of bridge railings. No separate measurement or payment shall be made for the provision of pre-moulded filler or expansion joints for concrete bridge railings.

The item shall include for:

- design, provision of data and drawings;
- approval of guardrails and handrails prior to installation;
- provision of data, drawings and details of reinforcement and fabrications;
- trial mixes;
- making good after sampling and testing;
- excavation of acceptable material;
- excavation of unacceptable material;
- excavation in Hard Material;
- disposal of material;
- dealing with the flow of water;
- concrete;
- formwork;
- reinforcement;
- mixing materials and extruding kerbs;
- bedding, bonding, jointing, including movement joints, filling and sealing of joints;
- keying of surfaces and tack coats;
- surface finishing, curing and protecting;
- gratings, frames, bedding and seatings;
- tie bars;
- drainage holes or pipes through concrete;
- quadrants, dropper kerbs and other special kerb units;
- edge support;
- cutting;

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- drainage layer;
- backfilling and compaction;
- special units and fittings;
- connections to chambers;
- cover, as applicable;
- reinstatement of surfaces;
- provision of all required materials, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(g) Drainage Spouts

Unit: number

Payment for this item will be at the contract unit price per complete installed drainage spout and includes:

- design, provision of data and drawings;
- provision and delivery of all necessary parts of drainage spouts on site,
- correct placing and fixing of drainage spouts;
- check of the correct alignment of the placed deck edge dewatering sheet,
- protective system;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract..

(h) Drainage Pipes

Unit: m

Payment for this item will be at the sum per linear metre for the fixing of new drainage pipes, including pipe supports.

The items for drainage pipes shall include for:

- delivery of the original certificate of the manufacturer for approval;
- provision and delivery of all parts for the drainage system including fixing items;
- placing of drainage pipes and required supports.
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(i) Bridge Deck Waterproofing

Unit: m²

Payment for this item will be at the unit price per square metre of waterproofing area. No deductions shall be made for openings of 1 square metre or less.

The item shall include for:

- preparation, cleaning and drying surfaces, including levelling courses;
- priming including protecting primed surfaces, adhesive coats, undercoats and all intermediate coats;
- laying to cambers and falls;
- forming nibs, angle fillets, drips, chases, external angles, mitres, stops, flashings and the like;
- forming joints and overlaps;
- sealing at edges and around interruptions and projections;
- temporary protection measures and subsequent removal;
- temporary measures to provide for drainage of surface water;
- curved work.
- complying with any special requirements in respect of ambient conditions and for intervals between successive operations and applications;
- masking and other measures to protect adjacent untreated areas;

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- provision and application of the sealing sheets;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(j) Bridge Name Board

Unit: number

Payment for this item will be at the contract unit price per delivered and installed bridge name board and includes:

- provision and delivery of bridge name board;
- correct placing and fixing;
- backboard, fixings, protective caps, sealing, grommets, spacers, mounting plates and strips;
- fixing to structures including attachment systems
- protective system, if required;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

SECTION 1500 - CAST-IN-SITU PILE FOUNDATION

- NOT USED -

SECTION 1600 - ROAD FURNITURE

CHAPTER	CONTENT
1601	MARKER POSTS
1602	GUIDE AND KILOMETER POSTS
1603	GUARDRAIL
1604	CONCRETE CURBS
1605	CONCRETE BARRIER (NEW JERSEY BARRIER)
1606	MEASUREMENT AND PAYMENT

1601 MARKER POSTS

The Contractor shall supply new guide posts, delineators, kilometer posts, and fixings in accordance with this section of the specification.

(a) Rigid Guide Posts

Where shown on the Drawings or directed by the Engineer, the Contractor shall provide and erect guide posts with such dimensions and at such intervals as specified in the standards being currently followed in Mongolia and as shown in the Drawings. The guide posts shall be erected at the outer edge of the shoulder with their tops at a constant height above the edge of the carriageway.

Guide posts shall be erected and painted with two coats of an approved white and red epoxy paint as shown in the Drawings and shall be kept clean until the issue of a Taking-Over Certificate. Damaged guide posts shall be replaced with new posts of same type.

(b) Flexible Guide and Delineator Posts

Retroreflective guide and delineator posts shall be installed in compliance with the Mongolian Design Standard and the Drawings. Flexible guide and delineator posts shall return to upright positions following repeated impacts and passages of vehicles over them. Such collisions shall not cause serious damage to the post or vehicle.

The post shall not be seriously affected by ozone, exhaust fumes, asphalt or road oils, dirt, vegetation, deicing salts or any other types of air contamination or materials likely to be encountered after installation. The post shall withstand without serious damage all elements likely to be encountered after installation including hot (50 C) or cold (-50 C) temperatures, rain, snow, hail, abrasion and physical abuse.

The retro-reflective sheeting is composed of a fungus resistant Type III, Type IV, or Type V retro-reflective sheeting material with a class 1 or 2 adhesive backing conforming to ASTM D 4956.

(c) Kilometers Posts

The contractor shall be installed the kilometer posts in accordance with the details shown on the Drawings. The kilometre guide posts shall be erected at the offset distance from the road centreline indicated on the Drawings or instructed by the Engineer. Kilometre guide posts shall be erected and painted with two coats of an approved white epoxy paint. The distances along the road shall be indicated by means of an approved retroreflective plate fixed to the front face as instructed by the Engineer. Kilometer marker posts and their retroreflective plates shall be kept clean until the issue of a Taking-Over Certificate. Damaged kilometre marker posts and their plates shall be replaced with new ones of same type.

(d) Culvert markings

The Contractor shall mark the chainage, serial number, number of channels and dimension of the culvert by red permanent paints on the front face of outlet headwall 150 mm below the top of headwall near to its vertical axis. Culvert markings shall be

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kept clear until the issue of a Taking-Over Certificate. No separate measurement or payment shall be made for culvert marking.

Construction Requirements

Each post shall be set accurately at the required location and elevation and in such manner as to ensure it is held firmly in place.

1602 PERMANENT ROAD SIGNS

The Contractor shall preform this works as shown on the Drawings. All permanent road signs shall comply with the requirements of MNS 4597:2003 unless instructed otherwise by the Engineer. The Contractor shall obtain road signs from a manufacturer approved by the Engineer and before placing any order for the manufacturer of road signs he shall submit to the Engineer two copies of the following information:

- a) Name of the firm from which the road signs are to be obtained, together with the place of manufacture or fabrication,
- b) a description of the items to be supplied,
- c) the manufacturer's specification together with a description of quality, grade, weight and strength,
- d) manufacturer's test certificates, or recent test results carried out on similar items by an authority or laboratory recognized by the Engineer, a sample sign, post and fittings that shall be stored on Site for the Engineer.

The manufacturer or supplier shall submit to the Engineer, via the Contractor, the following information:

- instructions in respect of the assembly and erection of the signs,
- details of any limitation in location or usage,

The manufacturer shall provide a warranty for his product valid for a 1-year period in such a form as is acceptable to the Engineer. The permanent road signs shall be retroreflective. The retroreflective sheeting shall comply with the requirements of Section 200 of this Specification and shall be applied by mechanical vacuum-heat application method to the approval of the Engineer. The sign plate shall be covered by clear lacquer of a make recommended by the manufacturer of the retroreflective material.

Permanent road signs shall comply with the requirements of BS 873 Parts 2, 6 and 7 in respect of quality including the pre-treatment, preparation and protective coatings for the frame, posts and fittings. Unless directed otherwise posts, frames, fittings and the backs of signs shall be painted with a finish coat of grey. Bolts and nuts shall be spot-welded after erection to prevent theft, and a grey epoxy paint shall be applied to all areas so treated.

The Contractor shall excavate in any material for the foundation of the road signs, provide and place concrete Grade M 20, embedded all round and under the posts and backfill the remaining excavation all as shown on the Drawings or directed by the Engineer. Foundations for signs of areas over 5 m² shall not be covered up until they have been approved by the Engineer.

The Contractor shall cut back trees and vegetation to permit visibility and shall not permit material to be dumped so as to obscure signs. All signs shall be maintained and cleaned as necessary by the Contractor such that they are kept in a clear and legible condition until a Defects Liability Certificate is issued by the Engineer.

1603 GUARDRAILS

Guardrails shall be constructed at the locations indicated on the Drawings or instructed by the Engineer guardrails in accordance with the dimensions and erection details.

I. Beams

Beams for guardrails shall be Class A with a Type 1 finish in accordance with AASHTO M180 and shall be procured from a manufacturer approved by the Engineer.

II. Posts

Posts shall be set plumb in excavated holes or driven if permitted. Driving shall be accomplished without splintering or distorting posts. Postholes shall be backfilled and compacted with specified material placed in layers. When it is necessary to excavate postholes in existing paving, all loose material shall be removed and the pavement replaced.

III. Guardrails terminals

Guardrail terminals shall consist of furnishing and installing an acceptable crashworthy end terminal for the selected beam guardrail at the locations shown in the plans or as directed by the Engineer. The guardrail terminal shall provide an anchor against which the full tensile strength of the rail can be developed for downstream hits while remaining crashworthy for end-on impacts.

Guardrail ends shall be attached to cast in place concrete anchorages, energy absorbing terminals (EAT's) or other terminal types, or transition between rail types at structure approaches as required for guardrail system installation or as directed by the Engineer.

If concrete anchorages are specified, place concrete without forms filling the entire excavation with concrete to the required elevation. Ensure that steel reinforcement and the rail are secured at their locations before placing concrete. Do not apply forces to the rail element embedded in the concrete anchor until after the concrete develops adequate strength.

If anchoring to structures, attach guardrail to the parapets of structures using anchor assemblies cast into the parapets or drill through the parapet. Plug anchor assemblies not receiving beam guard using cap screws with anti-seize compound applied to their threads.

Install EAT's according to manufacturer's instructions as directed by the Engineer. Attach reflective panels to the EAT head with stainless steel self-tapping screws and install EAT markers as directed by the Engineer.

IV. Erection of guardrail

Guardrail shall be erected in accordance with the manufacturer's published instructions and the Drawings or as directed by the Engineer. Approximate locations for guardrail are shown on the Drawings but precise details will be issued to the Contractor by the Engineer as construction proceeds. Generally, in those sections where guardrail is instructed, earthworks and shoulders shall be widened as directed by the Engineer to maintain the full width of shoulder from the edge of carriageway to the inside face of the guardrail. The Contractor shall excavate for the posts in any material and provide the guardrail with all posts, blocks, nuts, washers and shall repair galvanizing, backfill around the posts and remove surplus

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material to spoil. When erection is complete and the section has been approved by the Engineer the nuts shall be spot welded to the guardrail or to the bolt to stop their removal. Galvanized coating damaged by spot welding or cutting shall be renovated either by the use of low melting point zinc alloy repair rods or powders made specifically for this purpose, or by the use of at least two coats of good quality inorganic zinc-rich primer complying with the requirements of AASHTO M300.

V. Tolerances

Guardrail shall be erected at the instructed or detailed offsets and levels from the pavement centreline and shall be correct within a tolerance of + 20 mm in line and level. Adjacent plates shall not vary in line or grade by more than 5 mm measured from a line extended from one plate to the end of the adjacent plate.

1604 CONCRETE CURBS

(1) Installing the curbs

Concrete curbs shall be placed down the roadway alignment at offsets and locations shown on the Drawings.

(2) Tolerances

The gap between the curbs shall not exceed ± 2 mm than specified on the Drawings. Adjacent installed two curbs, their facing surface and elevations shall not differ by more than 1 mm.

1605 CONCRETE BARRIER (NEW JERSEY BARRIER)

Concrete barrier shall be precast or cast- in-place. Cast-in-place barrier shall be constructed with forms or by a slip-form machine.

Concrete Quality shall conform to Section 1300 of this Specification. Concrete grade of the barrier shall be B30. The strength level of the concrete shall be considered satisfactory if the compressive strength test result after 28 days equals or exceeds 30 MPa.

The surfaces of barriers shall vary no more than 6mm in 3m as measured from a straightedge in a longitudinal direction. A tolerance of 6 mm in vertical and horizontal alignment is permitted between adjoining units measured from a 3 meter straightedge in a longitudinal direction across the joint. Approved supports, bedding, or grout shall be used to obtain proper alignment.

Linkage for connecting precast barriers shall be cast with the concrete section and be of adequate strength so the entire barrier functions as a unit.

1606 MEASUREMENT AND PAYMENT

(a) Flexible Guideposts

Unit: number

The measurement shall be the complete installation.

The items for signal and kilometer posts shall include for:

- provision of materials;
- reflectorised strips or discs including adhesive;
- driving or excavating in any material;
- backfilling and compaction;
- sockets;

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- galvanized fixings and fittings;
- disposal of material;
- reinstatement of surfaces;
- Complying with the requirements of Clause 1601 of this Specification;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(b) Kilometer posts

Unit: number

The measurement shall be the complete installation.

The items for signal and kilometer posts shall include for:

- provision of materials;
- protective system;
- numerals, symbols and reflectorised strips or discs including adhesive;
- driving or excavating in any material;
- backfilling and compaction;
- sockets;
- galvanized fixings and fittings;
- disposal of material;
- in-situ concrete;
- formwork;
- reinstatement of surfaces;
- Complying with the requirements of Clause 1601 of this Specification;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(c) Permanent road signs

(i) Warning signs

Unit: number

(ii) Item: Regulatory, prohibitory, and mandatory signs

Unit: number

(iii) Item: Standard informative signs

Unit: number

(iv) Direction signs

Unit: m²

The measurement of warning, regulatory, prohibitory, mandatory and standard informative signs shall be the complete installation.

Direction signs will be measured by the area of each sign shown on the drawings or instructed by the Engineer.

The items for permanent traffic signs shall include for:

- excavation of acceptable material;
- excavation of unacceptable material;
- excavation in hard material;
- backfilling and compaction;
- in situ concrete;
- formwork;
- provision of data and drawings;
- provision of materials, fabrication;

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- loading, transporting from store, unloading and positioning,
- reinstatement of surfaces;
- covering and removal of covering of signs;
- disposal of material;
- location lettering and marking;
- bedding and grouting;
- protective system;
- rivets, bolts, nuts and the like;
- backboard, fixings, protective caps, sealing, grommets, spacers, mounting plates and strips;
- protective treatment;
- notices and recording;
- preparation and supply of record drawings;
- fixing to structures and foundations including attachment systems.

(d) Guardrail

Unit: m

The measurement of guardrails shall be the developed length along the centre line for the containment performance class between the end of each safety guardrail. The measurement shall be the complete installation.

The items for safety guardrail shall include for:

- provision of data and drawings;
- re-submissions and modifications;
- amendments to the Works;
- obtaining approvals;
- provision of materials;
- everything necessary for the design, fabrication, installation and testing of the Works, including all rail components, fittings, and fixtures, connecting to vehicular guardrails on bridges, terminal sections, and temporary supports to ensure correct line and level;
- driving or excavation in any material to any depth, including loading into transport, upholding the sides and keeping the excavation free of water;
- placement;
- supply and compaction of selected backfill;
- disposal of surplus material;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

(e) Concrete curbs and barriers

Unit: m per curb and barrier type

The measurement of curb stones and barriers shall be the lengths required by the Contract. No deduction shall be made for gaps of 1 linear metre or less.

The items for concrete curbs and barriers shall include for:

- trial mixes;
- making good after sampling and testing;
- excavation of acceptable material;
- excavation of unacceptable material;
- excavation in Hard Material;
- disposal of material;
- concrete;
- formwork;

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- reinforcement;
- mixing materials and extruding curbs;
- bedding, bonding, jointing, including movement joints, filling and sealing of joints;
- keying of surfaces and tack coats;
- surface finishing, curing and protecting;
- bedding and seatings;
- tie bars;
- drainage holes or pipes through concrete;
- quadrants, dropper curbs and other special curb units;
- edge support;
- cutting;
- drainage layer;
- backfilling and compaction;
- special units and fittings;
- in the case of combined drainage and curb blocks and linear drainage channel systems -design, certificates, provision of data and drawings, resubmissions, modifications and amendments to the Works.

(f) Bridge name plate

Unit: number

The measurement of bridge name plates shall be the complete installation.

The items for bridge name plate shall include for:

- provision of materials, fabrication;
- loading, transporting from store, unloading and positioning,
- reinstatement of surfaces;
- protective system;
- rivets, bolts, nuts and the like;
- protective treatment;
- notices and recording;
- preparation and supply of record drawings;
- fixing to structures including attachment systems.

SECTION 1700 - ROAD TRAFFIC MARKINGS

CHAPTER	CONTENT
1701	GENERAL
1702	EQUIPMENT
1703	SURFACE PREPARATION
1704	SETTING OUT OF ROAD TRAFFIC MARKING /RED/
1705	ENVIRONMENTAL LIMITATIONS
1706	EXECUTION OF ROAD TRAFFIC MARKINGS
1707	APPLICATION OF GLASS BEADS
1708	TOLERANCES
1709	PROTECTION FROM TRAFFIC
1710	FAULTY WORKMANSHIP OR MATERIALS
1711	AUDIO TACTILE LINE MARKINGS
1712	MEASUREMENT AND PAYMENT

1701 GENERAL

All road markings shall comply with the requirements of MNS 4759:2003 unless instructed otherwise by the Engineer. The dimensions and configurations of road traffic markings shall be as shown on the Drawings or as directed by the Engineer. The locations of each type of road marking shall be instructed by the Engineer. The colour for road marking shall be bright white and in some places yellow.

Reflectorized thermoplastic pavement striping material shall comply with the requirements of AASHTO M249.

Glass beads used in traffic paints shall comply with the requirements of AASHTO M247.

1702 EQUIPMENT

Equipment shall comprise :

- mechanical broom for cleaning the road surface,
- mechanized road marking apparatus with integral mechanized glass bead sprayer.
- Road marking and the surface application of glass beads shall only be carried out by mechanical means.
- Road marking machines shall have the capability of marking at a uniform rate of application and thickness. They shall have the capability to mark lines of a uniform width within the tolerances specified with sharp edges and without running, feathering or splashing.
- Road marking machines shall have the capability of being adjusted to mark lines of different widths and shall have a minimum operating velocity of 5 km/h.
- Hot thermoplastic material shall be mechanically extruded to produce a line thickness of 3.2-4.8 mm.
- Letters, figures and symbols shall be marked on the road by means of stencils.

1703 SURFACE PREPARATION

Traffic markings shall be applied to bituminous surfaces only after sufficient time has elapsed to allow for the evaporation of volatile substances from the bitumen.

The surfaces to be marked shall be thoroughly cleaned by means of watering, brooming or compressed air as required. Before road marking commences, the road surface shall be clean and dry and completely free from soil, dust, grease, petroleum products or other deleterious material.

1704 SETTING OUT OF ROAD TRAFFIC MARKING

The letters, figures, symbols and lines shall be set out by means of paint spots, 10 mm in diameter, of the same colour as that of the intended traffic marking. Paint spots shall be at such frequencies as will ensure that road traffic markings are accomplished accurately and in no case at an interval greater than 1.5 m. The positions of the start and finish of different line types shall be indicated on the road. The positions and outlines of other markings shall be marked in chalk on the road surface. The setting out of road traffic markings shall be subject to inspection and approval by the Engineer prior to the commencement of road marking activities.

1705 ENVIRONMENTAL LIMITATIONS

The Contractor shall suspend road marking activities if:

- the road surface is damp,
- the relative humidity exceeds 80%,
- ambient temperatures are less than 10 °C,
- wind velocities are such that, in the opinion of the Engineer, road marking activities are likely to be adversely affected.

1706 EXECUTION OF ROAD TRAFFIC MARKINGS

Thermoplastic material shall be applied as letters, figures, symbols, broken and unbroken lines as shown on the Drawings or instructed by the Engineer.

Thermoplastic material shall be applied to the molten state by mechanical means with surface application of glass bead in a single layer. Before road marking machines are used to mark the Permanent Works, the Contractor shall carry out Site trials to demonstrate, to the satisfaction of the Engineer, on a suitable site which does not form part of the Permanent Works, that such machines are capable of performing in compliance with this Specification. If any adjustments should be required, the Contractor shall carry out such further Site trials and adjustments as shall prove necessary until machines are correctly adjusted and approved Site trials have been conducted.

After Site trials have been conducted, only approved machines, operated by personnel experienced in their use shall be utilized to mark the Permanent Works.

Rates of application of road marking materials shall be checked and adjusted if necessary on a daily basis.

Thermoplastic material shall be stored and prepared in accordance with the manufacturer's instructions.

The rate of application of road marking paint shall be sufficient to give continuous coverage and a minimum thickness of 3.2 mm over the whole area to be painted. This rate of application will vary according to the surface texture of the road and shall be determined by the Engineer during Site trials.

1707 APPLICATION OF GLASS BEADS

The Contractor shall apply glass beads to road markings by means of spraying device, forming an integral part of the road marking machine, immediately after the application of the road marking material and in one continuous operation. Machines that apply beads by means of gravity only shall not be used.

The rate of application of glass beads to thermoplastic material shall be 0.35 kg/m² or such other rate as may be instructed by the Engineer.

1708 TOLERANCES

Road traffic markings shall be performed to an accuracy within the following tolerances

(a) Width

The width of lines and other markings shall not deviate from the specified width by more than 5%.

(b) Position

The position of letters, figures, symbols or lines shall not deviate from that shown on the Drawings or as directed by the Engineer by more than 20 mm in any direction.

(c) Alignment

The alignment of any edge of a line parallel to the road centreline shall not deviate from that shown on the Drawings or as directed by the Engineer by more than 10 mm in 15 m.

(d) Broken lines

The length of segments of any broken line parallel to the road centreline shall not deviate from that shown on the Drawings or as directed by the Engineer by more than 150 mm.

(e) Lines on horizontal curves

Both broken and unbroken lines on horizontal curves shall not be marked as chords but shall follow the correct arc not deviating from it by more than 20 mm.

1709 PROTECTION FROM TRAFFIC

After the application of road marking materials, road traffic markings shall be protected against damage by traffic until reflective thermoplastic material has sufficiently hardened. The Contractor shall provide, erect and remove all such warning signs, barriers, cones, boards or other protective measures as may be required.

1710 FAULTY WORKMANSHIP OR MATERIALS

Rejected road traffic markings and any marking material that has been deposited on the road surface, structures, signs or other surfaces shall be removed by the Contractor at his own expense and in such a way that they will not be revealed in the future.

1711 AUDIO TACTILE LINE MARKINGS (ATLM)

The requirements for Audio Tactile Line Markings (ATLM) complement the specifications provided in Clauses 1701 - 1711. In case of ambiguity, the provision of this clause prevail over those in Clauses 1701 - 1711.

Definition

Audio Tactile Line Marking (ATLM) is the combination of linemarking and raised profile thermoplastic ribs to provide greater lane delineation and a sensory indicator (both tactile and auditory indicators) of lane departure (crossing edge line or crossing centre line). Audio Tactile Line Marking is also referred to as raised profile edge line or centre line, tactile edge lines or tactile centre lines, rumble strips or audio tactile profiled (ATP) road markings.

Site Preparation

The area to be marked must be dry and free of dirt, gravel, flaking pavement marking material and other loose or foreign material. The area around the marking must also be free of dirt, gravel and other loose or foreign material so that tracking of such material on to the new marking is avoided.

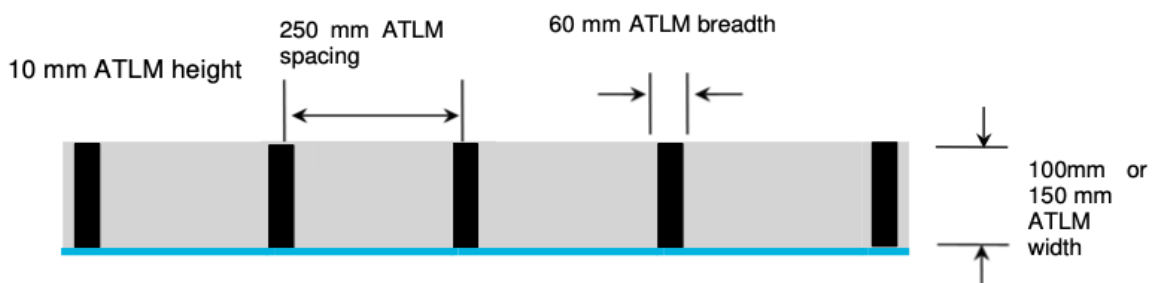
Where removal of unsuitable pavement marking is required, the removal must be undertaken so as to not adversely affect the skid resistance, texture depth, susceptibility to ponding and appearance of the road surface. The Contractor must obtain approval of the proposed removal method prior to undertaking the removal. Any materials produced by removal activity must be immediately collected and removed from site and disposed of in an environmentally acceptable manner.

Spotting Alignment

The Contractor must complete any spotting that may be required for the installation of the ATLM. If the edge line is missing the spotting must be completed to match the correct lane widths for that section of road.

Pattern and Dimensions

Unless specified otherwise or instruction by the Engineer, the pattern must conform to the following dimensions:



Application of Glass Beads

Glass beads must be sprinkled or sprayed on to the thermoplastic pavement marking material while it is in a fluid state immediately after it has been applied to the pavement. The surface beads must be distributed to give a uniform coverage over the whole surface of the plastic material.

The Contractor must ensure that glass beads adhere to the surface of the ATLM to achieve the retroreflectivity requirements.

Tolerances

Unless otherwise specified, the ATLM must be installed within the tolerances specified below:

ATLM width	+20 mm, -5 mm
ATLM height	+2 mm, -0 mm
ATLM spacing (in longitudinal direction)	± 50 mm

The apparent line of the markings must be smooth and continuous when viewed in the direction of the line.

Protection of Work

The Contractor is responsible for protecting the work by an appropriate means until the work can be trafficked without being picked up and / or spread by tyres of passing traffic. If pick-up does occur, the Contractor must remove the spread thermoplastic material.

Alternative Specifications

Alternatively, the Contractor may propose an equivalent, internationally acceptable standard to the Engineer for approval. The proposal must include the relevant extract from the standard as well as the manufacturer's specifications and quality certifications for the proposed product.

1712 MEASUREMENT AND PAYMENT

(a) Reflective hot applied thermoplastic road marking

- i. Item: Road marking by type
Unit: m
- ii. Item: Road marking (symbols, letters, figures)
Unit: m²

The unit of measurement for marking lines parallel to the road centreline shall be the meter of each specified width of line. No deduction will be made for gaps in broken lines. The unit of measurement for lettering, figures and symbols shall be the square metre.

Double lines shall be measured as two single lines. Diagonal lines between double lines and short transverse lines at the ends of any longitudinal lines shall be measured with the lines of which they form part.

Ancillary lines shall include lines forming hatched areas, chevrons, zigzag lines, boxed areas and lines enclosing boxed areas. In the case of hatched areas and chevrons the enclosing lines shall be measured as the longitudinal line of which they form part. The measurement of zigzag lines shall include any transverse or longitudinal lines at their ends.

The marking of solid areas shall only be measured for the solid infilling between converging lines; the enclosing lines themselves shall be measured as lines.

The measurement of circles with enclosing arrows (mini roundabouts) shall be for the complete marking, the external diameter of the circle being stated.

Distinction shall be made for all other arrows between straight, curved, turning or double headed.

Each letter or numeral shall be separately measured with all letters or numerals grouped together according to height.

Symbols shall be measured separately and grouped together according to size.

The items for road markings shall include for:

- provision of reference marking for identification and delivery of the thermoplastic material and glass beads manufactured and tested and/or certified
- provisions of materials;

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- cleaning, brushing and drying surfaces;
- application of the marking materials including the incorporation of specified reflecting medium;
- thinners, primers and tack coats;
- apostrophes in the case of letters and numerals;
- markings down the face of kerbs;
- adhesives;
- provision of all required material, labour, equipment, supervision, storage, delivery, handling, double handling for fixing, erecting, placing and installation in position etc. for realizing the whole of the works in accordance with the Contract.

SECTION 1800 – ADDITIONAL WORKS

CHAPTER	CONTENT
1801	CHAPTER CONTENT
1802	TREE PLANTING
1803	EARTH DAM FOR DIVERTING FLOOD WATER
1804	MEASUREMENT AND PAYMENT

1801 CHAPTER CONTENTS

This chapter covers additional works not covered in other sections of this specification.

1802 TREE PLANTING

Potential tree planting locations and species are indicated in the Environmental Impact Assessment (EIA) Report which is part of the Bidding Documents. Details will be finalised in coordination with the local government and communities.

All Planting Works shall be carried out in accordance with BS 4043, BS 4428 and BS 5837.

On completion of planting operations, all disturbed accesses to, and ground around the planted areas shall be completely reinstated to their former condition as at the commencement of planting.

All wrappings, insulation and padding shall be removed from root balls immediately before backfilling. No wire or plastic mesh containers may be left in position. Any damaged or torn roots shall be cut back cleanly to sound wood prior to planting.

Stakes for all standards and feathered trees shall be firmly driven and positioned into the tree planting pit. The stake shall be positioned off centre on the prevailing windward side of the tree as near to the tree as possible but shall not interfere with the free movement of the branches and shall cause no rubbing.

The Contractor shall use the shortest possible stake to support the tree; when the stake has been driven into the ground there shall be not more than one third of the height of the clear stem of the tree above ground.

For bare root trees, each tree shall be planted upright in the centre of the hole and the root system fully spread outwards and downwards in the pit, at the correct level so that the stake passes through the root system as closely to the trunk as possible, with minimal disturbance to the roots themselves. Once the tree has been correctly positioned the pit shall be backfilled with the pre-mixed soil/compost mixture.

During backfilling, the tree shall be gently shaken at regular intervals to settle the mixture closely around the roots. The backfill mixture shall be firmed in layers not exceeding 150 mm to a finished level equivalent to the nursery soil mark on the tree.

Each tree shall be watered in on the same day as planting. The water shall be delivered by means of a low-pressure hose to avoid any washing out of the soil, into a depression made in the planting medium around the base of the stem to ensure that the water goes to the root system. The planting medium shall then be returned to its previous level.

Responsibility for ongoing watering and maintenance shall be as agreed with the local government and community.

1803 EARTH DAM FOR DIVERTING FLOOD WATER

The works for the earth dam shall be executed generally in accordance with the drawings and this Specification or as the Engineer may direct. The Engineer reserves

the right to modify, during the progress of the Works, any other features as he may consider necessary for the proper performance of the Works.

The contractor shall be allowed to utilize suitable material obtained from excavation.

Dam embankments shall be constructed in accordance with the requirements of Section 500 Earthworks. Selected material shall be used that is resistant to erosion by running water and percolation of water through the embankment.

1804 MEASUREMENT AND PAYMENT

(a) Tree Planting

Unit: provisional sum

The items for tree planting shall include for:

- notices, inspections, provenance and reporting;
- transportation, packing and unpacking;
- plants;
- storage, handling and distribution;
- making arrangements for selection;
- treatment of nursery stock;
- protection;
- stakes, labelling, ties, strapping, spacers, anchors, timber frames, root barriers, cables and the like;
- marker posts;
- tubes, guards and ties;
- excavation, breaking up subsoil, backfilling, compaction and firming;
- topsoil;
- reinstatement;
- multiple handling;
- compost, fertiliser and mixing;
- cultivation;
- sprays, dips and additives;
- drainage layers;
- ameliorants;
- root spreading and other measures;
- measures to avoid root disturbance of adjacent plants;
- support;
- pruning roots;
- planting through turf and mulch mats;
- disposal of material;
- anchors;
- measures for planting in or adjacent to water areas;
- protective posts;
- additional ground preparation for wildflower planting;
- establishment maintenance of new planting;
- marking out and awaiting approval;
- anti-desiccant measures;
- notch planting;
- watering including water supply;
- weed control;
- pruning shrubs and climbers;
- scrub control;

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- hedge cutting, hedge laying;
- maintenance of trees.

(b) Earth dam

Unit: m³

The measurement shall be the volume of compacted fill.

The item shall include for:

- clearing of topsoil
- providing material and compacting
- trimming and shaping to levels and contours;

APPENDIX 1

SUMMARY OF QUANTITIES for FACILITIES FOR THE ENGINEER

Summary of Facilities for the Engineer (for details refer to Specification section 100 and Appendices 2 – 4)

№	Item	Contract CW2	Ownership
1	Site laboratory	150m2	Contractor
2	Furniture and equipment for laboratory (Appendix 2)	1 set	Contractor
3	Main office	150m2	Contractor
4	Furniture for office (Appendix 3)	1 set	Contractor
5	Accommodation	5 No.	Contractor
6	Furniture for accommodation (Appendix 4)	5 sets	Contractor
7	Vehicles	Type 1 - 1 No. Type 3 – 3 No. Type 4 – 1 No.	Employer
8	Survey equipment (Appendix 2)	1 set	Contractor
9	Safety clothing (Appendix 2)	10 sets	Employer
10	Radio system (Appendix 2)	1 system	Contractor
11	Specifications and standards (Appendix 2)	1 set	Contractor

APPENDIX 2

FIELD LABORATORY FURNITURE AND EQUIPMENT & SURVEY EQUIPMENT FOR THE ENGINEER & SAFETY CLOTHING & RADIO SYSTEM & SPECIFICATIONS AND STANDARDS

Furniture and Equipment for the Field Laboratory

(A) The Contractor shall provide and deliver to the Field laboratory the following new office furniture with the approval of the Engineer:

- | | | |
|-----|---------|--|
| (1) | 4 nos. | 4 drawer lockable steel filing cabinet, |
| (2) | 2 nos. | 6 drawer office desk and accompanying padded high-backed office chair with arms, |
| (3) | 4 nos. | 2 door lockable steel office cupboard with shelves, |
| (4) | 6 nos. | dust bin, |
| (5) | 10 nos. | office chairs, |
| (6) | 5 nos. | laboratory stools, |
| (7) | 4 nos. | wastepaper baskets, |
| (8) | 4 nos. | office table 1.8 m x 0.9 m. |

(B) The Contractor shall supply and maintain the following new laboratory equipment and apparatus for the use of the Engineer:

Sr. No.	Description	Quantity
<i>A - General Laboratory Equipment</i>		
(i)	Balance	
	(a) 12 kg portable electronic / rechargeable battery operated balance (with site carrying box).	3 No.
	(b) Top Pan electric balance 20 kg x 1 g accuracy	2 No.
	(c) Electronic, digital balance 2.2 kg capacity, accuracy equal to or better than 0.1 gm.	2 No.
	(d) Platform scale - 100 kg capacity x 10 g accuracy	1 No.
	(e) Pan Balance 5 kg capacity - accuracy 0.5 gm	2 No.
	(f) Electric Analytical balance 210 g x 0.1 mg for bitumen testing	1 No.
(ii)	Ovens electrically operated, thermostatically controlled	
	(a) Range up to 220°C with sensitivity accurate to or better than 0.1°C, 720 litre capacity	1 No.

Sr. No.	Description	Quantity
	(b) Range up to 220°C with sensitivity accurate to or better than 0.1°C, 220 litre capacity	3 No.
	(c) Range up to 220°C with sensitivity accurate to or better than 0.1°C, 100 litre capacity	2 No.
(iii)	Sieves:	
	(a) AASHTO/BS 812 Sieve sets 300 mm dia (Sieve sizes 75, 63, 53, 45, 40, 37.5, 31.5, 26.5, 25, 22.4, 19, 16, 13.2, 12.5, 11.2, 9.5, 8.00, 6.7, 4.75, 2.36, 1.7, 1.00, 0.300, 0.150 and 0.075 mm) complete with lid and pan.	2 sets
	(b) AASHTO/BS 812 Sieve sets 200 mm dia (Sieve sizes 10, 5.6, 4.75, 3.35, 2.8, 2.36, 2.0, 1.70, 1.18, 0.600, 0.500, 0.425, 0.300, 0.250, 0.150, 0.125, 0.09, 0.075 mm per set) complete with lid and pan.	3 sets
(iv)	Sieve shaker, electrically operated with time switch assembly.	
	(a) 200 mm dia sieves	1 No.
	(b) 300 mm dia sieves	1 No.
(v)	Compression, flexural and tensile universal testing machine of 1500 kN capacity with additional dial for flexural strength test and all other necessary accessories for concrete specimens up 160 mm x 300 mm diameter.	1 No.
(vi)	Electronic digital stop watches 1/5 sec accuracy.	3 No.
(vii)	Electronic programmable scientific calculator	10 No.
(viii)	Glassware comprising beakers, pipettes, dishes, measuring cylinders (100, 250, 500 & 1000 cc capacity) glass rods and funnels, glass thermometers range (0°C to 100°C) and mercury thermometers range up to 300°C.	6 of each
(ix)	Hot plates 200 mm dia (1500 watt.)	2 No.
(x)	Gas stove with LPG Cylinder	1 No.
(xi)	Enamel trays	
	(a) 600 mm x 450 mm x 50 mm	20 No.
	(b) 450 mm x 300 mm x 40 mm	20 No.
	(c) 300 mm x 250 mm x 40 mm	20 No.
	(d) Circular plates 250 mm dia.	20 No.
(xii)	Riffle Box – big size	2 No.
(xiii)	Riffle Box - small size	2 No.
(xiv)	Sufficient number of scoops, hand gloves steel measuring scales, tongs, ladle spoons, stirrers, aprons etc .	6 each
	B - For Soils	
(i)	AASHTO T 89 , Atterberg's Limits determination apparatus as per AASHTO/BS 1377 including liquid limit apparatus and grooving tools.	2 set
(ii)	Sampling pipettes fitted with pressure and suction inlets, 10 ml. Capacity	1 set

Sr. No.	Description	Quantity
(iii)	Compaction apparatus for Heavy Compaction as per AASHTO T 134 complete with 100 mm mould, 150 mm mould, mould collars and base plates and rammer. Also miscellaneous tools as per test method (4 sets)	2 set
(iv)	Compaction apparatus for Heavy Compaction as per AASHTO T 134 complete with 100 mm mould, 150 mm mould, mould collars and base plates and rammer, Automatic, motor driven.	1 set
(v)	Dry Bulk Density apparatus including sand pouring cylinder with conical funnel and tap and accessories complete as per AASHTO T 191 including modified equipment and 150 mm sand calibration mould.(1 calibration mould) 2 sets for 101.6 mm diameter hole and 2 sets 165.1 diameter holes.	4 set
(vi)	Sampling containers with lids, capacity 2 kg and miscellaneous items like moisture containers with lid of capacity 50 grams etc.	24 No. each
(vii)	Lab. CBR testing equipment for conducting CBR test, including load frame with 50 kN capacity, electrically operated with speed control, all as per AASHTO T 180 complete with accessories,	1 set
	(a) CBR moulds 150 mm dia – 175 mm ht. complete with collar, base plate, etc.	12 No.
	(b) Tripod stands for holding dial gauge holder.	12 No.
	(c) CBR plunger with settlement dial gauge holder.	1 No.
	(d) Surcharge weight 147 mm diameter 2.5 kg wt. with central hole	24 No.
	(e) Spacer disc 148 mm diameter, 47.7 mm ht. with handle	2 No.
	(f) Perforated plate (Brass)	12 No.
	(g) Soaking tank for accommodating 24 CBR moulds	1 No.
	(h) Proving rings of 10 kN capacity – calibrated	1 No. each
	(i) Proving rings of 50 kN capacity - calibrated	2 nos.
	(j) Dial gauges, 25 mm travel – 0.01 mm/division	12 No.
(viii)	AASHTO – T 209 – Maximum Theoretical density. Equipment as per test method including Vibro – deaerator, Vacuum Pycnometer, Two Stage Vacuum pump and regulator plus tubing and accessories.	1 set.
(ix)	AASHTO – T 84 Specific gravity bottles for fine grained soils plus mould and tamper and accessories as defined in test method.	2 No.
(x)	Chloride Test kit	1 No.
(xi)	Grain size analysis apparatus of fraction passing 75 micron as per AASHTO/BS 1377	2 No.
(xii)	Unconfined compression test apparatus	1 No.
(xiii)	150 mm diameter Augur with extensions to 5 metres.	1 No.
(xiv)	Standard Penetration Test Equipment (Ref Transport Research laboratory Specification – TRL) include 2 spare tips. Calibrated.	1 No.
(xv)	Mortar and pestle 200mm diameter	2 No.
(xvi)	AASHTO – T 90 – Plastic Limit set as per test method	1 set
(xvii)	BS 1377-2 – Linear Shrinkage Moulds	2 No.

Sr. No.	Description	Quantity
(xviii)	Universal sample extruders	2 No.
(xix)	Nuclear density equipment to AASHTO T191-02	1 No.
C - For Bitumen and Bituminous Mixes		
(i)	Bitumen Heater	1 No.
(ii)	AASHTO T 53 Softening Point Apparatus (Ring and Ball) and accessories as defined in test method.	1 No.
(iii)	Loss on Heating Apparatus AASHTO T 179 plus accessories as defined in test method	1 No.
(iv)	AASHTO T 48 -Flash Point Apparatus (Cleveland open Cup) plus accessories as defined in test method.	1 No.
(v)	AASHTO T 51 - Ductility Apparatus, 3 moulds and base plates and accessories as defined in test method.	1 No.
(vi)	Thin film oven test	1 No.
(vii)	Sampling scoops 450 ml capacity plus stainless steel trays 300 x 220 x 60 and dial thermometers 0°C – 200°C x 1°C.	10 each
(viii)	Heavy duty heat resistant gloves and laboratory coats plus rubber gloves for working with chemicals plus fume resistant breathing masks (box 50)	20 sets each,.
(ix)	Constant temperature high capacity water bath 20 litre for accommodating bitumen test specimens, electrically operated, and thermostatically controlled	1 No.
(x)	AASHTO T 49 Penetrometer automatic type, adjustable weight arrangement, and needles as per AASHTO M 20/BS 2000 plus water bath and other accessories as defined in test method.	1 No.
(xi)	Solvent recovery apparatus 10 litre/hour and fume cupboard	1 No.
(xii)	AASHTO T 164 Centrifuge type apparatus explosive proof of 3000 g capacity and speed controls complete with extraction thimbles, solvent and filter paper. (400 litres of solvent)	1 No.
(xiii)	Laboratory mixer including required accessories about 10 litre capacity, electrically operated, fitted with heating jacket.	1 No.
(xiv)	Marshall apparatus automatically operated as per AASHTO T 245 and complete with electrically operated loading unit, compaction pedestal breaking head assembly, dial micrometer and bracket for flow measurement, stability mould ,load transfer bar, specimen mould 100 mm dia. (4 in.) with base plate, collars, specimen extractor. Apparatus complete with calibrated 30 kN load ring. Apparatus complete with soundproof cabinet	1 set.
(xv)	Automatic Marshall compactor complete with CE protection	1 No.
(xvi)	Standard compaction moulds complete with collar and base plates	6 No.
(xvii)	Manual Marshall compaction assembly including wooden block, assembly and hammer	1 No.
(xviii)	101 mm diameter filter paper and 150 mm diameter filter paper boxes of 1000	4 boxes each
(xix)	Surface contact thermometers 0 – 60°C	4 No.

Sr. No.	Description	Quantity
<i>D - For Cement, Cement Concrete and Materials</i>		
(i)	Water still approx capacity 5 – 10 litre/hour	1 No.
(ii)	Vicat needle apparatus for setting time with plungers, as per AASHTO M 85	1 No.
(iii)	Specific Surface/Fineness Apparatus AASHTO M 85	1 No.
(iv)	Moulds	
	(a) 150 mm diameter x 300 mm ht. cylinder with capping component	36 No.
	(b) 150 mm cube	6 No.
	(c) 70 mm cube	6 No.
	(d) Mould for beam (flexural test)	6 No.
(v)	Concrete permeability test apparatus	1 No.
(vi)	High frequency mortar cube vibrator for cement testing	1 No.
(vii)	Pan type Concrete mixer power driven, 100 litre mixing capacity . capacity with safety guards	1 No.
(viii)	Variable frequency and amplitude vibrating table size 1 metre x 1 metre, as per the relevant British Standard	2 No.
(ix)	Flakiness Index and Elongation test gauges	2 No.
(x)	Aggregate Impact Test apparatus	2 No.
(xi)	Aggregate Crushing Value/10% Fines Mould and Taper (BS 812)	1 set.
(xii)	Los-Angeles Abrasion apparatus C/w soundproof cabinet, 2 x 1.7 mm sieves of 300 mm diameter and 12 steel balls as per AASHTO T 96 plus accessories as per test method	1 set
(xiii)	Sodium and Magnesium Sulphate Soundness test as per AASHTO T 104. 5 kg of Sodium sulphate in 500 g sealed bottles plus soaking tank, sieves etc as per test method.	1 set
(xiv)	Flow table as per AASHTO T 22/T 23	2 No.
(xv)	Equipment for slump test	4 No.
(xvi)	Steel Tensile testing machine 500 kN capacity complete with platens, wedges, holders etc for tensile testing of steel.	4 No.
(xvii)	Ph Meter complete with buffer solutions	1 set
(xviii)	Core cutting machine with 10 cm dia diamond cutting edge, suitable for coring in asphalt pavements, with min. 0.5 m penetration below surface, and for coring in structural concrete. Include 6 spare core barrel. Petrol driven of 6hp minimum. Plus core extractor.	1 No.
(xix)	Needle vibrator	2 No.
(xx)	Vibrating hammer as per BS Specification	1 No.
(xxi)	Air entrainment meter	1 No.
(xxii)	0.5 cu.ft, 1 cu.ft. cylinder for checking bulk density of aggregate with tamping rod	As required
(xxiii)	Soundness testing apparatus for cement	1 set

Sr. No.	Description	Quantity
(xxiv)	Temperature controlled curing tank of suitable capacity	3 No.
(xxv)	Specific Gravity Frame for Concrete / Asphalt. C/w top pan electronic balance 15 kg x 1 gm, Density basket and cradle for frame	2 No.
(xxvi)	Calibration masses C/w box and calibration certificate. 5kg, 2kg x 2, 1 kg, 500 g, 200 g x 2, 100 g, 50 g.	set
(xxvii)	Set class one calibration masses 10g, 5g , 2 g, 1 g, 0.5 g, 0.1 g, 1 mg – 5 mg in box and with calibration certificate	set
(xxviii)	Polythene sacks 500 mm x 900 mm for sampling of material	200 No.
(xxix)	Plastic Containers 5 litre capacity	25 No.
(xxx)	Plastic Containers 15 litre capacity	20 No.
(xxxi)	Concrete Test hammer Calibrated plus calibration anvil	1 set
(xxxii)	Cover meter – Concrete cover meter	1 set
(xxxiii)	Oven for Asphalt binder Content – Ignition method and accessories	1 set
(xxxiv)	Humboldt stiffness gauge	1 No.

In addition, the Contractor shall supply further jute, plastic or 4-ply brown paper sacks for sampling, paint, brushes, turpentine or any other laboratory equipment or materials required for use in the Site laboratories as may be instructed by the Engineer from time to time.

The laboratory equipment shall be of sound engineering design and construction and have the dimensions, characteristics and precision required for the proper sampling procedures and tests intended to be performed. The laboratory equipment shall be from manufacturers of international repute conforming to all applicable international standards indicated in this Specification. The make, model and technical specifications of all proposed laboratory equipment shall be submitted to the Engineer with accompanying manufacturers' literature in accordance with Clause 125 of this Specification. The Contractor shall obtain the Engineer's prior approval before any equipment for the Site laboratories is provided.

The Site laboratories is for the joint use of the Contractor and the Engineer. The laboratory equipment specified herein represents the minimum equipment required for the Engineer to perform sampling and testing in order to meet his obligations in respect of his Quality Assurance system. The Contractor is hereby advised that other supplementary equipment necessary for the performance of his own Project Quality Control Plan in accordance with Clause 109 of this Specification will be required. In particular the Contractor must ascertain for himself, taking into consideration the testing and sampling requirements of the Engineer, the quantities of equipment such as sample moulds and the size of ovens etc. that will be sufficient to meet the demands of the Project Quality Control Plan without causing unnecessary delay to the progress of the Works.

The Contractor shall have on site a sufficient stock of all laboratory consumables, spare parts, formats, filter paper, chemicals, solvents, etc. to allow the testing to be carried out in accordance with the work requirements including at least two months advance stock at all times. Also the following items shall be kept validated/calibrated to the Engineer's approval: The Contractor shall also ensure to supply of paper, print cartridges and photocopy toner, pens, staplers and staples and other minor equipment required for the operation and reporting of laboratory testing. All such items are deemed to be included in the item for Maintenance of Engineer's laboratory in the priced Bill of Quantities and no separate or additional payment shall be made. All supplies shall be of good quality to the satisfaction of the Engineer.

(C) Survey equipment

The Contractor shall provide and maintain the following new survey equipment with the approval of the Engineer:

No.	Quantity	Description
1	1 no.	Sokkia electronic total station power set 2030 with all associated equipment, data logger and spare battery packs or equivalent
2	2 nos.	levels and tripods Sokkia C41 type or equivalent,
3	4 nos.	metric levelling staffs approved by the Engineer,
4	4 nos.	rigid steel straight edge length 3 m,
5	2 nos.	optical squares,
6	4 nos.	100 m steel bands,
7	4 nos.	metric survey chains, and such number of ranging rods, drop arrows, steel tapes, hammers, road nails, spirit levels, field books, level books as the Engineer may require.

The survey equipment for sole use of the Engineer's supervisory staff must be handed over to the Engineer in its entirety not later than 14 days after the Engineer's order to commence the Works pursuant to Sub-Clause 41.1 of the Conditions of Contract.

Any delay to the Contractor's activities owing to the Engineer's inability to perform survey work as a result of the Contractor's failure to supply timely or adequately maintain the survey equipment shall be deemed to have been caused entirely by the Contractor's own actions or inactions and any consequences of such delays shall be so interpreted.

(D) The Contractor shall supply sets of the following items of clothing for the Engineer's supervisory Staff in the quantity as indicated in Appendix 1:

- 1 Safety helmet
- 2 Waterproof clothing,
- 3 Winter clothing suitable for field use for -30°C temperature
- 4 Pair of steel toe capped boots
- 5 Set of protective clothing for Site laboratory staff (glasses, gloves)

(E) Radio Communication System

The Contractor shall supply, install and commission a SSB radio communications system operable anywhere within a minimum radius of 150 km for the sole use of the Engineer's supervisory staff. The system shall comprise vehicle mounted transceivers with vehicle mounted antennae and a base stations with externally fixed inverted "V" aerials and all appurtenant fittings and accessories and any repeater stations necessary to ensure audible clear communication between all permutations of base and mobile units within the specified range. Base stations shall be relocated by the Contractor from time to time at the instruction of the Engineer to suit his requirements in respect of the supervision of the Works. The system shall operate on an exclusive wavelength dedicated to the Engineer and different from any radio communications system employed by the Contractor.

The Contractor shall arrange to obtain all necessary statutory approvals required by and comply with any regulations in force of various governmental agencies for operating the radio communications system. The Contractor shall maintain the system in good working order until the issue of a Defects Liability Certificate, or sooner at the discretion of the Engineer, upon which the system shall be dismantled.

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The radio communications system shall be commissioned approved and handed over to the Engineer no later than 3 months after receipt of the Engineer's notice to commence the Works.

If the Contractor fails to maintain or commission and hand over the system within the stipulated time the Engineer shall be empowered to make alternative arrangements the costs of which shall be reimbursed in full by the Contractor including a 25% addition for administrative overheads.

(F) Specifications and Standards

The Contractor shall provide the number of copies as indicated in Appendix 1 of the following latest editions of publications all to be kept in the Site laboratories. They may be provided in either paper copy or digital versions:

1. ASTM Volume 04,01 - Cement, Lime, Gypsum,
2. ASTM Volume 04,02 - Concrete and Mineral Aggregate,
3. ASTM Volume 04,03 - Road and Paving Materials,
4. ASM Volume 04,04 - Roofing, Waterproofing and Bituminous Materials,
5. ASTM Volume 04,08 - Natural Building Stones, Soils and Rock,
6. ASTM STP 599 - Soil Specimen Preparation for laboratory Testing,
7. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing Part 1A & 1B Specifications,
8. AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing Part 2A & 2B Tests,
9. AASHTO Standard Specifications for Highway Bridges,
10. BS 812 Methods for Sampling and Testing of Mineral Aggregates, Sands and Filters,
11. BS 1882 Methods of Testing Concrete.
12. AASHTO T99, R12-85 Bituminous Mixture Design Using the Marshall and Hveen procedures
13. MS 2 Mix design Methods for Asphalt Concrete and Other Hot Mix Types
14. ASTM D242-85, AASHTO T37-91 Specification for Mineral Filler for Bituminous Paving Mixture
15. ASTM D1664-85 T182-84 Test method for Coating and Stripping of Bitumen-Aggregate Mixtures
16. MNS Series as per Section 200 of this Specification

APPENDIX 3

FURNITURE AND EQUIPMENT FOR THE ENGINEER'S OFFICE

- (A) The Contractor shall provide and deliver to the Engineer's offices the following new office requisites with the approval of the Engineer:

Sr. No.	Quantity	Description
(1)	5 nos.	Notebook computer, 14" display, Inspiron Core I7 1255U, 16GB memory, 512GB SSD, with Window 11 Home, Microsoft Office Home and Business 2021, or equivalent
(2)	1 no.	Colour 3 in 1 Photocopy machine (A3 and A4 Paper with size reducing) including scanner, with sheet feeder and wireless capability
(3)	1 nos.	Fully automatic digital camera, min 8.0 mega pixel, x 10 optical zoom lens, flash, with carrying case and rechargeable battery,
(4)	2 nos.	approved triangular plastic metric scales,
(5)	2 nos.	metal straight edge 1 m long,
(6)	2 nos.	set squares, 2 x 45 degrees, and 2 x 60 degrees,
(7)	2 nos.	adjustable set squares,
(8)	2 nos.	Large protractors 360 degrees,
(9)	1 nos.	Letter punches,
(10)	1 nos.	heavy duty letter punch,
(11)	1 nos.	Stapling machines,
(12)	1 nos.	Heavy duty stapling machine,
(13)	2 nos.	stacking filing trays,
(14)	1 nos.	Spiral binding machine,
(15)	1 nos.	Fully equipped first aid box for 20 persons.
(16)	2 nos.	White board (A0 Size)
(17)	1 nos.	Laser Printer A4
(18)	1 no.	Inkjet colour printer A3
(19)	1 set	Network for computer and printers, incl. internet system/modem

- (B) The Contractor shall provide and deliver to the Engineer's offices within the time stipulated in Clause 126 of this Specification the following new office furniture with the approval of the Engineer:

Sr. No.	Quantity	Description
(1)	5 nos.	6 drawer office desk and accompanying high-backed padded office chair with arms,
(2)	5 nos.	Typist desk and chair,
(3)	5 nos.	Office chairs,
(4)	5 nos.	Office tables 1.8 m x 0.9 m,
(5)	1 set	Conference table and ten chairs,
(6)	2 nos.	4 drawer lockable steel filing cabinet,
(7)	2 nos.	2 door lockable steel office cupboard with shelves,
(8)	1 nos.	Refrigerator capacity 300 litres,
(9)	1 no.	Electric cooker, 4 rings and oven,
(10)	1 no.	Electric kettle, water boiler/water dispenser
(11)	2 no.	Dustbins with covers.
(12)	1 set	Cups, glasses, etc. for 10 people

APPENDIX 4

FURNITURE FOR THE ENGINEER'S ACCOMMODATION

The Contractor shall provide each house/apartment during the duration stipulated in the Contract documents new furniture subject to the approval of the Engineer:

1. 2 no. bedside tables,
2. 2 no. bedside lights,
3. 2 no. arm chairs,
4. 1 no. dressing table with mirror and stool,
5. 1 no. full length mirror,
6. 2 no. chests of drawers,
7. 2 no. double beds with interior sprung mattress,
8. 2 sets linen and bedding each set comprising,
 - 4 no. pillows
 - 1 no. quilt
 - 2 no. blankets
 - 2 no. quilt cover
 - 2 no. fitted sheets
 - 8 no. pillow cases
 - 2 no. bath towels
 - 2 no. hand towels
9. 1 no. desk and cushioned chair,
10. 1 no. sofa and matching chairs to seat 6,
11. 1 no. television, 510 mm screen,
12. 2 no. occasional side tables,
13. 1 no. standard lamp,
14. 1 no. sideboard,
15. 1 no. table lamp,
16. 1 no. dining table,
17. 6 no. cushioned dining chairs,
18. 1 no. bathroom cabinet with mirror,
19. 2 no. towel rails,
20. 2 no. water filters, with 3 candles,
21. 1 no. kitchen table with 4 chairs,
22. 1 no. automatic washing machine,
23. 1 no. electric iron and ironing board,
24. 1 no. electric kettle,
25. 1 no. vacuum cleaner
26. 1 set kitchen equipment comprising:
 - 1 no. dinner service for 6 persons,
 - 1 no. tea service for 6 persons,
 - 1 no. canteen of stainless steel cutlery for 6,
 - 6 no. tumblers,
 - 6 no. water glasses and jug,

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- 6 no. mugs,
 - 1 set of 3 no. enamel saucepans,
 - 1 no. stainless steel frying pan,
 - 1 no. cast iron skillet,
 - 1 set. of 3 no. ovenproof casserole dishes,
 - 1 set kitchen utensils,
 - 1 set steel kitchen knives and sharpening steel,
 - 1 set serving dishes,
 - other kitchen sundries as may be required,
27. 1 no. kitchen waste bin,
28. 1 no. dustbin,
29. 1 no. Fan 24 (GEC/National or equivalent)
30. 1 no. Electric heater

APPENDIX 5

ENVIRONMENTAL MANAGEMENT PLAN

The following tables are based on and revised from the Initial Environmental Evaluation (IEE) dated March 2023 which was submitted by MRTD to ADB and received its no objection and was published on ADB's website. The tables contain mitigation and monitoring actions during the design and construction stages. The Contractor is responsible for undertaking those actions assigned to the Contractor in Tables 1 and 2.

ABBREVIATIONS

ADB	Asian Development Bank
CSC	construction supervision consultant
EIA	environmental impact assessment
EMA	environmental monitoring agency
EMP	environmental management plan
EMoP	environmental monitoring plan
GHG	greenhouse gas emissions
GoM	Government of Mongolia
GRM	grievance redress mechanism
HSMP	health and safety management plan
IA	implementing agency
IEE	initial environmental examination
MET	Ministry of Environment and Tourism
MRTD	Ministry of Road and Transport Development
NP	natural park
NR	nature reserve
PCC	public complaints center
PIU	project implementation unit
PPE	personal protective equipment
Row	right of way
SPA	strictly protected area
SSHSM	site specific health and safety management plan
SSEMP	site specific environmental management plan

Table 1. Environmental management Plan during pre-construction and construction stages

Item	Potential impacts/ issues	Mitigation measures	Implement by
A. Detailed design and pre-construction stage			
Biodiversity	Disruption of Animal Migration Pattern	<ul style="list-style-type: none"> • In order to understand animal migration patterns and to design road crossings, carry out animal monitoring during pre construction and construction stages. Provide equipment (tracking collars) for detailed wildlife monitoring and identification of the locations where wild animals tend to cross the Project road. Monitoring details include: <ul style="list-style-type: none"> ○ Provision of tracking and monitoring equipment to the two environmental departments of the Provinces traversed by the Project road. ○ Training of the experts who will carry out the monitoring exercise. ○ Monitoring during pre construction and construction phase. 	Environmental departments of the Provinces traversed by the Project road in cooperation with the animal research team of the Mongolian Academy of Science and PIU.

Item	Potential impacts/ issues	Mitigation measures	Implement by
		<ul style="list-style-type: none"> ○ Species monitored will be Red Deer and Ibex which are considered indicator species whose migration pattern will correspond to migration patterns of other herbivores and carnivores (snow Leopard; lynx). ○ Ordering a tracking collar takes a minimum of 1 month, and collaring the animals takes about 3 weeks. ○ The animal research team of Mongolian Academy will provide training and support to the environmental departments in close cooperation with NGOs if needed. ○ The findings are to be promptly reported to the PIU so that crossing locations may be informed to the contractor and incorporated into the design. 	
Preparation of bidding documents	Environmental, health and safety duties	<ul style="list-style-type: none"> • Include in civil works bidding documents particular conditions of contract for duties relating to environmental protection, health and safety, and the Contractor duties under the EMP. • Include in civil works bidding documents requirement for contractor to employ a qualified environmental specialist. • Submission of bid documents to ADB for no objection. 	PIU
Detailed design phase	Strengthening the capacity of institutions to implement EMP	<ul style="list-style-type: none"> • Approximately 2 months prior to start of construction: <ul style="list-style-type: none"> ○ MRTD to appoint a full-time Environmental Officer, ○ MRTD to appoint a PIU Environmental Officer; • Organize and conduct training on EMP for relevant organizations. 	MRTD
	Detailed engineering design	<ul style="list-style-type: none"> • Update detailed engineering design including incorporation of animal crossings. • Preferred design option for animal crossings is level crossing (at grade crossing), consisting of earthwork ramps on each side of the road, speed reducing measures (e.g. rumble strips), and signage. 	Contractor
		<ul style="list-style-type: none"> • Oversee updating of detailed engineering design and approve the design. • Undertake public consultation activities. • Obtain PCC and ADB approval of the results of public consultation activities and proposals 	PIU
	Preparation of domestic EIA	<ul style="list-style-type: none"> • Undertake preparation of an EIA and all necessary environmental baseline assessments using a company licensed for such work in Mongolia; 	Contractor
		<ul style="list-style-type: none"> • Oversee preparation of the EIA including i) verification of the licensing status of the proposed firm; ii) review of MET final decisions regarding any conservation conditions or mitigation measures; (iii) Determine whether any amendment to the IEE and EMP is required based on the EIA findings or the updated detailed engineering design. 	PIU
Construction	Environmental monitoring plan	<ul style="list-style-type: none"> • Before starting the construction work, recruit an environmental monitoring organization and conduct 	PIU

Item	Potential impacts/ issues	Mitigation measures	Implement by
preparation		monitoring in accordance with the EMP monitoring plan;	
	Site specific Health and Safety Management Plan (SSHSMP)	<ul style="list-style-type: none"> • Prior to commencing work on the Site the Contractor shall submit to the Engineer for review a detailed SSHSMP showing how the Contractor intends to comply with health and safety requirements prescribed in the Contract. The SSHSMP shall include measures the Contractor proposes to manage the health and safety risks and impacts related to the Works, provide site workers with safe and healthy working conditions and establish an operating system to prevent accidents, injuries, and disease. As a minimum, it shall address requirements in the Environmental Management Plan (EMP) of the project and the following. <ul style="list-style-type: none"> ○ i) providing adequate clean water supplies to construction sites, temporary workers' camps and offices; ii) provision of adequate toilets and other sanitary facilities at construction sites and temporary settlements of construction workers; iii) use trash bins and change them regularly; iv) provide workers with the necessary personal protective equipment (boots, safety helmets, gloves, glasses, ear protection, etc.) in accordance with occupational health and safety regulations. ○ Develop an emergency response plan in discussion with the local Soum administration and the Local Professional Inspection Organization. Local hospital can be contacted by phone in the event of an accident. Provision of essential first aid equipment to each temporary construction site. ○ Create a management system for recording accidents, infectious diseases, and emergency cases that occurred during work. These records are reviewed during compliance reviews and audits. ○ Introduce occupational health and safety issues to everyone on the construction site. ○ Provide all employees with minimum knowledge of sanitation, health, safety and workplace hazards. Provide information about AIDS and other infectious diseases and implementing programs to prevent them with the participation of local residents and construction workers. ○ Implementation of core labor standards in accordance with the construction contract including: (i) encourage employment of local people; (ii) equal opportunities for women and men; (iii) provide equal pay and non-discrimination, and pay women their own wages; (iv) no recruitment or forced labor of children. 	Contractor

Item	Potential impacts/ issues	Mitigation measures	Implement by
		<ul style="list-style-type: none"> ○ Temporary staff quarters are clean, emergency response plans are in place, and staff are 100% knowledgeable about emergency response. ○ COVID-19 prevention and control measures will be taken if required following the Mongolia governments regulations ○ Outreach to local communities to disseminate knowledge about safety at or near the construction sites, installation of site safety fencing and warning signs (in Mongolian language). ○ On site supervision personnel (including night guards), as determined by the risk, to prevent unauthorized access to potentially hazardous construction areas. ○ Signs will be placed in clear view of the public to avoid public access to potentially hazardous locations on the site. 	
	Site specific Environmental Management Plan (SSEMP)	<ul style="list-style-type: none"> ● Prior to commencing work on the Site, the Contractor shall submit to the Engineer for review a detailed Site-Specific Environment Management Plan (SSEMP) which has been specifically prepared for the Works, the Site and other places (if any) where the Contractor intends to execute the Works. ● The SSEMP shall include measures the Contractor proposes to manage the environmental risks and impacts of the Works. As a minimum, it shall be based on the EMP of the project. 	Contractor
	Site planning	<ul style="list-style-type: none"> ● Contractor to propose for the Engineer's review and approval the proposed locations and arrangements of site offices and yards, workers camps, quarries and borrow pits, water sources, access roads, and batching plants, together with the proposed environmental protection arrangements. ● The Contractor shall also obtain location approval from the Soum administration. 	Contractor
	Licenses and permits	<ul style="list-style-type: none"> ● Obtain all required licenses and approvals, including for extraction of rock and soil and abstraction of water, and for establishment of construction yards and batching plants 	Contractor
	EMP training	<ul style="list-style-type: none"> ● Train contractors and construction supervision consultant staff on environmental management and monitoring as outlined in the EMP training plan. 	PIU
	Establish grievance redressal mechanism (GRM)	<ul style="list-style-type: none"> ● Establish and operate a GRM, this task to be undertaken by environmental and social experts from MRTD, PIU, and project managers of Soum administrations. ● Ensure all stakeholders are aware of the GRM and support environmental and social staff as needed; ● Ensure the GRM main contact information (phone number, fax, address, e-mail) is posted on MRTD, PIU 	PIU

Item	Potential impacts/ issues	Mitigation measures	Implement by
		and/or district administration websites and notice boards at construction sites.	
B. Construction Stage			
Topography and soil	Earthworks, soil erosion, soil pollution, soil damage	<ul style="list-style-type: none"> • Construct drains to prevent turbid runoff from the Site from entering streams, lakes or reservoirs; • Discharge turbid water from the site to settling ponds; • Limit construction work and use of materials during precipitation and wind storms; • Preserve native soil as much as possible; carry out stripping of topsoil and stockpiling for reuse in accordance with Mongolian regulations; • Ensure the stability of embankments and cuttings vulnerable to erosion during the work; • Rehabilitate all quarries, borrow pits, disposal sites and construction sites upon completion; • Grass sowing for site restoration is to include only local native species; and/or use sterile seedlings • Carry out topsoiling and erosion protection and stabilization of the site soil promptly after completion of earthworks • Dispose of on-site construction waste to approved central locations. • Store petroleum products, hazardous materials and waste in a protected and closed place with an impervious surface; • Develop an emergency preparedness and response plan for liquid pollution spills, place spilled pollution cleaning equipment at each construction site, develop liquid pollution spill response procedures, and conduct training; 	Contractor
Outdoor air	Air pollutant gases (SO ₂ , CO, NO _x) from dust caused by construction activities, construction machinery, asphalt paving work	<ul style="list-style-type: none"> • Spray water regularly during dry and windy weather on the construction site and access roads to reduce propagation of dust, especially in the vicinity of sensitive receptors; • Cover trucks transporting materials that are liable to generate dust in locations where it is a potential nuisance to other road users, residents, or land users. • Limit construction vehicles to speeds that are safe and limit generation of nuisance dust. • Vehicles and equipment to meet Mongolian standards for exhaust emissions. • Undertake regular maintenance of vehicles to limit particulate emissions. • Locate asphalt plants >200 m from residential or other sensitive areas; • Install wind barriers around stockpiles of fine or dust generating materials at batching plants. • Store petroleum and other harmful materials in suitable locations; • Site entry/ exit locations to asphalt paved public roads to be equipped with truck drive through wash ponds or wheel sprays where necessary. Promptly clean muddy or dusty material generated by works traffic from asphalt paved public roads. 	Contractor

Item	Potential impacts/ issues	Mitigation measures	Implement by
Noise and vibration	Noise from construction activities	<ul style="list-style-type: none"> • Reduce noise by proper operation and maintenance of vehicles and equipment. Equipment and machinery to be equipped with mufflers in accordance with relevant GoM regulations, and properly maintained to minimize noise. • Use noise reduction devices and methods for noisy equipment within 200 m of sensitive locations. • Stone crushing and concrete mixing sites should be >500 m away from sensitive locations. • Prohibition of operation of noisy equipment, piling, traffic of trucks on urban and village roads between 18:00 and 08:00. • If necessary, provide temporary fences or noise barriers outside the noise sources. • Transportation routes and delivery schedules will be planned to avoid densely populated and sensitive areas and high traffic times. • Transport vehicles will slow down and not use their horn when passing through or nearby sensitive receptors. • Noise protector personal protective equipment (PPE) will be provided to workers working in noisy environments. • Conduct noise monitoring at sensitive locations and close consultation with residents. If the noise exceeds the standard, check the equipment and construction conditions and take measures to reduce the noise. • Preconstruction survey to be conducted to document condition of potentially affected structures, including all the defects and existing damages, the surveys to be made in the presence of and with the permission of the property owners. The survey reports should also be verified by the property owners. • Notify nearby residents and property owners on the specific times and dates that vibration generating activities will occur. 	Contractor
Pollution to surface water resources	Impact on water quality and hydrology (lakes and tributaries); and water supply works	<ul style="list-style-type: none"> • Water use permit shall be obtained from relevant government authorities for domestic and construction water. Relevant authority is Khyargas lake-Zavkhan River Basin Authority. • Main labor camps, fuel storage, machinery maintenance workshop and vehicle cleaning areas must be at least 200 m away from waterways. • Portable toilets and on-site wastewater pre-treatment systems to be installed at construction camps with proper maintenance protocols. Direct disposal of construction or domestic wastewater to the river will not be allowed. • Wastewater from construction activities to be collected in sedimentation tanks and/or retention ponds. Oily water to first pass through oil-water separators. • Storage facilities for fuels, oil, and other hazardous materials will be within secured areas on 	Contractor

Item	Potential impacts/ issues	Mitigation measures	Implement by
		<p>impermeable surfaces and provided with absorbent mats and cleanup installations.</p> <ul style="list-style-type: none"> • All areas where construction equipment and vehicles are to be washed will be equipped with retention ponds or sediment traps. • Particular attention should be paid to road works <50 m from the shores of lakes and rivers. • contractor's fuel supplier must have the appropriate license and adhere to the relevant procedures for transporting fuel. 	
Solid waste	Solid waste generated from construction works and worker settlements	<ul style="list-style-type: none"> • Littering by workers is prohibited. • Waste to be reused or recycled to the extent possible. Recycling containers to be provided at all construction sites and be collected and transported to a recycling facility or company on a regular basis. • Domestic waste containers will be provided at all work sites. Domestic waste that cannot be recycled will be collected on a regular basis by a licensed local waste collection company and transported for disposal at a licensed landfill, in accordance with relevant Mongolian regulations and requirements. • Construction waste dumpsters will be provided at all work sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant Mongolia regulations and requirements. • Surplus soil will be backfilled onsite to the extent possible. Excess spoil that cannot be used on-site will be transported to an approved spoil disposal site. • Waste incineration at or near construction sites is strictly prohibited. • There will be no final waste disposal on site. Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on site after construction. 	Contractor
Flora and Vegetation	Tree felling	<ul style="list-style-type: none"> • Required tree felling (if any) will be identified in the domestic EIA conducted by the Contractor and pay the compensation costs to the local environmental protection fund before felling in accordance with Mongolian regulations . • Prior to tree felling, a rapid ecological survey will be conducted to prevent nests being disturbed. • For compensation of the required tree felling and also for acting as a greenhouse gas sink, 5,000 trees are to be planted. Only indigenous species, adapted to the natural conditions will be planted. • Suitable species are the following: Haloxylon ammodendron, Populus diversifolia and Hippophae rhamnoides. Suitable saplings can be purchased at the Laboratory of Biotechnology of Plants, Institute of Biology, Mongolia Academy of Science. 	Contractor

Item	Potential impacts/ issues	Mitigation measures	Implement by
		<ul style="list-style-type: none"> • Locations for the tree plantings are to be coordinated with the responsible forestry department. Preferable locations are within river floodplains and on mountain slopes. Locations close to settlements where local people can provide maintenance may be an advantage. • Within the first 3 years after planting, maintenance of trees will be the responsibility of the Contractor, either using its own staff or by subcontracting with the local community. 	
Ecological and wilderness values	Protection of flora and fauna around the construction site	<ul style="list-style-type: none"> • Continue animal monitoring during construction stage of the locations that wild animals are crossing using tracking collars, and advise the PIU if any changes to the pre-construction findings are found. • Improved accessibility because of road construction will require additional measures to be taken to prevent poaching, including raising awareness of contractors on regulations and penalties regarding hunting, and consultation with local residents to ensure that no illegal hunting by the contractors/construction workers occurs. 	Environmental departments of the Provinces traversed by the Project road.
Socio-economic resources	Protection of physical cultural heritage and sacred sites	<ul style="list-style-type: none"> • All project personnel are strictly prohibited from hunting and fishing in the nationally protected areas near the project, as identified in Section 5 of the IEE including 3 state natural reserves in the wider Project area (Tarvagatai nuruu, Otgontenger mountain protected areas, located at 33.5 km and 22.2 km respectively from the project alignment). • If livestock or large wild mammals are injured or killed by the Contractor's vehicles, or are encountered on this road, this should be reported to the PIU. 	Contractor
		<ul style="list-style-type: none"> • According to the results of the archaeological survey conducted in July 2022, 77 historic monuments were identified in close proximity to the overall Uliastai – Altai road alignment. The location of these 77 monuments are shown in the Archaeological Survey Report (Appendix 4 of the IEE). Coordinates and photographs of all 77 archaeological monuments will be provided to the Contractor by the PIU. • Erect warning signs and/or fences at known locations of historical monuments. • All Contractor staff should be informed about locations of historical monuments and their value; • If antiquities are found, the following actions should be taken <ul style="list-style-type: none"> ○ All construction activities in the vicinity of the artefact is ceased immediately and all remains must be left in the place. ○ The area with a buffer must be clearly marked and access prohibited. ○ Destroying, damaging, defacing, or concealing any physical, cultural and historic resources will be strictly prohibited. 	Contractor

Item	Potential impacts/ issues	Mitigation measures	Implement by
		<ul style="list-style-type: none"> ○ The location will be recorded with photographs in the chance find register. ○ The PIU and the Institute of Archaeology will be promptly informed and consulted. ○ Construction activities will resume only after thorough investigation and with the permission of Institute of Archaeology and relevant government authorities. 	
	Disruption of livestock migrations and division of pastureland	<ul style="list-style-type: none"> ● Conduct community consultation among local herders to determine livestock/herder migration crossing locations. 	PIU, Contractor
	Consultation with local residents	<ul style="list-style-type: none"> ● Meet with residents before any work begins on the construction site and inform them of the planned works, their schedule, possible impacts, and mitigation measures; ● Record feedback from local residents and discuss solutions to any concerns; ● Update the execution plan of the project site, including the work schedule, daily working hours, construction methods and mitigation measures in accordance with the above solutions; ● Outreach to local communities to disseminate knowledge about safety at or near the construction sites, installation of site safety fencing and warning signs (in Mongolian language) around potentially hazardous areas. 	Contractor, PIU
	Disruption of utilities	<ul style="list-style-type: none"> ● Take measures to prevent damage to buried or above ground utilities by provision of warning signs and/or fencing as appropriate. In case of accidental damage of the communication networks or other utilities, inform local residents and relevant authorities immediately and arrange their repair them as soon as possible. 	Contractor

Table 2. Environmental Monitoring Plan

Subject	Parameter/Methodology	Monitoring Location	Frequency	Implement by
Air Pollution	Ambient dust monitoring (TSP, PM10, PM25, SO2, NOx, etc.) following Mongolia requirements	5 locations near the sensitive receptors 6 locations near the quarries where road materials are extracted	Quarterly during construction	Environmental monitoring agency (EMA)
	Compliance inspection of implementation of air pollution control measures	Construction sites	Daily during construction season	Contractor
Water quality	pH, DO, EC, BOD5, Hardness, NH4, NO2, NO3, P, minerals, SO4, F, Heat-resistant intestinal bacteria (E-coli), intestinal pathogenic bacteria (coliform), suspended solids	At bridge construction sites (km 1+280, km 3+760 and km 39+100 (100 meters upstream and downstream of the planned bridge)	One time before construction and one time per	EMA

Specifications, Volume2, CW2, Construction of a new asphalt paved road for the section from Uliastai - Tsagaankhairkhan on a new alignment (40km)

	following Mongolia requirements	Deep wells in Aldarkhaan, Tsagaankhairkhan districts	construction season	
	Compliance inspection of implementation of wastewater pollution control measures	Construction sites	Daily during construction season	Contractor
Noise	Ambient noise monitoring (day and night Leq dB(A)) using portable monitoring device following Mongolia requirement	5 locations near the sensitive receptors 6 locations near the quarries where road materials are extracted	Quarterly during construction season	EMA
	Compliance inspection of implementation of noise control measures	Construction sites	Daily during construction season	Contractor
Solid Waste	Compliance inspection of implementation of solid waste management measures	Construction sites and waste collection points	Weekly during construction season	Contractor
Hazardous and Polluting Materials	Compliance inspections of implementation of hazardous materials management measures	Storage facilities for fuels, oil, chemicals and other hazardous materials.	Monthly during construction season	Contractor
Health and Safety and Emergency Response	Compliance inspection of implementation of Occupational and Community Health and Safety measures including records on near miss, minor, major, fatal accidents	Vehicle and equipment maintenance areas.	Monthly during construction season	Contractor
Biodiversity	Project-related injury to wildlife through collisions Project workers hunting and fishing	Construction site	Once a month	Contractor