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SPECIFICATION

For f/y 2083-84

National Competitive Bidding (NCB)

Single-Stage: Single-Envelope Bidding Procedure

***Water Resources and Irrigation Development
Division Office, Bardiya***



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Abbreviations

BD	Bidding Document
BDF	Bidding Forms
BDS	Bid Data Sheet
BOQ	Bill of Quantities
COF	Contract Forms
DP	Development Partners
DoLI.....	Department of Local Infrastructure
e-GP.....	Electronic Government Procurement
ELI	Eligibility
EEC.....	Evaluation and Eligibility Criteria
GCC	General Conditions of Contract
GoN ¹	Government of Nepal
ICC	International Chamber of Commerce
IFB	Invitation for Bids
ITB	Instructions to Bidders
JV	Joint Venture
NCB	National Competitive Bidding
NRs	Nepalese Rupees
PAN	Permanent Account Number
PPA	Public Procurement Act, 2063
PPMO	Public Procurement Monitoring Office
PPR	Public Procurement Regulations, 2064
PS	Provisional Sum
SBD	Standard Bidding Document
SCC	Special Conditions of Contract
TS	Technical Specifications
VAT	Value Added Tax
WRQ	Works Requirements

¹ “GoN” word indicates all public entities according to Public Procurement Act, 2063



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Specifications

Notes on the Specifications

A set of precise and clear specifications is a prerequisite for Bidders to respond realistically and competitively to the requirements of the Employer without qualifying or conditioning their Bids. The specifications must be drafted to permit the widest possible competition and, at the same time, present a clear statement of the required standards of workmanship, materials, and performance of the goods and services to be procured. Only if this is done will the objectives of economy, efficiency and fairness in procurement be realized, responsiveness of Bids be ensured, and the subsequent task of bid evaluation facilitated. The specifications should require that all goods and materials to be incorporated in the Works be new, unused, of the most recent or current models, and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.

Samples of specifications from previous similar projects are useful in this respect. The use of metric units is encouraged by the Funding Agency in case of funding assisted projects. Most specifications are normally written specially by the Employer or Project Manager to suit the Contract Works in hand. The available standard specification of works of Ministry of Physical Infrastructure and Transport, DoLI and Other line Ministries can be adopted for respective civil construction works.

There are considerable advantages in standardizing General Specifications for repetitive Works in recognized public sectors, such as highways, urban housing, irrigation, and water supply, in the same country or region where similar conditions prevail. The General Specifications should cover all classes of workmanship, materials, and equipment commonly involved in construction, however it may not necessarily be adequate to be used in a particular Works Contract and may necessitate preparation of Particular (Special) Specifications to amend and or supplement the provision of the General Specifications to meet the requirement of the particular Works.

Care must be taken in drafting specifications to ensure that they are not restrictive. In the specification of standards for goods, materials, and workmanship, recognized international standards should be used as much as possible. Where other particular standards are used, whether national standards of Nepal or other standards, the specifications should state that goods, materials, and workmanship that meet other authoritative standards, and which ensure substantially equal or higher quality than the standards mentioned, will also be acceptable.

Employers should decide whether technical solutions to specified parts of the Works are to be permitted. Alternatives are appropriate in cases where obvious (and potentially less costly) alternatives are possible to the technical solutions indicated in the Procurement Documents for certain elements of the Works, taking into consideration the comparative specialized advantage of potential bidders. For example:

The Employer should provide a description of the selected parts of the Works with appropriate references to Drawings, Specifications, Bill of Quantities, and Design or Performance criteria, stating that the alternative solutions if applicable shall be at least structurally and functionally equivalent to the basic design parameters and specifications.

Such alternative solutions shall be accompanied by all information necessary for a complete evaluation by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, proposed



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construction methodology, and other relevant details.

Sample Clause: Equivalency of Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Project Manager's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to the Project Manager at least 30 days prior to the date when the Contractor desires the Project Manager's consent. In the event the Project Manager determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the documents. These Notes for Preparing Specifications are intended only as information for the Employer or the person drafting the Procurement Documents. They should not be included in the final documents.



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CHAPTER 1 GENERAL REQUIREMENTS



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CHAPTER 1 GENERAL REQUIREMENTS

1.01. Abbreviations

The following abbreviations are used in this specification:

km	Kilometre	lin	linear
m	metre	cu.	cubic
mm	millimeter	sq.	square
ha	hectare	g	gram
m ² , sq.m	square metre	t	tonne
mm ²	Square millimeter	l	litre
m ³ ,	cubic metre	ml	milliliter
No	number	s	second
%	per cent	min	minute
°C	degree Centigrade	NS	Nepal Standard
Kg	kilogram	BS	British Standard
N	newton	IS	Indian Standard
kN	kilonewton	CP	British Code of Practice
ISO	International Standard Organization	ASTM	American Society for testing and Materials
US \$	Currency of USA	NRs	Nepalese Currency
VM	Vehicle Month		

1.02. Brief Description of the Works

As mentioned in Bidding document.

1.03. Ambient Conditions

The annual climatic cycle consists of the dry season from November to May, the wet season being the remaining months of the year. Shade temperature will normally vary between 5° and 40° C. Annual rainfall in Nepalgunj is around 1329 mm, most of which falls as intense rain during the wet season. Humidity in monsoon is as high as 80 – 100 %.

1.04. Drawings

1.04.1. Bidding Drawings

The drawings provided in Volume III of the Bidding Documents shows the general features of the construction works. The Contractor shall prepare construction and/or shop drawings as stipulated in Sub-Clause 1.04.3 of this Specification.

1.04.2. Additional Drawings



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The drawings attached to the Bidding Documents (hereinafter referred to as “Bidding Drawings”) accompany and form part of the Contract Documents. In addition to the Bidding Drawings, Additional Drawings may be delivered by the Engineer to the Contractor and such drawings shall thereupon become part of the Contract.

During the progress of the work, Additional Drawings will be issued by the Engineer as necessity arises to supplement and/or supersede the Bidding Drawings, and such Additional Drawings shall thereupon become part of the Contract. The Contractor shall prepare construction and/or shop drawings as stipulated in Sub-Clause 1.04.3 of this Specification.

The Contractor shall be governed by figures and dimensions as given on the drawings. Where required dimensions are not shown, the Contractor shall obtain such dimensions from the Engineer before proceeding with the construction of the portion of the Works to which they refer. In every case, detailed drawings shall take precedence of general drawings.

The Contractor shall scrutinise such drawings and such further drawings issued from time to time to the Contractor. If any ambiguity, discrepancy or mistake is found in the drawings, the same shall be referred to the Engineer before proceeding with the works, and the Engineer’s decision on resolving such ambiguity, discrepancy or mistake shall be final, conclusive and binding.

1.04.3. Drawings and Calculations to be furnished by the Contractor

Unless otherwise stated in the Contract, the Contractor shall prepare drawings for all Temporary Works to be constructed or supplied and installed by the Contractor or his Sub-Contractor.

The Bidding Drawings and the Additional Drawings delivered by the Engineer will not always be detailed enough for performance of the works. They will show many works only in typical forms supplemented by tables of dimensions. The Contractor shall at his own expense prepare detailed Construction Drawings of the individual works (hereinafter referred to as “Construction Drawings”) based on the Bidding Drawings and the Additional Drawings as needed for performance of the works. All Construction Drawings prepared by the Contractor shall be submitted to the Engineer for his approval.

If required by the Engineer, the Contractor shall also submit calculations to the Engineer for his approval. The drawings submitted by the Contractor shall be clear and complete. The recommendable scales of the drawings are 1:1,000, 1:100, 1:50, 1:20, 1:10, 1:5, 1:2 or 1:1 depending upon the type of drawing and/or details which have to be drawn. Drawings shall be of standard sizes as required by the Engineer.

In addition to the above, the Contractor shall at his own expense prepare reinforcement drawings based on the drawings supplied by the Employer/Engineer as needed for the performance of the works. These reinforcement drawings shall include such bar placing drawings, bar-bending drawings, bar list and any other reinforcement drawings as may be required to facilitate fabrication and placement of reinforcement bars. All reinforcement drawings prepared by the Contractor shall be submitted to the Engineer for his approval.

For all sections of the work to be executed under the Contract, the Contractor shall submit detailed drawings to the Engineer for his approval, including working drawings, shop drawings and



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specifications. The Contractor shall submit these drawings in four (4) copies to the Engineer for approval unless otherwise specified, and these drawings shall be sufficiently detailed to show:

- a. The general arrangement and dimensions of all the parts and the size of each and every part of the works to be executed under the Contract.
- b. The nature of the materials from which various parts are to be made, and
- c. Details of all construction.

Fabrication, manufacture or construction of any part of the works shall not commence until the drawings have been approved in writing by the Engineer, and thereafter no change shall be made to any drawings so approved without permission of the Engineer. Subsequent changes shall be reported by sending another set of four (4) or specified number of copies of each revised drawing to the Engineer for approval. The approval of Contractor's drawings by the Engineer shall not relieve the Contractor from any of his liabilities or responsibilities under the Contract.

The Engineer shall check or review the drawings submitted by the Contractor and shall return them with comments or approval within twenty-eight (28) days from the date of submission by the Contractor. If re-submission of the drawings is required by the Engineer, the Contractor shall re-submit them after necessary modifications and corrections until the approval of the Engineer is obtained. In the event of disagreement with alteration, the Contractor shall send a written notice to the Engineer within 7 days after receiving the altered drawing(s).

From the approved drawings and calculations, four paper copies and one reproducible copy (in CD) of each set shall be submitted to the Engineer.

1.04.4. Right to Change Design and Drawings

When additional information regarding foundation or conditions become available as a result of excavation work and further testing, and if found desirable to make changes in the alignment, cross-sections, dimensions or design to conform to such conditions, the Employer/Engineer reserves the right to make the necessary or desirable changes to the opinion of the Engineer.

1.04.5. "As-Built" Drawings

The Contractor shall submit whole sets of "As-Built" Drawings of the completed Works, clearly printed drawings along with soft copy, to the Employer before the expiration of Defect Liability Period.

The "As-Built" Drawings shall clearly show the lines and dimensions of the permanent construction actually made based on the original design and/or change of design from time to time ordered by the Engineer or proposed by the Contractor and approved by the Engineer. "As-Built" Drawings are to be prepared by the Contractor and submitted to the Engineer and/or the Employer.

1.04.6. Measurement and Payment

No separate payment shall be made for preparation of all construction drawings, reinforcement drawings, working drawings and shop drawings, drawing details, etc., to be prepared by the Contractor and submitted to the Engineer and/or the Employer in accordance with the provisions of the Contract, except for provision of "As-Built" Drawings.



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All costs including Contractor's margin, overhead, taxes, etc, incurred by the Contractor to provide and submit "As-Built" Drawings shall be deemed to be included in unit rate per Lump Sum Price from **Relevant Item** of the Bill of Quantities.

1.05. Setting-Out and Survey of the Works

The Contractor shall re-survey the Base Lines, Traverse Points, Bench Marks and confirm the co-ordinates and levels of the Stations before using them for setting out the Works. The Contractor shall immediately notify the Engineer of any discrepancies and shall agree with the Engineer any amended values to be used in the Contract, including replacement of any Stations missing from the original location.

The Contractor shall employ well-qualified and experienced surveyors for the execution of survey and setting-out works. The instruments to be used shall be of a make and type suitable for the intended works and shall be subject to Engineer's approval.

The Contractor shall be responsible for the setting-out centre-lines, longitudinal and cross sections of the ground and position of the structures in accordance with the drawings, and any other setting-out work necessary for the execution of the Works. Before commencing the works for structures, drains etc, the Contractor shall survey and take levels for longitudinal profile and cross sections along the routes/locations in which the works are to be executed out at his own expenses. The Contractor shall use benchmarks approved by the Engineer for such survey works. The surface levels so determined shall be subject to the approved surface levels.

The demarcation of right-of-way and all-necessary preparation connected with it shall be carried out by the Employer.

Along structures, drains, or combination thereof and roads, the Contractor shall install temporary benchmarks at intervals of 250m. Their distance from the centre-line shall be as instructed by the Engineer. The difference in double-levelling as executed for the levelling of the temporary benchmarks shall not exceed 5 mm times the square root of the length of the circuit in km. Ground levels shall be taken jointly by the contractor and the Engineer's representative both prior to commencing and after completion of earth works.

The Contractor shall level and draw the followings for all structures canal, drains, bunds and roads:

- longitudinal section
- Cross-sections at an interval not exceeding 25 m before and after the execution of the Works. The formation level shall be taken as reference while cross-sections shall cover at least a width as necessary for the Works to be constructed, including related earthworks.

All field-books, calculations, maps, etc. of the survey activities shall be handed over to the Engineer, immediately after the completion of the survey. All field data, derived from the survey activities, entered in the field-books that are handed over to the Engineer, shall also be entered into EXCEL spreadsheet or a compatible spreadsheet in a format approved by the Engineer. The data shall be submitted on a CD.

No separate payment shall be made to the Contractor for the works to be carried out under this Sub-Clause.

1.06. Layouts and Schedules Provisional



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The locations, levels and dimensions as shown on the Drawings or given in the design data or structure schedules are subject to amendment. The Contractor will be required to undertake surveys for confirmation of alignment and levels of canals, flood embankments, river bank protection, approach channels etc. Details of any such amendment or confirmation of the original design will be given by the Engineer or the Engineer's Representative during the course of construction.

1.07. Existing Irrigation System and Flow to be maintained

The Contractor shall provide all Temporary Works and do all things which may be necessary to maintain those parts of the existing irrigation and drainage system which may be affected by these operations in a condition not less satisfactory than they were prior to the commencement of the Works and shall maintain the normal irrigation supplies therein except when written permission to vary the supplies has been obtained from the Engineer.

When ordered by the Engineer the Contractor shall make connections and carry out such other works as may be necessary to transfer the supply of irrigation water between the existing system of canals and the system constructed under the contract. The Contractor shall submit to the Engineer his detailed proposals for carrying out this work.

The Contractor shall not start the work without the written approval of the Engineer and the cost of all such Temporary Works and all other charges arising from compliance with this Clause shall be deemed to be included in the Contract Rates.

1.08. Temporary Works

Not less than fourteen days before commencing any portion of the Works, the Contractor, if ordered, shall submit to the Engineer for his approval complete drawings of all Temporary Works the Contractor may require for the construction of that part of the Works.

Notwithstanding approval by the Engineer of any design for the Temporary Works the Contractor shall be entirely responsible for their efficiency, security and maintenance and for all obligations and risks in regard to such temporary Works which are specified or implied in the Contract.

Except where specific items are provided in the Bill of Quantities, the cost of all Temporary Works of every description, including de-watering, temporary diversions of canals, drains, roads, and all services shall be included in the Contracts' Rates.

1.09. Cofferdams

The term "cofferdam" denotes any temporary or removable structure, constructed to hold the surrounding earth, water, or both, out of the excavation, whether such structure is constructed of earth, timber, steel, concrete or any combinations of these. The term includes earth dikes, timber cribs, sheet piling, removable steel shells and all bracing; and it shall be understood to include excavation enclosed by pumping wells and well points. The cost of cofferdams is always to be included as part of the bid price for the structure.

The Contractor shall submit, upon request of the Engineer, Drawings showing his proposed method of cofferdam construction. Approval of the Drawings by the Engineer will not in any way relieve the Contractor of the responsibility for the adequacy of the design for strength and stability or for the safety of the people working therein.



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The interior dimensions of cofferdams shall be such as to give sufficient clearance for the construction and removal of any required forms and the inspection of the interior and to permit pumping outside the forms.

Material deposited within the stream area from foundations or other excavations shall be removed if, in the opinion of the Engineer, it obstructs the stream channels.

Unless otherwise provided, cofferdams shall be removed after the completion of the sub-structure. The removal shall be affected in such a manner as not disturb or mar the finished work. The Engineer may order the Contractor to leave any part or the whole or the cofferdam in place.

When conditions are encountered which, in the opinion of the Engineer, render it impractical to de-water the foundation before placing the footing, the Engineer may require the construction of a concrete foundation or seal of such dimensions as he may consider necessary, and of such thickness as to resist any possible uplift. The concrete for such a seal shall be placed as shown in the Drawings or required by the Engineer. The foundation shall then be de-watered and the footing placed.

Cofferdams shall be constructed so as to protect newly-cast concrete from suddenly rising water and to prevent damage to the foundation by erosion.

1.10. Notice of Operations

The Contractor shall give full and complete written notice of all-important operations, including setting out, to the Engineer sufficiently in advance to enable the Engineer to make such arrangements as the Engineer may consider necessary for inspection and for any other purpose. The Contractor shall not start any important operation without the written approval of the Engineer.

1.11. Suppliers of Materials

Before ordering a material for any description intended for the Permanent Works, the Contractor shall submit for the approval of the Engineer the name of the maker or supplier proposed and details of the place of origin and specification of the material. If requested by Engineer, the Contractor shall supply to the Engineer for his retention a copy of any such order place.

1.12. Natural Materials

The Contractor shall make all arrangements for locating, selecting and processing natural materials to comply with the Specification and shall submit to the Engineer for approval full information regarding the proposed location well in advance of commencement of working of the materials. Approval of a source does not imply that all material in that source is approved.

1.13. Disruption of Local Communities

The Contractor shall take all measures necessary to avoid nuisance and disruption to local communities. In particular the Contractor shall ensure no damage is done to crops, pasture or woodland and outside the area for which the Engineer's approval for land clearance has been given, that all irrigation supplies to such areas are maintained and that the Contractor's operations do not cause flooding or pollution hazards.

1.14. Delay and Increased Costs Due to Floods, Wash-out of Roads or Impassable Roads

Notwithstanding Clause 44 of the Conditions of Contract no increase in the Contract Rates shall be granted to the Contractor if he is delayed or impeded in the completion of the Works or involved in additional costs by flood, high river water levels, wash-out of roads or tracks or impassable roads.



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1.15. Supply of Fuel Oils

The Contractor shall be responsible for arranging and ensuring that adequate supplies of high speed diesel oil, motor spirits, kerosene, lubricants and other petroleum products are available at all times to meet his requirements for the purposes of or in connection with the contract; the Contractor's particular attention is drawn to this requirements as from time to time shortages and interruptions in the supply of fuel oils, etc occur in the region.

1.16. Assistance to Engineer's Staff

The Contractor shall render all necessary assistance to the Engineer's staff and shall provide and maintain sufficient number of pegs, poles, paints, survey equipment and tools, straight edges, staging, moulds, templates, profiles and all other requisites for checking the Contractor's setting-out and the measurement of the Works.

The Contractor shall provide such full time or part time surveyors as may be required. The cost of all labourers, surveyors, survey equipment and tools, and materials required by the Engineer and his staff for checking the setting-out and the measurement of the Works shall be covered by the Contractor's expense and no separate payment shall be made thereof.

1.17. Standards and Supplemental Specifications

Unless otherwise stated in the Contract, all workmanship, materials, and equipment shall comply with the relevant American, British, German, Nepal and Indian Standard or Code of Practice current on the date fixed for receipt of bids.

Whenever in these documents' references are made to particular reference standards or abbreviations thereof, their meaning shall be as listed below and copies of such standards shall be obtained at the Contractor's expense from the particular organisation at the address given:

AASHTO	American Association of State Highway and Transportation Officials, Suite 341 National Press Building, Washington D.C., 2004, USA
ACI	American Concrete Institute, P.O. Box 4754 Redford Station, Detroit, MI 48219, USA
AISC	American Institute of Steel Construction, 101 Park Avenue, New York, NY10017, USA
ASTM	American Society for Testing and Materials, 1916 Race St, Philadelphia, PA19103, USA
AWS	American Welding Society, Inc. 2501 N.W. 7th St., Miami, FL33125, USA
AWWA	American Water Works Association, 6666 West Quincy Avenue, Denver, Colorado80235, USA
BSI	British Standards Institution 101 Pantown Road, London NI 9ND, England
DIN	Deutsche Industrie Norm (German Industry Standard)



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DNA	Deutsche Normenausschuss Beuth-Vertrieb, Berlin 30 Koln, Federal Republic of Germany
ISO	International Organisation for Standardisation 1 Rue Devarembles, Geneva, Switzerland
SSPC	Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA15213, USA
U.S. Fed. Spec.	United States Federal Specifications Sales (3FRI) Building 197, Washington, Navy Yard General Services Administration Washington, D.C.20407, USA
USBR	United States Bureau of Reclamation Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20.402, U.
BIS	Bureau of Standards
NBSM	Nepal Bureau of Standards & Metrology

Wherever reference is made in the Contract to specific standards and codes to be met by the materials, Plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure a substantially equal or higher performance than the standards and codes 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 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure substantially equal performance, the Contractor shall comply with the standards specified in the documents.

No separate payment shall be made to the Contractor for complying with this Sub-Clause.

1.18. Construction Programme

The Contractor shall submit to the Engineer for approval at the time of contract agreement a complete and practicable construction programme showing the orderly performance of the Works. The Contractor shall note that the detailed design will be annually completed prior to commencement of construction works to be executed in the next working season. The Construction Programme shall show in detail the proposed method of operations, including purchase and delivery of materials and equipment, as well as the construction. The schedule shall be in precedence (activity on node) format,



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showing the proposed date of commencement and completion of each activity required under the contract. The Construction Programme shall when approved by the Engineer become a part of the Contract.

In amplification of the requirements in Sub-Clause 26.1 of the General Conditions of Contract, the particulars supplied by the Contractor with the programme shall include the following details:

- a. statement giving the numbers and categories of supervisory and technical staff and skilled/unskilled labour to be employed on the Works;
- b. a list and type/details of Contractor's Equipment (including vehicles) which the Contractor proposes to employ on the Works stating whether they are to be acquired from inside or outside Nepal, including programmed dates for order and delivery;
- c. a list detailing the purchase and delivery of materials and Plant from both inside and outside Nepal;
- d. Details of the Contractor's methods of working for all operations including construction by sequence. The programme shall also indicate the proposed temporary flow diversions and arrangements for de-watering illustrating the sequence of various critical stages of construction;
- e. a statement and outline layout giving the proposals for location or locations and sizes of constructional camps, accommodation, offices, workshops and stores at the Site; and
- f. details of the programme for the construction of the works from the date of receipt of the Notice to Commence, including a complete resource allocation showing the number of units and allotted times for each unit of Contractor's Equipment, Plant, materials and labour allocated for each part of the works.

The construction programme shall be reviewed and revised if necessary, at intervals of not more than three (3) months. In addition, the Contractor shall immediately advise the Engineer of any proposed changes in the Construction Programme. The Contractor shall prepare such programme by the Critical Path Method (CPM) or the Programme Evaluation and Review Technique (PERT) or by a similar type of construction scheduling. The Construction Programme and the revised Construction Programme shall include a schedule of anticipated monthly earnings during, the construction period.

The Contractor shall submit the revised programme within 15 days from the date of the instruction from the Engineer.

No separate payment shall be made to the Contractor for complying with this Sub-Clause.

1.19. Reports, Meetings and Data of the Works

1.19.1. Monthly Report

The Contractor shall furnish to the Engineer, at the Contractor's own costs, at regular monthly interval and in a form and number of copies determined by the Engineer, with the followings:

- i. physical progress for the preceding month and estimated progress for the report month;
- ii. completion schedules (target and actual) based on the approved Construction Programme as provided in Sub-Clause 26.1 of the Conditions of Contract;
- iii. estimated expenditures for the report month;
- iv. inventory of construction equipment and materials on which an advance was made by the Employer as provided in the Conditions of Contract;
- v. a tabulation of construction equipment, listing the major items and pieces of equipment which were utilised for performance of the Works during the preceding month;



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- vi. a tabulation of employees, showing the supervisory staff and the numbers of several classes of labourers employed by the Contractor in the preceding month;
- vii. purchase and expenditure report covering the Plant and materials furnished by the Contractor for the Works; and
- viii. any report which may be specifically requested by the Employer and/or the Engineer.

1.19.2. Site/Work Meetings

The Contractor shall attend all the Site/Work Meetings called by the Engineer.

1.19.3. Photographs

The Contractor shall make all arrangements to provide photographs in albums, but not pasted, showing the monthly work progress in general and shall promptly supply one electronic copy, of such portions of the works in progress and/or completed as may be directed by the Engineer.

1.19.4. Audits by the Employer

The Contractor shall note that the Employer shall be entitled at its discretion to conduct audits in respect to:

- a. costs incurred in the event of termination; and
- b. any other costs that the Contractor claims from the Employer which are not specifically covered by the terms of the Contract.

The Contractor shall be obliged to keep accurate up-to-date accounts with records concerning the above items.

1.19.5. Measurement and Payment

No separate payment shall be made for preparation of all documents, correspondence, returns and reports etc. and photographs to be prepared by the Contractor and submitted to the Engineer and/or the Employer.

1.20. Protection of Real Estate

The Contractor shall control the movement of his crews and equipment on right-of-way including access routes approved by the Engineer so as to minimise damage to crops and property and shall endeavour to avoid marring the lands. Ruts and scars shall be obliterated and damage to land shall be corrected and the land shall be restored as neatly as practicable to its original conditions.

The Contractor shall be responsible directly to the Employer for any excessive or unnecessary damage to crops or lands resulting from the Contractor's operations whether on lands adjacent to right-of-way or on approved access roads and deductions shall be made from payment due to Contractor to cover the amount of such excessive or unnecessary damage as determined by the Engineer.

No separate payment shall be made to the Contractor for complying with the stipulations of this Sub-Clause.

1.21. Safety Measures and Public Convenience

The Contractor shall provide necessary protection for all persons and properties at all times. The Contractor shall submit to the Engineer for his approval a "Safety Manual" with full details of safe construction methods. The Contractor shall comply with the stipulations of the safe construction



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methods specified in the “Safety Manual”, to the extent that such provisions do not conflict with the applicable laws. The Contractor shall take all necessary measures to protect the work and prevent accidents during the construction. He shall provide and maintain sufficient night-lights, barricades, guards, temporary sidewalks, temporary bridges, danger signals, watchmen and necessary alliances and safeguards to properly protect life and property. He shall also protect all excavations, equipment and materials so that the public are not be endangered.

The Contractor shall conduct his operations so as to give the least possible obstruction and inconvenience to traffic. Where existing access road or footpaths are not available for detours, traffic shall be permitted to pass through the work with as little delay and inconvenience as possible, unless otherwise authorised by the Engineer.

The Contractor shall also at all times provide convenient access for all entrances to property abutting the Site and shall maintain them in a clean and tidy position.

No separate payment shall be made to the Contractor in complying with the provisions of this Sub-Clause.

1.22. Temporary Fencing

If and where required the Contractor shall erect and maintain suitable and approved temporary fencing to enclose such areas of the works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract. Where temporary fencing has to be erected alongside a public road, footpath, etc., it shall be of the type required by the concerned authorities and shall be erected to their satisfaction.

The Contractor shall fence his labour camps and other compounds and his housing sites in an approved manner so as to exclude all wild or stray animals.

Fences crossed by the Works and forming boundaries of plots outside the area occupied by the Works shall not be cut through or destroyed for more than the distance necessary to permit the erection of new fencing etc, and the Contractor shall make the ends of the cut fences reasonably secure.

The Contractor shall regularly inspect all such fencing, and any defects which may occur, shall be made good without delay. Temporary Fencing shall remain in position until the Works are completed and the Site cleared of all plant, materials and/or other waste matter.

No separate payment shall be made to the Contractor for complying with the provisions of this Sub-Clause.

1.23. Notice Board

The Contractor shall erect a notice board of a size of not less than 1.5 m by 2.0 m at work site. The notice board shall be painted and the description therein shall be approved by the Engineer. The board shall be erected at a suitable place prior to the commencement of the work.

The Contractor shall not erect any advertisement signboard on or along the Site without the written approval of the Employer.

“provision for notice board” to be included in unit rate per Lump Sum Price from **Relevant Item** of the Bill of Quantities.



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1.24. Clean Up the Site

Prior to the issue of the latest Defect Liability Certificate by the Employer the Contractor shall remove from the Site all plant and equipment, tools, rubbish, concrete forms, boulders, bricks and other materials not incorporated in the permanent works.

Payment shall be made in unit rate per Lump sum price from **Relevant Item** of the Bill of Quantities. The unit rate shall include removing from the Site all plant and equipment, tools, rubbish, concrete forms, boulders, bricks and other materials not incorporated in the permanent works before and after construction works.

1.25. Contractor's Temporary Facilities

1.25.1. Contractor's Offices, Workshops, Quarters, etc.

The Contractor shall be responsible for the land he deems necessary for his offices, stores, warehouse, motor pool, laboratory, workshops, pre-cast concrete factory, screening plants, batching plants, staff quarters and labour camp. The Contractor shall be also responsible for construction, maintenance, operation and subsequent removal or handing over if the Engineer requests, of such temporary facilities as his office, stores, warehouse, motor pool, laboratory, workshops, pre-cast concrete factory, screening plants, batching plants staff quarters and labourer camps including feeding and accommodation. These facilities shall be equipped with adequate electricity and potable water supplies.

The Contractor shall submit for approval of the Engineer within Thirty (30) days from the date of the Notice to Commence his detailed plan and/or construction drawings of his offices, stores, warehouse, motor pool, workshops, staff quarters and labourer camps that he proposes to construct or rent, including his proposals for water and power supply and sewage facilities. All buildings and facilities shall conform to the Employer's standards.

Provided that the Employer arranges the acquisition of the land, the Engineer may request the Contractor to hand over the Contractor's temporary facilities to the Employer. The Contractor shall remove and clear the site, other than temporary structures requested by Engineer to the satisfaction of the Engineer. The Contractor shall start handing over his temporary facilities to the Employer after the issuance of Taking-Over Certificate and shall complete it before issuance of Defect Liability Certificate. The handing over shall be made in usable condition and the Contractor shall clean, repair and re-paint the temporary facilities, if necessary, to the satisfaction of the Engineer.

1.25.2. Lab Testing

The Contractor shall perform tests specified in the Technical Specifications for the materials and construction of earthworks, concrete, gravel wearing course, etc.

The Contractor shall within twenty-eight (28) days from the date of the Notice to Commence submit a Quality Assurance Plan. The plan shall include testing schedules, list of material sources, quality control procedures and other items as required by the Engineer. The plan shall also indicate testing equipment and consumables. The Contractor shall implement the quality control procedures in compliance with the approved Quality Assurance Plan.

The Contractor shall manage all testing staff, labours and consumable necessary for carrying out the testing.



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The Contractor shall when requested by the Engineer or the Engineer's Representative carry out any test in the presence of the Engineer or the Engineer's Representative, or shall provide all necessary testing engineers, laboratory assistants and labours required to the Engineer free of charge. The Contractor shall ensure that the Engineer and his staff have unrestricted access to these facilities free of any charge.

All costs including Contractor's margin, overhead, taxes, etc, incurred by the Contractor to perform all the tests shall be deemed to be included in unit rate per Lump sum price from **Relevant Item** of the Bill of Quantities. The unit cost shall include all the costs incurred in operation of the testing, testing staff, labours and consumable necessary for carrying out the testing.

1.26. Insurances

The Contractor shall be paid the provisional sum amount for fulfilling his obligations under Clause 13.1 to 13.5 of Conditions of Contract as mentioned in the following Sub-Clauses 1.34.1, 1.34.2 and 1.34.3.

Payment shall be made in two instalments, one-half of the provisional Sum amount for the items in each of the instalments. The first instalment shall be made after furnishing all the documentary evidence of the insurance policy in the first Running Bill and remaining one half instalments to the contractor shall be paid on next Bill. The total amount to be paid to the contractor shall be the minimum of two as below

1. The provisioned amount in the Bill of Quantities
2. The cost to fulfil the requirements as per requirement of this clause

1.26.1. Insurance of Works

For fulfilling his obligations under Clause 13 of the Conditions of Contract, the payment for Insurance of works shall be done in Unit Rate per Provisional sum amount from **Relevant Item** in the Bill of Quantities, which amount shall be deemed to include the entire Contractor's costs incidental to providing the specified insurance.

1.26.2. Third Party Insurance

For fulfilling his obligations under Clause 13 of Conditions of Contract, the payment for Third party Insurance shall be done in Unit Rate per Provisional sum amount from **Relevant Item** in the Bill of Quantities which amount shall be deemed to include the entire Contractor's cost incidental to providing the specified insurance.

1.26.3. Insurance against Accident to Workmen

For fulfilling his obligations under Clause 13 of the Conditions of Contract, the payment for Insurance against Accident to workmen shall be done in Unit Rate per Provisional sum amount from **Relevant Item** in the Bill of Quantities which amount shall be deemed to include the entire Contractor's cost incidental to providing the specified insurance.

1.27. Traffic

1.27.1. Traffic Safety and Control

The Contractor shall provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required for the information and protection of traffic approaching to or passing through the section of the road under improvement and/or diversions. Barricades, traffic signs and warning boards shall be provided as per the Traffic Signs Manual (Latest Publication)



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published by the Traffic Engineering and Safety Unit of the Design Branch of the Department of Roads.

The barricades erected on either side of the carriageway/portion of the carriageway close to movement of traffic, shall be of strong design to resist violation, and be painted as per the said Traffic Sign Manual. On both sides, suitable regulatory and/or warning signs shall be installed for the guidance of the road users. On each approach, at least two signs shall be put. The location of these signs shall be in accordance with the Code of Practice published by the Traffic Engineering and Safety Unit of the Design Branch of the Department of Roads.

In some locations steel drums may also be placed. These drums shall be white-washed, blasted with sand and provided with retro retro-reflective tape strips, red on the left-hand side facing oncoming traffic and white on the right-hand side as appropriate. The minimum size of these tapes shall be 0.01 sq.m. The drums shall be maintained in a clean and effective condition and no stones or any other warning device shall be placed on top of the drums.

1.27.2. Measurement and Payment

Unless otherwise provided in the contract, no separate measurement and/or payment shall be made for all materials and works required under this Clause. All costs including Contractor's margin, overhead, taxes, etc, in connection with the work specified herein shall be considered to be included with other related items of the work in the Bill of Quantities.

1.28. Temporary Diversions for Traffic

1.28.1. Provisions of Diversions

Where some portions of the existing road cannot be used by through traffic, diversions as may be required to deviate traffic from such portions shall be constructed.

1.28.2. Survey beacons and Monuments

Diversions shall be constructed so as not to damage or displace trigonometrically survey beacons and road monuments. In exceptional cases where this is not possible, arrangements shall be made to have survey beacons suitably referenced before they are displaced and relocated after the completion of the work.

1.28.3. Access to Properties

Access to properties which work is being carried out shall be provided in the manner as existed before the start of the work.

1.28.4. Temporary Works

If diversions are provided, they shall include the construction of temporary gates, grid gates, fences, drainage works, and other incidentals considered necessary.

1.28.5. Public Services

Arrangements shall be made for the continuity of all public services such as power lines, telephone lines, water mains, sewerage, drainage, etc., if the existing services are likely to be affected.

1.28.6. Width of Diversions

The usable width for accommodation of two-way traffic shall not be less than 6 m. Where diversions consist of two separate one-way lane the minimum usable width of each lane shall not be less than 3.5 m.



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1.28.7. Temporary Drainage Works

All necessary temporary drainage works required for proper surface run-off, such as side drains, catch water drains, temporary cross-drainage structures, etc. shall be constructed.

1.28.8. Earthworks for Diversion

Diversions shall be shaped and graded making full use of all material that can be obtained from side cut or from the immediate vicinity within the road reserve. If sufficient material cannot be obtained in this manner, material shall be imported from other sources. Where the sub-grade is not sufficiently compacted in its natural condition, it shall be compacted as specified in CHAPTER 3 prior to the commencement of the earthworks.

All fill material shall be compacted to a density of at least 90% of maximum dry density (Heavy Compaction).

1.28.9. Maintenance of Diversions

All diversions shall be maintained in a safe and smooth trafficable condition. Whenever required the diversions shall be bladed by means of graders to provide a smooth riding surface free of corrugations. All potholes shall be promptly repaired. Diversion shall be watered to keep down dust from traffic and in order to facilitate the proper blading of the surface. All drainage works shall be maintained in good working order and kept unblocked.

1.28.10. Removal of Diversions

When traffic is routed permanently onto the new road following the completion of construction, the diversions which are no longer required shall be removed and the ground reinstated to its original condition.

1.28.11. Measurement and payment

Unless otherwise provided in the contract, no separate measurement and/or payment shall be made for all materials and works required under this Clause. All including Contractor's margin, overhead, taxes, etc, costs in connection with the work specified herein shall be considered to be included in other related items of the work in the Bill of Quantities.

1.29. Maintenance of Road

The Contractor shall be responsible for undertaking all routine maintenance of the existing road and all bridges on the road from the day the road is officially handed-over to the Contractor until the issue of Defects Liability Certificate by the Engineer. The Contractor shall also carry out all routine maintenance of the completed works from the time of their substantial completion until the Defects Liability Certificate is issued.

The Contractor shall also maintain roads that he uses for construction or access and the use of Such roads shall be identified in advance to the Engineer for inspection prior to use.

The routine maintenance of the road shall include besides other, trimming vegetation, cleaning all culverts, ditches, borrow pits, road side drainage, drainage channels and any other obstructions cleaning road signs and checking and undertaking the repair of guardrails and other road safety structures cleaning including removal of obstructions on bridge decks and bridge deck drainage elements, checking and cleaning of expansion joints and bearings, cleaning bearing shelves and weep holes, removing accumulated debris and vegetation around and between piers and abutments, repairing parapets, clearance on the road to allow free flow of traffic and reinstatement of



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any damaged or deteriorated carriageway, and protection of adjoining works. In case of road Section where the surface is in badly damaged condition, the maintenance of existing road surface shall be maintained by potholes patching using gravel, re-profiling and re-grading as instructed by Engineer. The surface shall be maintained to ensure longitudinal and transverse profile. All the damages to the road carriageway and shoulder shall be repaired with the material of equal or higher standard than the original surfacing.

The Contractor shall perform the maintenance works as often as required to keep the carriageway, shoulders, and adjoining structures in proper working order to the satisfaction of the Engineer.

During the period of commencement of works the Contractor shall mobilize labour and equipment to make an immediate start on the maintenance of the existing road. The location and scope of the maintenance work shall be as directed by the Engineer.

1.30. Site Clearance after construction works

All the unnecessary or extra material deposited/placed during construction work shall be removed far from the construction site and placed at appropriate location without disturbing the local people and environment. The construction site shall be cleaned after the construction works to the satisfaction of the Engineer

Unless otherwise provided in the contract, no separate measurement and/or payment shall be made for all materials and works required under this Clause. All including Contractor's margin, overhead, taxes, etc, costs in connection with the work specified herein shall be considered to be included in other related items of the work in the Bill of Quantities.

1.31. Performance Security Commission

The Contractor shall be paid the provisional sum amount under bank commission incurred against the issuance of Performance Security bond from the respective commercial banks.

Payment for this item shall be done in unit rate per Provisional Sum from Item No. A.4 of the Bill of Quantities which shall be included in the first Interim Payment Certificate produced by the contractor.

The total amount to be paid to the contractor shall be the minimum of two as below

1. The provisioned amount in the Bill of Quantities
2. The cost to fulfil the requirements as per requirement of this clause



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SITE CLEARANCE AND REMOVAL OF EXISTING STRUCTURES

2.1. Clearing, Grubbing and Tree Removal

2.1.1. Clearing and Grubbing

During the Contractor's operations the removal of weeds, organic materials, unsuitable materials, shrubs, vegetation and small trees with a girth not exceeding 0.5 m measured 1 m above ground level may be required, in which case, the Contractor shall remove such materials, shrubs, vegetation and trees after obtaining prior written approval from the Engineer. All trees and shrubs to remain in place shall be protected from damage. Where clearing is required, in the right-of-way and borrow area outside the right-of-way, all combustible materials from clearing operations shall be burned or removed from the Site of work or disposed of as directed. However, the felled trees shall not be burned; but shall be deposited at the area designated by the Engineer.

All materials to be burned shall be piled neatly and when in a suitable condition shall be burned completely. Piling for burning shall be done in such manner and in such location as to cause the least fire risk. All burning shall be so performed that the cleared materials will be reduced to ashes. The Contractor shall at all times take special precautions to prevent fire from spreading and shall have at all times, suitable equipment and supplies for use in preventing and fighting fires.

Grubbing shall consist of the removal of the stumps, jungle growth, brush and rubbish from the work areas to be occupied by permanent structures, roads and canals and from the surface of borrow areas, stockpile sites and elsewhere as directed by the Engineer. The grubbing shall also include removal of roots and all the materials not suitable for embankment construction within 0.50 m depth from the existing ground surface, within the width of canal excavation. The disposal of materials obtained from grubbing shall be carried out to the distance, as directed by the Engineer.

No tree felling will generally be permitted unless essential for the construction of the works and no tree shall be cut without the written permission of the Engineer.

Payment for clearing and grubbing operation specified above shall be made in unit rate per square meter from Relevant Item of the Bill of Quantities.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Clearing and Grubbing, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of excavation/embankment construction.

2.1.2. Tree Removal

Where shown on the Drawings or directed by the Engineer trees exceeding 0.5 m girth measured 1 m above ground level shall be uprooted or cut down as near to ground level as possible and the root ball extracted separately. The Contractor shall clearly demarcate and count the number of trees to be removed and mark them as instructed by the Engineer. No tree shall be felled without obtaining such approval from the Engineer. Authority for cutting trees shall be obtained from the Ministry of Forests and Soil Conservation who may require that the trees be measured and marked in presence of officials from the Ministry.

The Contractor shall take necessary precautions to prevent damage to structures and public property. If necessary, trees shall be cut in sections from the top downwards. In order to prevent



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damage to trees that are to be left standing, trees shall be felled towards the center of the area being cleared.

The trees shall be felled, and the roots shall be dug out as far as possible, or directed by the Engineer. The earth filling in the area where roots have been dug out shall be compacted in 200 mm layer-wise with a suitable compacting machine.

The trees shall not be burned, but shall be transported to an area designated by the Employer and shall be stacked and deposited. Such timber shall not be used by the Contractor for any purpose and the felled trees shall be property of the Employer/GoN.

The Contractor shall be responsible for any theft and unauthorized removal of the felled trees and the trees which are stacked at the designated area and finally for handing over the stacked trees to the concerned authority under the Ministry of Forest and Soil Conservation. The contractor shall maintain a register showing the number of trees felled and stored in the designated area.

Payment for removal of trees and roots including chopping branches and stem to the length as directed, transportation, loading, unloading, stacking at the designated area by the Employer shall be made in unit rate per number from Relevant Item of the Bill of Quantities.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Removal of Trees, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of excavation/embankment construction.

2.2. Notice of Commencement

The Contractor shall give to the Engineer notice of his intention to commence the Clearing and Grubbing operations. The works shall not be commenced until written approval has been received from the Engineer.

2.3. Stripping of Top Soil

Stripping shall consist of the removal of all organic materials such as sod, topsoil and roots from all embankment foundations, from areas where the excavated material is to be further used in embankments, from the base of all roads and in all other areas shown on the Drawings or directed by the Engineer, and the stockpiling or disposal thereof.

Materials from stripping which are suitable for topsoil shall be selected during stripping operations and stockpiled for further use as directed by the Engineer.

Materials not suitable for topsoil or further use shall be disposed of in spoil banks as instructed by the Engineer. Materials from stripping shall be stockpiled or disposed thereof as provided in Sub-Clause 3.1.2 of this Specification. The disposal of all materials wasted from stripping shall be subject to the approval of the Engineer.

Measurement for payment for all stripping operations shall include only the stripping, on locations instructed by the Engineer and up to a depth of 150 mm or as shown on the Drawings. Payment for stripping shall be made in unit rate per square metre from Relevant Item of the Bill of Quantities.



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Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for Stripping, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for various types of embankment construction.

2.4. Removal of Existing Structures

Existing brick or boulder or concrete (plain concrete or reinforced concrete) structures shall be removed totally or partly where shown on the Drawings or directed by the Engineer, and the materials thereof shall become property of the Contractor. The Contractor shall remove such dismantled materials from the Site as directed by the Engineer or shall be incorporated into new works as approved by the Engineer. In case that such removed materials such as boulder or concrete block are used in a new structure, no payment for such removal works shall be made under this Clause. Where a structure is removed and a new structure is not required, the Contractor shall place backfill and compact it up to the elevations of the existing ground surface as directed by the Engineer.

Payment for demolishing of existing structures at various places shall not be paid for the cost incurred by the Contractor for complying with the stipulations of this sub-clause. Total demolishing work at different places of the contract is taken as one job. All costs in connection with this sub-clause shall be considered to be included in the relevant items of the works included in the Bill of Quantities. Excavation and earth filling will be paid for separately at the respective rates of related Items of the Bill of Quantities.



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CHAPTER 3 EARTHWORKS



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CHAPTER 3 EARTHWORKS

3.1. Excavation

3.1.1. General

Excavation shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of permanent works in accordance with the requirements of these Specifications, to the lines, grades and cross-sections shown on the Drawings or as otherwise directed by the Engineer. This work shall also include the hauling and stacking, or hauling of suitable materials to sites of embankment construction, disposal of unsuitable cut materials in specified manner, dewatering and pumping, and the trimming and finishing of excavation lines to such widths, depths and profiles as shown on the Drawings, or to such dimensions and levels as may be instructed by the Engineer.

The Contractor shall give to the Engineer, at least 7 days written notice of his intention to commence excavation works on any part of the Site. Such requests shall include details of initial and final levels, drainage works, foundation layout, etc. The excavation shall not commence until written approval has been received by the Contractor from the Engineer.

If, from any cause whatsoever, excavations other than for concrete works are carried out beyond their true line and level, the Contractor shall at his own cost make good to the required line and level with approved material and in such manner as the Engineer may direct.

If, from any cause whatsoever, excavations for concrete works are carried out beyond their true line and level other than at the direction of the Engineer, the Contractor shall at his own cost fill in to the required line and level with concrete of similar grade to that intended to be used.

When any excavation has been executed and trimmed, the Engineer shall be informed accordingly so that he may inspect the completed excavation, and no excavation shall be filled in or covered with concrete until it has been inspected and the Contractor has been authorised to proceed with the work.

3.1.2. Disposal of Excavated Materials

In so far as practicable, excavated materials from canals, drains, natural rivers and structures shall be used, as much as possible, in such permanent construction works as embankments, as required under the Specifications and as per standard engineering norms and practices for the given conditions of the soil.

Except for the materials stockpiled in the yards as directed by the Engineer, excavated materials shall be deposited or disposed of in spoil banks and/or rights-of-way of canals, drains and rivers as shown on the Drawings or as directed by the Engineer. The deposited or disposed of materials shall be levelled and trimmed to reasonable lines as instructed by the Engineer.

Where practicable, suitable materials for embankments shall be excavated separately from the materials to be wasted, and the suitable materials shall be placed in the designated final locations directly from the excavation, or may be placed in temporary stockpiles and later placed in the



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designated locations, as per standard engineering norms and practices for the given conditions of the soil. The excavated materials, which are suitable for embankments, but which are too wet for immediate compaction, shall be placed temporarily in stockpiles approved by the Engineer until the moisture content is reduced sufficiently to permit them to be placed in the embankment in conformity with the Specifications.

The cost of depositing, and/or disposing of, including proper treatment of spoil banks, shall be included in the relevant excavation items of the Bill of Quantities. Only the cost of hauling the excavated materials to the spoil banks, the rights-of-way and embankment sites designated by the Engineer shall be paid as stipulated in Sub-Clause 3.5 hereof, provided that the haulage is more than 200 metres from the free-haul limit.

3.1.3. Excavation for foundation of Structures

Excavation for structures shall, under dry and wet condition as well as under water for all depths of water, include common excavation. Excavation for structures shall be carried out in a safe manner and to the lines and levels shown on the Drawings, or to such lines and levels as may be approved by the Engineer. The bottom and side slopes of excavation work against which concrete is to be placed shall be finished accurately to the dimensions shown on the Drawings or prescribed by the Engineer, and the surface so prepared shall be moistened with water and tamped or rolled with suitable tools or equipment for the purpose of securing firm foundations. If, at any point, the natural foundation material is disturbed or loosened during the excavation process or otherwise, it shall be compacted in place, or it shall be removed and replaced with suitable earth materials or concrete as directed by the Engineer and at the expense of the Contractor.

If, at any point of excavation, material is excavated beyond the established lines and grades, it shall be re-filled and compacted by tamping or rolling in layers of not more than 150 mm thickness at the Contractor's expense.

Excavation for structures shall be measured for payment in cubic metre to the lines and levels shown on the Drawings. The quantities to be measured shall be the net cubic content of the voids formed by the removal of the materials enclosed between the bottom of the footing and the existing ground level by a surface generated by vertical lines passing through the periphery of the bottom of the footing. No measurement shall be made for any excavation over the limited excavation described above. Over-excavation of width, length, cutting of slopes, shoring and planking shall be deemed as convenience for the Contractor in executing the work and shall not be measured and paid separately. Backfill to be measured shall also be limited to this void only with due consideration to the nature of the structure.

Payment of excavation for excavation by excavator, measured as above, shall be made in unit rate per cubic metre from **Relevant Item** of the Bill of Quantities. Such unit rates shall include the costs of all labour, materials and construction equipment necessary for excavation, placing the materials in spoil banks as directed, disposing of the unsuitable or surplus material, disposing of ground and surface drainage water encountered, and all work necessary to maintain the excavation in good order during construction & unit rate shall include all costs of excavation, transportation of materials from excavation sites or from temporary stockpiles including re-handling.

Payment of excavation for Canal construction in soft clay & silty soil for excavation manually, measured as above, shall be made in unit rate per cubic metre from **Relevant clause of** the Bill of Quantities. Such unit rates shall include the costs of all labour, materials and construction equipment



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necessary for excavation, placing the materials in spoil banks as directed, disposing of the unsuitable or surplus material, disposing of ground and surface drainage water encountered, and all work necessary to maintain the excavation in good order during construction & unit rate shall include all costs of excavation, transportation of materials from excavation sites or from temporary stockpiles including re-handling

3.2. Embankments

3.2.1. General

Embankments shall include the construction of all embankments for the canal, drains, roads, natural rivers, structures and filling in other parts of the Works with suitable materials obtained from the canals, drains, rivers and structures excavation, or extracted from borrow areas.

All embankments shall be constructed to the lines and levels shown on the Drawings or as directed by the Engineer. Unless otherwise specified ten (10) percent of extra filling to the embankment height from the original ground shall be made. The materials for embankment shall not contain any stumps, brush, weeds, roots, clods and any matter that may decay.

Not less than seven (7) days before he intends to commence the works, the Contractor shall submit to the Engineer for his approval the details of his proposed method of obtaining embankment materials. The Contractor shall not commence any work necessary for furnishing the materials until the Engineer's approval has been obtained.

The entire ground surface to be under an embankment shall be scarified or ploughed thoroughly to a depth not less than 150 mm, and be compacted to meet requirements as specified by these Specifications. This operation shall commence only after the completion of stripping, as specified in Sub-Clause 2.3 of this Specification.

Where the ground surface to be under an embankment is not suitable for a foundation, as determined by the Engineer, the Contractor shall strip the area to be under the embankment down to such depth as may be directed. The material so removed shall be disposed of as provided in Sub-Clause 3.1.2 of this Specification.

Before commencing embankment filling, and from time to time as may be considered necessary by the Engineer, the Contractor shall carry out compaction trials in the presence of the Engineer on each type of soil to be used. He shall carry out all necessary laboratories and field testing as required by the Engineer and shall submit to the Engineer the results of all tests.

Following the completion of compaction trials, the Contractor shall submit to the Engineer, for his approval, proposals for the compaction of each type of material. The Contractor's proposal shall include reference to the types of equipment, operating weights and tyre pressure, method of adjusting moisture content, number of passes and loose depth of each layer.

If, in the opinion of the Engineer, the results of the compaction trials indicate that the Contractor's proposed equipment and methods will achieve the densities specified, the Engineer shall approve the same.

Notwithstanding the Engineer's approval of any of the Contractor's equipment or methods, the Contractor shall at all times be solely responsible for executing the works in accordance with the Specifications.



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The entire earthwork in embankments, and backfilling of structures, shall be spread in layers of uniform thickness not exceeding 200 mm over the entire width. The moisture content of the spread material shall be checked prior to commencement of compaction. If it is found to be outside the specified limits, the same shall be adjusted by watering or drying to the permissible limits specified, only then the soil shall be compacted by mechanical rollers to not less than the specified percentages of the maximum dry density. The compacted layer shall be tested by the Contractors for checking the density and other parameters in accordance with the frequencies specified in Sub-Clause 3.2.5 of this Specification.

For embankments, if the results of the field density tests show less than the specified density in a certain layer, the whole reach will be rejected and re-compaction shall be required.

Successive layers shall not be placed until the layer under construction has been approved by the Engineer.

3.2.2. Borrow Areas

The materials used for embankments shall be obtained from excavation borrow areas proposed by the Contractor and approved by the Engineer. The maximum depth of the borrow area shall be approved by the Engineer. The Contractor shall pay to the owners of such borrow areas the cost for procurement of the materials from such privately owned areas.

Borrow pits may be situated on both sides of the embankment depending on the availability of the soil. It shall be located in places approved by the Engineer, but shall not be within ten (10) metres from the toe of a completed embankment or other works.

The Contractor shall explore the possibility of utilising the borrow pits in future as fish ponds by the owners of the land. In case the owners wish to use borrow pits as fish ponds, the depth of the pits may be up to 3 m. In such cases, the borrow pits shall not be continuous over lengths of more than 100 m. A strip of no less than 30 m at the level of the original ground shall be left between the pits.

In other cases the Contractor shall arrange borrow areas in such a manner that the ground elevation of so arranged borrow areas will be more or less the same as the neighboring area, so that rain water will not stagnate in the borrow areas. The arrangement shall be to the full satisfaction of the owner of the borrow area and the Engineer, or as otherwise directed by the Engineer.

Except where provided elsewhere, no direct payment shall be made for the operation and maintenance of borrow pits, including clearing, stripping, excavation and any other works to acquire the embankment materials from the borrow areas. These costs shall be included in the appropriate unit rates for the embankment for which materials are used from the borrow areas.

3.2.3. Embankment Construction

Before the material for the first layer of the embankment is placed, the foundation for the embankment shall be prepared, as provided for in Sub-Clause 3.2.1 of this Specification hereof, and shall be moistened or dried and compacted in the manner hereinafter specified.

The material shall be deposited in horizontal layers and thickness of each horizontal layer, after compaction, shall not be more than 200 mm in any case. All lumps or clods of heavy clay shall be thoroughly broken down by means of proper instruments, and moisture control of the materials shall



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be thoroughly carried out so as to ensure the specified dry density. Compaction shall not be permitted until the moisture content of the soil has been adjusted and approved by the Engineer.

Moisture content, checked in accordance with IS 2720 (Part II), at the time of compaction shall be between 97 per cent and 103 per cent of the Optimum Moisture Content.

The natural moisture content and the optimum moisture content of the material shall be checked before compacting it. If they are found to be outside the specified limits, the same shall be made good. Where water is required to be added, water shall be sprinkled from a water tanker fitted with a sprinkler capable of applying water uniformly and then thoroughly mixed in the soil by blading or harrowing until uniform moisture content, as specified, is obtained throughout the depth of the layer.

If the material delivered is too wet, it shall be dried by aeration and exposure to sun, until the moisture content is acceptable for compaction.

The Contractor shall have deemed to have taken into account the fact that the materials encountered may vary widely with respect to their in-situ moisture content and the moisture content at which the materials are to be compacted. Accordingly, the materials may have to be wetted by adding water, or dried to the required degree, along with intimate mixing of the entire mass of the materials.

When the materials have been satisfactorily conditioned, it shall be compacted by pneumatic tired rollers, sheep-foot rollers, tamping rollers, vibrating rollers, steel-tired rollers, vibration rollers with pad-foot or by mechanical tampers upon the Engineer's approval after spreading the materials horizontally. Hand tampers shall not be permitted. Where mechanical tampers are used to compact soils in confined areas, they shall be equipped with suitably shaped heads to obtain the required density.

Where placing and spreading operations will be carried out by hand method which deposits materials directly from the excavation by human power, with the Engineer's approval, the materials shall be thoroughly compacted by mechanical tamper or other approved means. Hand tamper will not be permitted. The distribution of materials shall be such that the tamped materials will be homogeneous and free from lenses, pockets, streaks or other discontinuities.

The dry density of the soil in the compacted materials shall not be less than ninety five (95) percent of the maximum dry density as determined by the Standard Proctor Compaction Test (ASTM: D698-42T) for the materials being compacted with a probability of maximum ten (10) percent failure except as otherwise directed by the Engineer. The minimum number of samples for testing shall be as specified in Sub-Clause 3.2.5 of this Specification hereof.

Unless otherwise permitted by the Engineer, embankment shall be constructed evenly over the full width. The surface of the embankment at all time during construction shall be maintained at such a cross-fall as to prevent pounding of rain water.

Different layers shall be constructed one after another. In the time that might elapse between the acceptance of a lower layer and the placing of the overlying layer, if any damages such as cracking, rutting, corrugations, pot holes, erosion, etc. are caused to the lower layer due to whatever reasons, such damages shall be repaired by the Contractor at his own cost. The methods employed for



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repairing damages shall include scarification with re-compaction or reconstruction using new materials, as directed by the Engineer.

Finishing operations shall include the work of shaping and trimming the side slopes to conform to the levels, cross-sections and dimensions shown on the Drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain. Embankment slopes after trimming work shall be compacted by mechanical tamper or approved means.

3.2.4. Measurement and Payment

Measurements for payment of embankment construction as canal bank and guide bund shall be made from the new ground level after the stripping for the material placed to the prescribed lines, grades and dimensions shown on the Drawings or as directed by the Engineer

Payment for embankment construction by excavated earth material shall be made in unit rate per cubic meter from Relevant Item of the Bill of Quantities, which unit rate shall include all costs of placing materials in layers, furnishing water, moistening or drying the materials and compacting the materials as provided in this Sub-Clause, and trimming and compacting the slopes, including all costs of labor, materials and construction equipment. Payment for embankment construction by borrowed earth material shall not be paid separately which unit rate shall include all costs of excavation, transportation of materials from excavation sites or from temporary stockpiles including re-handling, if required, to the place of final use, and the costs of placing materials in layers, furnishing water, moistening or drying the materials and compacting the materials as provided in this Sub-Clause, and trimming and compacting the slopes, including all costs of labor, materials and construction equipment.

3.2.5. Field Embankment Tests

The Contractor shall carry out tests to determine the natural and optimum moisture content and the maximum dry density of soils in a given area. Then the Engineer shall determine the allowable moisture content range of the materials and the maximum thickness of each layer after spreading. The Engineer may change the allowable moisture content range of the materials prescribed in Sub-Clause 3.2.3 of this Specification hereof after field embankment tests.

The frequency of tests shall be as follows:

Particle Size:	every 2,000 cu.m or every change in source
Atterberg's Limits:	every 2,000 cu.m or every change in source
Moisture Density Relationship:	every 2,000 cu.m or every change in source
Natural Moisture Content:	every 500 sq.m
Field Density:	every 500 sq.m

No separate payment shall be made for the field embankment tests. All costs of furnishing, materials, labours, construction equipment and executing, the field embankment tests shall be included in the unit rates for applicable embankment items in the Bill of Quantities.



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3.2.6. Soil Sampling and Testing

The Contractor shall carry out control tests on fill materials as required in the Specifications, as and when required by the Engineer. The Engineer shall have unrestricted access to soil laboratories and their test results. Tests required are:

Moisture content	IS 2720 Part II or BS 1377 - 1A
Grain size analysis	BS 1377 - 7B and 7C
Liquid limit	BS1377 - 2A
Plastic limit	BS1377 - 3
Compaction test	IS 2720 Part VIII
Field density tests	Earth Manual, USBR

The Contractor shall provide the necessary equipment, labour and transport for carrying out the sampling and testing in the Site laboratory. The soil samples shall be stored and tested at the Site laboratory under the supervision of the Engineer.

3.3. Backfill for structures and foundations of core wall in river

The materials used for backfill of structures shall be suitable material for embankment construction, unless otherwise specified and obtained from excavations for structures, canals, drains and rivers or from borrow areas as directed by the Engineer. Backfill material shall be placed in layers, each with a maximum thickness of 200 mm. unless otherwise specified, the placing and compacting of all backfill/sand fill materials shall conform to the applicable requirements of Sub-Clause 3.2 of this Specification.

Moisture content, checked in accordance with IS 2720 (Part II), at the time of compaction shall be between 95 per cent and 105 per cent of the Optimum Moisture Content.

Prior to the commencement of placing backfill, all materials adjacent to structures such as concrete wastage, forms, stones, etc. shall be cleared to the satisfaction of the Engineer. Backfill materials shall be placed in such a manner as will ensure satisfactory compaction without damage to the structure. Compaction adjacent to all structures shall be carried out by engine-driven tampers, small vibratory rollers or approved hand tools.

The surface of the backfill or sand fill material shall be compacted so as to give a slightly cambered surface to facilitate drainage, and the backfill material shall be watered or allowed to dry, if necessary, in order to maintain or achieve the specified moisture content for compaction.

The dry density of the soil in the compacted materials shall not be less than ninety-five (95) per cent of the maximum dry density as determined by IS 2720, Part VIII.

Compaction of backfill materials above placed concrete shall not be permitted with vibrating rollers within 1.0 metre vertically of the surface of the concrete, except with the prior approval of the Engineer.



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Measurement for payment of backfill or sand fill for structures shall be made for the materials placed to the lines to which the structural excavation was measured according to the prescribed lines, grades and dimensions shown on the Drawings or as directed by the Engineer. Filling beyond the original ground line shall be deemed to be embankment.

The back filling shall be measured in cum. of finished and accepted work. Payment for backfilling shall be made in unit rate per cum. **from Relevant Item** of the Bill of Quantities. The unit rate shall be deemed to include the cost of furnishing all labour, material, incidentals for carrying out the work and all other procedures specified herein.

3.4. Tolerances

Permitted tolerance on levels and dimensions for earthwork shall be as stated below provided that the cross-sectional areas of channels, bed widths, and road surface widths shall not be less than those shown on the Drawings.

Description	Main canal	Drains	Road
Bed Level	+0 mm - 100 mm	+ 0 mm -100 mm	-
Side Slope (from positions shown on the Drawings)	± 150 mm	± 150 mm	± 150 mm
Bank Top Level	not lower than specified level plus extra filling		± 50 mm

The Contractor shall make due allowances for consolidation and settlements of embankments. The levels and dimensions shall be within the tolerances specified above at the end of the Defects Liability Period. The cost of such allowances shall be included in the rates.

3.5. Haulage of Excavated and Borrowed Materials more than 200 m

In the event that haulage of excavated/borrowed materials exceeds a free-haul limit of 200 metres, the haulage shall be counted as a cubic metre-kilometre which defines one cubic metre of excavated material hauled one kilometre in excess of the free-haul limit. Payment for the haulage exceeding a free-haul limit of 200 metres shall be made only for the excavated materials wasted to



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spoil banks, or excavated/borrowed materials carried for use in the embankment works, or backfill work as directed by the Engineer.

Unless otherwise specifically provided, no separate payment shall be made for the haulage of boulders or cobbles for rip-rap work, masonry work and gabion work, gravel or crushed aggregates and sand for concrete works, and gravel for wearing course and filters.

Measurement of the quantity of materials shall be made in cubic metre for the compacted volume in the embankment or backfill in case of borrowed materials and in the actually excavated volume in case of spoil materials as specified. The haulage distance shall be measured along the shortest direct route between the centre of excavation or borrow area and the centre of embankment, or backfill, or disposed area, as determined by the Engineer, regardless of haulage route actually run.

Payment for haulage shall be made at the unit rate per cubic metre-kilometre determined by the Engineer from Relevant Item of the Bill of Quantities, regardless of the methods and the type of equipment used for haulage, including loading and unloading, the materials.

Where a particular Bill/Sub-Bill of the Bill of Quantities does not include an item for this item of work, no separate payment shall be made for such work and all costs therein shall be deemed to be included in the unit rates for respective excavation/embankment /backfilling works.



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CHAPTER 4 CONCRETE WORKS



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CHAPTER 4 CONCRETE WORKS

4.1. General

4.1.1. Standards and Codes of Practice

All concrete work shall be carried out in accordance with IS 456:2000 unless otherwise specified herein. Conversion of stresses and densities in KN shall be made using the following factor:

$$1 \text{ KN} = 102.0 \text{ kg (force)}$$

4.1.2. Drawings, Calculations and Method Statements

Before commencement of the concrete works, the Contractor shall submit to the Engineer for his approval:

- Detailed Method Statements with related working drawings necessary for the construction, transportation and placing at site
- Detailed calculations
- Detailed construction drawings
- Detailed drawings of formwork

The Method Statement shall contain, among others, details about the following, but shall not be limited to:

- Detailed time schedule showing the preparation, production, testing and placing activities
- Details about material sources
- Construction method
- Details about placing the concrete
- Details of the vibration system to consolidate the concrete during construction
- Details of cooling system (method)
- Details of the curing system
- Transportation method
- Placing method
- Quality control system and quality assurance plan, etc.

4.1.3. Costs of Testing and Sampling of Concrete and Concrete Materials

The costs of all sampling, transport of samples and testing in connection with the concrete shall be in accordance with the Conditions of Contract and these Technical Specifications and such costs are to be borne by the Contractor. These costs shall be deemed to be included in and covered by the unit rates for concrete as shown in the Bill of Quantities.

4.1.4. Failure to Meet Specified Requirements

If the specified requirements have not been met, the Contractor shall take such remedial action as the Engineer or Engineer's Representative may order, and shall, before proceeding further



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with concreting, submit for their approval details of the action proposed to ensure that the concrete still to be placed in the Works shall comply with the Specifications.

4.2. Materials

4.2.1. Cement

4.2.1.1. Quality and Type

The cement to be used in the Works shall be ordinary Portland cement complying in all respects with IS 8112:1989 & IS 12269-1987. For the purposes of cement testing under IS 8112:1989 & IS 12269-1987, the Site shall be deemed to have a tropical climate.

4.2.1.2. Tests on Cement

Before any cement is ordered in quantity or brought on to the site, the Contractor shall submit to the Engineer a detailed list of the sources, country or countries of origin and manufacturer's brand names of the types of cement which he proposes to use.

The Contractor shall submit to the Engineer, without charge, test certificates relating to each consignment of cement. Each certificate shall show that a sample of the consignment has been tested by the manufacturer or by an approved laboratory and that it complies in all respects with the requirements of the Technical Specifications.

The cement will be tested in accordance with and shall meet the requirements of the IS Code. When required by the Engineer the Contractor shall supply to the Engineer samples of cement taken on delivery to, or during storage on the Site, for testing at the Contractor's laboratory without extra charge.

No cement from any consignment shall be used without the approval of the Engineer and the Contractor shall maintain a record of the locations of the concrete made from each consignment which record shall be available for inspection by the Engineer. If for any reason the Contractor wishes to vary the source, country or manufacturer in respect of any type of cement at any time during the Contract, he shall give adequate notice of every such variation and shall carry out all tests called for by the Engineer on the proposed substitute cement, and shall obtain written approval of the variation before ordering any substitute material.

The Engineer may call for new tests, at the Contractor's expense, in particular if the cement has been stored for a long time, to check the cement is still conforming to the requirements.

4.2.1.3. Delivery and Storage of Cement

Cement shall be delivered to the site in properly sealed bags or other approved containers, stamped with date of delivery and marked sound. Cement from abroad, except from India, shall be packed in sealed plastic bags inside the paper bag. Cement shall be delivered in quantities sufficient to ensure the proper progress of the Works and the quantities held in stock on site shall be to the approval of the Engineer.

Each consignment of cement shall be stored separately so as to provide easy access for inspection and testing. After they have been approved by the Engineer, consignments shall be used in the order in which they were delivered. Any cement which shall prove to have been exposed to damage by water will be rejected upon delivery.

Cement delivered in bags shall be stored in a weatherproof, waterproof and reasonably airtight building provided solely for that purpose. The floors of the building shall be raised at least 30



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cm above the ground level to prevent the absorption of moisture. It is not permitted to store bags to a greater height than 2 metres. Storage in the open may be permitted on small works by the written authority of the Engineer, in which case the cement shall be placed on a raised platform and amply protected by waterproof coverings to the approval of the Engineer.

Cement, when being conveyed to the site in Lorries or other vehicles, shall be adequately protected from the weather and from contamination by dust, sand or any organic materials. In the case of delivery of cement in bulk, the cement shall be stored in a properly designed silo. The silo must be provided with walls properly insulated against sun radiation.

No cement shall be taken from the storage, unless it is needed for immediate use.

4.2.1.4. Cement Measured by Weight

All cement used in the Works shall be measured by weight. Cement from partly filled or unsealed bags shall not be used.

4.2.1.5. Rejection of Cement

Notwithstanding the receipt of the test certificate as required by Sub-Clause 4.2.1.2 - Tests on Cement, and the approval of the Engineer, the Engineer may reject any cement as a result of further tests on compressive strength and chemical composition. The Engineer may also reject cement which has deteriorated owing to inadequate protection or other causes or in any other case where the cement is not to his satisfaction. Re-tests, if required, are at the Contractor's expense. The Contractor shall remove all rejected cement from the site without delay and at the Contractor's expense.

4.2.2. Aggregates

4.2.2.1. Supply and Classification

The Contractor shall make his own arrangements for procuring, crushing, grading and delivering aggregate for the Works, as required from sources to be approved by the Engineer. Separate fine and coarse aggregate shall be used for the manufacture of concrete. Aggregates shall be graded to produce a workable dense concrete.

(a) Coarse Aggregates

The term "coarse aggregate" is used to designate well graded aggregate mainly retained on a 5.00 mm, NS: 305-2050 or IS: 460 test sieve and mainly passing a 40 mm, NS: 305-2050 or IS: 460 test sieves. Coarse aggregate shall be supplied in the following primary sizes:

Size designation	Normal size range
10 mm	5 mm to 10 mm
20 mm	5 mm to 20 mm
40 mm	5 mm to 40 mm

Coarse aggregate shall consist of natural gravel or crushed rock. Friable and flaky pieces such as mica and shale shall not be present. Coarse aggregates shall be well graded within grading given in Table 4.1 and to the satisfaction of the Engineer.

Table 4.1: Percentage by Weight Passing Standard Sieves



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Sieve Size (mm)	Size Designation		
	5 mm to 10 mm	5 mm to 20 mm	5 mm to 40 mm
50.0	-	-	100
37.5	-	100	95 - 100
20.0	100	95 - 100	37 - 70
10.0	85 - 100	30 - 60	10 - 40
5.0	0 - 25	0 - 10	0 - 5

The aggregate shall be free from adherent coatings and shall, if necessary, be washed for this purpose and shall be free from sulphates.

(b) Fine Aggregates

The term “fine aggregates” is used to designate aggregate mainly passing a 0.075 mm, NS:305-2050 or IS:460 test sieve and containing only that much coarser material as is permitted for the various grading zones.

Fine aggregate shall consist of natural sand or a mixture of natural sand and crushed gravel or crushed rock. The aggregate shall not contain any flint, chert or lime. The quantity of silt, clay and dust, determined in accordance with the decantation method given in NS: 305-2050 or IS: 460, shall not exceed 3% by weight of the sample. The content of mica shall not exceed 3% by weight of the sample. The aggregate shall not contain any deleterious material in such form or in sufficient quantity as to affect adversely the quality of concrete.

The Engineer shall permit the addition of crushed gravel or crushed rock fine aggregates to the natural sand only where, in his opinion, it is impracticable to obtain the required fine aggregate grading other than by such addition. The grading of the fine aggregates shall lie within one of the grading zones as set out in Table 4.2 and specified in IS 393-1970.

Table 4.2 Percentage by Weight Passing Standard Sieves

IS Sieve Standard Mesh	Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
10.0 mm	100	100	100	100
4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100
2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100
1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100
600 μ m	15 - 35	35 - 60	60 - 80	80 - 100
300 μ m	5 - 20	8 - 30	12 - 40	15 - 50
150 μ m	0 - 10	0 - 10	0 - 10	0 - 15



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4.2.2.2. Quality

All aggregates to be used in concrete shall be clean, hard, dense, sound, chemically inert, or limited porosity and uncoated particles free from clayey or organic matter. Aggregates for concrete shall comply with related codes and the following:

- Grading: in accordance with Tables 4.1 and 4.2 herein.
- Mechanical Properties: when tested, the "Ten per cent Fines Value" shall be not less than 50 KN.
- mica content test
- Silt, Clay and Dust Fraction: when determined in accordance with the decantation method given in NS 305:2050 or IS: 460.
- Soundness: when tested in accordance with the sodium sulphate soundness test specified in ASTM C88 the aggregate shall have a percentage loss of less than 15.
- Alkali-Aggregate Reactivity: when tested in accordance with ASTM C 289 aggregates exhibiting evidence of alkali-aggregate reactivity will not be acceptable unless the Contractor can show that the proposed cement aggregate combination, when tested in accordance with ASTM C227 or other tests, will not produce deleterious alkali-aggregate reactivity, as to which the Engineer shall be the sole judge.
- Shrinkage: when determined in accordance with the BRE Digest 35 test the drying shrinkage shall not exceed 0.065%.
- Flaking Index shall not exceed 40.
- Elongation shall not exceed 40.
- Aggregate Crushing Value (ACV) shall not be more than 30%.

4.2.2.3. Testing

Testing of aggregates is to be in accordance with NS: 305-2050 or as specified herein. For each source of aggregate, and at least six weeks prior to the preparation of trial mixes, samples of aggregates together with the results of the test requirements shall be submitted to the Engineer for approval of the sources of aggregate and quality.

To check whether the aggregates contain lime, the particles shall be immersed in a 5 per cent HCL solution after crushing. The aggregate shall be rejected if the particles dissolve in the solution.

After approval has been given for any particular aggregate, a sample weighing at least 50 kg of the approved aggregate shall be retained by the Engineer as a standard against which all future samples can be compared.

Approval of a source of aggregate by the Engineer shall not be construed as constituting the approval of all materials to be taken from that source, and the Contractor shall be responsible for the specified quality of all such materials used in the Works. The Contractor shall not obtain aggregates from sources which have not been approved by the Engineer.

During the course of the Contract, the Contractor shall supply to the Engineer samples of aggregates taken in accordance with NS 305/IS 383 at a frequency of at least once a week, or as directed by the Engineer from each aggregate stockpile. The samples shall be delivered to the Site laboratory for testing under the supervision of the Engineer.

If the routine tests carried out by the Engineer show the aggregate to be not to the same standard as originally approved, then subsequent testing to obtain acceptable aggregates shall be undertaken by the Contractor at his own cost.



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4.2.2.4. Washing and Screening

Aggregates shall be washed and screened as necessary, to produce aggregates meeting the specified requirements. All such washing and screening shall be to the satisfaction of the Engineer.

Should mica be present in unacceptable quantities, its removal shall be affected by techniques approved by the Engineer. The costs of all washing and screening shall be included in the unit rates for concrete in the Bill of Quantities.

4.2.2.5. Storage

Aggregates shall be stored in separate stockpiles in such a manner that the intermingling of materials from separate stockpiles or bins is not possible, and so as to prevent contamination by mud, rubbish, windblown dust or vegetation. Aggregate stockpiles shall be provided with adequate drainage to ensure rapid drainage of the aggregates. The storage arrangements shall be to the approval of the Engineer.

4.2.3. Water

Water used in mixing and curing of concrete shall be subject to approval, and shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable or other substances injurious to the finished project.

In no case shall the water contain an amount of impurities which will cause a change in the time of initial or final set of the cement of more than 30 minutes, nor a reduction in the compressive strength of mortar of more than 10 per cent at any time of testing, when compared to the results obtained with distilled water.

Water for mixing, washing aggregates, curing and rinsing shall not contain:

- Organic <200 mg/lit;
- Inorganic <3000 mg/lit
- Sulphates as SO₃; <400 mg/lit
- Chlorides <2000 mg/lit for plain concrete
<500 mg/lit for reinforced concrete
- Suspended matter <2000 mg/lit;
- pH ≥ 6.

Furthermore, the chloride content in mixing water must be such that in no case, the total amount of chlorides in water, cement, aggregates and additives of the fresh concrete, shall exceed 0.3 per cent of the weight of cement.

The Contractor shall deliver to the Engineer, without charge, samples of the water proposed for use in the Works, for the Engineer to carry out such tests as he may require confirming its suitability. Samples will be delivered sufficiently in advance of the Works for completion of the tests before the water is required for use and at such other times during the course of the Contract as the Engineer may direct. If required by the Engineer, the Contractor shall, without extra charge, treat the water taken from any other source to such a degree as may be necessary in order to render it suitable for mixing and mortar.

4.2.4. Chemicals in Concrete

The total sulphate content, whether as gypsum or more soluble salts, of the concrete ingredients when measured as sulphur trioxide shall not exceed 4% of the weight of cement in the concrete. The chloride content of the concrete ingredients, when measured as chloride ion, shall not



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exceed 0.2% of the weight of cement in the concrete. If instructed by the Engineer, the Contractor shall obtain samples from the concrete for testing, in accordance with BS 1881, Part 6. The cost of sampling and transport shall be covered by the unit rates for concrete.

4.2.5. Admixtures

No materials of any description shall be used in any concrete mix other than aggregates, cement and water as defined in these Technical Specifications, unless specified otherwise or with the written approval of the Engineer in each and every case, or as otherwise instructed by him. The admixture to be used shall comply with IS 1999.

The Engineer shall only approve additives for which properly documented evidence is available, showing that the 28-day characteristic cube strengths produced with such additives are not less than the strengths of the corresponding plain concrete mixes. The Engineer may, in addition, order cubes to be made and tested at the Contractor's expense of concretes containing such additives before giving his approval to the incorporation of any of the proposed additives in concrete used for the permanent Works.

Additives (if applied) shall not produce concretes which are less dense, more porous, have inferior surface structures, or are more susceptible to humidity or temperature movement than the corresponding plain concrete mixes. Determination of water-soluble chlorides in concrete admixture shall be determined as per IS 6925. The additives shall be free from chloride ions. Additives shall be used with caution and every care shall be taken to prevent over-dosage.

The Contractor should note that any commercial description of any additive issued by manufacturers shall not be accepted when proposing such an additive for the approval of the Engineer. In order to save delay, the Contractor shall submit the complete description about the chemical composition of any additive, and of its anticipated effect on the particular mixes in which it is proposed to be used, including the reason for its necessity.

All additives shall be supplied to the Works in containers or packages clearly marked with the recommended dosage for each type of mix in which they are to be used.

As far as possible, powder additives shall be supplied in individual sacks containing the exact amount for one charge of a standard mixer. Liquids or powders, which are to be used as solutions, shall be dispensed by means of an appliance fixed to the mixer, whereby weight, volume or dosing time can be recorded.

All additive dispensers shall be thoroughly cleaned before commencing each day's work and at every interruption of the Works.

Samples for checking the calibration and dosage of additives shall be taken at regular intervals and records kept to enable correlations to be made with test cubes and the positions of concrete containing additives in the structure.

Any cement containing additives shall be supplied in bags or containers clearly marked to show the nature and quantity of such additives, and shall be stored separately from any other type of cement.

Before using any additive or combination of additives in any mix, the Contractor shall be required to prepare trial batches of concrete, at his own expense, for the approval of the Engineer to



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establish the compatibility of the additives with the cements and aggregates actually in use on the Site. As far as possible, such trial batches shall be mixed and compacted under similar conditions of temperature and humidity to that likely to be experienced by the bulk of the concrete to be used in the Works.

Selected specimens from these trial batches shall be tested at suitable times for hardness, colour match, surface finish, water absorption and density, and shall be compared with similar specimens of plain concrete without additives. The compaction, workability and slump of the mixes with and without additives shall be similarly compared.

Notwithstanding any previously given approval, the Engineer may withdraw such approval at any time with respect to any mix containing additives if the performance of the particular additive under actual site conditions is not completely satisfactory.

Any batch of concrete which has received an excessive dose of an additive or which shows deterioration after placing, as a result of incorrect use of additives, shall be cut out or otherwise replaced at the Contractor's expense. Claims for extra payment caused by delay, due to the rejection of any additive or mix containing an additive, will not be accepted. In case plain mixes are not adequate and additives are required, the Engineer reserves the right to specify other particular additives and/or methods. The price quoted by the Contractor for concrete works shall be deemed to include the cost of mixing, transporting, placing and compacting concrete containing additives when applicable.

These provisions shall also cover the use of additives in special grouts used for grouting the steel Seal Plates.

4.3. Concrete Properties/Tests and Placing /Compaction

4.3.1. Concrete Properties and Tests

4.3.1.1. Classes and Grades of Concrete

The concrete used in the Works shall be of the grades or classes shown on the Drawings or indicated in the Bill of Quantities or instructed by the Engineer. The characteristics of the mixes of concrete to be used in the Works shall be as given in Table 4.3 unless otherwise approved by the Engineer.

4.3.1.2. Maximum Sizes of Aggregate to be used

Unless shown on the Drawings or given in the Bill of Quantities, the maximum size of coarse aggregates in concrete for any part of the Works shall be the largest of the sizes given in Table 4.3. The Contractor shall obtain the approval of the Engineer for the maximum size of aggregates in each section of the Works.

4.3.1.3. Compressive Strength Compliance

The compressive strength of the concrete shall be based on the compression testing of 150 mm concrete cubes, made and tested in accordance with IS-516, on the testing equipment installed by the Contractor in the Site Laboratory under the supervision of the Engineer.

The compressive strength of the concrete is specified by the specified compressive strength in Table 4.3 for each grade of concrete. The concrete in the Works shall be considered to comply with the compressive strength requirements specified in Table 4.3 if not more than 5% of the 28-day cube



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compressive strength test results fall below the specified compressive strengths and the 28-day cube strengths shown in Table 4.4 are equal or exceeded.

Table 4.3: Classes of Concrete

Concrete Classes	M40	M25	M 20			M 15		M 10
Grades	M 40/20	M 25/20	M 20/40	M 20/20	M 20/10	M 15/40	M 15/20	M 10/40
Maximum Aggregate Size (mm)	20	20	40	20	10	40	20	40
Specified Compressive Strength (N/sq.mm.)	40	25	20	20	20	15	15	10
Minimum Cement Content (kg/cu.m.)	375	375	330	330	330	290	290	220
Maximum Cement Content (kg/cu.m.)	425	425	400	400	400	400	400	400
Maximum Water to Cement Ratio	0.5	0.5	0.50	0.50	0.50	0.55	0.60	0.60

The tentative use of the above classes of concrete shall be as follows:

Class	Use of Concrete
M 40	- Precast Piles, Heavy Diversion Structures, Wearing coat
M 20	- Reinforced concrete at important and/or thin parts/sections
M20 with abrasion resistant compound	- High abrasion prone Reinforced concrete at important and/or thin parts/sections
M 25	- Precast Units, water retaining structures
M 15	- Reinforced concrete at less important and/or thick parts/sections - Plain concrete at less important and/or thin parts/sections
M 10	- Plain concrete at less important and/or thick parts/sections - Mass concrete - Levelling/Lean concrete

The standard deviation (st.) in Table 4.4 shall be determined from cube results of at least 40 separate batches of concrete for each concrete grade produced on the Site from similar materials by the same plant under similar supervision. When 40 cube results are not available and for the initial mix designs the value of the standard deviation shall be taken as Table 4.5.



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The concrete represented by a group of four consecutive test cubes shall include the batches from which samples were taken to make the first and last cubes in the group of four, together with all the intervening batches. If only one cube result fails to meet the minimum individual cube strength given in Table 4.4, then the result shall be considered to represent only the particular batch of concrete from which that cube was taken, provided that the average strength of the group of four results in which the low cube occurs satisfies the second requirement of Table 4.4. The action to be taken in respect of the concrete represented by test cubes which fail to meet the compliance values given in Table 4.4 shall be determined by the Engineer which may range from qualified acceptance in less severe cases, to rejection and removal.

Table 4.4: Cube Strength Compliance Values

Concrete Grade	Minimum Individual Cube Result (N/sq.mm.)	Mean of any Four Consecutive Cube Results (N/sq.mm.)
M 40/20	34	$40 + 0.825 \text{ st}$
M25/20	21.1	$25 + 0.825 \text{ st}$
M 20/40	17	$20 + 0.825 \text{ st.}$
M 20/20	17	$20 + 0.825 \text{ st.}$
M 20/10	17	$20 + 0.825 \text{ st.}$
M 15/40	12.8	$15 + 0.825 \text{ st.}$
M 15/20	12.8	$15 + 0.825 \text{ st.}$
M 10/40	8.5	$10 + 0.825 \text{ st.}$

Table 4.5: Standard Deviation for Mix design

Concrete Grade	Standard Deviation (N/sq.mm)
40/20	9
25/20	9
20/40	9
20/20	9
20/10	9
15/40	6
15/20	6



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10/40	4
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4.3.1.4. Water Cement Ratio

The maximum water cement ratios specified in Table 4.3 shall be the ratios by weight of free water to cement in the mix based on the aggregates being in a saturated surface dry condition. Throughout concrete production the actual water cement ratio shall be strictly monitored and the batch quantities of aggregates and water regularly adjusted to maintain the design water cement ratio.

4.3.1.5. Workability

Concrete shall be of such consistency that it can be readily worked into the corners and angles of the formwork and around reinforcement without segregation of the materials or bleeding of free water at the free surface or against formwork. On striking the formwork the concrete shall present a face which is uniform, free from honeycombing, surface crazing, or excessive dusting, and which shall not, in the opinion of the Engineer, be inferior to the specified standards. Concrete to be placed underwater shall have high workability such that the specified strength is achieved without compaction.

Concrete workability shall be as low as practical for the placement and workability and shall be within the limits given in Table 4.6 unless otherwise approved by the Engineer.

Table 4.6. Range of Slump Values

Type of Concrete	Slump (mm)
Precast Concrete	10 to 50
Mass Concrete and Plain Concrete	25 to 75
Reinforced Concrete	50 to 100
Underwater Concrete	100 to 200

4.3.1.6. Mix Design

The Contractor shall prepare trial mixes having workability, strength and surface finish as criteria, to satisfy the Engineer regarding these qualities. The trial mixes shall be made and compacted in the presence of the Engineer, using the same type of equipment as will be used for the Works. Not later than 56 days before commencement of concreting operations, the Contractor shall inform the Engineer in writing about mix designs he proposes to use, and his target slumps for the various Items. The Contractor shall then conduct trials on mixes for each type, at least 45 days before concreting commences and at no extra cost to the Contract. These trials shall not cease until the Contractor has demonstrated that the requirements of these Technical Specifications have been met.

From each trial mix, preliminary 150 mm test cubes shall be made in sets of nine for testing after 28 days. The preliminary cubes shall be made, cured and tested. They shall be tested by the Contractor in a nominated laboratory in the presence of the Engineer and the certified copies of the results of all tests shall be submitted to the Engineer. The trial mix proportions shall be approved if the average of the nine cubes tested at 28 days exceeds the values specified Table 4.7.



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From the same mix as that from which the preliminary test cubes are made, the consistency of the concrete shall be determined by the compacting factor test. The remainder of the mix shall be cast in a wooden mould and compacted.

Table 4.7: Average Compressive Strength for Trial Mix Proportions.

Concrete Class	Average Compressive Strength (N/sq.mm)
40/20	40 + 1.64 st. - 3.5
25/20	25 + 1.64 st - 3.5
20/40	20 + 1.64 st. - 3.5
20/20	20 + 1.64 st. - 3.5
20/10	20 + 1.64 st. - 3.5
15/40	15 + 1.64 st. - 3.5
15/20	15 + 1.64 st. - 3.5
10/40	10 + 1.64 st. - 3.5

After 24 hours the sides of the mould shall be struck and the surface examined in order to satisfy the Engineer that an acceptable surface can be obtained with this mix. When a proposed mix has been approved, no variation shall be made in the mix proportions, grading zone or source of any of the constituents without the consent of the Engineer.

4.3.1.7. Concrete with Abrasion Resistant Compound

The use of abrasion resistant compound in concrete may be required under the contract to promote abrasion resistance properties in the finished concrete. The Engineer shall determine the location for such concrete works and instruct the contractor or shall be shown in the drawings. In such case the specification of such compound shall be as follows:

Material	: Natural Volcano Ash
Main Ingredient	: SiO ₂ above 85%
Characteristics of material	: Amorphous
Particle Size	: Less than 40 mm
Specific Surface Area	: More than 60,000cm ² /gm
Combination of all in one	: Strength enhancement, Durability, Water proofing, Abrasion Resistance
Permeability	: Less than 90% of normal cement within one hour
Dosage	: About 5% of cement by weight

The Contractor shall submit to the Engineer full details of the admixture he proposes to use as abrasion resistant compound and the manner in which he proposes to add it in the mix. The information provided shall include:



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- 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. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- iv. Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so the extent to which it does so.
- v. Details of previous uses of the admixture in Nepal.

The chloride ion content of any admixture shall not exceed 1 per cent by weight of the admixture nor 0.02 per cent by weight of the cement in the mix.

Admixtures shall not be mixed together without the consent of the Engineer.

4.3.1.8. Works Cube Tests

During the course of the Works and at such time as the Engineer may direct, 150 mm test cubes of concrete shall be made on site, cured and tested in a nominated, or in the Contractor's laboratory. Particular care shall be taken to ensure that the test cubes are stored under uniform conditions throughout the year, including a complete covering of damp thick jute sheet or similar approved material, constantly sprayed with water whilst in the mould and during any transit between site and laboratory, and also including subsequent storage immersed in water kept strictly within the specified temperature range.

If the cubes fail to attain the target average strength during an initial work test, additional tests may be required and the concrete which they represent shall be removed and replaced by concrete complying with the Technical Specifications to the satisfaction of the Engineer. In this case no extra costs can be claimed by the Contractor.

The cost of sampling, making and curing work test cubes, together with the provision of the cube moulds, all other necessary equipment and apparatus and the packing and transport to the laboratory, shall be included in the rates. All cubes shall be marked at the same time of casting with the date, the class of concrete and other necessary remarks to identify the part of the Works, from which such cubes were taken.

If, in the opinion of the Engineer, the quality of the concrete gives reason to perform additional tests, the Contractor shall make supplementary cubes. Payment for this is deemed to be included in the rates.

4.3.1.9. Frequency of Tests

During manufacture and placing of concrete, unless otherwise directed by the Engineer, at least two samples of each pour during each day, but not less than two samples for each 50 cu.m of concrete, shall be taken. All samples shall be random samples, taken in the presence of the Engineer, moulded and cured and tested in accordance with the requirements of IS: 1199.

The concrete shall be compacted by hand and well covered with wet gunny bags, all in the shade. After 24 hours in the mould the cubes shall be taken out and put in water. They shall be kept there until sent to the laboratory, well covered with wet gunny bags. In the laboratory the cubes shall be kept in water until being crushed, unless otherwise specified. The curing water at the site shall be



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well shaded and the temperature of the water shall be recorded daily using a maximum and minimum thermometer.

Unless otherwise instructed, each set of cube tests shall consist of 6 cubes, three cubes shall be crushed 7 days after mixing, and three cubes shall be crushed 28 days after mixing. The day of casting is to be clearly marked on the cubes. The results of the concrete cube tests shall be assessed in accordance with IS 1199.

The strength requirement shall be deemed to be satisfied if the 7-day cube strength is not less than three fourths of the specified 28-day cube strength for work tests. If the work cube strength derived from these tests do not reach the desired value, the mix shall be redesigned at no extra cost to the Employer.

The Engineer may direct the non-destructive test to the contractor for the completed portion of the concrete work as necessary. No separate payment will be paid for such tests.

4.3.1.10. Concrete Cores

If the results for the compressive strength of the concrete do not fulfil the requirements as stated in the foregoing Item, or if, in the opinion of the Engineer defects of workmanship during construction give rise to doubt as to the strength, durability and/or safety of the structure or part thereof, supplementary testing may be performed.

If, in the opinion of the Engineer additional testing is necessary, at least six concrete cores shall, where ordered by the Engineer, be drilled or cut from the work and tested in accordance with IS 1199. The cores shall be approximately 150 mm in diameter and, where possible, have a height/diameter ratio of two, the correction factor given in IS 1199 shall be applied to give the equivalent strength of a cylinder having a height/diameter ratio of two.

If the compressive strength of the cores, adjusted for height/diameter ratio and age, fails to attain the characteristic compressive strength at 28 days as specified above, the concrete which they represent shall be cut out, removed and replaced with concrete to the satisfaction of the Engineer at no extra cost. The cost of sampling, drilling or cutting and preparing cores, together with the provision of equipment and apparatus and the packing and transporting to the Employer's laboratory shall be included in the rates.

4.3.1.11. Water and Slump Tests

A check on the moisture content of the aggregate shall be made before concreting begins, for the purpose of assessing the amount of free water to be added at the mixer.

The Contractor shall provide himself with a chart, a copy of which shall be given to the Engineer for approval, relating moisture content in aggregate to water to be added at the mixer for the class of concrete in use. The amount of water introduced into the mix shall be strictly controlled and shall be the minimum amount consistent with complete compaction.

The device for measuring water shall show accurately the quantity, and be so designed that the water supply will be automatically cut off while water is being discharged into the mix. Frequent slump tests shall be carried out in accordance with IS 1199 on samples of concrete taken immediately before placing to determine the consistency of the concrete. The slumps of the trial mixes shall be recorded for identification purposes and for subsequent use as a rough routine check on quality.



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However, slump shall not be used as an officially acceptable measure of the workability of any concrete.

4.3.1.12. Weight Batching and Mixing

Materials for the concrete shall separately be proportioned by weight in an approved weigh-batcher and shall be thoroughly mixed in a mixer of an approved size and type so as to ensure a uniform distribution of the materials throughout the concrete. The majority of the concrete will have to be produced in a mixture plant of sufficient capacity for continuous casting of large quantities of concrete.

Under no circumstances shall concrete be mixed with more than one type of cement in any one batch. The Engineer may, at his discretion, forbid the mixing or placing of any concrete if he considers the ambient temperature too high. The Contractor may also be required by the Engineer to carry out frequent cleaning of equipment to remove deposits of hardened or dried concrete which accrete rapidly at high air temperatures. All hazards attaching to the batching and mixing of concrete under the climatic conditions at the site shall be deemed to be contingencies of the Contract and the Contractor shall make whatever allowances which he may consider necessary for ensuring the production of concretes complying fully with this Technical Specifications under any climatic conditions at any time during the Contract and to the entire satisfaction of the Engineer.

4.3.1.13. Ready Mixed Concrete

Ready mixed concrete may be used only with the approval of the Engineer and shall comply with all requirements of the Contract. The concrete shall be carried in purpose made agitators, operating continuously, or truck mixers, which shall comply with BS 4251, or similar approved. For each batch of concrete, the time of introduction of cement and water to the aggregates shall be recorded and forwarded to the Engineer. Water shall be added either at the delivery point or at the central batching plant. In no circumstances shall water be added in transit.

Concrete shall be discharged and placed within one hour after the time of loading, or other such time as may be found necessary and approved by the Engineer to ensure that the concrete has the required workability at the time of discharge and placing. The time of loading shall be the time of contact between the cement and aggregates or, when these are surface dry, between cement and added water.

4.3.2. Placing and Compaction

4.3.2.1. Preparatory Works

The Engineer's approval in writing shall always be obtained before any concrete is placed in the Works.

The formwork or area of disposition shall be cleaned as specified in Sub-Clause 4.4 of this Specification.

All construction equipment and materials required, or which may be required, during the concreting work and for cooling and curing, shall be on site and fully prepared for the work. The Engineer's approval to place concrete will only be given after all these preparations and other relevant requirements of the Technical Specifications have been carried out and complied with.



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If concreting is to be executed at night or when otherwise daylight is not sufficient, the Contractor shall provide for sufficient lamps on site so that all elements of the site relevant for the concreting will be clearly visible.

Struts, stays and braces, serving temporarily to hold the formwork for structures in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their services unnecessary. These temporary members shall be entirely removed from the formwork and not buried in the concrete. If necessary and/or directed by the Engineer, the Contractor shall cool any formwork that has become overheated or exceptionally dry through prolonged exposure to the sun. The Contractor shall ensure that all shuttering retains sufficient humidity content and does not become shrunken or warped. All soaking or spraying of shuttering shall be done with pure water. The Engineer may forbid altogether the placing of concrete in any formwork which he judges has become too hot and/or dry and that concrete members cannot be satisfactorily produced there from.

No extra payment for cooling or soaking formwork shall be claimed, and costs incurred by the Contractor, due to shuttering becoming too hot or dry, shall be deemed to be included in the rates.

4.3.2.2. Depositing in Works

The methods of conveying and depositing concrete shall be such as to prevent segregation of the materials, and shall be approved by the Engineer before concreting begins.

Concrete shall be deposited directly in the Works, without the need for rehandling, as soon as possible and not more than initial set has taken place. Transportation, deposition, placing, handling, compaction and finishing of concrete surface, all works shall be finished within the initial setting time of Cement. In no any circumstances shall all the process from mixing to finishing be delayed from the initial setting time of cement. If any delay has occurred after mixing and the concrete has begun to set, it shall not be used in the Works and shall be removed from the Site. Normally, concrete for structures may be deposited at a maximum vertical height of 1.50 metres without the use of tubes, provided suitable measures are taken to prevent segregation and premature coating of upper reinforcing steel.

When placing operations involves dropping concrete from more than 1.50 m height, it shall be deposited through sheet metal slides or other approved pipes. As far as practical, the pipes shall be kept full of concrete during placing and their lower ends shall be kept buried in the newly placed concrete.

Concreting of any section or unit of the Works shall be carried out in one continuous operation and no interruption of the concreting will be allowed without the approval of the Engineer.

Where deposition of concrete has to be interrupted, precautions shall be taken to ensure satisfactory adhesion of later batches of concrete to that previously placed. Where delays of more than one hour occur between successive concreting operations in one section or unit of Works, concreting shall only be resumed when, in the opinion of the Engineer, the previously placed concrete has had ample time to harden and the resulting joint shall be treated as a Construction Joint within the meaning and description of the Sub-Clause 4.7.1.1 of this Specification.

When concrete is being placed, a competent steel fixer shall be in continuous attendance to adjust and correct the position of any reinforcement which may be displaced. The Contractor shall



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take care that during, and immediately after, depositing in the work of the concrete, the concrete will not be contaminated by dust, organic matter or other foreign material.

Concrete that, in the opinion of the Engineer, has been contaminated will be regarded as inferior and shall be dealt with as described in Sub-Clause 4.3.2.9 of this Specification.

Transportation of concrete directly over the fixed reinforcement during the depositing shall not be allowed without proper provisions to avoid displacing or any other harm to the reinforcement.

4.3.2.3. Depositing Concrete under Water

A retarding agent shall be added to the concrete and Ordinary Portland cement according to IS 8112:1989 & IS 12269-1987 shall be used. The cement contents shall not be less than 400kg/cu.m of concrete. The consistency shall be such that the concrete will flow out evenly from the tremie tube.

Concreting shall commence immediately after approval of the bottom of the wall and after the reinforcing cage has been placed. If concreting has not been started within four hours after cleaning the bottom of the wall, the cleaning shall be repeated at the Contractor's expense. Continuity of concrete placing is essential.

Concreting of a wall shall be carried out without construction joints and executed under bentonite by the tremie method. The bentonite level within the wall shall be kept at a constant elevation, well above ground or water elevation outside the casing. The tremie tube shall be filled with concrete while slowly lowering a valve or plug. The tremie tube shall, at all times, be kept full of concrete up to the bottom of the hopper, while the discharge end shall be kept sufficiently submerged (2 to 6 m) in already deposited concrete to prevent surging of bentonite into the tube. The location of the discharge of the tremie tube, relative to the surface of deposited concrete, shall be kept under strict supervision at all times. If, by accident, the concrete in the tremie tube sinks below the bottom of the hopper, the tube shall be refilled in such a way that no air or bentonite is trapped in the tube.

The first 0.5 cu.m of concrete to be deposited in a wall may consist of grout, with a consistency and quality corresponding to the rest of the concrete in the wall.

Concreting shall be continued to such a level above the theoretical cut-off elevation (minimum 300 mm) in order to ensure the concrete below this cut-off elevation is of a satisfactory quality. The cut-off elevations are as shown on the Drawings unless otherwise directed by the Engineer.

After one week of hardening of the concrete the top of the wall shall be cut-off at the theoretical cut-off elevation without damaging the reinforcement or the concrete under the specified cut-off level, and in such a way as to produce a horizontal bearing surface.

4.3.2.4. Depositing in Layers

Concrete shall be deposited in approved quantities and in horizontal layers of such thickness as to permit thorough compaction, expel air and bond with the layers below. However, in no case shall the thickness of the layer be deeper than 0.30 m. Each layer shall be placed and consolidated before the preceding batch has started its initial set.

If, for unforeseen reasons, it is necessary to stop concreting before completion of the layer then construction joints as specified shall be formed and further concreting will be suspended for at least 24 hours.

4.3.2.5. Compaction of Concrete



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All concrete shall be thoroughly compacted immediately after deposition to expel air and to ensure the concrete is in full contact with all contained and embedded surfaces. Vibrators shall be used for compacting, unless otherwise specified or ordered by the Engineer. The type of vibrator to be used is subject to the approval of the Engineer. Vibrators of the immersion type shall have a frequency of 5,000 - 8,000 vibrations per minute for concrete with a slump of more than 80 mm and a frequency of 9,000 - 12,000 vibrations per minute for concrete with a slump less or equal to 80 mm. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the formwork.

The Contractor shall also provide at least a 50 per cent duplication of all vibration equipment as standby during any period of concreting.

Vibrators shall not be allowed to come into contact with the reinforcement or formwork and great care shall be taken to avoid over-vibration causing segregation or pockets in the finished mass. All personnel handling vibrators shall be trained in their proper use.

Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the formwork over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the formwork.

Every care shall be taken to see that reinforcement and fittings attached to the formwork are not disturbed and that no damage is caused to concrete that has already set or to the internal face of the formwork by using immersion type vibrators. In areas of congested reinforcement, it may be necessary to use small diameter poker and the Contractor shall supply suitable sizes of poker for each part of the work. Vibration of concrete by hammering the formwork with hand tools shall not be permitted.

Concrete that, in the opinion of the Engineer, has been compacted in a way that does not conform to the Technical Specifications as described above will be regarded as inferior and shall be dealt with as described in Sub-Clause 4.3.2.9 of this Specification.

4.3.2.6. Construction Joints

Construction joints shall be made only where located on the drawings prepared by the Contractor and approved by the Engineer. Construction joints shall be formed only on horizontal planes. Construction joints shall comply in all respects with Sub-Clause 4.7.1.1 of this Specification.

4.3.2.7. Concreting in Unfavourable Weather

Concreting shall not be permitted during heavy rain or stormy weather or when the concrete temperature rises above 32°C on discharge from the mixer. When the air temperature exceeds 25°C, concreting will only be permitted after special precautions, approved by the Engineer, have been taken to prevent early setting of the concrete, such as using chilled mixing water, keeping the aggregates and shutters continuously sprayed with water and erection of temporary sun shades over the working area. During concreting operations, the temperature of the placed concrete shall be recorded. The minimum internal temperature of the concrete within 24 hours after casting in place should not be more than 30°C in excess of the ambient temperature or more than 60°C.

Since the temperatures in the project area frequently exceed 25°C the Contractor shall submit a Method Statement, describing all special precautions as described above for the approval of the



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Engineer as required by Sub-Clause 4.1.2 of this Specification. Prior to giving his approval, the Engineer shall solicit the advice of the Employer. No concreting shall be allowed before approval of the Contractor's Method Statement.

The measures to be taken shall generally comply with the requirements and/or recommendations as described in ACI 305-R77 ("Hot weather concreting").

All cracks wider than 0.3 mm caused by thermal stresses or other causes shall be repaired by the Contractor, by injecting epoxy-resin with a low viscosity. The epoxy resin shall be subject to the Engineer's approval. Any additional cost in connection with the above-mentioned preparations and injections with epoxy-resin shall be included in the unit rate of concrete works.

4.3.2.8. Curing of Concrete

Until a period of 7 days has elapsed from the time of placing the concrete, it shall be kept protected against loss of moisture, rapid temperature change, rain and flowing water, mechanical injury and contamination by airborne dust and/or sand. All methods to be used for curing and protection of freshly placed concrete shall be subject to the prior approval of the Engineer. These methods shall include the use of curing membranes, watering, damp covers, shades and/or any other precautions that the Engineer may require.

Curing membranes shall be sprayed on the surface of the concrete as soon as all free water has evaporated from the surface. In the case of forms that have been eased or struck before 7 days have elapsed from the date of placing concrete, the curing membranes shall be applied immediately after the shutter has been removed.

In the case rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions.

The Contractor shall submit details of the curing procedure he proposes to use, to the Engineer for his approval.

During very hot weather conditions, the Contractor may be required to cool and/or wet formwork containing concrete by spraying with water and this shall be carried out where directed notwithstanding and whatever other measures the Contractor may employ for the curing of the concrete.

All materials, spray equipment and an ample supply of water for curing shall be ready on site before any concreting starts. The quality of water used for curing shall comply with Sub-Clause 4.2.2.3 of this Specification.

The Contractor may submit for the Engineer's consideration alternative methods of curing which will achieve a result at least as good as those specified, and the Engineer shall approve or reject such alternative methods without any reason being given. Concrete that is, in the opinion of the Engineer, not cured according to the approved curing procedure will be regarded as inferior and shall be dealt with as described in Sub-Clause 4.3.2.9 of this Specification.

4.3.2.9. Faulty Work



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Any portion of the work which is honeycombed or otherwise inferior shall, on the written instruction of the Engineer, immediately be cut out and reconstructed in an approved manner without extra charge. Plastering of defective Works shall not be permitted.

4.3.2.10. Record of Concreting

All pre-cast concrete elements shall have the date of casting engraved on them before the concrete has fully hardened. Any undated elements may be liable to be rejected by the Engineer. The Contractor shall take all measures necessary for the curing and protection of the elements after fabrication.

4.3.2.11. Cast-in Parts

The cast-in parts, such as lifting lugs, steel plates to fit the Rubber Seals, nosing angles, supporting structures, etc. shall be fixed in the positions as indicated on the Drawings or as directed by the Engineer.

Anchor bolts must be free from rust, dirt or grease and be properly stored before using. The delivering, processing and fixing of the cast-in parts shall be deemed to be included in the rates for the steel structures.

4.3.2.12. Blockouts

Concrete blockouts shall be formed where metalwork and other various items specified under the Contract are to be installed by the Contractor. Where blockouts are to be made, the concrete surfaces shall be chipped, roughened, cleaned and kept moist for at least 4 hours. After such surfaces have been approved by the Engineer and the metalwork and such other items as specified above have been installed in position, the Contractor shall place reinforcement (if required) and cement concrete of M15 grade or concrete of the same type as that specified for the surrounding concrete, whichever is of a higher grade.

If blockouts are filled with concrete as specified above, care shall be taken that the freshly placed concrete is tightly bonded to the previously placed concrete and that complete adhesion between the concrete and all metalwork and other items in the blockouts is obtained.

The cost of making and backfilling blockouts shall be included in the unit rate of the respective concrete types in the Bill of Quantities.

4.3.2.13. Grouting

All grout required to be used for spaces under readymade equipment metalwork (gates, guides etc.,) or as may be required by the Engineer shall be furnished by the Contractor. Unless otherwise specified, all materials shall conform to the requirements specified herein for concrete. Grout shall consist of one-part Portland cement to three parts sand by volume with sufficient water to obtain a consistency suitable for the intended use. All grouting operations shall be performed in the presence of the Engineer.

4.3.3. Measurement and Payment of Concrete

Measurement of concrete for payment shall be made only to the neat lines of the structures as shown in the Drawings or as established by the Engineer. In measuring concrete for payment, the volume of all cavities, depressions, openings, embedded pipes, woodwork and metalwork, except reinforcement bars, anchor bolts and bars, shall be deducted.



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Payment for concrete of M10 (1:3:6) grade will be made in unit rate per cubic metre from relevant **item** of the Bill of Quantities, concrete of M20 (1:1.5:3) grade will be made in unit rate per cubic metre from relevant **item** of the Bill of Quantities. The unit rate shall include the cost of all labour and materials required in the construction, including furnishing and handling cement and exclude the costs of furnishing and placing concrete forms and reinforcement bars. No separate payment shall be made except for items expressed in Bill of Quantities for construction joints, grouting, and other incidentals and all costs in connection therewith shall be considered to be covered by the unit rate of concrete.

4.4. Formwork

4.4.1. General

Formwork shall include all temporary moulds for forming the concrete, including the 'herring bone' steel, together with all temporary structures required to support such moulds. The Contractor shall submit drawings and calculations showing details of the formwork he intends to use, to the Engineer for approval. The drawings and calculations shall be in accordance with the provisions stipulated in Sub-Clause 1.04.3 of this Technical Specification.

The drawings shall show the materials proposed and indicate details of construction, such as sizes of members and spacing, and position of waling, struts, bolts and wedges. Formwork shall not be constructed until the drawings and the calculations, if applicable, have been approved by the Engineer. Such approval shall not relieve the Contractor of the responsibility for the sufficiency of the formwork. Any changes or modifications to the formwork required by the Engineer shall be borne by the Contractor.

Formwork shall be of suitable design and substantial construction to carry the loads resulting from placing and vibrating wet concrete and any incidental loads such as construction loads, wind and other forces, without inadmissible bulging, distortion or deflection. Formwork shall be sufficiently tight to prevent loss of water or mortar from the concrete. Special attention shall be paid to formwork where pokers or shutter vibrators are to be used.

4.4.2. Materials for Formwork

Formwork for the concrete structures shall be made from plywood or steel. The plywood shall be resistant to deterioration by water and shall be fixed and jointed in such a manner as to give a perfectly smooth and even finish to the concrete. It shall have a thickness of not less than 17.5 mm.

The steel formwork shall be accurately aligned and with close fitting joints. The outside of the steel formwork shall be painted in a light colour to prevent extreme temperatures due to solar radiation. Only with the approval of the Engineer can formwork be made from good quality seasoned timber, free from loose knots, shakes and warped surfaces. This timber shall not be less than 30 mm in thickness and the board faces in contact with concrete and the board edges shall be planed smooth and joints shall be tongued and grooved.

The Contractor shall submit to the Engineer, before commencing construction, a set of forms complying with the above requirements, but such submission to the Engineer or approval by him shall not relieve the Contractor of any of his responsibilities under the Contract for the successful completion of the structure.



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4.4.3. Fixing of Formwork

Formwork shall be fixed in perfect line and true plane, with no crevices and joints, and shall be securely braced, supported and wedged so as to retain its position without displacement or deflection during the placing and compaction of the concrete.

Joints in formwork shall be made so that no leakage of grout can occur from the concrete. All joints shall be either horizontal or vertical, unless the form of the finished concrete requires them to be otherwise. Chamfers measuring 30 mm by 30 mm are to be made to all exposed edges of concrete, unless otherwise indicated in the Technical Specifications or ordered by the Engineer.

Subject to the approval of the Engineer, internal ties may be used. All such fastening shall be so arranged that when the forms are removed, no metal left permanently in the work shall be within 50 mm of any surface.

The use of wire ties for supporting the forms shall not be permitted in concrete walls which are to be subject to water, or when the finished surface, required as determined by the Engineer, is to be permanently exposed; wire ties used for other concrete works shall be cut off flush with the concrete surface, after the forms are removed.

Connections shall be so formed as to permit the easy removal of the forms without hammering, etc., and without the necessity of levelling against the surface of the concrete.

Adequate access holes shall be left for the purpose of inspecting, cleaning out the forms and for placing and compacting the concrete.

Scaffolding (if required) shall be firmly constructed to the satisfaction of the Engineer. No separate payment shall be made for scaffolding.

Before placing any concrete, all bolts and the like (if required and which are to be built in) shall be fixed in their correct positions, and cores and other devices for forming holes, openings, etc., shall be fixed to the forms. No holes shall be cut in any concrete unless approved by the Engineer.

Surfaces of the forms to be in contact with concrete shall be free from adhering foreign matter, projecting nails and the like, grooves, splits or other defects.

A non-staining commercial mineral oil or other approved material shall be applied to the faces of the forms before concreting to prevent adherence to the concrete. Care shall be exercised to prevent the material applied to the faces of the forms from coming in contact with the reinforcement, but if this should inadvertently occur, the reinforcement shall be cleaned to the satisfaction of the Engineer.

When forms have been built and have been prepared ready for concreting, they will be inspected by the Engineer and no concrete shall be placed until the forms have been approved by him. In order to avoid delays in obtaining approval, the Contractor shall inform the Engineer, at least 24 hours in advance, of his intention to have the forms ready for inspection.

4.4.4. Dimensional Tolerances

Any deviation on the minus side in measurements of the finished concrete works is not permitted. Unless specifically indicated on the duly approved Drawings, tolerances on the plus side can only be accepted up to a range of 4% at the most with a maximum of 5 mm.



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4.4.5. Cleaning and Re-using of Shuttering

Before any concrete is placed, the forms shall be properly cleaned and washed out with water and air under pressure to remove saw-dust, shavings and all other foreign matter. All water shall then be trained and mopped out from the formwork.

If side forms are to be re-used, all surfaces shall be cleaned and shall be completely free from remains of concrete or mortar.

If, in the opinion of the Engineer, moulds are not acceptable for re-use, they shall be either properly repaired or be substituted by other moulds. Substituting moulds shall comply with the requirements as specified above.

4.4.6. Removal of Forms

Forms shall be removed only under skilled supervision and in such a manner as to not damage the concrete. Forms shall not be removed before the concrete is sufficiently set and hardened. Nevertheless, the forms shall not be struck without the prior approval of the Engineer. The minimum periods which shall elapse between placing concrete and the removal of the forms are given in Table 4.8.

Table 4.8: Removal of Forms

Type of formwork	Minimum net period before removal in days
Vertical : Columns and walls	2
Soffit : Slabs	5
Beams	8
Drops : Slab	16
Beams	18

Compliance with the above requirements shall not relieve the Contractor of his obligation to delay the removal of the forms if the concrete has not sufficiently set. Due to variations in site temperatures and depending on the curing conditions, the Engineer may, at his discretion, vary the time listed above.

Any damage to the concrete, which may occur by the removal of the forms or by overloading, shall be fixed at the Contractor's expense and to the satisfaction of the Engineer.

4.4.7. Finishing of Concrete

Surface finishing shall be classified as follows:

- Ordinary finish;
- Wire Brush finish.
- Power Trowel finish



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4.4.7.1. Ordinary Finish

If not otherwise specified, exposed surfaces shall be given an ordinary finish. Immediately following the removal of forms, fins and irregular projections shall be removed from surfaces. On all surfaces, the cavities produced by form ties and all other holes, broken corners or edges, and other defects shall be thoroughly cleaned, and after having been thoroughly saturated with water shall be carefully pointed and trued with an approved non-shrinkable polymer modified cement mortar with at least the same qualities of the adjacent concrete. The concrete shall then be rubbed if required or cured. Construction joints in the work shall be left carefully tooled and free of mortar and concrete. The resulting surfaces shall be true and uniform.

Exposed surfaces not protected by forms shall be struck off with a straight-edge and finished with a wood float to a true and even surface. The use of additional mortar to provide a grout finish will not be permitted.

4.4.7.2. Wire Brush Finish

All surfaces that will come into contact with cementitious grout or epoxy bonding grout shall be ridged finished by means of a wire brush.

As soon as the forms are removed, and while the concrete is still comparatively green, the surface shall be thoroughly and evenly scrubbed with stiff wire or fibre brushes, using a solution of muriatic acid in the proportion of one part acid to four parts of water until the cement film or surface is completely removed and the aggregate particles are exposed, leaving an even pebbled texture presenting an appearance grading from that of fine granite to coarse conglomerate, depending upon the size and grading of aggregate used. When the scrubbing has progressed sufficiently to produce the texture desired, the entire surface shall be thoroughly washed with water to which a small amount of ammonia has been added, to remove all traces of acid.

4.4.7.3. Power Trowel Finish

Where indicated in the drawings as power trowel finish, the surface will be finished with a steel trowelled 3 mm thick floating coat of neat cement.

Immediately after trowelling and removing excess laitance, well-mixed cement slurry consisting of ordinary Portland cement or coloured cement and water solution shall be mixed with hardener and sprinkled over the surface in a uniform layer at maximum rate of 2.5 kg per square metre. The cement slurry shall then be steel trowelled perfectly smooth.

4.4.8. Measurement and Payment

Measurement of formwork for payment shall be in square metre. Measurement shall be made only for the forms that have been used and approved by the Engineer. Payment for formwork measured shall be made in unit rate per square metre from relevant **item** of the Bill of Quantities. The unit rate shall cover the cost of furnishing all labourers, equipment and materials, erecting and removing the forms and scaffolding, staging, falsework and all incidental costs necessary to complete the works to the required dimensions and shape, including chamfering in accordance with these Specifications and as instructed by the Engineer.

4.5. Reinforcement Steel

4.5.1. Material and Tests

Reinforcement steel shall include the steel bars in reinforced concrete structures as well as the steel bar supports, and shall be laid in accordance with the approved Drawings.



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Steel reinforcements shall be of grade Fe 415 and shall comply with the requirements of IS: 1786-1985. However, high strength deformed steel bars of grade Fe-500 and Fe-550, having elongation more than 14.5 percent and confirming to other requirements of IS: 1786-1985 may also be used.

When required by the Engineer, the Contractor shall submit three copies of mill sheets of steel bars for the approval of the Engineer before each shipment, and inspection at site will be made by the Engineer in accordance with the Specifications and the above mill sheets.

The Contractor shall prepare test specimens of steel reinforcement to be used in the works. Test specimens shall be taken in the presence of the Engineer and shall be of a size sufficient to carry out the specified test.

The test specimens shall be tested in an approved laboratory and the certified copies of the results of the tests shall be submitted to the Engineer. The specimen shall be tested for bending and tensile properties. The methods and requirements for testing shall be carried out in accordance with the applicable specifications of NS-333-2050.

If necessary, other equivalent National Standards may be substituted after obtaining the approval of the Engineer.

If ordered by the Engineer, test procedures shall be repeated at the Contractor's own expense for any new supply of steel reinforcement.

4.5.2. Storage of Steel Reinforcement

Steel reinforcement shall be stored above the ground on platforms, skids or other approved supports, and shall be protected from mechanical injury and surface deterioration caused by exposure to conditions producing rust. Different types and dimensions of reinforcement shall be kept separately.

4.5.3. Preparation of Reinforcement Drawings

The Contractor shall prepare, at his own expense, all detailed reinforcement and bending drawings. The drawings shall include all bar-placing drawings, bar-bending schedules, bar lists, and any other reinforcement drawings as may be required to facilitate fabrication and placement of reinforcement bars.

Reinforcement drawings shall be submitted to the Engineer for approval. Reinforcement drawings and bar lists prepared by the Contractor shall conform to the standard practices of the industry.

4.5.4. Bending of Steel Reinforcement

Steel reinforcement shall be cut from straight bars, free from kinks and bends or other damage, and bent cold by experienced competent workmen. Bar diameters greater than 19 mm shall be bent in a bending machine designed for the purpose and approved by the Engineer. Any steel that has already been bent shall not be re-bent at the place of the previously made bend. Dimension for bending shall be in accordance with the requirements as set out in IS, SP 24.

4.5.5. Placing Reinforcement Steel

The number, size, form and position of all reinforcement steel bars, fabric, ties, links, stirrups and other parts of the reinforcement shall be placed in exact position in accordance with the



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Drawings and kept in the correct position in the forms without displacement during the process of vibrating, tamping and ramming the concrete in place. The Contractor shall provide all necessary distance pieces and space bars at his own cost to maintain the reinforcement in the correct position.

Correct positioning will be achieved with the use of stays, blocks, ties, hangers or other approved supports. Blocks for holding the reinforcement from contact with the forms of adjacent reinforcement shall be precast concrete mortar blocks of approved shapes and dimension consisting of 1:2 cement/sand mortar. The Contractor shall provide evidence that mortar is of the same quality and density as the surrounding concrete. The water tightness of the mortar blocks shall be at least similar to the concrete into which they are concreted. The blocks shall be fitted with a semi-circular hollowing and double bent poured-in 16-gauge annealed steel wire. The use of pebbles, pieces of broken stone or brick, or other materials shall not be permitted.

Any ties, links or stirrups connecting the bars shall be taut, so that the bars are properly braced, the inside of their curved parts shall be in actual contact with the bars around which they are intended to fit. Bars shall be bound together with the best black annealed mild steel wire which is subject to the Engineer's approval, and the binding shall be twisted tight with proper pliers. The free ends of the binding wire shall be bent inwards.

Before any steel reinforcement is embedded in the concrete, any scale, loose rust, oil, grease or other deleterious matter shall be removed. Partially set concrete which may have adhered to the exposed bars during concreting operations shall likewise be removed.

When the reinforcement has been placed and is ready for concreting, it will be inspected by the Engineer, and no concrete shall be placed until the reinforcement has been approved by him. The Contractor shall inform the Engineer at least 24 hours in advance of his intention to have the reinforcement ready for inspection.

4.5.6. Splicing of Reinforcement Steel

All steel reinforcement shall be furnished in full length as indicated on the Drawings. Welding or Splicing of bars, except where shown on the Drawings, shall not be permitted. Splices shall be staggered. Welding of the bar shall not be permitted.

When it is necessary to splice reinforcement bars at points other than any shown on the Drawings, position and methods of splicing shall be determined based on strength calculations and approved by the Engineer. In lapped splices, the bars shall be lapped 20 times the diameter of the bar or the following, whichever is larger. No hooks shall be required for lap joints, unless otherwise specified.

The lap length shall be calculated as follows:

i. For tension reinforcement bars

$$l = \frac{f_y}{4 \tau_{bd}} \phi$$

where, f_y = Yield strength of reinforcement steel.

τ_{bd} = Bond strength of concrete.



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$\varnothing$ = Diameter of reinforcement bar

1 = Lap length

(ii) For compressive reinforcement bars

80 per cent of "1" calculated by the above formula.

When gas pressure welding of joints is used, the operation shall be made by conforming to the following requirements:

- The welding equipment shall be so designed as to hold both bars to be jointed in a straight line, applying pressure of more than 3 kg/sq.mm to the contact surface of the bars.
- The blowpipe shall emit a constant flow of gas, and its diameter shall be suitable for the diameter of the bars to be welded.
- Oil, rust, paint, and dust shall be completely removed, by a grinder, from the surfaces to be jointed.
- The edge surface of bars to be jointed shall be inclined to the axis of the bar at more than 80 degrees, and shall be so planed that the clearance between bars being in contact shall not be more than 4 mm.
- Bars to be jointed shall be butted with pressure of more than 1 kg/sq mm. The pressure shall be increased gradually with heating, until the diameter of the joint portion increases to 1.2 times the original diameter of the bars.
- The joint portion shall be heated uniformly with more than two blowpipes. Flames shall always completely cover the heated portion.
- After jointing, the joint shall not be cooled rapidly by rain, etc. Re-jointing shall be made, when inflation of the joint portion is insufficient.

4.5.7. Cover to Reinforcement Steel

The concrete cover to reinforcement shall be as shown on the Drawings, or as directed by the Engineer. Unless otherwise specified on the Drawings, the concrete cover on the steel reinforcement shall be at least 50 mm, if the concrete is subject to exposure to soil or water. In other cases, a cover of 40 mm shall be acceptable.

The Contractor shall provide any necessary cement pads for ensuring that the cover is attained, and in no case may the use of pebble, pieces of broken stone or brick, or other packing materials be permitted.

4.5.8. Measurement and Payment of Reinforcement Steel

Measurement for payment of furnishing and placing reinforcement bars shall be made only for the weight of the bars placed in the concrete in accordance with the Drawings, or as directed by the Engineer. Clips, ties, wastage, overlaps, spacer bars, annealed wire or other material used for positioning and fastening the reinforcement bars in place shall not be measured for payment. Only reinforcement bars in laps indicated on the Drawings shall be included in the measurements for payment. Payment for furnishing and placing reinforcement bars shall be made in the unit rate per Kg of relevant **item** of the Bill of Quantities, which unit rate shall include the cost of furnishing reinforcement bars, furnishing and attaching wire ties and metal supports, if used, and of delivering, unloading, hauling, storing, sorting, cutting bending, cleaning, placing and securing, and maintaining in position all reinforcement bars, as shown on the Drawings, or as directed by the Engineer.

4.6. Steel Construction and Other Items to Be Cast-In



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The work covered by this item shall include cleaning, placing and fixing of all structural metalwork, miscellaneous steel and non-ferrous metal items, to be cast-in or bolted-in the grooves according to these Technical Specifications and the Drawings.

The metalwork and other items to be cast-in shall, among others, consist of:

- lifting provisions for stop logs, anchor bolts, gates
- steel seal support
- steel gate supporting plates, nosing angles, timber guiding beams in the groove conforming to the dimensions shown on the Drawings, ladder, trash rack gauges, etc.

The Contractor shall provide templates and other auxiliary equipment for the correct positioning of the construction. Further details concerning metal works are described in Technical Specifications.

The Contractor shall ensure that all the items to be cast-in are on site in scheduled time, in order to avoid interruptions during the execution of the Works. If recesses are provided, these shall be sufficiently larger in size than the dimensions of the structure to be cast-in.

The screw thread of anchor bolts or other items shall be protected in advance and cleaned and greased immediately after filling or grouting.

The tolerances of the sealing plates, after installation, shall be such that during the commissioning test the deflection of the rubber sealing in all sections shall be limited to 20-30 mm.

Payment for the items to be cast-in shall be made in accordance with relevant item for various items included in the Bill of Quantities.

4.7. Joints

4.7.1. General

4.7.1.1. Construction Joints

The location of all construction joints in concrete work shall be subject to approval by the Engineer, and the joints shall be constructed as specified herein.

Construction joints are joints which are placed in structures to facilitate construction, or which occur in structures as a result of inadvertent delays in concrete placing operations. Construction joints are to be placed to reduce initial shrinkage stresses and cracks, to allow time for the installation of embedded metalwork, or to allow for the subsequent placing of other concrete, blockout concrete, or second stage concrete.

All vertical members such as columns and walls shall be in place for not less than four (4) hours, before any concrete is placed in concrete elements directly over such columns or walls. Before placing is resumed, all excess water and fine materials, which have risen to the top, shall be removed and the concrete shall be cut away as may be necessary to ensure a strong and dense concrete at the joint. The surface of construction joints shall be clean, rough, and dry when covered with fresh concrete or mortar. Cleaning shall consist of the removal of all laitance, loose or defective concrete, coatings, sand, sealing compound if used, and other foreign materials. The surfaces of construction joints shall be wet-sandblasted, washed thoroughly with air-water jets, and surface dried prior to placement of adjoining concrete. Construction joints in beams and slabs shall not be permitted, except where the Engineer approves.



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Where construction joints are made in plain and reinforced concrete of monolithic construction other than beams, a tongue and groove joint and reinforcement bars equal in area to not less than 0.25 per cent of the surfaces to be connected and forty (40) diameters in length shall be provided unless otherwise shown on the Drawings.

At horizontal construction joints which will be exposed, the concrete shall be struck off at the level of the top of the form sheathing or shall be carried about 12 mm above the underside of a 25 mm high by 12 mm thick strip set level on the form. Beams, brackets, column capitals, and haunches shall be considered as part of the floor system and shall be placed monolithically therewith. Where new concrete is to be bonded to existing concrete, the existing surface shall be cleaned and roughened thoroughly in order to remove all laitance and loose matter.

Unscheduled construction joints in structures requiring water tightness shall have waterstop approved by the Engineer. Such joints shall be located by the Contractor so as to least impair the strength of the structure and shall be subject to the approval of the Engineer.

4.7.1.2. Contraction Joints

Contraction expansion joints, of the types shown on the Drawings, shall be provided in walls, floors, beams, footings, and foundations where indicated on the Drawings, or directed by the Engineer. The joints shall be made by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. The surface of the concrete first placed at the contraction joint shall be coated with bitumen or other materials so as to avoid bond.

Water stops, specified in Sub-Clause 4.8 of this Specification hereof, shall be provided where so shown on the Drawings, or as directed by the Engineer. All the joints shall be provided with dowel bars of plain round steel bars, as specified in Sub-Clause 4.9 hereof.

4.7.1.3. Measurement and Payment

Based on the type of joints and the works performed to make the joints the works to be measured and for which payment shall be made, are the works to furnish and to place waterstop, form works, dowel bars, Joint filler, Joint sealer, bituminous paint as per their use. The measurement of each work item shall be made as specified elsewhere and payment shall be made at the unit Rate per Unit from Related items of the Bill of quantities.

4.8. Rubber Seal/PVC Water Stopper

4.8.1. Scope

The Contractor shall furnish and install PVC water stopper work of polyvinyl chloride in the shape and dimensions specified, and in the locations as shown on the Drawings, or as directed by the Engineer. For convenience of placement in forms, a PVC water stopper work utilizing a split flange may be used; however, prior to placement of final concrete, the split flange portion shall be jointed in an approved manner such that no concrete or mortar can enter between the two split portions of the flange.



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Unless otherwise specified, two kinds of Rubber Seal, 230 mm wide PVC water stopper work shall be used depending on the magnitude and importance of the works as designated on the Drawings or as directed by the Engineer.

4.8.2. Material

PVC water stopper work shall be manufactured by the extrusion process from an elastomeric plastic compound, the basic resin of which is one hundred (100) per cent polyvinyl chloride (PVC). The product shall be dense, homogeneous and free from holes and other imperfections.

The PVC water stopper work as described herein shall have the following physical properties as per IS: 15058:2002

Specific gravity	1.33 + 0.03 at 23°C	
Tensile strength, min.	13.8 Mpa	(IS8543 Part 4-sec 1)
Ultimate elongation, min	285%	(IS8543 Part 4-sec 1)
Brittleness	- 25°C	(Annex of IS 9766)
Hardness (Shore-A) min	65	(IS 13360 Part 5 sec 1)
Maximum water absorption	0.6	Annex of IS:5058:2002

The Contractor shall provide the Engineer with a sample to be used in the Works and the manufacturer's test certificate for the Engineer's approval, before issuing the purchasing order to the suppliers, and shall, if requested, supply a sufficient length of each sample for confirmatory tests to be carried out in accordance with the appropriate test procedure, at the Contractor's own expense.

4.8.3. Workmanship

The Contractor shall furnish all materials, equipment and electric power required for making field splices and installing the Rubber Seal. Field splices for PVC water stopper work shall be made by cutting the PVC water stopper work as required, heating the ends to the melting point and jointing them to form the desired splice. The heating of the splice ends shall be made by means of the splicing machine recommended by the waterstop manufacturer or by any other approved electric heating device acceptable to the Engineer.

Care shall be taken when installing the PVC water stopper work to ensure that the centers of the PVC water stopper work coincide at the joints. The Contractor shall suitably support and protect the PVC water stopper work during the progress of the Works. The stop-boards on each side of the PVC water stopper work shall be accurately wrought to match the profile of the waterstop. The concrete shall be carefully compacted under and around the waterstop so as to leave no cavities.

4.8.4. Measurement and Payment



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Measurement for payment of PVC water stopper work shall be made for the length in meters of PVC water stopper work in place, measured along the centerline of the Rubber Seal, in accordance with the Drawings and accepted by the Engineer. Payment for waterstop shall be made at the respective unit rates per linear meter from relevant **item** of the Bill of Quantities, which unit rates shall include all costs of furnishing and placing the PVC water stopper as described above.

4.9. Dowel Bars

In the contraction joint, dowel bars shall be provided, as shown on the Drawings, or as written in BOQ, or as directed by the Engineer. The dowel bars shall be of straight plain round steel bars conforming to the requirements specified for reinforcement bars in Clause 4.5 of this Specification.

In joints, the part of the dowel bar to be free to move shall be encased in rigid PVC hose, or pipe, or metal sleeve, or other approved materials and fitted with a compressible cap of joint filler to prevent bonding and shall be placed at intervals shown on the Drawings or as directed by the Engineer. The free end of the dowel bar shall be coated with an approved bitumen bond breaking compound. The diameter of the sleeve shall be the minimum necessary to allow free sliding movement of the bar after concreting. The other half shall be bonded firmly on one side of the joint.

Measurement for payment of dowel bars shall be made for the design weight of bars actually placed in the concrete at contraction joints in accordance with the Drawing, or as directed by the Engineer. Payment for dowel bars shall be made at the unit rate per kilogram from Relevant Item of the Bill of Quantities which unit rate shall include all costs of furnishing and placing dowel bars, as stipulated above, including furnishing and providing cover materials such as PVC hose, tube or pipe.

4.10. Joint Filler

The Contractor shall supply and fix pre-moulded joint fillers in expansion joints as shown on the Drawings. Unless otherwise specified, the joint filler shall be resin bonded cork such as Expandite "Hydrocor" or similar approved. It shall be obtained from manufacturers approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions.

Resin bonded cork filler shall comply with the United States Federal Specification HH-F-341e Type II Class B with the following limitations when tested in accordance with the said specification:

- a. the load required to compress the material to 50% of its thickness shall be more than 0.035 N/sq.mm and less than 0.35 N/sq.mm.
- b. the recovery after compression to 50% of the original thickness shall be not less than 95% of the original thickness.

The Contractor shall provide the Engineer with a sample to be used in the Works and the manufacturer's test certificate for the Engineer's approval, before issuing the purchasing



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order to the suppliers, and shall, if requested, supply sufficient of each sample for confirmatory tests to be carried out in accordance with the appropriate test procedure.

The joint filler of the thickness specified shall be cut to shape, and fixed to fill the whole space between the concrete faces of the joint which is not otherwise filled by waterstop or joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent passage of cement grout.

4.11. Joint Sealer

Joint sealer shall be Expandite "Thioflex 600 based on a liquid polysulphide polymer", or similar approved. It shall be obtained from manufacturers approved by the Engineer, and shall be used in accordance with the manufacturer's instruction inclusive of the supply and application of any priming materials. An approved bond breaker shall be supplied for placing between the sealant and the joint filler.

The Contractor shall provide the Engineer with a sample to be used in the Works and the manufacturer's test certificate for the Engineer's approval, before issuing the purchasing order to the suppliers, and shall, if requested, supply sufficient of each sample for confirmatory tests to be carried out in accordance with the appropriate test procedure.

4.12. Bitumen Joint Coating

Where the Drawings show a layer of bituminous paint between concrete faces, the Contractor shall clean and dry the face to which the bitumen is to be applied and shall then paint the bitumen in two separate applications. The bitumen for coating concrete joints shall be a straight run bitumen, grade 40/50 penetration or other approved by the Engineer. Measurement for payment of bituminous paint shall be made the unit rate per square meter from Relevant Item of the Bill of Quantities actually placed in the joint in accordance with the Drawings, or as directed by the Engineer



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CHAPTER 5 MISCELLANEOUS WORKS



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CHAPTER 5 MISCELLANEOUS WORKS

5.1. HDPE & RCC Pipes

5.1.1. Scope

This Clause covers the works for High Density Polythene pipes used for conveying water as well as construction of pipe drains and culverts with or without prefabricated reinforced cement concrete pipes and/or high-density polythene pipes (HDP Pipes).

5.1.2. Materials

a. Reinforced Concrete Pipes

Reinforced concrete pipes shall comply with the requirements of NS 80/2042 or IS 458:1988.

b. HDP Pipes

HDP pipes shall comply with the requirements of NS 40/2040.

5.1.3. Excavation for pipe

The foundation bed for the pipe culverts/drains shall be excavated in accordance with Section 900 true to the lines and levels shown on the Drawing or to such other lines and depths as the Engineer may direct. The pipes shall be placed in shallow excavation of the natural ground or in open trenches cut in existing embankments, taken down to the levels as shown on the Drawing. The additional width of the trench on either side of the pipe shall be 150 mm or one-fourth of the diameter of the pipe whichever is more. Should the Contractor desire to use mechanical plant for excavating trenches or for laying pipes he shall submit his proposals for approval by the Engineer, but such approval shall not relieve the Contractor from his responsibilities in case of damage to pipes. The pipe shall be placed where the ground for the foundation is reasonable firm. Where the bottom of the trench as excavated does not provide a suitably firm foundation for the culvert, due to soft, mucky or other unsuitable material being encountered, the unsuitable material shall be excavated to such depth, width and length as directed by the Engineer. The excavation shall then be backfilled with gravel or other approved granular material which shall be properly shaped and thoroughly compacted up to the specified level.

5.1.4. Timbering Pits and Trenches

The sides of trenches shall, where required, be adequately timbered and supported to the satisfaction of the Engineer. All such excavations shall be of sizes sufficient to enable the pipes and concrete to be laid accurately and the formwork withdrawn before refilling and ramming is carried out.

5.1.5. Water in Excavation

Trenches shall be kept free from water until the pipes are installed and the joints have hardened. The Contractor shall, at his own expense, construct any sumps or temporary drains that the Engineer may consider necessary. The Contractor shall make good at his own expense, any damage caused by prolonged and excessive pumping, and shall take all precautions necessary for the safety of adjoining structures by shoring or otherwise, during the time the trenches are excavated or open.

5.1.6. Laying and Jointing Pipes

Arrangement for handling lifting, loading, transporting, unloading, storage and lowering the pipes in bed shall be such that the pipes do not suffer any damage. The pipes shall be laid true to line



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and level, commencing from the outfall. No pipes shall be laid until it has been approved by the Engineer. Pipes shall be laid such that each one is in contact with the bed throughout the length of barrel. The pipes shall be laid closely together against each other so as to obtain tight joints. Where two or more pipes are be laid adjacent to each other, they shall be separated by a distance equal to half the diameter of the pipe subject to a minimum of 450 mm. Concrete pipe culverts shall be laid on granular bedding or concrete bedding or as shown on the Drawing. The concrete pipes shall be jointed either by collar joint or flush joint. In case of collar joint, the collar shall be of reinforced cement concrete 150 to 200 mm wide according to the diameter of the pipe and having the same structural strength as the pipes to be jointed. Caulking space shall be between 13 to 19 mm according to the diameter of the pipe as specified by NS 80/2042 or IS: 458:1988. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1: 2 rammed with caulking irons. Before caulking, the collar shall be placed such that its centre coincides with the joint and an even annular space is left between the collar and the pipe. In case of flush joint, the ends of the pipes shall be spaced to from a self centering joint with a joining space of 13 mm side. The jointing space shall be filled with cement sand mortar in the ratio of 1:2. Care shall be taken to fill all voids and to see that any excess of cement mortar is neatly cleaned off while each joint is being made and any earth, cement or other material thoroughly cleaned out of the pipes. All joints shall be made with care so that the interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joint shall be kept covered and damped for at least four days. A properly fitted plug shall be well secured at the end of each pipes already laid and shall be removed only when next pipe is being laid or on completion of the culvert or drain. The trench shall be kept free from water until the joint are thoroughly set. Jointing of HDP pipes shall be done by heating as prescribed by the manufacturer.

5.1.7. Cement Mortar for Jointing

Cement mortar for jointing pipes shall consist of one part by weight of Portland cement to two parts by weight of sand. Sand shall comply with Sub-clause 4.2.2 of this Specification. The materials shall be accurately gauged and mixed in an approved manner. Cement mortar shall be made in suitable small quantities only and when required, and any mortar which has begun to set or which has been mixed for a period of more than the initial setting time shall be rejected.

5.1.8. Pipe to be left Clean on Completion

On completion, all pipe lines, drains etc., shall be flushed from end to end with water and left clean and free from obstructions.

5.1.9. Pipes Bedding and Encasing

Pipes shall be laid on granular or concrete bedding or as shown on the Drawing.

5.1.10. Granular Bedding

The pipes shall be laid on a layer of fine granular material, 100 mm thick, after the bottom of excavation has been shaped to conform to the lower part of the pipe as shown on the Drawing. The bedding material shall be well graded granular material passing 5.6 mm sieve and suitable compacted.

5.1.11. Concrete Bedding

Where indicated on the Drawing, the pipes shall be laid on grade as directed concrete confirming to Section 2000 so that the bottom of the pipe rests on concrete of the specified thickness. The thickness of the concrete below the pipe and the height to which it extends upwards shall be as indicated on the Drawing.



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5.1.12. Concrete Encasing

Where shown on the Drawing, pipes shall be fully encased in concrete as shown on the Drawing. The grade of the concrete shall be as shown on the Drawing. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete; in no instance shall the concrete be thrown directly on the pipes. The concrete shall be placed in such a way that all spaces around the pipe are completely filled with concrete. Concrete casing shall be cast in one continuous operation until completed. The upper surface of the concrete shall be struck off with a wooden screed and neatly finished off.

5.1.13. Joining New Work to Old Work

Where partial demolition is required for extension to the existing structures, the contact face shall be cut to predetermined lines and levels. The loose and fragmented material shall be removed and projecting steel cleaned and bent as directed by the Engineer. Where no partial demolition but only extension is required, the contact area shall be roughened and cleaned of all dirt and loose particles.

5.1.14. Refilling Trenches

Backfill for pipes and minor drainage structure shall be obtained from the material excavated in forming the excavation. In the event of there being insufficient excavated material or the culvert is laid close to or above existing ground level then selected backfill shall be obtained from borrow pits. All backfill whether from excavated material or borrow pits shall be of suitable material as defined in Clause 3.3 of this specification and shall have a CBR of at least 5% measured after 4 days soak on laboratory mix compacted to 93% MDD (Heavy Compaction), plasticity Index of less than 35%, maximum particle size of 40 mm and shall be compacted to a dry density of 93% MDD (Heavy Compaction) For pipe culvert which have been placed and where no concrete haunch or surround is called for, selected fill of suitable material available from the excavation shall be place in layers not exceeding 150 mm of loose thickness. The material shall be uniformly mixed with water or dried out such that the moisture content at the time of compaction is between 95% and 100% of the Optimum Moisture Content. Then it shall be compacted thoroughly. Similar selected material shall then be laid in layers, not exceeding 150 mm of loose thickness, mixed, dried or watered as necessary and carefully compacted, and brought up uniformly on both sides of the pipe up to a height of not less than 300 mm over the crown. The remainder of the trench shall then be backfilled with suitable materials, placed in layers not exceeding 150 mm of loose thickness, mixed, watered or dried as necessary and carefully compacted. All backfilling material except the top 300 mm below formation level shall be compacted to a minimum dry density of 93% of MDD (Heavy Compaction). The top 300 mm below formation level shall be placed in layers not exceeding 150 mm of loose thickness, mixed, watered or dried as necessary and carefully compacted to at least 95% of MDD (Heavy Compaction). For pipe culverts which have been constructed close to, above or where the culverts protrudes above the existing ground the backfilling under the flanks and alongside and over the culverts shall be placed and compacted in layers not exceeding 150 mm to a density of at least the density required for the material in adjoining layers of fill. All existing ground under this backfill shall be compacted to 93% MDD (Heavy Compaction) to a depth of 150mm. Backfilling shall be carried out simultaneously and equally on both sides of the culvert to avoid unequal lateral forces. In all cases there shall be cover of at least 600 mm over the crown of the culvert before construction equipment is driven over it unless protective measures approved by the Engineer have been provided.

5.1.15. Inlet and Outlet Structures and Catch pits



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Catch pits, headwalls, wing walls, aprons and other ancillary works shall be constructed in accordance with the details shown on the Drawing.

5.1.16. Opening to Traffic

No traffic shall be allowed to cross the pipeline unless the height of the filling is not than 600 mm above the top of the pipe line or is as shown on the Drawing.

5.1.17. Tests and Standard of Acceptance

The Contractor shall submit manufacturer's test certificate for each lot of pipes supplied. The test result shall meet the requirements of the Specifications. Backfilling/Refilling shall be tested in accordance with process set for respective item and all the test result shall meet the criteria specified. Compaction shall be tested in each layer of backfill, gradation of granular bedding shall be tested at least once a day and the test results shall meet the specified criteria. The pipe drains/culverts shall be constructed to the true lines and levels indicated on the Drawing or instructed by the Engineer.

5.1.18. Measurement

Pipes shall be measured along their centre between the inlet and outlet ends in linear meters of individual pipe element of each sizes, completed and accepted in place. Collar shall not be measured for payment. Excavation, bedding, concrete for encasing and backfilling works shall be measured separately in cubic meter. Ancillary works such as head walls, wing walls, etc. shall be measured as provided for in the respective Sections of these Specifications.

5.1.19. Payment

Reinforced concrete pipe as measured according to sub clause 5.1.18 of this specification shall be paid in unit rate per Running meter from **Relevant item** of the Bill of Quantity. Cost for cement jointing shall be deemed to be included in the contract unit rate of pipe. Ancillary works such as excavation, backfilling, granular bedding and/or concrete for bedding/encasing and masonry shall be paid for separately, as provided under respective Clause of this Specification.



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CHAPTER 6 : PROTECTION WORKS

6.1 Stone Works

6.1.1 Materials

6.1.1.1 Stones

Stones shall be procured from an approved source. The sources shall be the natural boulders from the rivers or from rock quarrying of granite, quartzite, or similar material having a minimum specific gravity of 2.5. The stones shall be free from seams and other defects, and shall be hard, sound and durable. Stones shall be the best available and shall be sound, durable, free from flaws and soft weathered or decomposed parts. The compressive strength shall not be less than 40 N/sq.mm. The stone and the source from which it is obtained shall be subject to approval of the Engineer before any of that material is brought to site. Stones shall be hammer dressed to the size and shape as shown on the Drawings, or as required by the Engineer, to fit the size of the structure.

6.2 Gabion Mattresses

6.2.1 Materials

6.2.1.1 Stones

Stones used for filling gabion boxes shall comply with Sub-Clause 6.1.1.1. The smallest dimension of any stone shall be at least twice that of the longer dimension of the mesh of the box. The exposed face of the boulder filled in gabion boxes shall be chiselled and trimmed.

6.2.1.2 Gabion

Gabions shall consist of steel wire mesh boxes. The steel wire shall be mild steel wire complying with IS 280-1978 or NS 169-2045. All wire used in the manufacture of the boxes, diaphragms, binding, and connecting wire shall be galvanised with a heavy coating of zinc by an electrolytic galvanising process. The weight of deposition of zinc shall be in accordance with IS 4826-1979 or NS 169-2045. Zinc coatings shall be uniform and at all points more than 25 mm from a cut end, the coating shall be able to withstand a minimum number of dips and adhesion tests specified as per IS 4826-1979. Tolerance on diameter of wire shall be ± 2.5 per cent.

For Machine made and mechanically selvedge Gabion Boxes:

Gabions shall be manufactured in the standard sizes shown below:

Gabions and mattresses shall be of the mesh type, wire diameter and box sizes as shown on the table below.

S.	Mesh	Wire Diameter (mm)	Box size	Tolerances in Box
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N.	Type	Mesh	Selvedge	Lacing	(L x B x H) m	Sizes
1	6 x 8	2.20	2.70	2.20	L = 3 m, 4 m, 5 m, 6 m B = 2 m H = 0.17 m, 0.23 m, 0.3 m	±3% on length and width and ±2.5 cm on depth
2	10 x 12	3.00	3.90	2.40	L = 1.5 m, 2 m, 3 m, 4 m	±5% on each
3	10 x 12	3.00	3.90	2.40	B = 1 m, 2 m, H = 0.5 m, 1 m	

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. Diaphragms shall be positioned in such a way that no internal dimension in a gabion box and mattress exceeds 1.0 m along length of the gabion boxes.

All boxes shall be supplied with binding and connecting wires of sufficient quantity to bind all diaphragms and closing edges.

Mechanical properties of meshes of different size

The wire mesh making the gabions and mattresses shall have the mesh size, mesh panel strength and selvedging strength (connection to selvedges) as per the table below:

Mesh Type	Nominal Mesh Opening and Tolerances		Wire Diameter (mm)	
	Mesh opening (D)	Tolerances	Mesh	Selvedge
6 x 8	60.00 mm	+18% - 4%	2.20	2.70
10 x 12	100.00	+16% -	2.70	3.40



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	mm	4%		
10 x 12	100.00 mm	+16% 4%	- 3.00	3.90

i. For Box Sizes with 0.50 m or 1.0 m thickness:

The wire shall be woven into a hexagonal mesh of 100 mm x 120 mm mesh type made by 3mm mesh wire with a minimum of three twists with a selvedge wire of 3.90 mm. The tightness of the twisted joints shall be such that a force of 7 KN is required to pull on one wire to separate it from the other wire provided that each wire is prevented from turning and the whole process is done in one plane. All edges of the boxes shall be finished with a selvedge wire. Gabions shall be manufactured in the standard sizes boxes with number of diaphragm as shown in the Bill of Quantities.

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. Diaphragms shall be positioned in such a way that no internal dimension in a gabion box and mattress exceeds 1.0 m along length of the gabion boxes.

All boxes shall be supplied with binding and connecting wires of 2.40 mm lacing wire in sufficient quantity to bind all diaphragms and closing edges.

ii. For Box Sizes with 0.30 m thickness:

The wire shall be woven into a hexagonal mesh of 60 mm x 80 mm mesh type made by 2.20 mm mesh wire with a minimum of three twists with a selvedge wire of 2.70 mm mesh wire. The tightness of the twisted joints shall be such that a force of 7 KN is required to pull on one wire to separate it from the other wire provided that each wire is prevented from turning and the whole process is done in one plane. All edges of the boxes shall be finished with a selvedge wire. Gabions shall be manufactured in the standard sizes boxes with number of diaphragm as shown in the Bill of Quantities.

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. Diaphragms shall be positioned in such a way that no internal dimension in a gabion box and mattress exceeds 1.0 m along length of the gabion boxes.

All boxes shall be supplied with binding and connecting wires of 2.20 mm lacing wire in sufficient quantity to bind all diaphragms and closing edges.

For Hand woven Gabion Boxes:



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The wire shall be woven into a double knotted square mesh of mesh size as given in Bill of Quantities. The tightness of the knotted joints shall be such that a force of 7 kN is required to pull on one wire to separate it from the other wire provided that each wire is prevented from turning and the whole process is done in one plane. All edges of the boxes shall be finished with a selvedge wire of at least 2 gauges heavier than the mesh wire. Gabions shall be manufactured in the box sizes as shown in the Drawings or as directed by the Engineer.

All boxes shall be supplied with binding and connecting wires of sufficient quantity to bind all diaphragms and closing edges.

6.2.2 Construction of Gabions

6.2.2.1 General Requirements

Before filling any gabion boxes and mattresses the Contractor shall also submit samples of gabion boxes and gabion mattresses assembled and erected, including filling, for approval, which when approved shall be retained for reference and comparison with the gabions built as part of the permanent Works. The size, type and location of the samples shall be as directed by the Engineer. Geo-textile shall be laid under gabion boxes. The geo-textile used shall comply with Sub-clause 6.3.

The measurement and payment of geo-textile shall be made in square meter for the relevant item of the Bill of Quantities.

Gabion boxes/mattresses shall be assembled and erected; including filling in the dry prepared surfaces, except as may be otherwise approved. Approval for assembling and erecting gabions in water will be given only if, in the Engineer's opinion, such a method will produce work which is otherwise in accordance with the Specifications.

6.2.2.2 Preparation of Foundation and Surface for Bedding

The bed on which the gabion boxes/mattresses are to be laid prior to filling shall be at the levels shown on the Drawings with an even surface.

6.2.2.3 Assembly

Gabion boxes/mattresses shall be assembled on a hard flat surface. After fabrication or unpacking and unfolding, they shall be stretched out and any kinks removed. Creases shall be in the correct position for forming the box/mattress compartments. The side and end panels shall be folded into an upright position to form rectangular boxes or compartments. The top corners shall be joined together with the thick selvedge wires sticking out of the corners of each panel. The tops of all sides and partitions shall be levelled except as may be appropriate to special units. The sides and end panels shall be wired together using binding wire starting at the top of the panel by looping the wire through the corner and twisting the wires together. Binding shall continue by lacing the wire through each mesh and around both selvages, which shall be joined tightly together, with two round turns after every second mesh. Finally the end of the wire shall be secured at the bottom corner and the end poked



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inside the unit. The diaphragms shall be secured in their correct positions by binding in the same way. The binding wire shall be fixed using 250 mm long nose fencing pliers or equivalent approved tools.

6.2.2.4 Filling

The boxes shall be placed in their final position before filling commences. They shall be stretched to their full dimensions and securely pegged to the ground or wired to adjacent gabions before filling. The vertical corners shall be kept square and to full dimensions by inserting a steel bar of at least 20 mm diameter at each vertical corner, maintaining it in the correct final position throughout the filling process, and removing it when the box is full. Before filling commences, the selvages of the box shall be bound to the selvages of adjacent boxes with binding wire.

Before filling with stones, gabions shall be anchored at one end or side and stretched from the opposite end by inserting temporary bars and levering them forward. The top and bottom shall be kept stretched by tensioning with tie wires attached to an anchor or equivalent approved method until the gabion has been filled. The gabions shall be inspected at this stage but before filling with stones to ensure that the tie wiring has been properly carried out and the gabion boxes/mattresses are not pulling apart.

The filling shall be carried out by placing individual stones into the gabion by hand in courses in such a manner that the stones are bedded on each other and bonded. No loose stones shall be tipped into the box and the practice of coursing and bonding the outer layer and filling the interior with unlaidd stones shall not be permitted.

All 1.0 m deep gabions shall be filled in three equal layers, and 0.5 m deep gabions in two equal layers. Where the upper faces of gabion boxes are not covered with further gabions, vertical bracing wires shall be fitted between the top and bottom mesh using two tie wires per square metre of surface. The top layer of stones shall be placed with their flattest side uppermost to provide a small surface for placing the lid. The gabions shall be filled 25 mm above the top so that the lid can be tightly stretched over the stones.

6.2.2.5 Securing Lids

The gabion box/mattress compartments shall be filled slightly overfull to allow for subsequent settlement. The lids shall then be laced down with binding wire to the tops of all partition panels. The lids shall be stretched to fit the sides exactly, by means of a suitable tool, but due care shall be taken to ensure that the gabions are not so full that the lids are over-stretched. The corners shall be temporarily secured first. Gabion boxes/mattresses shall be laid so that the hinge of the lid is on the lower side of slopes and on the outer side in flat planes.

Where laid horizontally, hinges shall not be placed on the downstream side, and where practical shall be placed on the upstream side.



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On completion, the boxes shall be completely and tightly filled, square, true to dimensions and the line and level shown on the Drawings.

6.2.3 Testing

Zinc coating and diameter test of gabion wires shall be carried out by the Contractor as directed by the Engineer. Failure to comply with the Specifications shall lead to the rejection of gabion wires. Tests shall be carried out in accordance with IS 280 and IS 4826 on each lot of supply received at Site.

6.2.4 Measurement and Payment

Measurement for payment of gabion boxes/mattresses shall be made in place to the dimensions of the gabion boxes/mattresses shown on the Drawings, or approved by the Engineer. The payment shall be made by type at the unit rates per square meter of **relevant item** of the Bill of Quantity for Machine fabricated gabion boxes. In case of Hand woven gabion boxes, the payment shall be made at the unit rates per square meter of surface area of Relevant Item of Bill of Quantity.

The unit rates shall include all costs of supply of materials, wires and knitting of wire boxes/mattresses, placing the box/mattress in place all complete, in accordance with these Specifications. Excavation up to an average depth of 150 mm shall be deemed to be included in the rate as dressing of the bed. Excavation beyond this depth shall be paid for separately, unless otherwise specified.

Measurement for payment of boulder filled in gabion boxes shall be made by volume to the lines and dimensions shown on the Drawings, or as directed by the Engineer. Payment for boulder filling shall be made at the unit rate per cubic metre of **relevant item** of the Bill of Quantity. The unit rate shall cover the cost of all boulder, labour, materials, equipment and tools, and operations required for the filling of boulder in gabion boxes.

6.3 Geo-textiles

Geo-textile used for sub-surface drains shall be made of polyethylene or polypropylene or polyester or similar fibres, either woven or non-woven. Unless otherwise shown on the Drawing, the geo-textile shall:

- a. sustain a load of not less than 10 kN/m at break and have a minimum failure strain of 10 percent when determined in accordance with BS: 6906 or shall have a grab tensile strength more than 0.4 kN/m and grab elongation corresponding to this limit in accordance with ASTM D4632.
- b. have apparent opening size as shown on the Drawing. If no size is shown on the Drawing, then the apparent size shall be 0.1 mm.
- c. allow water to flow through it at right angles to its principal plane, in either direction at a rate of not less than 50 litres/sq.m./sec. under a constant head of 100 mm, determined in accordance with BS: 6906 (Part 3) or ASTM D4491, unless otherwise shown on the Drawing. The flow rate determined in the test



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shall be corrected to that applicable to a temperature of 15°C using data on variation in viscosity of water with temperature.

- d. have a minimum puncture resistance of 200 N when determined in accordance with ASTM D4833.
- e. have a minimum tear resistance of 350 N when determined in accordance with ASTM D4533.

The higher tensile strength alignment of the geo-textile should in cross sectional direction. Unless otherwise specified, the overlap between two pieces should be at least 0.50 m. The supplier shall provide a method statement detailing installation procedures. Prior to deliver material at site the supplier shall submit a representative geo-textile sample minimum 4.0 m², to be retained by the engineer for purpose of comparative testing together with materials sampled from product delivered to site.

Payment for geo-textiles shall be made in the unit rate per square meter for **relevant item** of the Bill of Quantities. The unit rate shall include the cost of material, furnishing, transporting cutting and installing of geo-textiles including its testing. No extra payment shall be made for the overlap between the geo-textile pieces and accessories.