Annexure 4 A. TECHNICAL SPECIFICATION FOR ROADS & BRIDGES

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1. CONSTRUCTION OF ACCESS ROAD & BRIDGES

1.1 Scope of Work

The scope of work includes construction of access roads (29.1 km) and bridges (2 nos. of Bailey bridge) to various project components under contract package Infra-1. The detail scope of the works for each LOT of the contract package is as follows:

Contract	Description	Length (km)
package		8 ()
	Access road to Dam top	1.06
	Access road to Adit 1	0.96
	Sub structure, launching & testing of Bailey Bridge	
Infra 1- Lot 1	1-on the road to Adit 1 and Dam top (55m)	1 no.
	Access road connection Adit 1 and Adit 2	
	(Dorjilung by-pass road)	2.86
	OHS Costs (PPE+Accommodation)	
	Total Cost	
	Access road to Adit 3	3.35
	Sub Structure, launching & testing of Bailey Bridge	1 no
	2 on the road to Adit 2 (58m)	1 110.
Infra 1- Lot 2	Access road connecting Tsamang Banjar farm road	1.64
	Improvement of Tsamang Banjar farm road	4.9
	OHS Costs (PPE+Accommodation)	
Total Cost		
	Access road to Adit 4	6.1
	Access road to muck dump site 7 (main workshop)	1.93
Infra 1 – Lot 3	OHS Costs (PPE+ Accommodation)	
	Total Cost	
	Access road to Adit 5	2.16
	Access road to Adit 6	3.12
Infra I – Lot 4	Access road to Surge Shaft top	1.02
	OHS Costs (PPE+Accommodation)	
	Total Cost	

Supply of Superstructure of Bailey bridge (compact 200/equivalent), launching and testing (58 m and 55 m)	2 sets
Concrete pavement of road	29.1 km

The road and bridge construction shall be executed as per the technical specifications as detailed hereunder and involves the following activities:

- Clearing of bushes and trees along the alignment corridor
- Excavation for formation cutting both in soils and in rock with and without blasting
- Disposal of excavated materials at the designated dumping yards and as per the procedures and standards detailed in this Technical Specification (TS).
- Construction of permanent structure such as Retaining walls and Breast walls using both RRM and Gabion works.
- Construction of cross drainages including, culverts, causeways and installation of Hume pipes where necessary as directed by the Engineer.
- Construction of bridges as per the design and details in the drawing and technical specification.
- Preparation of surface for sub-base and base course.
- Laying of stone soling/granular sub-base course for the carriage width specified in this TS
- Preparation of road side shoulders and construction of line drains along the road length

The general geometry along the road alignment is detailed in Table 2.

As shown in the drawing
6.00 m
1 m on valley of carriage way and as specified in drawings
As per the technical specification and tender drawings
Widening width:
1.8 m on both side (3.6 m total)
0.45 m on both sides (0.9 m total)
0.3 m on both sides (0.6 m total)

Table 2: General Road geometry

Load classification	IRC class 40R wheeled/track loading

1.2 Submittals

At least fifteen (15) days prior to the commencement of the works, the contractor shall submit to the Employer for his approval the following but not limited to:

- Detailed work schedule
- Setting out methods for arrangement
- Source of supply of materials to be used for construction
- Details of the personnel both for execution and quality control of the work;
- List of equipment to be deployed
- Work plan for the complete work containing sequencing and scheduling of each activity of the work.
- Implementation of activities provided in the Environmental Management Plan
- Testing and acceptance procedure including documentation
- Any other information required by the Engineer

1.3 Conformity with Drawings/Allowable Deviations

All works performed and all materials furnished shall be in conformity with the lines, grades, typical sections, dimensions, material requirements, and tolerances shown in the drawings or as indicated in the Specifications.

The works to be performed shall also include all general works preparatory to the construction of roads, bridges, structures, canal crossings, drainage, and all other related works. The works shall include work of any kind necessary for the due and satisfactory construction, completion and maintenance of works to the intent and meaning of the drawings and these Specifications and further drawings and orders that may be issued by the Engineer from time to time. The scope of work shall include compliance by the Contractor with all Conditions of Contract, whether specifically mentioned or not in the various Sections of these Specifications, all materials, apparatus, plant, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and the provision of proper and sufficient protective works, diversions, temporary fencing and lighting. It shall include all work related to safety of the road users. It shall also include safety of workers at construction site, first- aid equipment, suitable accommodation for the staff and workmen with adequate sanitary arrangements, the effecting and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or other charges arising out of the erection of works and the regular clearance of rubbish, reinstatement and clearing-up of the site as may be required on completion of works, safety of the public and protection of the works and adjoining land/ structures.

The Contractor shall ensure that all actions are taken to build in quality assurance (QA) in the



planning, management, and execution of works. The quality assurance shall cover all stages of work such as setting out, selection of materials, selection of construction methods, selection of equipment and plant, deployment of personnel and supervisory staff, quality control testing, etc. The QA programme shall cover the details as per IRC: SP:47 and IRC: SP:57.

These shall broadly cover quality assurance aspects of all services rendered, all items to be supplied and all activities to be performed under the contract including temporary structures and equipment which will influence the quality of the completed works or the progress of the contract.

As a minimum, it shall cover the following:

- i) Organization and management responsibility,
- ii) Document and data control,
- iii) Construction programme,
- iv) Method statement,
- v) Process control,
- vi) Working, inspection, testing and documentary procedures,
- vii) Control and documentation of purchasing and handling of materials,
- viii) Maintenance of records for non-conformity and timely corrective actions,
- ix) Internal quality audit,

The QA plan shall be submitted to the Engineer for approval, not later than 28 days from the date of signing of the contract agreement. The work of building in quality assurance shall be deemed to be covered in the scope of the work.

The Contractor shall furnish, at least 7 days in advance, unless otherwise stipulated in the contract, his programme of commencement of each item of work, including the method statement including deployment of plant and equipment for the works included in the contract and any other work for which the Engineer may demand the method statement. He shall provide all information to the satisfaction of the Engineer to ensure its adequacy. The sole responsibility for the safety and adequacy of the methods adopted by the Contractor will, however, rest on the Contractor, irrespective of any approval given by the Engineer.

1.4 Inspection of Materials before Incorporation

All materials shall be inspected, tested and accepted by the Engineer as per these specifications, before incorporation in the work. The frequencies and methods of sampling and testing materials, including those required for definite purpose and not covered by these specifications shall be in accordance with the relevant IRC or AASHTO/ASTM/ BS Standards in order of priority.



All materials or work not conforming to the requirements of the Specifications shall be considered unacceptable and rejected. The unacceptable materials or work that are rejected shall be immediately removed unless the defects are corrected and approved by the Engineer. If the Contractor fails to comply promptly with any order of the Engineer made under the provisions of this Clause, the Engineer has the authority to remove and replace unacceptable materials or work and to deduct from money due to the Contractor the cost of removal and replacement.

1.5 Inspection of Materials at Source

The Engineer may choose to inspect material at source. In the event, the following conditions shall be met.

- The Contractor and the manufacturer of material shall assist and co-operate with the Engineer in carrying out the inspection.
- The Engineer shall have the right to enter areas of plant where the manufacture or production of material is carried out.

1.6 Delivery, Storage and Handling of Materials

All materials shall be handled and stored in an appropriate manner to preserve their quality and fitness for the work. During the handling of all aggregates or other construction materials, special care shall be taken to prevent contamination. Furthermore, aggregate shall be handled in such a manner as to prevent segregation.

Vehicles used in transporting construction material shall be kept clean and in proper working condition so as to prevent the loss of materials during transportation and meet the requirements of the Specifications.

The Contractor may be allowed to store materials and equipment within the right-of-way at location approved by the Engineer but shall be responsible for the restoration and repair of any damage to plantation, signs, property or any assets resulting from such operations. Any additional space that may be needed for storage purposes and for the placing of plant and equipment shall be provided by the Contractor at no additional cost to the Employer.

1.7 Materials Furnished by the Employer

When the Contract provides that certain materials required to complete the work will be supplied by the Employer, such material will be delivered or made available to the Contractor at the location(s) specified in the Contract.

The Contractor shall be responsible for all damage occurring to the materials furnished by the Employer while the materials are in his possession. Any demurrage or storage charges shall also be the responsibility of the Contractor.



The Contractor shall include the cost of handling, transportation and placing all Employerfurnished materials in the Contract unit price for the relevant pay item.

1.8 Laws to be Observed

The Contractor shall observe and comply with all National and Local laws which affect those employed on the work or affect the conduct of the work.

The Contractor shall provide all safeguards, safety devices, and protective equipment and take any other actions necessary for safety and health of employees on the project.

1.9 Patented Devices, Materials and Processes

If the Contractor is required or desires with the approval of the Engineer to use any design, device, material, or process covered by trademark, patent or copyright, the Contractor shall obtain the right for its use by legal agreement with the patentee or owner. A copy of the agreement shall be furnished to the Engineer. Contract prices shall include all royalties and costs arising from patents, trademarks and copyrights.

1.10 Construction Equipment

In addition to the conditions indicated in the Contract Documents, the following conditions regarding use of equipment in works shall be satisfied:

The Contractor shall be required to give a trial run of the equipment to establish their capability to achieve the laid down Specifications and tolerances to the satisfaction of the Engineer before commencement of the work;

All equipment provided shall be of proven efficiency and shall be operated and maintained at all times in a manner acceptable to the Engineer;

Plants, equipment and instruments provided shall have adequate sensitivity, facility for calibration to desired level and shall be robust;

Plant, equipment and instrument provided shall have data logging arrangement and control systems to enable automatic feedback control of process;

Plants, equipment and instruments provided shall have adequate safety features and pollution control devices;

Plant, equipment and instruments provided shall be operated by skilled and qualified operators;

All the plant/equipment to be deployed on the works shall be got approved from the Engineer for ensuring their fitness and efficiency before commencement of work;

Any material or equipment not meeting the approval of the Engineer shall be removed from the



No equipment shall be removed from site without permission of the Engineer;

The Contractor shall also make available stand by equipment and spare parts; and

The Contractor shall also make available equipment for site quality control work as directed by the Engineer.

1.11 Drawings

The drawings provided in the Tender Documents shall be used as reference only. The Contractor shall study the nature and type of work and ensure that the rates and prices quoted by him in the Bill of Quantities have due consideration of the site and complexities of work involved during actual execution/construction.

The Contractor based on his surveys and investigations, shall submit the working drawings (hard and soft copy) to the Engineer if there are any changes in the drawings provided in the tender document, for each activity at least 45 days in advance of the scheduled date to the start of the activity as per his approved work programme. The working drawings shall clearly show the modifications, if any, proposed with reference to corresponding tender drawings. The Engineer shall review the working drawings including the modifications proposed, if any, revise the drawings, if required, approve and issue to the Contractor two copies of Good for Construction (GFC) drawings at least 28 days in advance of the scheduled date of the start of the activity.

Examination and/or approval by the Engineer of any drawings or other documents submitted by the Contractor shall not relieve the Contractor of his responsibilities or liabilities under the Contract.

The tendered rates/prices for the work shall be deemed to include the cost of preparation, supply and delivery of all necessary drawings, prints, tracings, and negatives which the Contractor is required to provide in accordance with the Contract.

1.12 Site Information

The information about the site of work and site conditions in the Tender Documents is given in good faith for guidance only but it shall be the responsibility of the Contractor to satisfy himself regarding all aspects of site conditions.

The location of the works and the general site particulars are as shown in the Site plan/Index plan enclosed with the Tender Documents.

Whereas the right-of-way to the bridge sites/road works shall be provided to the Contractor by the Employer, the Contractor shall have to make his own arrangement for the land required by him for site offices, field laboratory, site for plants and equipment, maintenance and repair workshop, construction workers' camp, stores etc.



The affected services like water pipes, sewers, oil pipelines, cables, gas ducts etc. owned by various authorities including Public Undertakings and Local Authorities shall be verified by the Contractor prior to the commencement of any work.

The Contractor shall notify all utility agencies who may have installation in the work area and secure their assistance in locating and identifying all utilities before starting any work that may cause any damage to such utilities.

The Contractor shall schedule work in such a manner as to protect existing utility facilities until they are relocated, abandoned or replaced.

The Contractor shall ensure that all utilities encountered within the Right of Way i.e. OFC Cable, telephone, power, water supply, sewerage or any others, remain operational at all times. Any utility, if damaged due to construction operation, shall be promptly repaired by the Contractor at his cost.

No removal of or alterations to the utility shall be carried out unless written instructions are issued by the Engineer.

Any services affected by the Works must be temporarily supported by the Contractor who must also take all measures reasonably required by the various bodies to protect their services and property during the progress of the Works.

The Contractor may be required to carry out certain works for and on behalf of various bodies, which he shall provide, with the prior approval of the Engineer.

The work of temporarily supporting and protecting the public utility services during execution of the Works shall be deemed to be part of the Contract and no extra payment shall be made for the same.

The Contractor shall be responsible to co-ordinate with the service providers for cutting of trees, shifting of utilities, removal of encroachments etc. to make site unencumbered for completion of work. This will include frequent follow-up meetings. Co- ordination for making project site unencumbered shall be deemed to be part of the Contract and no extra payment shall be made for the same.

In some cases, the Contractor may be required to carry out the removal or shifting of certain services/utilities on specific orders from the Engineer for which payment shall be made to him. Such works, however, shall be taken up by the Contractor only after obtaining clearance from the Engineer and ensuring adequate safety measures.



2. MATERIAL

2.1 General

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work.

If any material, not covered in these Specifications, is required to be used in the work, it shall conform to relevant Indian or Bhutanese Standards, if there are any, or to the requirements specified by the Engineer.

2.2 Sources of Materials

The Contractor shall identify the sources of materials like coarse aggregate and fine aggregate and notify the Engineer regarding the proposed sources prior to delivery.

Samples of materials from the source shall be tested in the presence of the Engineer for conformity to specifications. It shall also be ensured that the variation in test results of different samples, is within acceptable limits.

For manufactured items like cement and steel reinforcement, the contractor shall intimate the Engineer the details of the source, testing facilities available with the manufacturer and arrangements for transport and storage of material at site. If directed by the Engineer, the contractor shall furnish samples and test results of recently received material. The Engineer, at his discretion, in case of doubt, may require the contractor to test the materials in an independent laboratory approved by the Engineer and furnish test certificates. The cost of these tests shall be borne by the contractor. The sampling and testing procedures shall be as laid down in the relevant Indian Standards and where they are not available, the same shall be carried out as per the directions of the Engineer. Only materials from sources approved by the Engineer shall be brought to the site. If the material from the approved source proves unacceptable at any time, the contractor shall identify new sources of acceptable materials conforming to specifications.

2.3 Stones and Blocks

Stones shall be of the type specified. They shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stones with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water of more than 5 percent of their dry weight when tested in accordance with IS:1124.

The length of stone shall not exceed three times its height and the width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

2.4 Cement

Cement to be used shall be any of the following types with the prior approval of the Engineer.



- a) Ordinary Portland cement, 43 Grade, conforming to 18:8112.
- b) Ordinary Portland cement, 53 Grade, conforming to 18:12269.
- c) Portland Pozzolana cement (fly ash based) conforming to 18:1489 (Part 1)
- d) Portland slag cement conforming to JS:455
- e) Rapid Hardening Portland cement, conforming to JS:8041.
- e) Low heat Portland cement conforming to IS:12600

Total chloride content shall be 0.1 percent by mass of cement for the cement to be used in structures other than prestressed concrete structures and 0.05% by mass of cement in prestressed concrete structures. Also, total sulphur content calculated as sulphuric anhydride (S03) shall in no case exceed 3.5 percent.

Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C3A content from 5 to 8 percent shall be preferably used in concrete, instead of sulphate resisting cement.

Manufacturer's test certificate shall be submitted to the Engineer by the contractor for every consignment of cement. The certificate shall cover all the tests for chemical requirements, physical requirements and chloride content as per relevant codes as applicable.

Independent tests of samples drawn from the consignment, shall be carried out at the site laboratory or in an independent laboratory approved by the Engineer, immediately after delivery. The following properties shall be tested:

- i) Compressive strength.
- ii) Setting time.

The cost of the tests shall be borne by the Contractor.

Cement in bags in local storage for more than 3 months after completion of tests, may be re-tested for compressive strength and setting times (initial and final) before use and may be rejected if it fails to conform to any of the requirements.

2.5 Coarse Aggregates

For plain and reinforced cement concrete (PCC and RCC) works, coarse aggregates shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not contain pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregates having positive alkali-silica



reaction shall not be used. All coarse aggregates shall conform to IS: 383 and tests for conformity shall be carried out as per 182386, Parts I to VIII.

The contractor shall submit for the approval of the Engineer, the entire information indicated in Appendix A of IS:383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC, shall conform to *Section Error! Reference source not found.* of these Specifications.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 percent. The coarse aggregate shall satisfy the requirements of grading as given in *Table 2-1*:

IS Sieve Size	Percentage Passing for Graded Aggregate of Nominal Size		
	40mm	20mm	12.5 mm
63 mm	-	-	-
40 mm	90-100	100	-
20 mm	30-70	95-100	100
12.5 mm	-	-	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

Table 2-1: Grading requirements for coarse aggregates

2.6 Fine Aggregates

For masonry work, sand shall conform to the requirements of IS:2116.

Natural sand, crushed stone sand or crushed gravel sand or a suitable combination of natural sand, crushed stone or gravel, shall be used as fine aggregates in plain, reinforced and prestressed concrete works. The fine aggregates shall be dense, durable, clean and free from veins and adherent coating and other deleterious substances. They shall not contain dust, lumps, soft or flaky materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Mechanized sand washing machines should be used to remove impurities from sand. Fine aggregates having positive alkalisilica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts Ito VIII). The Contractor shall submit to the Engineer the entire information indicated in Appendix A of IS:383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.

Fine aggregate for structural concrete shall conform to the following grading requirements:



IS Sieve Size	Percent Passing for		
	Grading Zone I	Grading Zone II	Grading Zone Ill
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

Note: When the grading falls outside the limits of any particular grading zone of sieves other than 600-micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. However, for crushed stone sand, the permissible limit on 150-micron IS Sieve is increased to 20 percent. Reference shall be made to Clause: 4.3 of IS:383.

2.7 Steel

2.7.1 Reinforcing Bars

For plain and reinforced cement concrete (PCC and RCC) works, the reinforcement/un-tensioned steel as the case may be, shall consist of the following grades of reinforcing bars.

Table 2-3: Grades of Reinforcing Bars

Crada	Der Tyme Conforming to Coverning		Elastic
Designation	on Specifications	Characteristic	Modulus
Designation		Strength fy	GP
Fe 500 or Fe	IS:1786 High Strength Deformed Steel	500	200
Fe 550 or Fe	IS:1786 High Strength Deformed Steel	550	200
Fe 600	IS:1786 High Strength Deformed Steel	600	200
	Bars (HSD)		

Note: If any grade of steel given in the above table is not available steel of next higher grade may be used.

All steel shall be procured from 'Original producers' who manufacture billets directly from iron ores and roll the billets to produce steel conforming to IS:1786. No re-rolled steel shall be incorporated in the works. However, in case the original producers give certificate that they are unable to supply the steel within the required time period or that they are not producing bars of the required diameter, the Engineer may allow the procurement of steel from other suppliers, provided that the reinforcement is manufactured from billets procured from the original producers. In such cases, the manufacturer's certificate alone shall not be considered as sufficient and the steel shall be tested by the Engineer in a government accredited laboratories only, as a third party check. It shall be ensured that all the test results conform to IS:1786 requirements.



Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bars shall be discarded. Bars with cracked ends shall be discarded.

For the steel procured from original producers also, the Engineer/Employer may carry out occasional checks on materials through third party as mentioned above, for confirming the test results shown in the certificates, in case of any doubt regarding the quality of steel supplied.

2.7.2 Structural Steel

Unless otherwise permitted, all structural steel shall, before fabrication, comply with the requirements of the following Indian Standards:

- IS:226 Structural Steel (Standard Quality)
- IS:961 Structural Steel (High Tensile)
- IS:2062 Weldable Structural Steel
- IS:8500 Weldable Structural Steel (medium and high strength qualities)
- IS:1148 Hot rolled rivet bars (upto 40 mm dia) for structural purposes
- JS:1149 High tensile rivet bars for structural purposes
- JS:1161 Steel tubes for structural purposes
- IS:4923 Hollow Steel sections for structural use
- IS:11587 Structural weather resistant steel
- IS:80S Specifications for Rolled Steel Beam, Channel and Angle Sections
- JS:1239 Mild Steel Tubes

IS:1730 Dimension for Steel Plate, sheet and strip for structural and general Engineering purposes.

IS:1731 Dimension for Steel flats for structural and general engineering purposes

JS:1732 Dimension for round and square steel bars for structural and general engineering purposes.

15:1852 Rolling and cutting tolerances for hot rolled steel products

The use of structural steel not covered by the above standards may be permitted with the specific approval of the Engineer.



2.8 Water

Water used for mixing and curing shall be clean and free from oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

If unsure, the suitability of water proposed to be used for the production of concrete shall be ascertained by carrying out tests for the compressive strength of concrete and initial setting time of cement using the same water.

The sample of water taken for testing shall represent the water proposed to be used for concreting, taking into account seasonal variations, if any. The sample shall not receive any treatment before testing other than that being given to the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used, shall not be less than 90 percent of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS:516.

The initial setting time of test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not be more than 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of IS:4031 (Part5).

pH value of water shall not be less than 6. Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted.

As a guide, the following concentrations represent the maximum permissible values:

a)To neutralize 100 ml sample of water, using phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH. For details of test refer IS:3025(Part 22).

b) To neutralize 100 ml sample of water, using mixed indicator, it should not require more than 25 ml of 0.02 normal. H2S04 • For details of test refer IS: 3025(Part 23).

c) The Permissible limit's for solids shall be as follows

	Tested as per	Permissible Limit Max
Organic	IS:3025	3000 mg/lit
	(Pt.18)	
Inorganic	IS:3025(Pt.18)	400 mg/lt
Sulphates	IS:3025	2000 mg/lit for concrete work not containing
(SO ₃)	(Pt.28)	embedded steel and



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Chlorides	IS:3025(Pt.32)	500 mg/lit for prestressed/reinforced concrete
(Cl)		work
Suspended	IS:3025(Pt.17)	2000 mg/lit
matter		

All samples of water (including potable water) shall be tested and suitable measures taken, where necessary, to ensure conformity of the water to the requirements stated herein.

2.9 Concrete Admixtures

2.9.1 General

Admixtures may be added to the concrete before or during mixing with a view to modifying one or more of the properties of concrete in the plastic or hardened state.

2.9.2 Mineral Admixtures

Any of the following mineral admixtures may be used as part replacement of Portland Cement with the approval of the Engineer.

Fly ash: conforming to of IS:3812-3

Granulated slag: Ground granulated slag obtained by grinding granulated slag conforming to IS:12089.

Silica fume: Silica fume is very fine, non- crystalline SiO_2 , obtained as a by-product of Silicon and Ferro-Silicon alloy industries and shall conform to IS:15388

2.9.3 Chemical Admixtures

Information Required from the Manufacturer

Chemical admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full-fledged laboratory facilities for the manufacture and testing of concrete.

The contractor shall provide the following information concerning each admixture, after obtaining the same from the manufacturer:

a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.

b) The chemical names of the main ingredients.

c)The chloride content, if any, expressed as a percentage by weight of the admixture.

d) Values of dry material content, ash content and relative density which can be used for Uniformity Tests.

e) Whether it leads to the entrainment of air when used as per the manufacturer's recommended desage, and it so to what extent.



- f) Confirmation regarding its compatibility with type of cement.
- g) Whether it increases the risk of corrosion of reinforcement or other embedments.
- h) Whether it affects the durability of concrete adversely.

2.9.4 Physical and Chemical Requirements

Admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied.

a) "Plasticizers" and "Super-Plasticizers" shall meet the requirements indicated for "Water reducing Admixture".

b) Except where resistance to freezing and thawing and to disruptive action of deicing salts is required, the air content of freshly mixed concrete in accordance with the pressure method given in IS:1199, shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 percent of the test mix.

c) The chloride content of the admixtures shall not exceed 0.2 percent when tested in accordance with IS:6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in *Section Error! Reference source not found*. of these Specifications shall also not be exceeded:

d) Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations are as follows:

i) Dry Material Content: within 3 percent and 5 percent of liquid and solid

ii) Ash content: within 1 percent of the value stated by the manufacturer.

iii) Relative Density (for liquid admixtures): within 2 percent of the value stated by the manufacturer.

e) All tests relating to concrete admixtures shall be conducted periodically at an independent laboratory and the results compared with the data given by the manufacturer

3. WORK SPECIFICATION

3.1 Setting Out

i. The contractor shall establish working bench marks at suitable locations, tied with the reference Bench Marks through their own qualified Surveyor in the area soon after taking possession of the site. The Reference Bench Marks for the area shall be indicated in the contract document/drawing or shall be obtained by the contractor from the Engineer.



- ii. The working Bench Mark /Levels should be approved by the Engineer. Monthly checks on the Bench Marks must be carried out and adjustments, if any, should be recorded and agreed with the Engineer. An up-to-date record of all Bench Marks including approved adjustments, if any, shall be maintained by the contractor and also a copy submitted to the Engineer for his records.
- iii. The alignment of the road as indicated in the drawing or as per the center line coordinates provided shall be translated on the ground during the setting out survey and pegging (centerline and batter peg) of the alignment on the ground to be done as survey proceeds. Co-ordinates of road alignment at all change of direction points are to be recorded. Fixing of reference marks (to be pegged) along the alignment of road shall be at 15m apart in straight reaches, 10m apart or closer along curves reaches and near all cross-drainage structures, bridges and causeway. Along with finalization of alignment, cutting of trace path may also be undertaken for inspection of alignment by the Engineer.
- iv. Reference pillars/ control pillars of random rubble masonry blocks of size 30cmx30cmx60cm (deep) should be embedded in the ground and should be located beyond the maximum excavation lines along the road alignment firmly placed to ensure it does not get disturbed during construction.
- v. Maximum spacing of the control pillars shall not be more than 100m. Each Reference/Control pillars shall be inscribed with the following information: Reduced distance, Horizontal distance of the block from the centerline (measured along the slope), Reduced level and Road formation level. Description and specification of reference / control pillar along with co-ordinate should be recorded for the reproduction of the drawings.
- vi. Above procedure should be followed along the entire length. Any discrepancies between the existing bench mark and reference bench mark at site/available in the drawing shall be informed to the Engineer for further verification during the verification survey.
- vii. The contractor will be the sole responsible party for safeguarding all bench marks, beacons, etc. The Engineer will initially provide the contractor with the reference benchmark data necessary for setting out the alignment of road. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the contract shall be verified by the contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions or levels. The contractor shall while setting out the road alignment, survey and pick up natural ground levels covering the entire corridor along the road alignment before the commencement of excavation works and shall submit to the Engineer for his approval, profile covering the center line of the road, and cross-sections at intervals as required by the Engineer shall also be submitted to the Engineer. The original ground level survey record, both in hard and editable copy shall be submitted by the contractor,



which shall be signed by both the contractor and Engineer, which shall serve as the reference for cross checking at later date.

- viii. After obtaining approval of the Engineer, work on earthwork excavation can commence following the survey coordinates and the profile section submitted and approved by the Engineer. The contractor shall be responsible for ensuring that all the basic traverse points are in place at the commencement of work and if any are missing, or appear to have been disturbed, the contractor shall make arrangement to re-establish these points. A "survey File" containing all survey records and calculations shall be maintained by the contractor and shall be made available to the Engineer on his demand. If in the opinion of the Engineer, design modifications of the centerline or grades are advisable, the Engineer will issue detailed instructions to the contractor and the contractor shall perform the modifications in the field, as required, and modify the ground levels on the cross-section accordingly as many times as may be required. There will be no separate payment for any survey work performed and cutting of trace path by the contractor. The cost of these services shall be considered as being included in the cost of the other item of work.
- ix. Precision automatic levels, having a standard deviation of $\pm 2mm$ per km, and fitted with micrometer attachment shall be used for all double run levelling works. Setting out of the road alignment shall be done by using Total Station, having an accuracy of at least five seconds.
- x. The contractor shall submit to the Engineer, survey maps and drawings covering all road works on original ground levels before the commencement of the excavation works and another as built survey maps and drawings covering as built structures including road sections at cross intervals as covered in the payments invoices or as directed by the Engineer.
- xi. Measurement and payment: Unless otherwise specifically stated in the relevant sections of the contract, no separate payments shall be payable to the contractor for any survey works. All cost and other incidentals expenses incurred for the survey works is deemed included in the other items under the contract.

4. CLEARING AND GRUBBING

The work shall consist of cutting, removing and disposing of all materials such as rank vegetation, grass, brush-wood, shrubs, stumps trees and saplings of girth up to 300 mm measured at a height of 1m above ground level which, in the opinion of Engineer are unsuitable for incorporation in the works. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to require compaction, handling, salvaging, and disposal of cleared material. Clearing and grubbing shall be performed in advance of earthwork operation and in according with the requirement of these specifications.

4.1 Disposal of material



All materials arising from clearing and grubbing operation shall be properly disposed of from the work site by the contractor at a designated location approved or as directed by the Engineer.

4.2 Measurements

The payment for clearing jungles shall be paid as per the BOQ item and measured in sq.m along the natural surface before commencement of excavation along the road alignment.

4.3 Rates

The rate shall cover the cost of carrying out all the required operations including cost of labour, materials, equipment hired, tools and plants, and incidentals necessary to complete the work. The rate shall also include removal of stumps of trees less than 300mm in girth excavation, back filling to the required density, where necessary as well as handling, salvaging, piling and disposing of the cleared materials with all lift and lead up to 50m.

5. FELLING TREES

- i. While clearing jungle growth, the trees 300 mm and above in girth (measured at a height of one meter above ground level) to be cut shall be approved by the Engineer and then marked at the site.
- Felling trees shall include taking out roots up to 600mm below ground level or 300mm below formation level or 150mm below sub-grade level whichever is higher. Before the cutting of the trees, the contractor through the Engineer shall inform the officials of the Department of Forest & Park Services (DoFPS) and enumerate the number and size of the trees that fall along the road alignment. These enumerated records shall be properly maintained with the road chainage and proper sign and seal of the contractor, officials of DoFPS and the Engineers representative.
- iii. All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 200mm layer and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut to suitable pieces as directed by the Engineer. Logs, branches, twigs of trees and other useful material shall be the property of the Government, and the Engineer shall inform the DoFPS for the removal of the same from the site. All unserviceable materials shall be disposed of as per the directions of the Engineer.

5.1 Measurements

Felling of trees (girth measured at a height of one meter above ground level or top of the stump if the height of the stump is less than 1m from the ground) shall be paid for in terms of numbers according to the size given in BOQ.



The rate shall cover the cost of carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. The rate shall also include removal of stumps of trees greater than 300mm in girth excavation, back filling to the required density, where necessary, as well as handling, salvaging, piling and disposing of the cleared materials with all lift and lead up to 50m. The rate shall include royalty to be paid to the government and no separate payment shall be done.

Where a contract does not include separate items of clearing or grubbing the same shall be considered incidental and the contract unit price for the same shall be considered as including clearing and grubbing operation.

For the measurement and payment of the tree cutting, in addition to the trees enumerated at site by the officials of the DoFPS, the contractor shall also maintain the record of actual numbers of trees cut and its girth cut, on daily basis, which shall be signed and sealed by the representative of the Engineer, which shall serve as the supporting document for the tree cutting.

6. EXCAVATION OF ROADWAYS AND DRAINS

6.1 General

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and water ways in accordance with requirement of these specification and the lines, grades and cross-section shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and sub grade construction, suitable cut material as required, and the disposal of unsuitable cut material in specified manner, trimming and finishing of the road to specified dimension or as directed by the Engineer.

6.2 Setting Out

After the site has been cleared, the limits of excavation shall be set out true to lines, curves, slopes, grades and section as shown on the drawing or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, the establishment of bench marks. The contractor shall be responsible for the maintenance of bench marks, and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

6.3 Excavation

i. All excavation shall be carried out in conformity with the direction laid here-in-under and in a manner approved by the Engineer. The work shall be so done that the suitable construction materials available from excavation are satisfactorily utilized as decided upon beforehand.



- ii. The contractor shall take all adequate precautions against soil erosion, water pollution etc. and take appropriate drainage measures to keep the site free of water.
- iii. Any damages to the work due to the contractor's operation, including shattering of the materials beyond the excavation lines, shall be repaired at the expenses of and by the contractor. Any and all excess excavation for the convenience of the contractor for any purpose or reason, except as may be ordered in writing by the Engineer, and whether or not due to the fault of the contractor, shall be at the expense of the contractor, where required to complete the work. All such excess excavation and over-excavation shall be filled and compacted with suitable material supplied and placed at the expense of and by the Contractor.
- iv. The contractor shall take all necessary precautions including supplying and operation of all necessary pumping plants to remove all water from any source whatsoever which may enter the excavation whether these are in progress or completed.
- v. If excavation is carried out within 5m of building or other constructions, the contractor shall execute the work in a way that will minimize damage and disturbance. In general verticality sided excavation will be required in such places and all necessary timbering or other support shall be provided. Undercutting of excavation sides will not be permitted. The contractor shall be responsible for any claims for damage of existing structures and properties during the execution of the excavation works and shall indemnify the employer from such claims.
- vi. In the case where, in the opinion of the Engineer, the work is likely to cause interference to the public, the contractor shall organize his operations in such a way as to reduce to a minimum, the interval between opening up and back-filling the excavation. No further works shall commence until the Engineer has inspected and approved the completed excavation.
- vii. All excavation operation shall include excavation and "getting out" the excavated materials."Getting out" shall include disposing the excavated materials; as directed by the Engineer.
- viii. The excavation shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerance, any excess depth/width excavated beyond the specified levels/dimensions on the drawing shall be made good at the cost of the contractor with suitable materials of characteristics similar to the removed and compacted to the requirements.
- ix. All debris and loose materials on the slopes of cutting shall be removed. No backfilling shall be allowed to obtain required slope excepting that when boulder or soft materials are encountered in cuts slopes, these shall be excavated to approve depth on instruction of the Engineer and the resulting cavities filled with suitable materials and thoroughly compacted in an approved manner.



- x. After excavation the side of excavated area shall be trimmed and the area contoured to minimize erosion and ponding, allowing for natural drainage to take place. When the cutting has reached to the formation width the contractor shall immediately construct and maintain temporary V-shaped earth drain of size 1000mm wide and 550mm deep as per the drawing. No extra payment shall be made for the construction and maintenance of the temporary drain, the rate shall be deemed to be covered by excavation of road formation/trace/box cutting.
- xi. Rock when excavated in road excavation shall be removed up to the formation level or as otherwise indicated on the drawings. Where, however unstable shales or other unsuitable material are encountered at the formation level, these shall be excavated to the extent of 500mm below the formation level or as directed by the Engineer. In all cases, the excavation operation shall be so carried out that at no point on cut formation the rock protrudes above the specified levels. Rock and large boulders which are likely to cause different settlement and also local drainage problem should be removed to the extent of 500mm below the formation level in full formation width including drains and cut through the side drains.
- xii. Where excavation is done to level lower than those specified, the excess excavation shall be made good to the satisfaction of the Engineer.
- xiii. Slopes in rock cutting shall be finished to the uniform lines corresponding to slope lines shown on the drawing or as directed by Engineer. Notwithstanding the foregoing, all loose pieces of rock on excavated slope surface shall be removed.
- xiv. If slips, slides, over breaks or subsidence occur in cutting during the process of construction due to the negligence of the contractor, they shall be removed at the cost of the contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or given rise to recurrent slides after construction. If finished slopes slides into the road way subsequently, such slides shall be removed and paid for at the contract rate, provided the slide are not due to any negligence on the part of the contractor.

6.4 Classification of Excavated Material

All materials involved in excavation shall be classified by the Geologist/Engineer in the following manner:

a) All types of soil

This shall comprise organic soil, sand, silt, loam clay, peat, topsoil, turf, land, sill, loon, clay, mud, peat. black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having dimension in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under



Rock types such as laterites, shales, conglomerates, varieties of limestone and sandstone, hard granitic, hard stacked river boulders etc, which can be excavated using only excavators but without the need for blasting operation.

Surfaces such as soling of roads, paths etc. and hard core; compact moorum or stabilized soil requiring grafting tool or pick or both and shovel, closely applied; gravel and cobble stone having maximum dimension in any one direction between 75 and 300 mm.

Lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and boulders which do not require blasting having maximum dimension in any direction of more than 300 mm, found lying loose on (the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

b) Hard Rock (requiring blasting)

This shall comprise: This is a sub division of the rock that may or may not require blasting as segregated above.

This shall include: generally, any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like, Or Hard rock requiring blasting as described above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

Authority for classification

The Contractor shall notify the Engineer on each occasion when he considers that he is entitled to payment for excavation of rock and shall not fill in any rock excavation until it has been inspected by the Engineer and the excavated material has been classified into ordinary rock or hard rock.

The classification of excavation shall be jointly decided by the clients Geologist, Engineer in consultation with the contractors Engineer. In times of disagreement, the client Geologists/Engineers decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

The total quantity of excavated volume shall be initially classified as A) all kinds of soils and B) Hard rock requiring blasting. Rock types such as laterites, shales, conglomerates, varieties of limestone and sandstone, hard granitic, hard stacked river boulders etc, which can be



excavated using only excavators without the need for blasting operation will be classified as all kinds of soil.

a) General

- i. Blasting shall be carried out in a manner that completes the excavation to the lines indicated in drawings, with the least disturbances to adjacent materials. It shall be done only with the written permission of the Engineer. All the statuary laws, regulations, rules, etc, pertaining to the acquisition, transportation, storage, handling and use of explosives shall be strictly adhered to as per the existing Royal Government of Bhutan's laws (RGoB) in force. The contractor may adopt any method or methods of blasting consistent with the safety and job requirements. Prior to starting any phase of the operation, the contractor shall provide information describing pertinent procedures, dimensions and notes.
- ii. The portable magazine for the storage of explosives shall be built as per the specifications of the RGoB laws in place and located at a site approved by the Engineer. No unauthorized persons shall be admitted into the boundary of portable magazine which when not use shall be kept under lock and key. No match boxes or inflammable materials shall be allowed within the premise of the portable magazine. An appropriate lightning arrester arrangement shall be provided at the portable magazine site. The blasting operation and handling of explosives shall be done by a competent blaster certified by approved authority. The following records shall be maintained at the portable magazine site shall be produced at the instruction of Engineer or competent authority of the RGOB.
 - Copy of relevant rules regarding the storing, handling of the explosives.
 - The daily consumption and balance sheet records of the explosives
 - Notice prohibiting smoking in the restricted area.

All explosives shall be stored in a secure place in compliance with all laws and ordinances, and all such storages place of portable magazine shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided to the satisfaction of the Engineer and in general not closer than 300m from the road or from the buildings or camping area or place of human occupancy. In addition to these, the contractors shall also observe the following instructions and any further additional instructions which may be given by the Engineer and shall be responsible for theft/damage to the property and any incidents which may occur to workmen or public on account of any operation connected with the storage, handling or use of explosives and blasting. The Engineer shall frequently check the contractor's compliance with these precautions.

b) Materials, Tools and Equipment



All the materials, tools and equipment used for blasting operation shall be of approved standards. The Engineer may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such length being cut as will permit sufficient time to the firer to reach a safe place before explosion take place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators, fuses, etc, shall be fresh and not damaged due to dampness, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed from the site immediately.

c) Personnel

The blasting operation shall remain in the charge of the competent and experienced supervisors and or with a licensed Blaster & workman who are thoroughly acquainted with the details of handling explosives and blasting operations.

d) Blasting Operation

The blasting operations for the surface works shall be carried out during fixed hours of the day preferably during early morning /mid-day luncheon hour or at the close of the work at dusk as ordered in writing by the Engineer. The hours shall be made known to the people in the vicinity. All the charge shall be prepared by the man in charge only.

The contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from damage. Red danger flags shall be displayed prominently in all directions especially on the highway during the blasting operation. The flags shall be planted 200m from the blasting site in all directions. People, except those actually light the fuse shall be prohibited from entering this area and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing. A warning siren or whistle shall be sounded or blown 10 minutes before the blast at three intervals of time to warn of the blasting in progress.

The charge hole shall be drilled to required depth and at suitable place. Blasting should be as light as possible consistent with through breakage of the material necessary for economic loading and hauling. Any methods of blasting which lead to over shooting shall be discontinued.

When blasting is done with dynamite and other high explosives, dynamite cartridges shall be prepared by inserting the square cut end of fuse into detonators and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3 of the copper tube exposed outside. The paper cartridge shall then be closed up and securely bound with wire or twine. The primer shall then be housed into the explosive. Borehole shall be such size that the cartridge

can easily go down. The holes shall be cleared of all debris and explosive inserted. The space

of about 200mm above the charge shall then be gently filled with dry clay. Pressed home and the rest of the tamping formed of any convenient material gently packed with a wooden rammer.

At a time, not more than 10 such charges will be prepared and fired. The man in-charge shall blow a siren/whistle in a recognized manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man-in charge only. The blaster shall count the number of explosions. He shall satisfy himself that all the charge has been explode before allowing the workmen to go back to the work site. After blasting operation, the contractor shall compact the loose residuals materials below subgrade and replace the material removed below subgrade with suitable material.

e) Misfire

In case of misfire, the following procedure shall be observed:

Sufficient time shall be allowed to account for the delayed blast. The blaster shall inspect all the charges and determine the missed charge.

If it is blasting power charge, it shall be completely flooded with water. A new hole shall be drilled at around 450mm from the old hole and fired. This should blast the old charge. Should it not blast the old charge, the procedure shall be repeated till the old charge is blasted.

In case of charges of gelatin, dynamite, etc, the blaster shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge. Alternately, the hole may be cleared of 300 mm of tamping and the direction then ascertain by placing a stick in the hole. Another hole may then be drilled 150 mm away and parallel to it. The blaster shall at once report to the contractor's office and the Engineer all causes of misfire; the cause of the same and what steps were taken in connection therewith.

If a misfire has been found to be due to defective detonator or dynamite, the whole quantity in the box from which defective article was taken shall be inspected to ascertain whether the remaining materials in the box are also defective. The defective materials shall be destroyed properly.

f) Controlled Blasting

Since all the access roads fall either through the human settlement or as the whole project is located nearby the protected park area, maximum restraint shall be taken while taking blasting operation. All the blasting operations shall be resorted to controlled blast to minimize the effect and disturbance of the blasting operation to the wildlife and nearby human settlement. The contractor will have to take all precautions so that there is no accident and damage to the property. For all controlled blasting, depth of holes and charge will have to be reduced and then covered with sand bags, as well as, by nets fixed properly all around to avoid flying of blasted tragments splinters. This is however applicable only in the areas where the blasting is going



very close to human settlement or property. No additional payment shall be what so ever it may be, for resorting to controlled blasting shall be made and therefore, the contractor will have to quote all-inclusive rates for the excavation in rock.

g) Explosive Account

A careful day to day account of the explosive shall be maintained by the contractor in an approved format register which shall be open to inspection by the Engineer and authorized RGoB officials at all times. The monthly explosive account should be submitted to the Engineer duly signed for further submission to the concerned department of RGoB by the first week.

6.5 Measurement for payment

Excavation of roadway shall be measured by taking cross sections at every 10m interval or at intervals as directed by the Engineer. The volume calculation shall be based on any standard formulas when regular geometry is encountered during excavation or by using the AutoCAD drawings developed using the initial survey points taken on the natural ground levels taken before the commencement of the work and the actual levels and cross sections achieved during the execution of the work.

Considering the complexity of getting regular shape, size and continuous stretches of homogeneous layers and lengths, the classification of the excavation class shall be done jointly by the client geologist, Engineer and contractors Engineer. In event of disagreement between the contractors Engineers and the client representatives, the decision of the client geologist/Engineer shall be final and binding.

The length, breadth and depth shall be measured correct to 10 mm. In case the measurements are taken with staff and level, the level shall be recorded correct to 5 mm and depth of cutting and heights of filling calculated correct to 5 mm.

6.6 Rates

The rates shall cover the cost for carrying out all the required excavation and banking operations within 250m lead including cost of labour, materials, equipment hired/owned, tools and plants, survey, blasting materials and all incidentals necessary to complete the work. In case of rock, the rate shall include the cost of all operations of blasting with explosives, chiseling and machineries and other accessories or other means as mentioned above.

6.7 Methods, tools and Equipment

Only such methods, tools and equipment as approved by the Engineer shall be adopted/ used in the work. If so desired by the Engineer, the contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.



7. TRENCHES EXCAVATION

- i. Excavation for structures shall be carried out to the levels and dimensions shown on the Drawings or as directed by the Engineer. Excavation will be carried out to the least dimensions required to accommodate all parts of the works and will include only the minimum working space necessary for their execution.
- ii. When the foundation level as shown on the Drawings, or as directed, is exposed by the Contractor the Engineer shall approve the foundation prior to the start of structure construction.
- iii. All excavation will be carried out in such a manner that the surrounding materials receive the minimum amount of disturbance. Any damage or disturbance caused to materials, whether or not within the area of operations, will be made good by the Contractor at his own expense, as directed.
- iv. Excavations will be kept free from water and the Contractor shall make all necessary arrangements to dispose of any water, which enters the excavation.
- v. Suitable material removed from foundation excavations, which are required for subsequent backfilling of the excavation will be stockpiled at an approved location adjacent to the excavation. All other material excavated will be disposed off to spoil tips provided by the Engineer. All soft or loose material will be removed and any cavities backfilled with compacted rock fill as directed.
- vi. Trench excavations shall be carried out with great care, true to line and gradient and as near as practicable to the size required for construction of the Permanent Works. Nowhere shall the external dimensions of the excavations be less than the required dimensions shown on the Drawings or ordered by the Engineer.
- vii. Any excavated materials stored on Site for back filling or other purposes shall be deposited along the excavation at a minimum distance of 0.5m in such a manner that it will cause no damage or inconvenience. The surface shall be dressed properly. If the excavation is done to a depth greater than that shown in the drawings or greater than that required by the Engineer, the excess depth shall be made good at the cost of the contractor. The subsequent disposal of the excavated material shall either be as directed by the Engineer under a separate item or as included in this item disposal up to 50 meters lead.
- viii.All excavations shall be carried out in conformity with the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer.
- ix. Protection and supporting of existing services i.e. pipe, water mains, cables met within the course of excavation. Care shall be taken not to disturb electric and communication cables, and, if necessary for removal it shall be arranged by the Engineer.


- x. **Measurement:** The length, breadth and depth shall be measured correct to 10 mm. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.
- xi. **Rates:** The rates shall cover the cost for carrying out all the required excavation and banking operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work. In case of rock, the rate shall also include the cost of all operations of blasting with explosive and accessories as mentioned above. However, the payments shall be made as per the BoQ items for excavation covered under the road excavations as covered in the preceding chapters.

7.1 Disposal of Excavated Materials

- i. The free and indiscriminate disposal of any surplus materials is strictly prohibited. All the excavated materials shall be properly disposed at the designated disposal area identified by the client. The material obtained from the excavation of roadway, shoulder, verges, drains, cross drainage works etc, shall be used for filling up:
 - Roadway embankment
 - The existing pits in the right of way and
 - Landscaping of the road as directed by the Engineer, including levelling and spreading and disposal of surplus soil at the designated dumping area or as directed by the Engineer and no extra payment shall be made for the same.
- ii. These disposal sites shall be improved by construction log, boulder barriers, gabion wall etc. The dumping shall be done by benching with the excavator releasing the material from the bucket at a very low height to prevent the material from rolling down. For dumping the boulders or rocks the space shall be created first to place them firmly.
- iii. **Measurement:** For the overall volume calculation of the disposed materials from the excavation site, the volume calculation shall be done through survey of the muck disposal yard, for which the original ground levels shall be surveyed by the contractor and submitted to the employer, before the commencement of the work, and the actual levels achieved measured from actual ground levels obtained from the fills at the disposal site. The length, breadth and depth of the loose volume (excavated material) shall be measured correct to 10 mm. 20% deduction for voids for the measured quantity shall be done for all types of soil and rocks. The cubical contents shall be worked out to the nearest two places of decimal in cubic meters. The contractor shall carry out the final survey of the dump site after the completion of dumping/disposal to determine the total quantity for the payment.
- iv. **Rates:** The rates shall cover the cost for carrying out all the operations described above including labour charges, loading, unloading, engaging of excavator for levelling and



compacting the spoil deposits, spreading of top soil, construction log, boulder barriers, gabion wall etc and other incidentals involved in the operation.

7.2 Filling

- i. Earth used shall be free from stone, shingles or boulders larger than 75mm in any directions, slats, organic or other foreign matter. Normally earth excavated filling, however from the same area shall be used for filling. However, if such earth contains deleterious material, saltpetre earth etc. the same shall not be used. All cold lump earth shall be broken or removed.
- ii. The spaces around the foundations, pipes, drains etc. shall be cleared of all debris, brickbats etc. The filling shall be done in layers not exceeding 20 cm. Each layer be rammed with iron rammer where feasible and with butt-ends of crowbars where rammers cannot be used. Special care shall be taken to avoid damage to pipes, drains, masonry, cables etc. Density of compaction shall not be less than 90% of the maximum dry density as determined by the standard proctor test.
- iii. Measurements: The cubical contents of foundation concrete and masonry in foundation up to ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations to arrive at the quantity for filling sides of foundation. For filling in plinths and under floors, depth shall be the consolidated depth. The length, breadth and depth shall be measured correct to 10mm. the cubical contents shall be worked out to the nearest two places of decimal in cubic meters.
- iv. **Rates:** The rates shall cover the cost for carrying out all the required filling operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work.

7.3 Backfilling of Structures

- No fill shall be placed until the foundation for the fill has been reviewed by the Engineer. Backfilling of structures shall be done with two hand packed filter layer of stone aggregates of size 100 to 200 mm and 600 mm thickness along the structure wherever possible.
- ii. **Measurement:** The length, breadth & depth of the finished work shall be measured correct to 10 mm & the cubical contents shall be worked out to the nearest two places of decimal.
- iii. Rates: The rates shall cover the cost of carrying out all the required filling operation including cost of labour, material, equipment hired/owned, tools and plants and incidentals necessary to complete the work.



8. CONCRETING WORKS

8.1 Grades of Concrete

The grades of concrete shall be designated by the characteristic strength as given in *Table 8-1*, where the characteristic strength is defined as the strength of concrete below which not more than 5 percent of the test results are expected to fall.

Table 8-1: Grades of Concrete

Type of Concrete/Grade Designation			Characteristic Strength
Nominal Mix	Standard	High Performance	in MPa
Concrete	Concrete	Concrete	
M15	M15		15
M20	M20		20
	M25		25
	M30	M30	30
	M40	M35	35
	M45	M40	40
	M50	M45	45
		M50	50
		M55	55
		M60	60
		M65	65
		M70	70
		M75	75
		M80	80
		M85	85
		M90	90

- Normal Mix Concrete is made on the basis of nominal mix proportioned by weight of its main ingredients- cement, coarse and fine aggregates and water.
- 2) Standard concrete is made on the basis of design mix proportioned by weight of its ingredients, which in addition to cement, aggregates and water, may contain chemical admixtures to achieve certain target values of various properties in fresh condition, achievement of which is monitored and controlled during production by suitable tests. Generally, concrete grades up to M50 are included in this type.

The minimum grades of concrete and corresponding minimum cement content and maximum water/cement ratios for different exposure conditions shall be as indicated in *Table 8-2*.

Table 8-2: Requirement of Concrete for Different Exposure Condition using 20mm aggregate

Exposure	Maximum Water	Minimum Cement	Minimum Grade of
Condition	Cement Ratio	Content, kg/m ³	Concrete
Moderate	0.4	340	М
Severe	0.4	360	М
Very Severe	0.40	380	M40
DGPE			
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Concrete used in any component or structure shall be specified by designation along with prescribed method of design of mix i.e., 'Design Mix' or 'Nominal Mix'. For all items of concrete, only design mix shall be used, except where nominal mix concrete is permitted as per drawing or by the Engineer.

If the Contractor so proposes, the Engineer may permit the use of concrete of higher grade than that specified on the drawing, provided the higher-grade concrete meets the specifications applicable. The additional cost of such higher-grade concrete shall be borne by the Contractor.

- i. The concrete (PCC or RCC) to be produced and placed according to this specification shall be of the highest quality and uniformity. Special emphasis shall be made on the uniformity of the coarse aggregate, water-cement ratio, consistency, air content and the temperature control of the concrete at the time of placement in the formwork, as well as the density and finishing when placed. Water, Cement, fine aggregate and coarse aggregate shall conform to material specifications. Concrete can be specified by proportions or by nominating the required strength. Concrete shall be prepared by mixing graded stone aggregate or gravel of normal size as specified with fine aggregate and cement in specified proportions with required quantity of water.
- ii. The contractor shall be fully responsible for producing and maintaining the quality of concrete with especially compressive strength not inferior to the specified one, except if different instruction is given by the Engineer.

The Engineer shall have the right to reject concrete in any of the following events;

- When mixing operations are not started within thirty (30) minutes after cement is added to the aggregate or;
- When more than fifteen (15) minutes has elapsed between the discharging of the mixture and the actual placing of the concrete, without agitating the concrete mix or,
- When more than one (1) hour has elapsed between the adding of the cement to the aggregate, and the actual placing of the concrete.
- iii. The Engineer reserves the right to specify a lesser time, if hot weather or other conditions causes quick stiffening of the concrete.
- iv. None of the concrete rejected by the Engineer shall be utilized in any of the permanent works. The re-tempering of concrete, which has partially hardened, that is, remixing with or without additional cement, aggregate or water shall not be permitted.

8.2 Concreting Under Water

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used, shall be got approved from the Engineer before any work is started.



Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall not be less than 16°C, nor more than 30°C.

Coffer dams or forms shall be sufficiently tight to ensure still water conditions, if practicable, and in any case to reduce the flow of water to less than 3 m per minute through the space into which concrete is to be deposited. Coffer dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the walls. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter. To minimize the formation of laitance, care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

All under water concreting shall be carried out by tremie method only. The number and spacing of the tremies should be worked out to ensure proper concreting. However, it is necessary to have a minimum number of 2 tremies for any concreting operation, so that even if one of the tremies goes out of commission during concreting, the other one can be used to complete the work. The tremie concreting when started, should continue without interruption for the full height of the member being concreted. The capacity of the concrete production and placement equipment should be sufficient to enable the underwater concreting to be completed uninterrupted within the stipulated time.

The top section of the tremie shall have a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket, as the case may be. The tremie pipe shall not be less than 200 mm in diameter and shall be large enough to allow a free flow

of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped within approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe, it will force the plug (and along with it any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise the tremie slowly in order to allow a uniform flow of concrete. At all times after placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the surface of the plastic concrete and shall not be taken out of concrete. This will cause the concrete to build up from below instead of flowing out over the surface and thus avoid formation of layers of laitance. It is advisable to use retarders or suitable superplasticizers to retard the setting time of concrete, which shall be established before the commencement of work.



8.3.1 Concreting in Cold Weather

Where concrete is to be deposited at or near freezing temperature, precautions shall be taken to ensure that at the time of placing, it has a temperature of not less than 5°C and that the temperature shall be maintained above 4°C until the concrete has hardened. When necessary, concrete ingredients shall be heated before mixing but cement shall not be heated artificially other than by the heat transmitted to it from other ingredients of the concrete. Stock- piled aggregate may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or on sheet metal over fire. In general, the temperature of aggregates or water shall not exceed 65°C. Salt or other chemicals shall be used. All concrete damaged by frost shall be removed. Concrete exposed to freezing weather shall have entrained air and the water content of the mix shall not exceed 30 litres per 50 kg of cement. To counter slower setting of concrete, accelerators can be used.

8.3.2 Concreting in Hot Weather

When depositing concrete in hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 30°C while placing. This shall be achieved by using chilled mixing water, using crushed ice as a part of mixing water, shading stock piles of aggregates from direct rays of the sun, sprinkling the stock piles of coarse aggregate with water to keep them moist, limiting temperature of cement below 30°C at the time of use, starting curing before concrete dries out and restricting time of concreting as far as possible to early mornings and late evenings. When ice is used to cool mixing water, it will be considered as part of the water in design mix. Under no circumstances shall the mixing operation be considered complete until all ice in the mixing drum has melted. The Contractor will be required to state his methodology for the Engineer's approval when the temperature of concrete is likely to exceed 30°C during the work.

8.4 Proportioning

It shall be done by volume. Boxes of suitable size shall be used for measuring sand and aggregate. The internal dimensions of the boxes shall be generally $35 \times 25 \times 40$ cm deep or as otherwise approved by the Engineer. The unit of measurement for cement shall be a bag of 50 kg and this shall be taken as 0.035cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand allowance for bulkage shall be made by adopting the method prescribed under IS 2386 (part III).



It shall be done in mechanical mixer. Mixing by hand shall be employed only in special cases with the specific prior permission of the Engineer. Stone aggregate shall be washed with water to remove dirt, dust or any other foreign materials, where necessary.

8.5.1 Machine Mixing

The mixer drum shall be flushed clean with water. Measured quantity of dry coarse aggregate shall be followed with measured quantity of fine aggregate and then cement. In case damp sand is used, add half of the quantity of coarse aggregate followed by cement and sand. Finally add balance quantity of the coarse aggregate. The skip shall be raised and dry materials slipped into the drum. The dry materials shall be mixed for at least four turns of the drum, after which the correct quantity of water shall be added gradually while the drum is in motion, to ensure even distribution with the dry material. The total quantity of water for mixing shall be introduced before 25% of mixing time has elapsed and shall be regulated to achieve the specified water cement ratio. The complete contents of the mixed concrete shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed clean.

8.5.2 Mixing time

The materials shall be mixed for a period of not less than 2 minutes and until a uniform colour and consistency is obtained. The time shall be counted from the moment all the materials have been put into the drum.

8.5.3 Hand Mixing

Hand mixing shall be done on a smooth, clean and water-tight platform of suitable size in the following manner.

- Measured quantity of sand shall be spread evenly.
- The cement shall be dumped on the sand and distributed evenly.
- The sand and cement shall be mixed intimately with spade, turning the mixture over and over again, until it is of even colour throughout and free from streaks.
- The sand cement mixture shall be spread out and measured quantity of coarse aggregate shall be spread on its top. Alternatively, the measured quantity of coarse aggregate shall be spread out and the sand cement mixture shall be spread on its top.
- The above materials shall be mixed at least three times by shovelling and turning over by twist from centre to side, then back to the centre and again to the sides.
- A hollow shall be made in the middle of the mixed pile.
- Three quarters of the total quantity of water required shall be added while the material is turned in towards the centre with spades. The remaining water shall be added by a water-



can fitted with rose head, slowly turning the whole mixture over and over again until a uniform colour and consistency is obtained throughout the pile.

• The mixing platform shall be washed at the end of the day

8.6 Consistency

i. The quantity of water to be used for each mix of 50kg cement, to give the required consistency shall not be more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix, 27 litres for 1:1 1/2:3 mix and 25 litres for 1:1:2 mix. In the case of vibrated concrete, the limit specified may be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests.

The following slumps shall be adopted for different kinds of works:

Works	Slump in mm	
	Vibrator Used	Vibrator not
		used
Mass concrete in foundation footings retaining walls	10-25	50-75
and pavement	10 25	50 75
Thin sections of flooring less than 75 mm thickness	25-40	75 -100

- ii. The entire concrete used in the work shall be laid gently (not thrown) in layers not exceeding 150mm and shall be thoroughly vibrated by means of mechanical vibrators till a dense concrete is obtained. The Engineer may however relax the condition specifying use of mechanical vibrators at his discretion for certain items depending upon the thickness of the members and feasibility of vibrating the same and permit hand compaction. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked into the corners of the formwork. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. Compaction shall be completed before the initial setting starts i.e. within 30 minutes of addition of water to the dry mixture. For items where the vibrators are not to be used, it shall be the duty of the contractor to take the permission of the Engineer before the start of work.
- iii. During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. Please see specifications relating to cold weather concreting Reinforced Cement Concrete. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38°C.
- iv. When the placing of concrete is suspended, necessary removal of laitance and roughening the contract of jointing future work shall be done before the concrete sets. When the work is

resumed the previous work must be thoroughly cleaned, roughened, watered and a grout of neat cement slurry of the proportion, 1 kg of cement per 2 litres of water applied uniformly.

8.7 Curing

- i. Green work shall be protected from rain by suitable covering. The work should also be protected from damage and rain during construction.
- ii. After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected with moist gunny bags, sand or any other material approved by the Engineer against quick drying. After 24 hours of laying of concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering with wet absorbent materials. The curing shall be done for a minimum period of 14 days. In special cases, curing may have to be done for a greater number of days as required by the Engineer. Over the foundation concrete, the masonry work may be started after 48 hours of its laying, but the curing of cement concrete shall be continued along with the masonry work for minimum period of 14 days. Where cement concrete is used as sub-grade for flooring, the flooring may be commenced before the curing period of sub-grade is over but the curing of sub-grade shall be continued along with the top layer of flooring for a minimum period of 14 days. The water used for curing shall not produce any objectionable stains or unsightly deposit on concrete surface. In special circumstances and locations curing by other means such as sealing material insulating blankets etc. may be adopted with the specific prior approval of the Engineer.

Mix	Compressive strength in kg/sc	.cm at 28 days
At 7 days	At 28 day	/S
1:1.5:3	175	265
1:2:4	140	210

iii. The minimum compressive strength of mix 1 :1.5 :3 and 1 :2 :4 shall be as follows:

8.8 Finishing

Immediately after the removal of forms, exposed bars or bolts, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes filled with cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners, and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar. The mortar shall be of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished and of as dry a consistency as possible. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been pointed shall be kept moist for a period of twenty-four



hours. Special pre-packaged proprietary mortars shall be used where appropriate or where specified in the drawing.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

Immediately on removal of forms, the concrete work shall be examined by the Engineer before any defects are made good. The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural appearance of the member, shall be rejected. Surface defects of a minor nature may be accepted. On acceptance of such work, the same shall be rectified as directed by the Engineer.

8.9 Measurement

Cubical contents of the concrete placed shall be measured correct to 0.01 cu.m.

8.10 Rate

The rates shall cover the cost for carrying out all the required operations including cost of labour, materials, equipment hired/owned, tools and plants, and incidentals necessary to complete the work for all lifts and heights.

9. PLASTERING

9.1 Preparation of surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. In case of concrete surface, if a chemical retarder has been applied to the formwork, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarder is left on the surface. The joints of masonry shall be raked out properly so that the plaster is well keyed with the masonry.

9.2 Mortar

The mortar of the specified mix described in the item shall be used.

9.3 Application of Plaster

Plastering shall be started from the top and worked down towards the structure. To ensure even thickness and true surface, plaster about 15 x 15 cm, shall be first applied, horizontally and vertically, at not more than 2 meters intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be faid on the wall, between the gauges with trowel. The mortar shall be applied in a



uniform surface slightly more than the specified thickness. The surface shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally, the surface shall be finished off true with trowel or wooden float accordingly as a smooth or a sandy granular texture is required. Excessive troweling or over working the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, junctions etc. where required shall be done without any extra payment. Such rounding or chamfering shall be carried out with proper templates to the sizes required. In suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically, when recommencing the plastering, the edge of the old work shall be scraped cleaned and wetted with lime putty or cement grout before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of the wall and not nearer than 15 cm to any corners or arises. It shall not be closed on the body of the features such as plasters, bands and copings, as these invariable lead to leakages. No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

9.4 Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

9.5 Precaution

Any cracks which appear in the surface and all portions, which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer.

9.6 Thickness

The thickness of the plaster specified shall be measured exclusive of the thickness of key. The average thickness of the plaster shall not be less than the specified thickness and the minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3 mm.

9.7 Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered. The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer may



approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

9.8 Measurement

Length and breadth shall be measured correct to 10 mm and its area shall be calculated in square meters correct to two places of decimal. Thickness of the plaster shall be exclusive of the thickness of the key in masonry works.

9.9 Rate

The rate shall include the cost of the labour and materials involved in all the operations described above for all heights and lifts.

10. FORMWORK

10.1 Propping and Centering

- i. Props used for centering shall be steel, timber posts, bellies or any other materials approved by the Engineer. In no case bellies shall be of diameter less than 100mm measured at mid length and 80mm at thin end. Maximum permissible spacing shall be 1.2 m centre to centre. Bellies shall rest squarely on wooden sole plates of 40mm thickness and minimum bearing area of 0.1 sq.m laid either on ground or on 40x40 cm thickness and minimum bearing area not exceeding 40 cm. double wedges shall further be provided between the sole plates and the wooden props so as to facilitate tightening and easing of shuttering without jarring the concrete. In case of brick masonry pillars of adequate sections are used instead of props, wooden sole plates shall be provided at the top of pillars and double wedges inserted between the sole plate and the bottom of shuttering.
- ii. The details of formwork stated above shall be applicable for span of 4.5m and height up to 3.5m. In case these limits are exceeded, the formwork shall be properly designed for the self-weight, weight of reinforcement. Weight of fresh concrete, various live loads imposed during the construction process (such as workmen and equipment) dumping of concrete, movement of construction equipment and action of the wind may produce lateral forces which must be resisted by the formwork to prevent lateral failure for which suitable horizontal as well as diagonal bracings shall be provided. The permissible stresses in bending, buckling load of props, permissible deflection of shuttering should not be exceeded.
- iii. In case the height of centring exceeds 3.5m, the props may be provided in multi-stages. Before the concreting is started, the props and wedges shall be thoroughly checked to see that these are intact. And take suitable action in case there are loose. While the concreting is in progress, at least one carpenter shall be readily available at the site. The carpenter shall keep a constant watch on the props and take immediate remedial measures, as soon as any of these get loosened.



Care shall be taken that props and wedges do not get loose for a minimum period as specified below.

10.2 Shuttering

- i. The shuttering shall have smooth and even surface and the joints shall not permit leakage of cement grout. Timber used shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may damage the cement surface of concrete. It shall not be so dry as to absorb water from concrete and swell and bulge, or so green or wet as to shrink after erection. Species of timber that are not affected appreciably by its contact with water shall be used. The timber shall be accurately sawn and planed on the sides and the surface coming in contact with concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.
- ii. Wooden formwork with metal sheet lining or steel plates stiffened by steel angles shall also be permitted. Where metal forms are used, all bolts and nuts shall be countersunk and well ground to provide a smooth plane surface. The chamfers, beveled edges and moldings shall be made in the formwork itself. Opening for fan clamps and other fittings connected with services shall be provided in the shuttering as directed by the Engineer. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn. Use of double head nails shall be preferred.

10.3 Surface Treatment for Shuttering

- i. The surfaces of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution, raw linseed oil, form oil of approved manufacture or any other approved material (such as polythene/polyethylene sheets), to prevent adhesion of concrete to formwork. Soap solution, for the purpose shall be prepared by dissolving yellow soap in water to get the consistency of paint. Inside surfaces of forms shall be thoroughly cleaned before application of any of the materials mentioned above. Release agents shall be applied strictly in accordance with the manufacturers' instructions and shall not be allowed to come in contact with any reinforcement. Re-use of the shuttering shall be permitted only after the inside surface has been thoroughly cleaned in the manner described above.
- ii. Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and accept the formwork as to its strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibility for safety of workman, machinery, materials and for results obtained.

10.4 Special Formwork



For special type of work-locations like tall structures etc. use of special types of formwork like moving or climbing forms shall be permitted. The details of such formworks along with the sequence of working shall be got approved from the Engineer before their erection.

10.5 Removal of Formwork

- i. No formwork or any part thereof shall be removed without prior approval of the Engineer. The formwork shall be so removed as not to cause any damage to concrete due to shock or vibration.
- ii. The whole of the formwork should be planned and a definite scheme of operation worked out. In no circumstances should forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subjected at the time of striking. Where possible the formwork should be left longer as it would assist curing. Forms should be eased carefully in order to prevent the load being suddenly transferred to concrete. The period that shall elapse after the concrete has been laid, before easing and removal of centering and shuttering is undertaken shall be as given in Table below.

Type of formwork	Minimum period before striking formwork
Vertical formwork to columns, walls and beams	16 – 24 h
Soffit formwork to slabs (props to be re- fixed immediately after removal of formwork)	3 days
Soffit formwork to beams (props to be re- fixed immediately after removal of formwork)	7 days
Props to slabs spanning up to 4.5 m	7 days
Props to slabs spanning over 4.5 m	14 days
Props to beams and arches spanning up to 6 m	14 days
Props to beams and arches spanning over 6 m	21 days

Note 1: For rapid hardening cement, 3/7 of the above periods will be sufficient in all cases, except for vertical sides of slabs, beams and columns which should be retained for at least 24 hours.

Note 2: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.



Note 3: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all cements in cold weather.

Note 4: Work damaged through premature or careless removal of forms shall be reconstructed.

10.6 Measurements

All measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to 10mm. no deductions from the shuttering due to the opening/obstructions shall be made if the area of such opening/obstructions does not exceed 0.1 sq.m. Nothing extra shall be paid for forming such opening.

10.7 Rate

Payments for formworks which includes centering and shuttering for all heights, shall be paid at unit rate for the items specified in BOQ. Where it is not specially stated in the description of the item that formwork shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of formwork. The unit rate for formworks shall include the cost of labour, materials, tools and plants and all incidentals required for all operations including supporting the members until the concrete is cured, set and hardened as required for plinth level, all heights and lifts. No separate payment shall be made for items such as forms releasing agent, connections, provisions for opening and other items required for completion of the work unless specified otherwise.

11. MASONARY WORK

11.1 Scope of work

The scope of works covered under its section shall comprise of stone masonry works including supply of all construction materials, equipment, tools and plants, labour (skilled or unskilled), etc. as would be required for construction of all types of masonry as shown in the drawings and as specified herein and /or as directed by the Engineer. The scope of works shall also include to provide all structural parts, scaffolding, transportation, loading, unloading, inspection test and quality control, preparation of foundation surface, adjustment of surface adjacent to the walls, linings, pavement including curing and protection, etc. and all other incidental and operations required to complete the masonry work in all respect.

11.2 Material

i. Stone for masonry shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible, stones shall be of uniform colour, quality and texture. Generally, stones shall not contain crystals silica or chart, mica and other deleterious materials like iron-oxide organic impurities

etc. stones with round faces shall not be used. The stones shall be obtained from quarries, approved by the Engineer.

- ii. The percentage of water absorption, accordance to test conforming to IS-1124 shall not exceed 1% to 2% of its own dry weight, after 24 hours submersion in water. The crushing strength in unconfined compression test shall be less than 150 kg/cm² when tested on any plane. The most of the stone material shall be used from rock excavation however, the samples shall be tested for compressive strength in accordance with IS: 1121. The compressive strength testing shall be conducted with the load parallel to the bedding plane and also perpendicular to the bedding plane. The stone sample shall also be tested for water absorption and also for soundness to ensure suitability of stone for use.
- iii. All material and structural parts incorporated in the permanent work shall be new and unused. Quality and dimensions of materials as well as works carried out at the site to allow the performance of all works simultaneously without causing any hindrance to other works.

11.3 Stone Soling

Stones as obtained shall be packed with their broader surface as base. The packing shall be as dense as possible and the interstice shall be filled with small stones. The height of stones shall be as per the thickness of soling required. The stones shall be arranged neatly and the joints shall be as thin as possible.

11.4 Measurements

The length, breadth and height shall be measured correct to 10 mm. and the volume calculated correct to 0.01 cum.

11.5 Rate

The rate shall include the materials and labour involved in all operation described above.

12. RANDOM RUBBLE MASONARY

12.1 Dressing

Stones shall be hammer dressed, on the face, the sides and the beds, to enable it to come into close proximity with the neighboring stone. The bushing in the face shall not project more than 4 cm in an exposed face, and one cm on a face to be plastered. The hammer dressed stone shall have a rough tooling for a minimum width of 2.5 cm along the four edges of the face of stone.

12.2 Laying

i. All stone shall be wetted before use. All construction shall be carried up truly plumb or to the specified batter. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. The bond shall be obtained by fitting in closely, the adjacent stones and by

using bond-stones. Face stones shall extend and bond well into the backing. These shall be arranged to-break joints as much as possible, and to avoid long vertical lines of joints.

- ii. The hearting or interior filling of the wall shall consist of rubble stones, which may be of anyshape but shall not pass through a circular ring of 15 cm inner diameter; thickness of these stones in any direction shall not be less than 10 cm. These shall be carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar, chips and spalls of stone being used wherever necessary to avoid thick mortar beds or joints and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The hearting will be laid nearly level with facing and backing, except that at about one meter intervals, vertical 'plumb' projecting about 15 cm to 20 cm shall be firmly embedded to form a bond between successive courses.
- iii. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting, and then shall not exceed 20% of the quantity of stone masonry. The masonry in a structure shall be carried regularly. Where the masonry of one part has to be delayed the work shall be raked back at an angle not steeper than 45 degree.

12.3 Bond Stones

- i. Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60 cm thick and in case of walls above 60 cm thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back.
- ii. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) the-bond stone shall extend about two- third into the wall. Through stones in such cases may give rise to-damp penetrations therefore, for all thickness of such walls, a set of two or more bond stones overlapping-each other by at least 15 cm shall be provided. Where bond stone of suitable lengths are not available cement concrete block of 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) conforming to sizes mentioned above shall be used.
- iii. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq.m of the wall surface. All bond stones in stone masonry shall be marked suitably as directed by the Engineer.

12.4 Quoins or corner stone

The quoins shall be of selected stones neatly dressed with the hammer and / or chisel to form the required angle, and laid header and stretcher alternately. The length of these stones shall be 45cm or more and at least 25% of the stones shall be 50cm or more in length.

12.5 Jambs

Stones used in jambs shall be similar to those in quoin, excepting the length of the stem, which shall be 45cm, or thickness of the wall whichever less is.



12.6 Joints

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be thicker than 20 mm.

12.7 Weep Holes

- i. The weep hole shall be provided as specified in BOQ. Weep holes shall extend through the full width of the concrete/masonry with slope of about 1 vertical: 20 horizontals towards the draining face. The spacing of weep holes shall generally be 1.5m in either direction or as shown in the drawing with the lowest at about 150 mm above the low water level or ground level whichever is higher or as directed by Engineer.
- ii. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

12.8 Scaffolding

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and string tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars less than one meter in width or near the skew-back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 stone aggregate 20 mm nominal size).

12.9 Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all face for a minimum period of seven days. In case of masonry with fat-lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

12.10 Protection

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

12.11 Measurement

The length, height and thickness shall be measured correct to 10 mm. The thickness of wall shall be measured at joints, excluding the bushings. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic meter nearest to two places of decimal.



The rate shall include the cost of materials and labour required for all the operations described above covering plinth level, all heights and lifts.

13. GABION WALL

13.1 Material

- i. Stones used for filling for gabion boxes shall be clean, hard, sound, unweathered and angular rock fragments or boulders. The smallest dimension of any stone shall be at least twice that of the longer dimension of the mesh of the crate. Before filling any gabion boxes, the Contractor shall submit representative samples of the rock he proposes to use in the gabions for approval by the Engineer. Further representative samples shall be submitted for approval each time whenever there is a change in the type or strength of the rock that the Contractor proposes to use in gabion work.
- ii. Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel wire complying with IS 280-197. All wire used in the manufacture of the crates and for use as diaphragms, binding and connecting wire shall be galvanized with an extra heavy coating of zinc by an electrolytic galvanizing process. The weight of deposition of zinc shall be in accordance with IS 4826-1979. Zinc coating shall be uniform and shall be able to withstand a minimum number of dips and adhesion test specified as per IS 4826-1979. Tolerance on diameter of wire shall be 2.5 percent. The tensile strength shall be between 300 to 550 N/mm².
- iii. The wire shall be mechanical woven into a hexagonal mesh of standard size with tolerance of +16 and -4. 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 crates shall be finished with a selvedge wire. Gabions shall be manufactured in the standard sizes shown below.

Dimensions (m)	Diaphragms (No)	Dimensions of Diaphragms (m)	Volume of Crate (m ³)
1 x 1 x 1	1	1 x 1	1
1.5 x 1 x 1	1	1 x 1	1.5
2 x 1 x 1	1	1 x 1	2
3 x 1 x 1	2	1 x 1	3
2 x 1 x 0.5	1	1 x 0.5	1

Diaphragms shall be manufactured of the same materials as the parent gabion and shall have selvedge wire throughout their perimeter. The number and size of diaphragms to be provided with each crate shall be as in the table above. All crates shall be supplied with binding and



13.2 Construction of Gabions

a) General Requirements

Before filling any gabion boxes, the Contractor shall also submit samples of gabion boxes assembled for approval and shall be retained for reference and comparison with the gabions built. The size, type and location of the samples shall be as directed by the Engineer.

Gabion boxes shall be assembled and erected including filling in the dry on 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 Specification.

b) Preparation of Foundation and Surface for Bedding

The bed on which the gabion boxes are to be laid prior to filling shall be at the levels shown on the Drawings with an even surface. If necessary, cavities between rock protrusions shall be filled with material similar to that specified for gabion filling.

c) Assembly

Gabion boxes 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 boxes. 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 wire 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 wire together. Binding shall continue by lacing the wire through each mesh and around both selvedge, which shall be joined tightly together, with two round turns after every section mesh. Finally, the end of the wire shall be secured at the bottom corner and the end poked inside the unit. The diaphragms shall be secured in their correct positions by binding in the same way. The bindings wire shall be fixed using 250 mm long nose fencing pliers or equivalent approved tools.

d) Filling

i. The crates shall be placed in their final position before filling commences. They shall be stretched to their full dimension and securely pegged to the ground or wired to adjacent gabions before filling. The vertical corners shall be kept square and to full dimension 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 crate is full. Before filling commences, the selvedges of the crate will be bound to the selvedges of adjacent crates with binding wire. Where crates are being assembled in position in a wall, the binding of the edges of each crate

may be carried out in the same operation.



- ii. Before filling with stone, gabions shall be anchored at one end or side and stretched from the opposite end or side by inserting temporary bars and levering them forward. The top and bottom shall be kept stretched by tensioning with tie wires attached to an anchorage or equivalent approved method until the gabion has been filled. The gabions shall be inspected at this stage but before filling with stone to ensure that the tie wiring has been properly carried out and the gabion boxes are not pulling apart. Gabion boxes may be tensioned either singly or in the case of a long straight structure by straining a number of units together using an approved tensioning system.
- iii. The filling will 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 as in dry stone masonry. No loose stones shall be tipped into the crate and the practice of coursing and bonding the outer layer and filling the interior with un-laid stones will not be permitted.
- iv. All 1 m deep gabions shall be filled in three equal layers and 0.5 m depth gabions in two equal layers. Horizontal bracing wires made with the same binding wires as used for lacing shall be fixed directly above each layer of the stone in the compartments, the wires being looped round two adjoining meshes in each side of the compartment and joined together to form a double tie which shall be tensioned by winding the bracing wires together with a flat stone in order to keep the face of the gabions even and free from bulges. Bracing wires shall be spaced horizontally along and across the gabions at distances not greater than 0.33 m.

e) Securing Lids

- i. The gabion box compartments shall be filled slightly over-full 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 laid so that the hinge of the lid is on the lower side on slopes and on the outer side in walls.
- ii. Where laid horizontally, hinges for retaining walls shall be placed on the valley side and for breast walls on the mountain side. On completion the crates shall be completely and tightly filled, square, true to dimensions and the line and level shown on the Drawings.

f) Arrangement of Joints

 In walls, gabion boxes shall be placed such that vertical joints are not continuous but staggered. Aprons shall be formed of headers. If more than one unit is required to obtain the necessary width, units of unequal length shall be used and the joints between them should be staggered. The adjoining boxes shall be joined together with the selvedge wire.



ii. Testing: Zinc coating, tensile strength and bending test of gabion wires shall be carried out by the Contractor as directed by the Engineer. Failure of test results 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.

g) Measurement

In case of gabion retaining and breast walls, the length of the wall shall be measured in running meter correct to 10 mm and the quantity shall be calculated nearest to two places of decimal.

In case gabion protection works the measurement shall be taken in cubic meter and volume calculated nearest to two places of decimal.

h) Rates

- i. In case of gabion retaining walls and breast walls, the rate shall include the cost of excavation to foundation level, back and side filling and providing and delivering stones from quarry and their preparation to use for gabion walls, as well as the providing, delivery and filling and closing of the gabion boxes, materials, including all testing, labour, equipment, tools, and incidentals necessary to complete the works as specified.
- ii. In case of protection works, the rate shall include providing and delivering stones from quarry and their preparation to use for gabion walls, as well as the providing, delivery and filling and closing of the gabion boxes, materials, including all testing, labour, equipment, tools, and incidentals necessary to complete the works as specified.

14. CONSTRUCTION OF PIPE CULVERTS

14.1 Scope of Work

The Contractor shall furnish all materials, equipment, and labour necessary to construct RC Hume pipes in accordance with these Specifications, the lines and inverts on the construction drawings and good construction practice.

14.2 Material

Providing and laying NP2 class RC pipes, including Collars, jointing in cement mortar 1:2 including visual inspection of joints etc. Including excavation, supply and placing of gravel bedding and suitable trench backfill as per the contract drawings.

14.3 Excavation

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The ground shall be excavated to the lines and depths shown on the Drawings or to such other lines and depths as the Engineer may direct. Trenches shall be of sufficient width to enable the pipes to be properly laid, jointed and haunched. 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 will not relieve the Contractor from responsibility for damage to pipes.

14.4 Water in Pipe Excavations

Trenches shall be kept free from water, until, in the opinion of the Engineer, the works will not suffer any deleterious effect from water. 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 and buildings by shoring or otherwise, during the time the trenches are open.

14.5 Laying of Concrete Pipes

Concrete pipes shall comply with the requirements of I.S. 458-1971. The pipes shall be laid true to line and level, commencing at the outfall, each pipe being separately boned between sight rails. Laying of pipes shall proceed upgrade of a slope. Before placing the pipe culverts, the bottom width of the excavation shall be covered with a drainage layer of stones of specification and depth as noted on the contract drawings. On completion, all pipe lines shall be flushed from end to end with water and left clean and free from obstructions.

Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used.

In case where the foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks, manholes etc. the pipe shall be encased all round in compacted sand or gravel for its full length.

14.6 Measurement and payment

All measurement and payment will be done in accordance with the specific item coverage for the works as per the unit rates in Bill of Quantity.

15. CAUSEWAYS

15.1 Vented Causeways



The ground shall be excavated to the lines and depths shown on the Drawings with a gradient of 5% in the flow direction or to such other lines and depths as the Engineer may direct. Trenches shall be kept free from water, until, in the opinion of the Engineer, the works will not suffer any deleterious effect from water. The Contractor shall, at his own expense, construct any sumps or temporary drains that the Engineer may consider necessary.

15.1.2 Preparation of Surface for Bedding

The bed on which the stone pitching is to be laid as a basis for the concrete causeway slab shall be with an even surface. If necessary, cavities between rock protrusions shall be filled with material similar to that specified for gabion filling.

15.1.3 Reinforcement

The temperature reinforcement shall confirm to Indian Standards IS: 1786 – 1985. The reinforcement shall be laid on top allowing a minimum cover of 40 mm.

QA/QC

The slope of the causeway shall be not more than 1 in 20 (5% in flow direction) and cross slope of 10:1 (Span: Depth).

- The causeway shall not contract the stream and shall be built at right angles to prevent scouring.
- Protection work shall be done in the upstream and the downstream as per the specification.
- The temperature reinforcement of specified diameter shall be laid at spacing mentioned in the drawing.

15.1.4 Measurement:

The length and breadth of completed causeway shall be measured correct to 10 mm and the area calculated nearest to two places decimal.

15.2 Submersible Causeways

15.2.1 Excavation

The slope of the causeway shall be not more than 7% in flow direction and cross slope of 10:1. The ground shall be excavated to the lines and depths shown on the Drawings with a gradient of 7% in the flow direction or to such other lines and depths as the Project Manager/Engineer may direct. Trenches shall be kept free from water, until, in the opinion of the Project Manager, the works will not suffer any deleterious effect from water. The Contractor shall, at his own



expense, construct any sumps or temporary drains that the Project Manager may consider necessary.

15.2.2 Preparation of Surface for Bedding

The bed on which the stone pitching are to be laid as a basis for the concrete causeway slab shall be with an even surface. If necessary cavities between rock protrusions shall be filled with material similar to that specified for gabion filling.

15.2.3 Reinforcement

The reinforcement shall confirm to Indian Standards IS :1786 – 1985. The reinforcement shall be laid allowing a minimum cover of 40 mm, 10mm dia. at 200mm spacing top and bottom

15.2.4 Measurement

All measurement will be done in accordance with the specific item coverage for the works as per the unit rates in Bill of Quantity.

16. DRAINS

16.1 Line Catch drains

Construction of lined catch drains as per drawings including excavation and delivery of materials.

16.2 Materials

16.2.1 Stone

The stones shall be of durable nature from quarry or excavation and be angular in shape. If boulders are used, they shall be broken into angular pieces. The stone shall be sound, hard, and free from iron bands, spots, sand holes, flaws, shakes, cracks or other defects. At least 80% of the stones shall have individual volumes of more than 0.01 m3. Representative samples of stone intended for use in the Works shall be submitted for the Engineer's prior approval. Further representative samples shall be submitted for approval whenever there is a change in the type or strength of rock that the Contractor intends to use in masonry work.

16.2.2 Mortar

Mortar for masonry shall comply with IS 2250 Code of Practice for preparation and use of mortar. Mortar shall be of mix ratio 1:3 (I Cement: 3 Sand) by volume. For field conditions the mortar strength shall be at least 30 percent higher than the laboratory strength.



The excavation for the drain shall be done according to the Drawings provided and the cut material placed without compaction as a bund immediately on the valley side of the cut. The bottom of the excavation shall be levelled carefully. Any pockets of soft material or loose rock in the bottom of the excavation shall be removed and the resulting cavities filled with suitable material and compacted.

16.4 Construction

Construction shall be carried out generally in accordance with IS 1597-1967, Code of Practice for construction of stone masonry. For lined catch drains a 50 mm bed of mortar shall first be placed on the prepared ground surface. All stones shall be carefully shaped to obtain as close as fit as possible at all beds and joints, any interstices between the stones being filled with selected stone spalls. The stone courses shall be laid perpendicular to the face batter.

16.5 Measurement

The length shall be measured in running meter correct to 10 mm.

17. EXCECUTION OF REINFORCED CONCRETE WORKS (RCC)

17.1 General Requirement

The Concrete shall be always mixed by mechanical mixer unless the Engineer permits hand mixing.

Fabrication of reinforcement. The reinforcement, in general shall be of Fe 500 grade unless otherwise specified. The contractor shall fabricate reinforcing steel to the dimension and configuration as shown on the drawings or as approved by the Engineer.

17.2 Bending

All bars shall be cut to the lengths and bent in accordance with IS-2502 the bar bending schedule as approved by the Engineer. Bars shall not be pre-heated for bending. Once bent, bars shall not be straightened or re-bent. Bending of bars protruding from matured concrete for the purpose of clearing embedded items shall be carried out only with the approval of the Engineer.

17.3 Placing of reinforcement

Before the reinforcement bars are placed, the surface of the bars shall be cleaned of flaky rust, oils, or other foreign substances that are harmful to the bonding of reinforcement bars with the concrete. Reinforcement bars shall be accurately placed in the position as shown on the drawings or directed by the Engineer and special care shall be exercised to prevent the reinforcement bars from being displaced during the placement of concrete.

Intersection points and splices of the reinforcement bars shall be fixed by using suitable clips



structures shall be placed and supported by use of precast spacer blocks to ensure required cover between the reinforcement bars and the shutters. Unless otherwise shown or approved the minimum cover of concrete reinforcement steel shall be as in table below:

Conditions of placement	Minimum cover (mm)
Structures exposed to weather, backfill or submerged but	40
accessible.	-10
Structures not exposed to whether or not in contact with ground.	40
Beams, girders and columns principal reinforcing steel, ties,	
stirrups and spirals	
Upper -structures of buildings:	
Beams, girders, columns and slabs without finishing	30
Slabs with finishing	20
Sub-structures of buildings:	
Beams, girders, columns and slabs	40
Footing	50

17.4 Splicing of reinforcement

The number of splicing shall be kept to a minimum. Location and length of laps shall be in accordance with IS standards IS 456-2000/Sp-34.

Tolerance for placing Reinforcement Steel unless otherwise required by the Engineer, reinforcement shall be placed within the following tolerance

- for effective depth of 200mm or less ± 5 mm
- for effective depth more than $200 \text{mm} \pm 15 \text{mm}$

The overall shall, in no case, be reduced by more than one-third of specified cover or 5 mm whichever is less.

17.5 Mixing of concrete

The concrete which flows sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar, shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped. It shall be determined by slump test as prescribed in mandatory test. The slump of concrete for different types of RCC work shall be as given in table below, unless otherwise specified.

Туре		Slump (mm) (at the Time of
		Placing of Concrete)
1) a) Structure with exposed inclin	ed surface requiring low slump	25
concrete to allow proper compac	tion	
b) Plain cement concrete		25
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2)	RCC structure with widely spaced reinforcements, e.g. solid	40-50
	columns, piers, abutments, footings, well steining	
3)	RCC structure with fair degree of congestion of	50-75
	reinforcement, e.g. pier and abutment caps, box culverts, well	
	curb, well cap, walls with thickness greater than 300mm	
4)	RCC and PSG structure with highly congested reinforcements	75-125
	e.g. deck slab girders, box girders, walls with thickness less than	
	300 mm	
5)	Underwater concreting through tremie e.g. bottom plug, cast in-	150-200
	situ piling	

17.6 Formworks

17.6.1 Centering and shuttering

- i. Props used for centering shall be steel, timber posts, ballies or any other materials approved by the Engineer. In no case ballies shall be of diameter less than 100mm measured at mid length and 80mm at thin end. Maximum permissible spacing shall be 1.2 m centre to centre. Ballies shall rest squarely on wooden sole plates of 40mm thickness and minimum bearing area of 0.1 sq.m laid either on ground or on 40x40 cm thickness and minimum bearing area not exceeding 40 cm. double wedges shall further be provided between the sole plates and the wooden props so as to facilitate tightening and easing of shuttering without jarring the concrete. In case of brick masonry pillars of adequate sections are used instead of props, wooden sole plates shall be provided at the top of pillars and double wedges inserted between the sole plate and the bottom of shuttering.
- ii. The details of formwork stated above shall be applicable for span of 4.5m and height up to 3.5m. In case these limits are exceeded, the formwork shall be properly designed for the self-weight, weight of reinforcement. Weight of fresh concrete, various live loads imposed during the construction process (such as workmen and equipment) dumping of concrete, movement of construction equipment and action of the wind may produce lateral forces which must be resisted by the formwork to prevent lateral failure for which suitable horizontal as well as diagonal bracings shall be provided. The permissible stresses in bending, buckling load of props, permissible deflection of shuttering should not be exceeded.
- iii. In case the height of centering exceeds 3.5m, the props may be provided in multi-stages. Before the concreting is started, the props and wedges shall be thoroughly checked to see that these are intact. And take suitable action in case there are loose. While the concreting is in progress, at least one carpenter shall be readily available at the site. The carpenter shall keep a constant watch on the props and take immediate remedial measures, as soon as any of these get loosened.

Care shall be taken that props and wedges do not get loose for a minimum period as specified in table below.

17.6.2 Shuttering

- i. The shuttering shall have smooth and even surface and the joints shall not permit leakages of cement grout. Timber used shall be well seasoned, free from loose knots, projecting nails, splits or other defects that may mar the cement surface of concrete. It shall not be so dry as to absorb water from the concrete and swell and bulge, or so green or wet as to shrink after erection. Species of timber that are not affected appreciably by its contact with water shall be used. The timber shall be accurately swan and planned on the sides and the surface coming in contact with concrete. For exposed concrete faces, timber for shuttering shall be wrought on all faces in contact with concrete.
- ii. Wooden formwork with metal sheet lining of steel plates stiffened by steel angles shall also be permitted where metal forms are used, all bolts and nuts shall be contour sunk and well ground to provide a smooth plane surface. The chambers, bevelled edges and moulding shall be made in the formwork itself. Opening for and clamps and other fittings connected with services shall be provided in the shuttering as directed by the Engineer, as far as practicable, clamps shall be sued to hold the forms together. Where use of nails in unavoidable minimum number of nails shall be used and this shall be left projecting so that they can be easily withdrawn. Use of double head nails shall be performed.

17.6.3 Surface treatment for shuttering

- i. The surface of timber that would come in contact with concrete shall be well wetted and coated with soap solution, raw linseed oil, form oil of approved manufacturer or any other approved material (such as polythene/ polyethylene sheets), to prevent adhesion of concrete to formwork. Some solution, for the purpose shall be prepared by dissolving yellow soap in water to egg the consistency of paint. Inside surface of forms shall be thoroughly cleaned before application or any of the materials mentioned above. Released agents shall be applied strictly in accordance with the manufacturer's instruction and shall not be allowed to come in contact with any reinforcement. Reuse of the shuttering shall be permitted only after the inside surface has been thoroughly cleaned in the manner described above.
- ii. Contractor shall give the Engineer due notice before placing any concrete in the forms to permit him to inspect and accept the formwork as to its strength alignment and general fitness, but such inspection shall not relieve the contractor of his responsibilities for safety of workman, machineries, materials and for results obtained.

17.7 Placing of concrete

i. The concrete shall be deposited generally in horizontal layers in such a manner as to maintain,



layer shall be as approved by the Engineer and the placement shall be carried out at such a rate that no concrete surface can reach as initial set, before additional concrete is placed thereon.

- ii. Concrete shall be disposed as closely as possible, directly into its final position and in such a way as to avoid segregation or modification of other properties. Bouncing concrete off forms, reinforcing steel or any other obstruction is prohibited. Distributing of concrete with vibrators or by other means will not be permitted.
- iii. Any tendency to segregation shall be corrected by shoveling aggregates into mortar, rather than mortar into aggregates. Concrete that is of excessive slump, segregated, partially hardened, or unworkable, shall not be placed in forms or if placed, shall be removed and dumped as directed by the Engineer at the contractor's expense.
- iv. Each type of vibrators, until the concrete is consolidated to the maximum practicable density, shall be free of pockets of coarse aggregates, and fits tightly against all form surfaces and embedded materials. During placement, and until curing has been completed, the concrete shall be protected to the satisfaction of the Engineer, against the harmful effects of exposure to sunlight, wind and rain.
- v. The contractor shall remove laitance on concrete surfaces, on which another lift of concrete will be placed, by green cutting with a high velocity water jet or air-water jet. Green cutting shall be performed before concrete has taken its final set so that all laitance will be removed, but that large pieces of aggregates will remain embedded in the matrix. Materials which are loosened or dislodged as a result of green cutting shall be completely removed from the surface of the lift.

17.8 Consolidation of concrete

- i. Concrete shall be compacted with mechanical vibrating equipment, supplemented by hand spading and tamping, to a maximum practicable density so that it is in complete contact with the forms, reinforcement and other embedded parts. The vibration shall be carried out by means of immersion type high frequency vibrators.
- ii. For the consolidation of concrete where immersion vibrations shall prove impracticable, vibrators rigidly attached to the forms shall be adopted subject to the approval of the Engineer. The size and the number of vibrators, at each pour shall be sufficient to thoroughly compact concrete, at the arte and condition of placement.
- iii. When vibrating a layer of fresh concrete, vibrator shall be held in a near vertical position. The immersion of the vibrator shall be sufficiently deep to vibrate the entire depth of the new layer, the vibration should penetrate several cm into the layers below, to ensure thorough union of the layer.
- iv. No new layers of concrete shall be placed, before the underlying one has been thoroughly vibrated, tumersion point for the vibrator shall be adequately spaced, so as to make sure that



every part of the concrete has been properly vibrated. Care shall be taken to prevent contact of vibrators against reinforcement steel, specially that starting initial set. Vibrators shall not be allowed to come into contact with forms or finished surface.

17.9 Tolerance for concrete works

Construction tolerance for concrete works shall be limited to the values given in the table below

Particulars of structure	Limit of tolerance (mm)
A. Deviation from specified dimension of cross	+ 12
section of columns and beams	
B. Deviation from dimensions of footings	+50
Dimension in plan	0.02 times the width of the footings in
Eccentricity in plan	the direction of deviation, but not
	more than 50mm
Thickness	+ 0.05 times the specified thickness

17.10 Joints in concrete

a) Construction joints

The construction joints shall be provided as approved by the Engineer, if not shown on the drawings. Forms surface of the construction joints shall be roughened prior to the continuing concreting and shall be clean and free from oil, objectionable coating and loose, semi-detached or unsound fragments. Wherever possible, forms for construction joints shall be made of expanded metal. The period of moistening shall be 2 days. Form surface of construction joints to be grouted shall be cleaned of all accretions of concrete or other foreign material by scraping, chiseling or other effective means.

b) Expansion or contraction joints

Joints shall be provided at the locations as directed/ approved by the Engineer. The opposite faces, which form the joint, shall be completely separate. When shown on the drawings or ordered by Engineer, a sheet of plan joint feeler or other approved material may be placed in contact with the first pouring before starting the second pouring. The joint feeler will not be paid for.

17.11 Removal of formworks

No formwork of any part thereof shall be removed without prior approval of Engineer. The formwork shall be so removed as not to cause any damage to concrete due to shock or vibration. In a slab and beam construction, site of beam shall be striped first and then the underside of slab and lastly the underside of beam. Formwork must be so designed that they can be striped in the order required i.e.

Shutters to verticals (non load bearing) face eg. Column boxes, beams sides, wall forms



- Shutter forming soffits to slab, horizontal and inclined which carry only light load, eg. Slab, roofs, floor and canopies etc.
- Soffits shutters carrying heavy load e.g., Beam and girder bottoms.
- ii. The whole of the formwork should be planned and definite scheme of operation worked out. In no circumstances should forms be struck until the concrete reaches strength of at least twice the stress of which the concrete may be subjected at the time of striking. Where possible the formwork should be left longer as it would assist curing. Forms should be eased carefully in order to prevent the load being suddenly transferred to concrete. The period that shall elapsed after the concrete has been laid, before easing and removal of cent ring and shuttering is under taken shall be as given in the table below.

Types of formwork	Minimum period before striking formwork
Vertical formwork to columns, walls and beams	15-24 h
Soffit formwork to slabs (props to be re-fixed immediately after removal of formwork)	3 days
Soffit formworks to beams (props to be re-fixed immediately after removal of formwork)	7 days
Props to slab spanning up to 4.7m	7 days
Props to slabs spanning over 4.7m	14 days
Props to beam and arches spanning up to 7m	14 days
Props to beams and arches spanning over 7m	21 days

Notes:

- 1. For rapid hardening cement, 3/7 of the above period will be sufficient in all cases except for vertical sides of slabs, beams and columns which should be retained for at least 24 hours.
- 2. In case of cantilever slabs and beams, the centering shall remain till structure for counter acting or bearing down have been erected and have attained sufficient strength.
- 3. Proper precaution should be taken to allow for decrease in the rate of hardening that occurs with all cement in cold weather.
- 4. Work damaged through pre-mature or careless removal of forms shall be reconstructed.

17.12 Protection and curing of concrete

i. Green work shall be protected from rain by suitable covering. The work should also be protected from damage and rain during construction. After the concrete has begun to hardened i.e about 1 to 2 hours after it's laying, it shall be protect with moist gunny bags, sand or any other material approved by the Engineer against quick drying. After 24 hours of laying of

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concrete, the surface shall be cured by flooding with water of minimum 25mm depth, or by covering wet absorbent materials.

ii. The curing shall be done for minimum period of 14 days. In special case curing may have to be done for more number of days required by the Engineer. Over the foundation concrete, the masonry work may be started after 48 hours of its laying but the curing of cement concrete shall be continued along with the masonry work minimum period of 14 days. Where the cement concrete is used as sub grade for flooring, the flooring may be commenced before the curing period of sub grade is over but the curing of sub grade shall be continued along with the top layer of flooring for a minimum period of 14 day. The water used for curing shall not produce any objectionable strains or unsightly deposit on concrete surface. In special circumstances and locations curing by other means such as sealing material insulating blankets etc. may be adopted with the specific prior approval of the Engineer.

17.13 Repair of concrete

- i. Any indentation, irregularity and bulge occurring beyond the specified tolerance, or any voids and honeycombs, fractures or other damage, shall be repaired. Repair shall be performed by skilled workman and the contractor shall inform the Engineer before starting the repair work, materials, procedures and operations used in the repair of concrete, and also the finished work, shall be done in accordance with the orders and instructions of the Engineer.
- ii. In general, the repair work shall be started within24 hours after stripping of the formwork. Concrete damage by any cause and concrete that is honeycombed, fractured or otherwise defective, and concrete which, because of excessive surface depressions must be cut back and rebuilt, shall be replaced with mortar, concrete or epoxy resin or as otherwise directed by the Engineer.

17.14 Inspection

No placing of concrete shall be permitted without prior inspection and approval by the Engineer for the reinforcing steel. When the Engineer performs prior inspection and issues conditional approval for the reinforcing steel, the contractor shall fulfil the said conditions so as to properly complete the reinforcing steel. Unless the said conditions are fulfilled, no placing of concrete shall be permitted.

17.15 Quality control

- i. The contractor shall construct, operate and carry all test and analysis for determining the mix proportions of each class of concrete including test of aggregate, so as to produce concrete specified in this clause under the direction of Engineer.
- ii. The contractor shall supply labour, material and equipment necessary to sample and transport material to the field laboratory from any part of the project area.



iii. The requirement for, and the method of taking samples and testing concrete and component of concrete shall be in compliance with standards specified, or as approved by Engineer. Other standard test for the aggregate, cement, water, admixture etc. as given in the specification shall be carried out by the contractor at periodic intervals as directed by Engineer.

17.16 Measurements and payments for concrete

17.16.1 Measurement and payment for concrete

i. The consolidated cubicle content shall be calculated net nearest to 0.01cu.m. Concrete laid in excess, of the sections shown in the drawing unless directed by the Engineer shall not be measured.

No deductions shall be made for;

- Opening up to 0.1m² or as specified.
- Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq. cm each in cross sectional area.
- Volume occupied by reinforcement.
- ii. Payment for concrete work shall be made at unit rate in the schedule of quantities. The unit rate shall include the cost for carrying out all the required operations including the cost of labour, material, equipment, tools and plant, and incidentals, etc., but excluding reinforcement and formwork, necessary to complete the work.

17.16.2 Measurement and payment for formwork

- i. All measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to 10mm. no deductions from the shuttering due to the opening/obstructions shall be made if the area of such opening/obstructions does not exceed 0.1 sq.m. Nothing extra shall be paid for forming such opening.
- ii. Payments for formworks which includes cantering and strutting for all heights, shall be paid at unit rate for the items specified in schedule of quantities. Where it is not specially stated in the description of the item that formwork shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of formwork. The unit rate for formworks shall include the cost of labour, materials, tools and plants and all incidentals required for all operations including supporting the members until the concrete is cured, set and hardened as required. No separate payment shall be made for items such as forms releasing agent, connections, provisions for opening and other items required for completion of the work unless specified otherwise.

17.16.3 Measurement and payment for reinforcement

i. Measurement for reinforcing bars will be made for actual length of reinforcement bars including



for each size of bar from the unit weight as stated on the certified copies of manufacturers report, which the contractor shall submit to the Engineer or otherwise standard weight/RM for each size of bars as provided in the steel tables shall be used.

Before starting concreting, the contractor shall make sure that the measurement of reinforcing bars placed in position has been recorded and that the Engineer has certified the correctness of the reinforcement used.

ii. The payment for reinforcement shall be made at the unit rate in the schedule of quantities, which shall include the entire cost of supply, taxes, handling, storage, cutting, bending, placing, wire clips, ties, separators and any other fastening devices. No separate payment will be made for the following, which shall be included in the quoted unit price.

a) Wire for tying reinforcement.

- i. Any additional reinforcement or splices required when contractors casting sequence differs from construction joints shown on the drawing.
- ii. Any reinforcement steel placed by the contractor for his own convenience in addition to those shown on the drawings.
- iii. Device like steel chairs, hangers, spacers, small spacer concrete blocks, other supports, ties and anchor rods etc. used to maintain reinforcement steel in position.

b) Any reinforcing steel delivered for testing

- i. Carrying out test for checking butt welds to replace lapping/splicing of reinforcing bars.
- ii. Carrying test to verify quality of steel reinforcement to be used as required and directed by the Engineer.

18. SUB GRADE

18.1 Preparation of sub-grade

- i. The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and base course below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft fielding patches that appear due to improper drainage condition, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.
- ii. If sub-grade composed of clay, fine sand or other soil that may be forced up into the coarse aggregate during rolling operation, an insulation layer or granular material or oversized brick aggregate not less than 10 cm thick of suitable thickness shall be provided for blanketing the



iii. In slushy soil or in areas that are water logged, special arrangement shall be made to improve the sub-grade soil and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

18.2 Consolidation

The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely consolidated and behaves as elastic mass (the roller shall pass a minimum of 5 runs on the sub-grade). All the undulation in the surface that develop due to rolling shall be made good with material or quarry spoils as the case may be and the sub-grade is re-rolled.

Surface Regularity

The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified under.

Permissible Tolerances of Surface Regularity

Longitudinal profile	Cross profile
Maximum permissible undulation when	Maximum permissible variation from specified
measured with a 3 m straight edge	profile when measured with a camber template
24 mm	15 mm

When the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall rectify these with fresh material or quarry spoils as the case may be, and the sub-grade re-rolled to the satisfaction of the Engineer.

Measurement

The length and width shall be measured correct to a cm. The area shall be worked out in square meter, correct to two places of decimal.

Rate

The rate shall include the cost of material and labour required for all the operation mentioned above, unless specified otherwise.

18.3 Compaction

i. Compaction of earth in embankments under suitable moisture conditions to give at least 95% of the proctor density


- ii. In the case of earthwork consolidated under optimum moisture conditions, each layer of earth shall be carefully moistened to give field moisture content of about +1% to -2% of the optimum content (OMC). Each layer of uniform thickness not exceeding 200mm shall then be compacted by rolling with 8 to 10 tonnes power road roller and a sheep-foot roller if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved shall not be less than 95% of the density obtained in the laboratory.
- iii. Each compacted layer shall be tested in the field for density and accepted before the operations for next layer are begun. Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent ponding.
- iv. Density Measurement and Acceptance Criteria: One measurement of density shall be made for each 500 sq.m of compacted area or for a smaller area as directed by the Engineer. Each measurement shall consist of at least 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved. In general, the control at the top 40 cm thickness of the formation shall be stricter with density measurements being done at the rate of one measurement for 250 sq.m of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.
- v. When density measurements reveal any soft areas in the embankment, the Engineer shall direct that these be compacted further. If in spite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer. Should circumstances arises, owing to wet weather the moisture content cannot be reduced to the required amount by above procedure, compaction work shall be suspended.

Control Tests on Borrow Material

Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics:

- Minimum percentage of clay 10%
- Liquid Limit 14
- Plasticity index 4

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- Percentage of silt should not exceed 50%
- Peat, muck and organic soils are unsuitable.

The Engineer, may, however, relax these requirements considering availability of materials, cost of transportation and other relevant factors. Various tests required to be conducted on the borrow material with their recommended frequency are indicated below. All the tests need not be stipulated on every project. Depending upon site conditions etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.

Gradation: At least one test for each kind of soil. Usual rate of testing shall be 1 to 2 tests per 8000 cu.m of soil.

Plasticity: At least one test for each kind of soil. Usual rate of testing shall be 1 to 2 tests per 8000 cu.m of soil.

Proctor Tests: At the rate of 1 to 2 per 8000 cu.m of soil.

Deleterious Contents: As required.

Moisture Contents: One test for every 250 cu.m of soil.

Measurement: The filling shall be measured and quantity of earthwork computed from crosssections of filling or the embankment. No deduction shall be made for voids.

Rate: The rate shall include the testing, additional rolling to obtain required density in addition to the cost of materials and labour required for all the operations mentioned above.

19. GRANULAR SUB-BASE

19.1 Scope

This work shall consist of providing, laying and compacting well-graded material on prepared sub grade in accordance with the requirement of these specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grade and cross –section shown on the drawing or as directed by the Engineer.

19.2 Materials

The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Material like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer.

The material shall be free from organic or other deleterious constituents and conform to grading-I as given under:



IS Sieve designation	% by weight passing the IS Sieve						
15 Sieve designation	Grading-I	Grading-II	Grading-II				
Granular Sub Base M	aterial						
75.00mm	100						
53.0mm	80-100	100					
26.5mm	55-90	70-100	100				
9.50mm	35-65	50-80	65-95				
4.75mm	25-55	40-65	50-80				
2.36mm	20-40	30-50	40-65				
0.425mm	10-25	15-25	20-35				
0.075mm	3-10	3-10	3-10				
CBR value	30	25	20				
(Minimum)							
Coarse Graded GSB N	Vaterials	1					
75.0 mm	100	-	-				
53.0 mm		100					
26.5 mm	55 - 75	50 - 80	100				
9.50 mm							
4.75 mm	10 - 30	15 - 35	25 - 45				
2.36 mm							
0.425 mm							
0.075 mm	<10	<10	<10				
Min. CBR Value	30	25	20				

Note: The material passing 425-micron (0.425 mm) sieve for all the three grading when tested according to IS 2720 (Part-V) shall have liquid limit and plasticity index not more than 25 and 6 % respectively.

While the grading in table above is in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm. The corresponding grading



for the coarse graded materials for each of the three maximum particle sizes are given in table. The grading to be adopted for the project shall be as specified in the contract.

19.3 Physical Requirements

The material shall have a 10 % fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS 812 (Part-III). The material absorption of the coarse aggregate shall be determined as per IS 2386 (Part-III). If this value is greater than 2% the soundness test shall be carried out on the material as per IS 383. For grading II and III material, the CBR shall be determined at type density and moisture content likely to be developed in equilibrium condition which shall be taken as being the density to uniform air voids content of 5 %.

19.4 Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirement of CBR and other physical requirement when compact and finished. When directed by the Engineer, this shall be verified by performing CBR test in the laboratory as required on specimen remoulded at field dry density and moisture content and any other test for the "quality" of material, as may be necessary.

19.5 Construction operation

19.5.1 Preparation of sub-grade

Immediately prior to the laying of sub-base, the sub-grade already finished to clause 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous material, lightly sprinkled with water if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

19.5.2 Spreading and compacting

- i. The sub-base material of grading as specified above shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic control suitable for initial adjustment and for maintaining the require thickness, slope and grade during the operation or other means as approved by Engineer.
- ii. When the sub-base materials consist of combination of materials mentioned above, mixing shall be mechanically done by the mix-in place method. Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, Trial runs with the equipment shall be carried out to establish its suitability for the work.



- iii. Moisture content of the loose material shall be checked in accordance with IS 2720 (Part-2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable width of surface or other means approved by Engineer so that, at the time of compaction, it is 1% above to 2% below the optimum moisture content corresponding to IS 2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.
- iv. Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100mm, a smooth wheeled roller of 80-100 kN weight may be used. For a compacted single layer up to 225mm the compaction shall be done with plane drum or pad foot drum or heavy Pneumatic tyred roller of minimum 200-300 kN weight having a minimum tyre pressure of 0.7kN/m² or equivalent capacity roller capable of achieving the required compaction. Where specified heavy roller is not available, compaction should be done in layers not exceeding 100mm to achieve the specified thickness. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portion having unidirectional cross fall and super elevation and commence at the edge and progress towards the centre for portions having cross fall on both sides.
- v. Each pass of the roller shall uniformly overlap not less than 1/3 of the track made in the preceding pass. During rolling, the grade and the cross fall (Camber) shall be checked and any high spots or depression which becomes apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km/hr.
- vi. Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material determined as per IS 2720 (Part-8). The surface of any layer of material on completion of compaction shall be well closed, Free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

19.6 Measurement for payment

Granular sub-base shall be measured as finished work in position in cu.m. The protection of edges of granular sub base extended over the full formation as shown in the drawings shall be considered incidental to the work of providing granular sub-base as such no extra payment shall be made for the same.

19.7 Rate

The contract unit rate for granular sub-base shall be payment in full for carrying out the required



20. WET MIX MACADAM (WMM) - Scope of work is not applicable to this contract

20.1 Scope

- i. This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-base in accordance with the requirement of these specifications. The material shall be laid in one or more layers as necessary to lines, grade and cross section shown on the approved drawing or as directed by the Engineer.
- ii. The thickness of single compacted wet mix macadam layer shall not be less than 75mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of the single layer of the sub –base course may be increased to 200mm upon approval of the Engineer.

20.2 Material

Physical requirement

Coarse aggregate shall be crushed stone. If crushed gravel/shingle is used, not less than 90% by weight of the gravel/shingle piece retained on 4.75 mm sieve shall have at least 2 fractured faces. The aggregate shall conform to the physical requirement as under:

Sl. No	Test	Test Method	Requirements		
1	Los Angeles Abrasion value,	IS-2386 (Part-4) 40 percent (M			
	or aggregate impact value	IS-2386 (Part-4) or	30% (Max)		
		IS-5640			
2	Combined flakiness and	IS-2386 (Part-1)	30% (Max)		
	elongation indices (Total)				

Aggregate may satisfy requirement of the following test:

• If water absorption value of coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered at the site as per IS-2386(Part-5).

Grading Requirement

R

The aggregate shall conform to the grading as under:

	IS Sieve Designation	Percent by weight passing IS sieve
	53.0mm	100
	45.0mm	95-100
Se Contract	26.50 mm	-
DGP¢		
oad Works		Page 70 of 87

IS Sieve Designation	Percent by weight passing IS sieve
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600 micron	8-22
75 micron	0-8

Material finer than 425 micron shall have plasticity index (pi) not exceeding 6.

20.3 Construction operation

Preparation of Base

The sub-base to receive the Wet Mix Macadam shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any rust and soft yielding plans shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

Provision of lateral confinement of aggregate

While construction Wet Mix Macadam, arrangement shall be made for the lateral confinement of the wet mix. This shall be done by laying material in adjoining shoulder by providing stone edging as per relevant item of Bill of Quantities.

Preparation of Mix

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/ positive mixing arrangement like pub mill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixer. Optimum moisture content for mixing shall be determined in accordance with IS 2720(Part-8) after replacing the aggregate fraction retained on 22.4mm sieve with material of 4.75mm to 22.4mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limit. The mix material should be uniformly wet and no segregation should be allowed.

Spreading of Mix

Immediately after mixing, the aggregate shall be spread uniformly and evenly upon the prepared sub-base in required quantities. In no case should these be dumped in heaps directly



on the area where these are to be laid nor shall there hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable initial adjustment and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

- Loading hopper and suitable distribution mechanism.
- The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.
- The paver shall be equipped with the necessary control mechanism so as to ensure that finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth block during construction. No segregation of layer and fine particle should be allowed. The aggregate as spread should be of uniform gradation with no pockets of fine material.

Compaction

- i. After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted to the full depth with suitable roller. If the thickness of single compact layer does not exceed 100mm, a smooth wheel of 80-100 kN weight may be used. For a compacted layer up to 200mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80-100 kN or equivalent capacity roller. The speed of the roller shall not exceed 5km/hr in case vibratory roller of 80-100 kN is not available, compaction shall be done in a layers not exceeding 100mm to achieve the specified thickness exceeding 100mm in portion having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly overlapping each preceding track by at least 1/3 width until the entire surface has been rolled. Alternate trips of roller shall be terminated in stops at least 1m away from any preceding stop.
- ii. In portion in camber, rolling should begin at the edge with the roller running forward and backward until the edge has been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding tracks by atleast 1/3 width until the entire surface has been rolled.



- iii. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/ or removed and made good. Along forms, kerbs, wall or other place not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tamper or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.
- iv. Rolling should not be done when the sub-grade is soft or yielding or when it causes waver like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceed 123mm when tested with a 3m stretch edge, the surface should be loosened and pre-mix material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of un-mix material be permitted to make up the depression.
- v. Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material as determined by the method outlined in IS-2720(part-8).
- vi. After completion, the surface of any finished layer shall be well closed, free from movement under compaction equipment of any compaction planes, ridges, cracks and loose materials. All loose, segregated or otherwise defective area shall be made good to the full thickness of the layer and re compacted.

Setting and Drying

After final compacting of wet mix macadam course, the road shall be allowed to dry for 24 hours.

Opening to Traffic

No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

Rectification of surface irregularities

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerance or where the course is otherwise is defective due to sub grade soil getting mixed with the aggregate, the full thickness of layer shall be scarified over the affected area, reshaped with added premix material or removed and replaced with fresh premix materials as applicable and re compacted in accordance with clause 10.3.5. The area treated in the aforesaid manner shall not be less than 5m long and 2m wide. In no case shall the depression be filled up with unfixed and ungraded material or fines.

Measurement and payment

Wet mix macadam shall be measured as finished work in position in cubic meters.



The contract unit rate for wet mix macadam shall be payment in full for carrying out the required operations.

21. SUBSTRUCTURE OF BRIDGE

21.1 Abutments

The work shall be strictly in accordance with the drawings or as directed by the Engineer.

The top surface of foundation over which new concrete is to be laid, shall be scraped with wire brush and all loose materials removed. In case reinforcing bars projecting from foundations are coated with cement slurry, the same shall be removed by lapping, hammering or wire brushing. Care shall be taken to remove all loose materials around reinforcements. Just before commencing masonry or concrete work, the surface shall be thoroughly wetted.

The recommended minimum height per lift of concrete casting shall be 1.20m. Where shown in the drawings, the Construction Joints (CJ) shall be provided as specified.

The weep holes as shown on the drawings or as directed by the Engineer, shall be provided in conformity with the relevant clause of these Specifications. The surface finish shall be smooth, except on the earth face of abutments which shall be rough finished.

21.2 Abutment Cap

The locations and levels of abutment cap, pedestals and bolts for fixing bearings, shall be checked carefully to ensure alignment in accordance with the drawings.

The surface of cap shall be finished smooth and shall have a slope for draining off water as shown on the drawings or as directed by the Engineer. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

21.3 Back Wall, Return Wall and Wing Wall

In case of cantilever return walls, no construction joint shall be permitted. The dirt wall and cantilever return walls shall be cast in one operation.

The finish of the surface on the earth side shall be rough while that of the front face shall be smooth.

21.4 Tests and Standards of Acceptance

The materials shall be tested in accordance with these Specifications and shall meet the prescribed requirements.

The work shall conform to these Specifications and shall meet the prescribed standards of



21.5 Tolerances in Concrete Elements

a)	Variation in cross-sectional dimensions	-	+10 mm, -5 mm
b)	Misplacement from specified position in plan	-	10 mm
c)	Variation of levels at the top	-	±10 mm
d)	Variations of reduced levels of bearing areas	-	±5mm
e)	Variations from plumb over full height	-	±10 mm
f)	Surface unevenness measured with 3 m straight	t edge	
	All surfaces except bearing areas	-	5mm
	Bearing areas	-	3mm

21.6 Measurements for Payment

Concrete in substructure shall be measured in cubic metres in accordance with *Section Error! Reference source not found.* of these Specifications, based on the quantity ordered or as shown on the drawings. No deduction shall be made for weep holes.

Steel in concrete of substructures shall be measured in tonnes, in accordance with *Section IError! Reference source not found.* of these Specifications, based on the quantity ordered or as shown on the drawings.

Weep holes shall be measured as per piece, based on the numbers provided or as shown on the drawings.

21.7 Rate

The contract unit rates for concrete, reinforcement and weep holes shall include all works as given in respective Sections of these Specifications and cover all incidental items for furnishing and providing substructure as mentioned in these Specifications and shown on the drawings.

22. RIVER TRAINING & PROTECTION WORKS

22.1 Description

River training and protection work shall include construction of guide bunds, guide walls, spurs, bank protection, flooring, cut-off walls, apron and approach embankment protection, as required for ensuring safety of the bridge structure and its approaches against damage due to flood/flowing water. Construction of various components shall conform to IRC: 89 and these Specifications or as directed by the Engineer.



This work shall consist of laying boulders directly on the bed of rivers for protection against scour.

The stones used in fill shall be sound, hard and durable. Stones subject to marked deterioration by water or weather shall not be used.

Quarry stones having angular shapes shall be preferred to round boulders.

The size of stone shall be as large as possible and no stone shall weigh less than 50 kg. The specific gravity of stones shall be as high as possible and not less than 2.4.

To ensure regular and orderly disposition of the full intended quantity of stone in the apron, the stones shall be, to the extent possible, graded before being carefully packed in layers so that the void between the stone blocks is minimized.

The surface on which the boulders are to be laid shall be levelled and prepared for the length and width, as shown in the drawings.

22.3 Measurements for Payment

The packed boulder filling/pitching for toe protection shall be measured in cubic metres.

If directed by the Engineer, the materials shall have to be stacked at site before laying and such stacking shall be considered incidental to the work.

22.4 Rate

The contract unit rate for the construction of toe protection for the abutments shall cover the cost of all materials including transportation, laying, compacting, all labour, tools, equipment, sampling and testing, supervision and all incidentals necessary for completing the work according to these Specifications or as per drawings or as directed by the Engineer.

23. BAILEY BRIDGE SUPERSTRUCTURE

23.1 Description

This work shall include supply, assembly and launching of the compact 200 type Bailey bridge. The company identified by the contractor and approved by the Engineer for manufacture of the bridge components shall be hereafter termed as "**the manufacturer**".

Note: the supply of Bailey bridge superstructure is not included in the scope of this contract. The scope of the bridge work includes bridge foundation, protection works and launching & testing.

23.2 Supply of the Bailey Bridge Parts



The Bailey bridge shall be Compact 200 type (minimum panel height 2.20m).

23.2.2 Technical specifications

The bridge shall meet the following technical requirements:

Span: As per drawing/BoQ

Load Capacity: Class 40R as per IRC 6 -2016

Clear Carriage way width: 4.25m

Deck type: Steel deck with checkered surface

Painted/Galvanized: Painted

Truss configuration: To be recommended by the manufacturer based on span, carriageway width and the load capacity.

23.2.3 Corrosion protection and Painting

The corrosion protection works - surface preparation, application of primer, paints (at least two coats) including the paint materials must be all carried out in the manufacturers yard strictly as the per the relevant standard code of practice. The finish and durability of the paint must conform to highest quality standards. The manufacturer shall submit the type, number of coats and thickness of each coat as a part of the internal QA/QC report.

The final shade of the paint shall be army green or as decided otherwise by the Engineer/Client.

23.2.4 Additional requirements

The manufacturer shall promptly submit the geometric requirements of the abutment top for both the launching end and landing end to enable to designer to, if required, make necessary modifications of the abutment top geometry to suit the bridge supplied by the manufacturer.

The manufacturer/contractor shall submit a design report for the Bailey bridge superstructure including calculation sheets that confirm the bridge to be safe for the applied loads.

The manufacturer shall submit a letter of warranty covering the Client against all damages from possible design or manufacturing defects for a period of one year from the date of supply of the bridge parts.

23.2.5 Recommended manufacturers

Owing to the specialized nature of the job, the bridge parts shall be sourced only from reputed manufacturers.

A few manufacturers with past experience of having supplied compact 200 type bridges to Bhutan are listed below:



1. Garden Reach Shipbuilders & Engineers Ltd.

61, Garden Reach Road, Kolkatta-700 024

(A government of India Undertaking)

2. Jiangsu Bailey Steel Bridge Co., Ltd

No.2 South Jingwu Road, Dingmao District, Zhenjiang,

Jiangsu Province, CHINA

E-mail: csmbailey@163.com

3. Mabey Bridge

Unit 9, Lydney Harbour Estate

Lydney, Gloucestershire GL154EJ, United Kingdom

Email: mail@mabeybridge.com.

While Mabey has not supplied compact 200 bridges to Bhutan so far, they are one of the pioneers of the Bailey bridge system and renowned world over for Bailey type bridges.

The contractor may explore other reputable manufacturers of Bailey bridges in the region and around the world.

However, the company identified by the contractor for manufacture and supply of the Bailey bridge components must be approved by the Engineer. The Contractor shall submit the required credentials of the Company to the Engineer for this purpose.

23.2.6 Quality Assurance/Quality Control

The bridge components shall be manufactured under stringent quality control and quality assurance regime.

The manufacturer shall submit the following:

- a. The mill/test certificates of the materials used
- b. Internal QA/QC record of the manufacturing process
- c. Third party quality certification by a government accredited testing house
- d. Any other QA/QC related documents required by the Engineer

In line with standard practice, a team of two engineers representing the Client organization shall carry out physical inspection of the bridge components during the manufacturing process of the bridge parts at the manufacturer's premises. Based on the state of the production process, the team may demand certain tests to be conducted on the materials/bridge components which the manufacturer shall promptly facilitate. While the expenses for the visit



shall be borne by the Client organization, the manufacturer shall accord full cooperation to the team by way of providing unrestricted access of its fabrication yard, sharing the QA/QC documents and reports related to the bridge, facilitate/demonstrate the tests on materials or components as demanded by the team.

23.2.7 Method of Measurement and Payment

The Bailey bridge components shall be paid as a lump-sum for the supply to the bridge site of full unit of the bridge components for the span, width, load capacity and other relevant specifications covered in the drawings and the Bill of Quantities. The rates shall be inclusive of material, manufacture, tests, transportation to bridge site, insurance, loading & unloading, all forms of taxes and all other costs and efforts required to supply the bridge components to the bridge site in full.

23.3 Assembly and Launching of the Bailey Bridge

Note: Applicable for Contract package LOT1 and Lot 2 only.

23.3.1 General

The assembly and launching of the bridge at site shall be carried out under the supervision of a competent engineer from the manufacturer/supplier. The employer will arrange the supervising engineer from the manufacturer/supplier of the bridge.

The contractor shall submit the following prior to commencement of the bridge assembly and launching for approval by the Engineer:

1. Detailed launching method statement including the drawings showing the step-by-step process.

2. List of launching equipment, machineries, tools and manpower (both skilled and unskilled) required.

3. Check list of activities and items prior to start of the bridge assembly and launching process

- 4. Check list of activities during the bridge assembly and launching process.
- 5. Check list of activities after the bridge launching is complete.
- 6. Procedures and methods for bridge loading testing.

Care must be taken during bridge assembly and launching to prevent damage to the bridge components, particularly the paints.

23.3.2 Method of Measurement and Payment

The bridge assembly and launching shall be paid as a lump-sum for the whole of the tasks,

i.e., completion of the bridge assembly and launching in full as per the lines and levels shown



The cost of bridge assembly and launching shall include, but not limited, to the following:

- a. Hire/purchase (as may be applicable) of the additional bridge parts required for launching nose/counterweight.
- b. Hire/purchase of machineries and full set of equipment and tools required
- c. Preparation of the launching space as per the launching method statement approved by the Engineer.
- d. Bridge load testing includes mobilization of test vehicle(s), equipment and instruments required to carry out the load test.
- e. Any additional tasks required to complete the bridge assembly and launching in full.

24. QUALITY CONTROL

24.1 General

- i. All materials to be used, all methods adopted and all works performed shall be strictly in accordance with requirement of these specifications. The contractors shall carry out the test in the laboratory in Bhutan as approved by the Engineer.
- ii. The Contractor shall carryout quality control tests of the materials and work to the frequency stipulated in the subsequent paragraphs. In absence of clear indications about method and or frequency of tests for any item, the instruction of the Engineer shall be followed.
- iii. For the work of backfill sub-grade and pavement, construction of subsequent layers of same or other material over the finished layer shall be done after obtaining permission from the Engineer. Similar permission from the Engineer shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.
- iv. The Contractor shall carry out modification in the procedure of work, if found necessary, as directed by the Engineer during inspection. Works falling soft of quality shall be rectified/redone by the Contactors at his own cost, and defective work shall also be removed from the site of works by the Contactor at his own cost.
- v. All charges for the test shall be borne by the Contractor and shall be deemed to be incidental to the work and no extra payment shall be made for the same.
- vi. For testing of samples of soils/soil mixes. Granular materials, and mixes, aggregates, cores, samples in the required quantity and form shall be supplied to the Engineer by the Contactor at his own cost.
- vii. For cement mild steel, and similar other materials where essential tests are to be carried out at the manufacture's plants or at laboratories other than the site laboratory, the cost of samples,



sampling, testing and furnishing of test certifications shall be borne by the Contactor. He shall also furnish the test certifications to the Engineer.

- viii. For testing of cement concrete at site during construction, arrangements for supply of samples, sampling, testing and supply of test results shall be made by the contactor as per the frequency and number of tests specified in the Handbook of Quality Control for Construction of Road and Runways (IRC: SP: 11) and relevant IS codes or relevant clauses of these specifications, the cost of which shall be borne by the Contactor.
- ix. The method of sampling and testing of materials shall be as required by the Handbook of Quality Control for Construction of Road and Runways (IRC: SP: 11). Where they are contradicting, the provision in these specifications shall be followed. Where they are silent, sound practices shall be adopted. The sampling and testing procedure to be used shall be as approved by the Engineer and his decision shall be final and binding on the Contactor.
- x. The materials of backfill construction shall be approved by the Engineer. The responsibility for arranging and obtaining the land for borrowing or exploitation in any other way shall rest with the Contactor who shall ensure smooth and uninterrupted supply of materials in the required quantity during the construction period. Similarly, the supply of aggregates for construction of road pavement shall be from quarries approved by the Engineer. Responsibility for arranging uninterrupted supply of material from the source shall be that of the Contractor.

24.2 Defective Materials

All materials which the Engineer has determined as not conforming to the requirement of the Contract shall be rejected whether in place or not; they shall be removed immediately from the site as directed. Materials which have been subsequently corrected, shall not be used in the work unless approval is accorded in writing by the Engineer. Upon failure of the Contractor to comply with an order of the Engineer/his representative, given under this Clause, the Engineer/his representative shall have authority to cause the removal of rejected material and to deduct the removal cost thereof from any payment due to the Contractor.

24.3 Imported Materials

- i. The Contractor shall furnish a list of materials, finished products manufactures, produced or fabricated outside India which he proposed to use in work. For all materials and equipment that the Contractor is going to import, timely delivery to the job site shall be liable by the Contractor and no time extension will be entitled.
- ii. The materials imported from outside shall conform to the relevant specification of the tender. In case where materials/finished products are not covered by the Specification in the Contract, the details of Specifications proposed to be followed and testing procedure as well as laboratories where tests are to carried out shall be specifically brought out and agreed to in the



Contract. The Contactor shall furnish to the Engineer a certificate of compliance of the tests carried out.

24.4 Control of Alignment, Level and Surface Regularity

All works performed shall conform to lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to permitted tolerances described hereinafter.

24.5 Horizontal alignment

Horizontal alignment shall be rocked with respect to the centre line of the carriageway as shown on the drawings. The edge of the carriageway as constructed shall be corrected within tolerance of ± 0 mm therefrom. The corresponding tolerance for edge of the roadway and lower layers of pavement shall be ± 25 mm.

24.6 Surface Levels

i. The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances as mentioned below.

Sub-grade	+20 mm
	-25 mm

For checking compliance with the above requirement for subgrade, measurement of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

24.7 Surface Regularity of Pavement Courses

The longitudinal profile shall be checked with a 3-meter-long straight edge/moving straightedge as desired by the Engineer at the middle of each traffic lane along a line parallel to the centre line of the road. The maximum permitted number of surface irregularities shall be as under:

	Surfaces of carriageways and shoulders				Surfaces of layers, service areas			
Irregularity	4 n	nm	7 mm		4	mm		
Length (m)	300	75	300	75	300	75	300	75



	Surfaces of carriageways and shoulders				Surfa	ces of la	yers, serv	ice areas
Max permitted no. of surface irregularities	20	9	2	1	40	18	4	3

*Category of each section of road as described in the Contract

The maximum allowable difference for pavement surface (cement concrete), between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be 3 mm.

24.8 Rectification

Where the surface regularity of subgrade falls outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of relevant specifications.

25. QUALITY CONTROL TESTS DURING CONSTRUCTION

25.1 General

- i. The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the respective relevant Clauses. For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended under may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.
- ii. Test procedures for the various quality control tests are indicated in the respective sections of these specifications or for certain tests within this section. When no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent practice to the directions of the Engineer.



Borrow material

Grid the borrow area at 25 m c/c (or closer, if the variability is high) to full depth of proposed working. These pits should be logged and plotted for proper identification of suitable sources of material. The following tests on representative samples shall be carried out:

- Sand Content [IS: 2720 (Part 4)]: 2 tests per 3000 cubic meters of soil.
- Plasticity Test [IS: 2720 (Part 5)]: Each type to be tested, 2 tests per 3000 cubic meters of soil.
- Density Test (IS: 2720 (Part 5)]: Each soil type to be tested, 2 tests per 3000 cubic meters of soil.
- Deleterious Content Test [IS: 2720 (Part-27)]: As and when required by the Engineer.
- Moisture Content Test [IS: 2720 (Part 2)]: One test for every 250 cubic meters of soil.

CBR Test on materials to be incorporated in the subgrade on soaked/ unsoaked samples [IS: 2720 (Part-16)]: One CBR at least for every 3000 cu.m at least or closer as and when required by the Engineer.

Compaction Control

- Control shall be exercised on each layer by taking at least one measurement of density for each 1000 square meters of compacted area, or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis.
- ii. The determination of density shall be in accordance with IS: 2720 (Part-28). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 6 (if non-destructive tests are carried out, the number of tests shall be doubled) as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. IF considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance criteria shall be subject to the condition that the mean density is not less than the specified density plus: 1.65- (1.65/ (No. of samples) 0.5) times the standard deviation

However, for earthwork in shoulders and in the sub grade, at least one density measurement shall be taken for every 500 square meters for the compacted area provided further that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

25.3 Maintenance and repair work on access roads during road construction period

i. The maintenance and repair work to be carried out by the Contractor on access roads within the project area shall include, but not limited to, the following work:



- Immediate repair of all irregularities produced by traffic/water, such as potholes or other damage to the roadway surface.
- Repair of any road-related structures damaged by traffic and weather.
- Periodic shaping and grading of the roadway where necessary to allow good lined drainage and to maintain it in optimal condition for traffic at all times.
- Clearing of slides onto the roadway and lateral slopes, during and after monsoons.
- Keeping the drainage structures and culverts etc., free of debris or any other material that may reduce their flow capacity.
- Disposal of materials removed by the above-mentioned operation to approved spoil areas.
- Provide the necessary traffic signs and signals, and effective dust control.
- ii. If during monsoons there is heavy damage to the protection works (Retaining walls, gabions) and these are required to be rebuilt, the same shall be rebuilt at the orders of the Engineer. The payment for such cases shall be deemed covered under the contractor's insurance for its works and machineries. Client shall not be liable for any financial implication due to such calamities.

25.4 **Turning Radius**

At the turnings, proper turning radius for the road has to be provided. The minimum turning radius required for all curves and turnings should be 12 m and the width of the road at the turnings and curves should be increased as specified in the preceding section of the Technical Specifications.

25.5 Area for vehicle siding

racts

At every 500 m along the road, vehicle siding area as shown in the drawing shall be provided. The cost of excavation/widening of this shall not be paid separately but shall be deemed included in the quoted rate for other items of work of road.

26. ENVIRONMENTAL MANAGEMENT AND MONITORING & OCCUPATIONAL **HEALTH AND SAFETY (OHS)**

Refer ESMP for access road enclosed as annexure 1.

27. ACCOMMODATION STANDARD

When providing living accommodation to workers at construction sites, the objective should be to ensure adequate and decent accommodation and a suitable living environment for workers. The provision of accommodation to workers shall align with the objectives of DGPØ

Occupational Health and Safety. Therefore, it shall meet certain minimum specifications in respect of the nature and standard of the accommodation, and facilities to be made available. The following specifications are drawn for the provision of accommodation to workers in Bhutanese construction industry based on international labour standards.

27.1 Location

The temporary living accommodation for employees should be constructed at the safest place where there is no risk of flooding, landslide, collapse hazards, falling boulders and other elements.

27.2 Accommodation

- a. A gender friendly living accommodation should be provided.
- b. Accommodation should be constructed where workers are protected against the elements (such as wind, cold, rain, heat, etc.)
- c. There should be one room for every 4 employees. Adequate headroom and movement space shall be provided. The size of the room shall be at least 3.5 square meter per person (refer drawing).
- d. A separate kitchen shall be provided if employees cook by themselves. However, if the meals are provided by the employer, a common dining room, canteen or mess room, located away from the sleeping areas should be provided.
- e. A separate pour-flush toilet cum bathroom, washing facilities for male and female shall be provided. There shall be one toilet cum bathroom for every six users. The size of the toilet shall comply with the Building Code of Bhutan/ the attached drawing.
- f. The floors of each room shall be constructed of wood or concrete. Floor shall be provided with good finishes. All wooden floors shall be elevated not less than 1 foot above the ground level at all points to prevent dampness and to permit free circulation of air beneath.
- g. The walls of the bed room and the kitchen must be constructed preferably with ply boards of at least 10 mm thickness (or equivalent) and CGI/ PPI Sheet for roofing. For toilets, both walls and roof shall be constructed with CGI/ PPI sheets (or equivalent).
- h. There should be adequate natural light during the daytime and adequate artificial light (refer drawing).
- i. Adequate ventilation to ensure sufficient movement of air in all conditions of weather and climate.

27.3 Health and Hygiene

a. An adequate and convenient water supply shall be provided for drinking, cooking, bathing, and laundry purposes.



- b. The accommodation should maintain good sanitation and hygiene (proper drainage system, proper waste management, good housekeeping, etc.).
- c. Measures should be taken to prevent the spread of diseases, especially communicable diseases.

27.4 Safety at temporary accommodation site

- a. Any electricity supplied for the accommodation should abide by the Electricity Act of Bhutan, 2001.
- b. There should not be any exposed live wire or unattended electrical switches & sockets in the living accommodation.
- c. Every cable used for any purpose should have a plug at one end.
- d. Combustible, explosive, and highly flammable materials should not be stored in the living accommodation.
- e. Fire safety measures should be taken, including installing and maintaining fire equipment.
- f. As far as possible, floors, walls, ceilings and equipment should be constructed to minimize health risks. The accommodation shall be provided and maintained for the entire contract period including the time extension if any or the delays. The complete work of providing temporary living accommodation to workers at construction sites shall be treated as an item of work under Occupational Health and Safety. The construction shall be durable taking into account local conditions, such as liability to earthquakes, flood and landslide. The materials used for accommodation will remain as the property of the bidder upon completion of the project. The reuse of the materials may be permitted as long as these reused items serve the intended purpose or as approved by the procuring agency.

Note: Details dimension of temporary quarter, contractor may refer to SPECIFICATION OF BUILDING AND ROAD-2022.

