



Government of Koshi Provincial
Ministry of Water Supply, Irrigation and Energy
Chanda Mohana Irrigation Management Office
Koshi Province, Biratnagar

**STANDARD
SPECIFICATIONS
FOR
IRRIGATION AND RIVER TRAINING
WORKS**

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SECTION 100- GENERAL

101 INTRODUCTION

These Specifications shall be applicable to all such Irrigation and River Training works as are required to be executed as per Contract or as per instruction of the Engineer. All Works performed shall be in compliance with the alignment, lines, grades, slopes, cross-sections data, and dimensions as shown in the Drawings. If the Drawings, Special Provisions, or these Specifications, state specific tolerances, then the Work shall be performed within those specified tolerances limits.

The quality of materials, processing of materials as may be needed at the site, salient features of the construction work and quality of finished work shall comply with the requirements set forth in succeeding sections. Where the drawings and Specifications describe a portion of the work in only general terms, and not in complete detail, it shall be understood that only the sound practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be fully complied.

102 DEFINITION

The words such as Contract, Contractor, Engineer/Engineer Incharge, Drawings, Employer, Government, Works and site used in this specification shall be considered to have the meaning as specified in definitions of these terms given in the General conditions of Contract.

103 SCOPE OF WORK

- A. The work to be carried out under the Contract shall be generally described in the Bid Documents as well as in the Bill of Quantities furnished in the Bid Documents.
- B. The works to be performed shall also include all general works preparatory to the construction of canals, irrigation structures, canal crossings, drainage, drainage structures, river training structures and all due and satisfactory construction, completion and maintenance of works to the intent and meaning of the drawings and these specifications and further drawings and other instruction that may be issued by the Engineer from time to time.

The scope of work requires the Contractor to fully comply with all contract conditions, whether explicitly stated or implied, and to provide all necessary materials, equipment, tools, labor, and support services. This includes ensuring safety measures for workers and the public, supplying first-aid and proper accommodation with sanitary facilities, maintaining protective works like fencing and lighting, managing insurance and all related payments such as wages and royalties, and responsibly clearing, reinstating, and cleaning the site upon completion of the work.

- C. 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 Quality Assurance Plan (QAP) shall cover but not be limited only to the followings:

- Organization and management responsibility



- Document and data control
- Construction program
- Method statement
- Process control
- Working Inspection, Testing and documentary procedures
- Arrangement for smooth safe traffic flow during construction and maintenance
- Control and documentation of purchasing and handling of materials
- Maintenance of records for non-conformity and timely corrective actions
- Internal quality audit
- Training to staff
- Environmental Management Action Plan (EMAP)

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

- D.** The Contractor shall furnish, at least 7 days in advance, unless otherwise stipulated in the contract, his program of commencement of item of work, including method for deployment of plant and equipment for the works included in the contract and any other works for which the Engineer may demand the method statement. He shall provide all information to the satisfaction of the Engineer to insure 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

104 PUBLICLY AND PRIVATELY OWNED SERVICES

- Contractor must provide alternative services in full working order before disconnecting any private water, electricity, drainage, etc., affected by the works, approved by the service owner and Engineer.
- Contractor must verify drawings and schedules of affected services (water pipes, sewers, cables, etc.) from various authorities before starting work.
- Final positions of services are assumed based on information from relevant bodies; Contractor must coordinate regularly with them throughout the project.
- Contractor must adapt if public utility bodies change plans, given reasonable notice and Engineer's approval.
- No utility clearance or alterations are allowed without the Engineer's instruction.
- Any affected services must be immediately restored, and the Contractor must protect services/property as required by authorities.
- Removal or shifting of services may be required by the Engineer, with payment made; work starts only after clearance and safety measures are ensured.
- No separate payment is made for temporarily supporting/protecting services or for constructing/maintaining replacement services unless otherwise stated.



105 SURVEY AND SETTING OUT

- Contractor shall resurvey Alignment Lines, Traverse Points, and Bench Marks at work start, confirm coordinates and levels, and report any discrepancies to the Engineer for agreement on amendments or replacements.
- Contractor must check, replace, and supplement station points as needed, agreeing changes with the Engineer.
- All stations and reference points must be clearly marked and protected to the Engineer's satisfaction.
- If a Station Point may be disturbed, the Contractor shall establish alternative reference stations in safe locations; old stations must not be disturbed until approved references are set.
- Working Bench Marks tied to reference stations must be established at a rate of two per km and near major structures, regularly checked, and adjusted as agreed with the Engineer.
- Contractor is responsible for accurate centre line establishment, with reference points every 50 m in flat terrain and every 20 m in hilly terrain, marked with pegs and chainage boards; a reference dimension schedule must be submitted to the Engineer.
- Existing alignment, profile, and cross-sections shall be surveyed jointly by Contractor and Engineer and used for measurements and payments; any design changes from the Engineer must be implemented by the Contractor in the field.
- Accurate control of lines and levels must be maintained throughout construction, with controls at least every 10 m for canals or as directed by the Engineer; gradients and cross-sections must be checked frequently.
- Contractor shall assist the Engineer with all surveys by providing qualified surveyors, support staff, tools, and equipment (levels, theodolite, total station, distomat) as required.
- No separate payment will be made for these survey and setting out works; costs are included in related BOQ items.

106 SITE INFORMATION

- A.** The Contractor shall erect Information boards (size: 1.8m high and 1.2m wide) at the beginning of the each construction site giving details of the contract information in the format and wording as instructed by the Engineer. These boards shall be erected within 14 days after the Contractor has been given the Possession of Site.

The Contractor shall not erect any kind of advertisement on or along the information board without the prior approval of the Employer.

All information boards erected at site shall be removed by the Contractor at his own cost by the end of the Defects Liability Period.

B. Measurement and Payment

Unless stated otherwise, no separate measurement and payment shall be made for erection of information board at site as described in this Clause 110 (standard specification for IRS, DoWRI, 2081) as the cost of such works is deemed to be included in the rates of other items under BOQ.



107 ENVIRONMENTAL PROTECTION WORKS

The environment means the surrounding area including human and natural resources that may be affected by the execution and after completion of works.

The Contractor shall take all precautions for safeguarding the environment during the course of the construction of the works. He shall abide by all prevalent laws, rules and regulations governing pollution and environmental protection mitigation measure specified in the EPA/EPR, Latest Publication of “**Environmental Management Guidelines**”, and “**Environmental and Social Management Framework**” published by the concerned Government agency.

The Contractor shall prohibit employees from unauthorized use of explosives, poaching wild life and cutting trees. The Contractor shall be responsible for any such action of his employees.

Environmental protection works, among others, shall also include the following:

A. Borrow/Quarry Sites

The Contractor shall obtain the permission of the Engineer before opening up any borrows pits or quarries. Such borrow pits and quarries may be prohibited or restricted in dimensions and depth by the Engineer where:

They might affect the stability or safety of the works or adjacent property;

They might interfere with natural or artificial drainage or irrigation;

They may be environmentally unsuitable.

At least 14 days before he intends to commence opening up any approved borrow pit or quarry, the Contractor shall submit to the Engineer his intended method of working and restoration. These shall include but not be limited to:

The location, design and method of construction of any access track;

The volume and nature of materials to be removed;

The sequence and method of excavation of materials;

Measures for controlling run off and sediment from the site during operations;

Proposals for site restoration including approximate finished levels, drainage, erosion and sediment control, and slope stabilization and revegetation, including reinstatement of any access track.

Operations of borrow pit or borrow area shall not be permitted until the method of working for that particular pit or area has been approved by the Engineer in writing. Restoration shall be to the satisfaction of the Engineer.

B. Disposal of Spoil and Construction Waste

Materials in excess of the requirements for permanent works and unsuitable materials shall be disposed off in locations and in the manner as agreed with the Engineer. The locations of disposal sites shall be such as not to promote instability, destruction of properties and public service systems. Exposed areas of such disposal sites shall be

suitably dressed and be planted with suitable vegetation.



The Contractor shall plan his works in such a way that there is no spillage of POL (Petroleum Oil Lubricants) products to the surface or sub-surface water.

C. Provision and Maintenance of Camps, Offices, Stores, Equipment Yards and Workshops

Various works defined under this item are related to provision and maintenance of camps for work person and employees, Contractor's site offices, stores equipment yards and workshops. These camps must be adequate, rain-proof, spacious, airy and hygienic with proper lightning and materials storage facilities. The area shall be kept neat and clean.

Space allocated for storage of materials such as cement, gabion wire, reinforcing wire etc. shall in general be damp-free, rain-proof and away from petroleum products storage.

Written information must be given to and approval be taken from the Engineer regarding proper establishment and maintenance of such camps.

Failure in compliance with Engineer's instruction in respect of overall standard will Lead to reduction or withholding of payment.

D. Provision and Maintenance of Toilets

Provision of toilets for labour and employees shall be made to avoid public nuisance as well as pollution of water courses and air. The Contractor shall construct suitable septic tanks and/or soak pits along with room of pit-type latrines. Sufficient water must be provided and maintained in the toilets. Proper methods of sanitation and hygiene should be employed during the whole project duration.

E. Provision of Potable Water

The Contractor shall supply potable water along with commencement of work to Contractor's staff and work person both at camps and construction-sites. This arrangement shall be enforced to avoid proliferation and generation of various waterborne-diseases.

The Contractor shall inform the Engineer regarding sources, installation and operation of supply of potable water within a week after the supply is commenced.

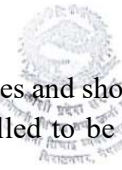
F. Provision of First Aid/Medical Facilities

Provision of first aid/medical facilities shall be made along with commencement of work to provide quick medical service to injured/sick work person, and employees. Services shall also include on-the way service and other arrangements required for taking them to the nearest hospital in case of emergency.

The scope of works shall include service of at least one part-time experienced health worker/health assistant with a minimum of once a week full time site visit as work assignment. The Contractor shall also supply and provide adequate medicines and facilities required for standard first aid.

The Contractor shall inform the Engineer regarding the medical facility within a week after its establishment and operation.

G. Crushing Plants



Crushing plants shall be located away from the population centers, water intakes and should not disturb the sensitive ecosystem. Suitable dust control device shall be fitted to the crusher to control emission of dust from the plant.

H. Batching Plants

Batching plants shall be located away from the population centers. The Contractor shall take every precaution to reduce levels of noise, vibration, dust and emission from his plants.

No waste concrete material shall be discharged into drains. Nearby trees, vegetation and property shall be protected during carriage of mixed concrete by transit mixers.

I. Hazardous Materials

The Contractor shall not store hazardous materials near water surfaces. The Contractor shall provide protective clothing or appliances when it is necessary to use some hazardous substances.

High concentration of airborne dust resulting in deposition and damage to crops and water resources shall be avoided. The Contractor shall take every precaution to control excessive noise resulting in disruption to wildlife and human population.

Only controlled explosives methods shall be applied and used in construction works.

J. Reinstatement of Environment

The Contractor shall arrange and execute works as well as related activities in such away that environmental conditions are reinstated. He may be required to carry out filling, removal and disposal works along with plantation of grass and trees as directed by the Engineer at his own costs at identified locations to reinstate environment.

Written instruction/approval shall be given by/sought from the Engineer regarding reinstatement of environment both during and after completion of works and upto the end of Defects Liability Period.

K. Measurement and Payment

Unless stated otherwise, no separate measurement and payment shall be made for the works described in this Clause 111 as the cost of such environment protection works is deemed to be included in the rates of items under BOQ.

108 AS-BUILT DRAWINGS AND COMMISSION FOR PERFORMANCE BOND

A. AS BUILT DRAWINGS

The Contractor shall prepare the as built drawings of the works actually constructed at the site. One set of all such drawings shall be kept on site and shall be marked up by the Contractor to show variations in the works.

They shall be used to maintain a record of the dimensions and other particulars of the works as they are actually constructed, as and when these particulars differ from what is shown on the for-Contract Drawings prepared by the Contractor.

These records shall be available at all reasonable times on the site for inspection and use by



the Employer and by any other person authorized in writing by the Employer.

Prior to requesting a Certificate of Substantial Completion for the whole of the works, the Contractor shall provide the Employer with 1 (one) reproducible copy and 3 (three) prints of all As Built Drawings.

The drawings shall be suitable for reduction to readable A3 size and for inclusion in the operating and maintenance manuals.

Measurement and payment

Upon the submission of required As built Drawings and their approval by the Engineer, the cost incurred by the Contractor in compliance with the preparation of as built shall be paid as per the unit rate for the item in the BOQ.

B. COMMISSION FOR PERFORMANCE BOND

The contractor shall be responsible to submit performance bond during contract agreement as per the condition of contract. Upon the submission of required performance bonds and their approval by the Engineer, the cost incurred by the Contractor in compliance with the preparation of such bond shall be paid from provisional sum as set up in the BoQ of the contract.

109 INSURANCE OF WORKS, DAMAGE TO PROPERTY, LOSS TO THIRD PARTY AND ACCIDENT TO WORKMEN

(1) General

The Contractor shall provide, in the joint names of the Employer and the Contractor, insurance cover as per the provision included in the Conditions of Contract from the Start Date to the end of the Defects Liability Period, in the amounts and deductibles stated in the Contract Data for the following events which are due to the Contractor's risks:

- (a) Loss of or damage to the Works, Plant and Materials;
- (b) Loss of or damage to Equipment;
- (c) Contractor's Workmen and Employees
- (d) Third Party Liability Insurance;

The Contractor shall produce the insurance policy from any insuring company operative and recognized within Nepal. The Contractor shall, immediately after securing the insurance policy (ies) shall produce to the Engineer the original bills paid against the premiums.

(2) Insurance of Works

- The Contractor shall take out Insurance for the Works from approved agency/institution staff if provided in the contract\
- Payments made to the agency/institution and stamp charges/duties incurred if any, by the contractor in compliance of the above work shall be paid as per the item in the BOQ after submission of the insurance document to the satisfaction of the Engineer.



(3) Third Party Insurance

- The Contractor shall take out Third-Party Insurance from an approved agency/institution staff if provided in the contract.
- Payments made to the agency/institution and stamp charges/duties incurred if any, by the Contractor in compliance of the above work shall be paid as per the item in the BOQ after submission of the insurance document to the satisfaction of the Engineer.

(4) Insurance of Contractor's Workmen and Employees

- The Contractor shall take out Insurance for the Contractor's Workmen and Employees from approved agency/institution staff if provided in the contract.
- Payments made to the agency/institution and stamp charges/duties incurred if any, by the Contractor in compliance of the above work shall be paid as per the item in the BOQ after submission of the insurance document to the satisfaction of the Engineer.

(5) Insurance of Equipment

- The Contractor shall take out Equipment insurance from an approved agency/institution staff if provided in the contract.
- Payments made to the agency/institution and stamp charges/duties incurred if any, by the Contractor in compliance of the above work shall be paid as per the item in the BOQ after submission of the insurance document to the satisfaction of the Engineer.

110 NOTES ABOUT MEASUREMENT AND PAYMENT

A. Measurement

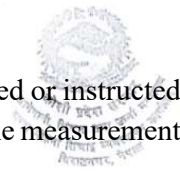
Unless otherwise specified, all measurements shall be made in metric system. Different items of work shall be measured in accordance with the procedures set forth in the relevant Sections read in conjunction with the General conditions of Contract. The same shall not, however, apply in the case of lump sum contracts.

All measurements and computations, unless otherwise indicated, shall be carried nearest to the following limits:

- (i) Length and Width - 10mm
- (ii) Height, Depth or Thickness of:
 - a. Earthwork in excavation - 5 mm
 - b. Embankment - 5 mm
- (iii) Structural members- 2.5 mm
- (iv) Areas- 0.01 m²
- (v) Volume- 0.01 m³

In recording dimensions of work, these limit of tolerances for accuracy of length, width and height or depth or thickness shall be followed.

The tolerances specified in these Specifications are for evaluation of accuracies only based on which the work shall be accepted or rejected. However, the measurement of the work performed within the limits of tolerances shall be the measurement of actual work done in place, if their dimensions are less than what have been specified or instructed by the



Engineer. If the actual work done in place is more than what has been specified or instructed by the Engineer, but within the limit of tolerance, the measurement shall be the measurement of the work what has been specified or instructed by the Engineer.

B. Payment

Unless otherwise specified in the Contract, the unit rates and/or prices for items as set out in the Bill of Quantities are the full and the final compensation to the Contractor for:

- (i) General works such as setting out, clearance of site before setting out and clearance of works after completion;
- (ii) A detailed programme using modern project management software for the construction and completion of the works, including:
 - Construction activities,
 - Submission and approval of materials,
 - Procurement of critical materials/equipment,
 - Fabrication and installation of special products/equipment,
 - Activities of the Engineer/Employer that may affect progress,
 - Periodic updates as per site meetings or Engineer's instructions.
- (iii) Sampling and testing of materials (e.g., reinforcement, cement, concrete, GI wire, bearings) and furnishing of test reports/certificates;
- (iv) Design of mixes as per specifications, including:
 - Proportions of ingredients,
 - Sources of materials,
 - Trial mixes submitted for Engineer's approval.
- (v) Cost of laying trial stretches;
- (vi) Preparation of detailed drawings as per site conditions;
- (vii) Design calculations and drawings for all Temporary Works (formwork, staging, centering, handling equipment, etc.);
- (viii) Detailed drawings for templates, bar bending schedules, reinforcement cutting, structural steel fabrication, etc.;
- (ix) Mill test reports for cement, GI wires, mild and high-tensile steel, and cast steel as per specifications;
- (x) Supply of all materials necessary to complete the work as per specifications;
- (xi) Use of materials, labour, tools, equipment, machines, and other resources as needed;
- (xii) All handling, packing charges, and transportation;
- (xiii) Site commissioning;
- (xiv) Operations like storing, erection, moving into final position, etc., necessary to complete and



- protect the work until handover;
- (xv) Inspection reports for formwork, staging, reinforcement, and other components as per specifications;
- (xvi) Any other data required by Specifications, Conditions of Contract, or annexures/schedules of the Contract;
- (xvii) All temporary works, formwork, and falsework;
- (xviii) Cost of in-built provisions for Quality Assurance;
- (xix) Maintenance and making good;
- (xx) All duties and obligations set out in the Contract;
- (xxi) All incidental costs necessary for completing the work and meeting the Contract requirements not explicitly covered above.

Where the Bill of Quantities does not include items mentioned in **Section 100**, no separate payment shall be made for such works. The costs for these shall be considered included in the relevant BOQ items or as incidental to the work. Items in this Section that are included in the BOQ shall be paid at the agreed contract unit rates.

111 EQUIVALENCY OF STANDARDS

A. Wherever reference is made in these Specifications to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work to be performed or tested, the provisions of latest current edition or revision of relevant standards and codes in effect shall apply. Other authoritative standards which ensure a substantially equal or higher performance than the specified standards and codes shall be accepted subject to the Engineer's prior review and approval. Differences between the standards specified and the proposed alternative standards shall be fully described by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event that the Engineer determines that such proposed deviations do not ensure substantially performance, the Contractor shall comply with the standards and codes specified. No additional payment shall be made for adoption of higher standards.

B. Certain Specifications issued by various national or other widely recognized bodies are referred to in these Specifications. Such Specifications shall be defined and referred as Specifications.

The Contractor may propose that the materials and workmanship be defined in accordance with the requirements of other equivalent Specifications and he may execute the works in accordance with such Specifications as may be approved by the Engineer. A copy of the Specification, together with its translation into the English language if the Specification is in another language, shall be submitted to the Engineer along with the request for its



adoption.

In referring to Specifications, the following hierarchy shall be used:

- (i) NS : Nepal Bureau of Standards and Metrology
- (ii) IRC : Indian Road Congress (i.e. recommended Code of Practice by IRC.
- (iii) IS : Indian Standards
- (iv) BS : British Standards
- (v) ASTM : American Society of Testing and Materials
- (vi) AASHTO : American Association of State Highway and Transportation Officials.
- (vii) BSCP : British Standard Code of Practice
- (viii) ISO : International Organization for Standardization.
- (ix) EN : European Norm

112 UNITS OF MEASUREMENT, ABBREVIATION AND TERMINOLOGY

A. Units of Measurement

The Symbols for units of measurement used in these Specifications are as they are given below.

μ	: micron =
mX10-6	
mm	:
Millimeter	
m	:
Meter	
Km	:
Kilometer	
sq. mm. or mm ²	: Square
Millimeter	
Sq. m. or m ²	: Square
Meter	
Sq.km. or km ²	: Square
Kilometer	
Ha/ha	:
Hectare	
Cu.m. or m ³	: Cubic
meter	
lit or l	: Liter
rad	:
Radian	
°C	:
Degrees Celsius	
Kg	:



Kilogram	
Gm	
Gram = kgX10-3	
mg	:
Milligram = kgX10-6	
mg/l	:
Milligram per liter	
T	:
	: Ton
= kgX103	
Kg/m3	:
Kilogram per cubic meter	
t/m3	:
	: Ton
per cubic meter	
N	:
Newton	
N/m2	:
Newton per square meter	
Lin.m	:
Linear meter	

Symbols of other units, if not covered above, shall be as per SI system set out in ISO31/1.

B. Abbreviations

The following abbreviations are used in these Specifications.

ACV	:
Aggregate Crushing Value	
AIV	:
Aggregate Impact Value	
ALD	: Average
Least Dimension	
BA	: Bitumen
Affinity	
BOQ	: Bill of
Quantities	
CBR	: California
Bearing Ratio	
CR	: Crushing
Ratio	
Dia	: Diameter
DOR	:
Department of Roads	
DWRI	:
Department of Water Resources and Irrigation	
FI	: Flakiness
Index	



Hr/hr	: Hour
LAA	: Los
Angeles Abrasion Value	
LS	: Linear
Shrinkage	
MC	: Moisture
Content	
MDD	:
Maximum Dry Density	
Min/min	: Minute
No	: Number
(Units) as in 6 no	
OMC	: Optimum
Moisture Content	
OPC	: Ordinary
Portland Cement	
PI	: Plasticity
Index	
PL	: Plastic
Limit	
PM	: Plasticity
Modulus (PI*%passing 0.425mm sieve)	
POL	: Petrol,
Oil & Lubricant	
ROW	: Right of
Way	
SE	: Sand
Equivalent	
Sec	: Second
SG	: Specific
Gravity	
IS	:
International Standard Units of Measurements	
SSS	: Sodium
Sulphate Soundness test, loss on 5 cycles	
STV	: Standard
Tar Viscosity	
TS	: Tensile
Strength	
UC	:
Uniformity Coefficient	
UCS	:
Unconfined Compressive Strength	
VIM	: Voids in
Mix	



W/c
cement ratio
wt
%

C. Terminology

The term “the Specifications” shall be construed as the Standard Specification and the Special Specification altogether.

The Sections, Clauses and/or Sub-Clauses mentioned in these Specifications deem to apply to those of these Specifications only, if otherwise not specified.

SECTION 200: SITE PREPARATION

201 CLEARING AND GRUBBING

(1) Scope

The Section covers the clearing and grubbing necessary for the construction of the works covered by the contract. Conservation of the top soil and flora is also covered under this Section.

(2) Description of Work

(a) Clearing

Clearing involves cutting, removing, and disposing of all vegetation like trees, bushes, grass, weeds, anthills, rubbish, fences, and the top organic soil up to 150 mm thick. It also includes removing any structures that obstruct the work. Some soil or gravel may be moved during clearing without extra payment. Additionally, all surface rocks and boulders up to 0.15 cubic meters in size must be removed.

(b) Grubbing

In the canal way all trees up to 300 mm girth, stumps and roots shall be removed to a depth of not less than 500 mm below the original ground level and a minimum of 700 mm below the original ground level.

Except in borrow areas the cavities resulting from the grubbing shall be backfilled with approved material and compacted to a density not less than the density of the surrounding ground.

(c) Conservation of Top Soil

Where suitable top soil exists within the limits of the area to be cleared and grubbed, the Contractor shall, if ordered by the Engineer, remove the top soil together with any grass and other suitable vegetation. If not used immediately, the top soil shall be transported and deposited in stockpiles for later use.

**(d) Conservation of Flora**

Where provided for in the contract, certain designated flora encountered in the canal reserve and borrow areas shall be carefully protected by the Contractor. In his tendered rate for Site Clearance, he shall include for the careful removal and planting of the flora in a protected and fenced-off area and, on completion of the canal, for the planting of the flora in suitable positions in the canal reserve in accordance with the Engineer's instructions.



(3) Execution of Work

(a) Areas to be Cleared and Grubbed

All stumps, logs, roots, vegetation, rubbish, and other unwanted materials must be fully removed to the depth specified. Typically, the entire canal reserve within the canal prism and some borrow areas will be cleared and grubbed, except for trees the Engineer specifies to leave intact. The Contractor must mark the clearing boundaries and get the Engineer's approval before starting. The Engineer will define the exact areas and timing for clearing and grubbing.

(b) Cutting of Trees

The Contractor must avoid damaging structures and property during work. Trees may be cut from the top down if needed, and those to remain must be trimmed to avoid obstructing the canal. Trees marked by the Engineer must be preserved. If directed, trees should be felled inward to minimize damage.

Tree cutting requires permission from the relevant authority, and officials may need to be present for numbering, measuring, and marking. The Contractor must store felled timber at designated sites and follow authority guidelines.

Timber over 150 mm in diameter must be cleaned, cut, and stacked as directed, and remains the Employer's property—not to be used by the Contractor. All unusable timber, brush, and debris must be completely cleared from the canal area.

(c) Dealing with Anthills

Where anthills are encountered within the limits of the canal way, they shall be excavated to a depth of not less than 500 mm below the original ground level and the material carted to spoil. Cavities resulting from the clearance of anthill material shall be backfilled as required with approved material and compacted to a density not less than that of the surrounding ground.

Where directed by the Engineer, the area covered by anthills shall be treated, after excavation and before backfilling of cavities, with an approved ant control chemical. Payment for such treatment shall be made in the manner specified in the contract.

(d) Disposal of Material

Material obtained from clearing and grubbing shall be disposed off in borrow pits or other suitable places and be covered up with soil or gravel as directed by the Engineer. The burning of combustible material shall not, normally, be permitted and may only be done with the prior written approval of the Engineer.

Where fences have to be taken down, fencing wire shall be neatly wound into reels and all such wire, together with all fence posts and other serviceable material from structures, etc., shall be stacked at sites indicated by the Engineer.



(e) Reclearing of Vegetation

When portions of the canal reserve, borrow or other areas have been cleared in accordance with the Specifications, but in the course of time, vegetation grows again during construction, the Engineer may, if he considers it necessary, order that the area be recleared.

Before the bottom layer of the embankment is made, the Contractor shall grub up and remove any vegetation that may in the meantime have grown on the surfaces previously cleared and grubbed.

Such re clearing of areas previously cleared include the removal and disposal of grass, shrubs and other vegetation in the same manner as for the first cleaning operation. No separate payment shall be made for reclearing of vegetation.

(4) Measurement

Clearing and grubbing executed as per this Specification shall be measured in square meter. Cutting trees including removal of stumps and their roots of girth from 120 mm and backfilling to required compaction shall be measured in number according to the sizes given below:

- (a) 120 mm to 300 mm
- (b) Above 300 mm to 600 mm
- (c) Above 600 mm to 900 mm
- (d) Above 900 mm to 1200 mm
- (e) Above 1200 mm to 1800 mm
- (f) Above 1800 mm to 2400 mm
- (g) Above 2400 mm to 3000 mm
- (h) Above 3000 mm

For this purpose, girth shall be measured at a height 1 meter above the ground. Cutting of trees up to 120 mm girth including removal of stumps and roots and backfilling of holes with compaction shall not be measure separately.

(5) Payment

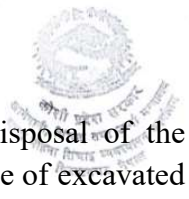
Clearing and grubbing and cutting trees shall be paid at their respective contract unit rates which shall be the full and the final compensation to the Contractor as per **Clause 108**. The contract unit rate for cutting of trees of girth 120 mm shall also include handling, salvaging, piling and disposing off the cleared materials with all leads and lifts.

SECTION 300: EARTHWORKS

301 SCOPE

This Section covers the works related to the canal excavation, filling for canal banks and embankments, excavation for foundation, backfilling, excavation for drains, channels etc.

302 DEFINITIONS AND GENERAL REQUIREMENTS



- (1) Earthwork includes two types of operations i.e. (i) earth excavation and disposal of the excavated materials (ii) earth excavation and use of excavated materials. The use of excavated material may be in the form of filling embankment, backfilling, filling other areas as required.

Earth excavation and disposal implies excavation of all types of materials including part of the structures below ground level within and outside of the limit of the right ofway of canal except for otherwise specified, shaping the exposed surface of excavation as specified or directed by the Engineer, removal, hauling and disposal of the excavated material at the locations and in the manner as specified or directed by the Engineer.

Excavation and filling implies excavation of materials and shaping the exposed surface of excavated as stated, removal hauling and use of the excavated material at the location and in the manner as specified or directed by the Engineer.

Excavation and disposal shall include:

- (i) Excavation and disposal of any type of material included on the Drawing.
- (ii) The excavation and disposal of existing surfacing.
- (iii) Excavation and disposal of slides, breakages and caving-ins.
- (iv) Excavation and disposal for stream channel, trenches and drains etc.
- (v) Excavation required in cuts or under embankments below the lowest normal limit of excavation as indicated on the Drawing or below ground line.
- (vi) Excavation and disposal of unsuitable materials.
- (vii) Removal or partial removal of existing embankments and disposal of the materials as shown on the Drawing or as directed by the Engineer.
- (viii) Excavation for foundation and disposal of materials.

Excavation and filling shall include:

- (i) Filling for embankment
- (ii) Filling for guide bunds, coffer dams, etc.
- (iii) Backfilling in trenches, foundation pits etc.
- (iv) Any type of other filling or backfilling whereby the ground level is raised or a hole is filled up.

- (2) The following definitions of earthworks materials shall apply to this and other Clauses of these specifications, if otherwise not specified.

- (i) “Topsoil” shall mean the top layer of soil that can support vegetation. It shall include all turf acceptable for turfing.
- (ii) “Suitable Material” shall comprise all that is acceptable in the accordance with the Contract for use in the Works and which is capable of being compacted in the manner specified in Clause 309 and 310 (standard specification for Irrigation, River Training and Study Works) to form a stable fill having side slopes as indicated in the Drawing. The material used in fill (except for rock fill) shall not contain rock fragments with dimensions of more than 75 mm.
- (iii) “Unsuitable Material” which cannot be considered suitable for embankment shall mean other than suitable material and shall include:



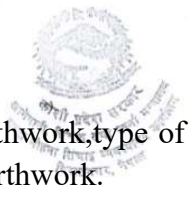
- (a) Material from swamp, marshes or bogs;
- (b) Peat, logs, stumps, perishable material, organic clays;
- (c) Material susceptible to spontaneous combustion;
- (d) Material in a frozen condition;
- (e) Clay of liquid limit exceeding 50 and/or plasticity index exceeding 25;
- (f) Dispersive soil (Soil with predominance of sodium cations) ;

Material stated above in (d) if otherwise suitable shall be classified suitable when unfrozen.

- (iv) “Unsuitable Material” which cannot be considered suitable for construction of irrigation/drainage canal shall mean other than suitable material and shall include:
 - (a) Dispersive soil (Soil with predominance of sodium cations) ;
 - (v) “Rock Fill” shall consist of hard material of suitable size for deposition and compaction as given in Clause 309 (standard specification for Irrigation, River Training and Study Works) and also may comprise rock as defined in Clause 303 and broken stones.
 - (vi) “Well Graded Granular Material” consists of gravel and/or sand conforming to relate IS Codes.
- (3) No excavated suitable material other than surplus to requirements of the contract shall be removed from the site except on the direction of the Engineer. Should the Contractor be permitted to remove suitable material from Site to suit his operational procedure, then he shall make good at this own expense any consequent deficit of filling arising therefrom.
 - (4) Material in surplus to the total requirements of works, and all unsuitable material shall, unless the Engineer permits otherwise, be run to spoil dumps.
 - (5) Where the excavation reveals a combination of suitable and unsuitable materials the Contractor shall carry out the excavation in such a manner that the suitable materials are excavated separately for use in the works without contamination by the unsuitable materials.
 - (6) The Contractor shall make his own arrangements for the stockpiling of top-soil and/or suitable material.
 - (7) At all times the Contractor shall ensure that earthworks are not damaged by weather or traffic. In event of such damage, the Engineer may withdraw approval from the affected works until the Contractor has carried out repairs to restore the works to their original condition.

The cost of all such repairs and any additional testing shall be borne by the Contractor.

- (8) Prior to commencement of any earthwork, the work shall be set out where required as specified in Clause 104 (standard specification for IRS, DoWRI, 2081) following the clearing and grubbing as per Section 200 and Survey of the existing ground shall be conducted jointly by the Contractor and the Engineer. The survey records shall serve as initial measurements for the determination of the final quantities of earthwork performed under the contract.
- (9) Works on embankments and/or cutting in areas required for the construction of bridges and other structures shall not be carried out until the Engineer agrees that construction of such structures is sufficiently advanced that there is no interference or damage to them.



- (10) The Contractor shall get approval of the Engineer in respect of method of earthwork, type of equipment to be used, disposal and other details before commencement of the earthwork.

303 CLASSIFICATION OF EXCAVATED MATERIALS

The excavated materials shall be classified under the following categories. The decision of the Engineer in respect of the classification of excavated materials shall be the final and binding upon the Contractor.

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

(1) Soil

This shall comprise topsoil, turf, sand, silt, loam, 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 this category.

(2) Gravel Boulder Mixed Soil (GBM Soil)

Gravel Boulder Mixed (GBM) soil is a coarse-grained soil composed primarily of gravel, cobbles, and some topsoil. It typically occurs in rocky or mountainous regions where natural weathering and erosion processes have accumulated larger-sized particles. This type of soil is challenging to handle during construction and excavation due to its rough texture and the presence of large materials. GBM soil includes gravel particles smaller than 75 mm and cobbles that range between 75 mm and 300 mm in size. Materials larger than 300 mm, known as boulders, are not considered part of GBM. Despite its coarse nature, GBM can generally be worked using ordinary hand tools such as picks, shovels, rakes, or similar digging equipment.

(3) Dispersive Clay

Dispersive soil is a type of clay soil characterized by a high concentration of sodium cations, making it highly susceptible to erosion when exposed to flowing water. This erosion occurs as individual clay particles are easily separated and carried away, leading to structural failures such as piping in canals and hydraulic structures. Due to its instability, dispersive soil is unsuitable for use in canal cuttings, embankments, or any hydraulic or road structures unless properly treated. These soils can look identical to normal clays and cannot be identified by standard tests like grain size analysis or Atterberg limits. Instead, specialized tests such as the crumb test, pinhole test, and chemical analysis are required. Dispersive soils are found globally, often in alluvial deposits like lake beds, loess, and flood plains, and they pose serious engineering risks if not correctly identified and managed. The key difference between dispersive and stable clays lies in the dominant pore water cations—sodium in dispersive clays versus calcium, magnesium, or potassium in stable clays.

(4) Ordinary Rock (not requiring blasting)



This shall include:

- (i) This category includes various types of materials and formations that range in hardness and workability. It covers rock types like laterites, shales, conglomerates, certain limestones and sandstones that can be quarried or split with crowbars, and rocks that may require blasting when dry but soften when wet. It also includes macadam road surfaces (water-bound or bitumen/tar-bound), road soling, hard core, compact moorum, and stabilized soil that require tools like grafting tools, picks, and shovels. Additionally, it includes gravel and cobblestones sized between 75 mm and 300 mm, lime concrete, stone or brick masonry in lime or cement mortar below ground level, and reinforced concrete that can be broken with hand tools. Loose or embedded boulders over 300 mm that do not require blasting, found in riverbeds, slopes, or terrace deposits, also fall under this category.

(5) Hard Rock (requiring blasting)

This shall comprise:

- (i) any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required;
- (ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
- (iii) Boulders requiring blasting.

(6) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.

(7) Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

(8) Authority for classification:

The classification of excavation shall be decided by the Engineer and his 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.

304 EXCAVATION IN CUTTING

- (1) Cleaning and grubbing shall be performed as specified in Section above.
- (2) While executing excavations, the Contractor shall take adequate precautions against soil erosion and water pollution.
- (3) All suitable excavated materials shall be used in construction of the canal banks/embankment to the extent as required.
- (4) Hauling of material from cutting or borrow pits to embankments other areas of fill shall proceed



only when plant or labour is operating at the place of deposition to ensure that adequate spreading and compaction of material can take place.

- (5) Over-excavation shall not be permitted. Any excess depth excavated below the formation levels as specified shall be made good by the Contractor at his own expense by backfilling with suitable material of similar characteristics to those of moved materials with compaction as specified in Clauses 309 and 310 (standard specification for IRS, DoWRI, 2081).
- (6) The slopes of cutting shall be cleared of all rock fragments which move when prized by a crowbar, unless otherwise directed by the Engineer. Where the Engineer considers that the slope, immediately after dressing, shall not be permanently stable, he shall direct the Contractor as to the stabilization measures required. The Contractor shall carry out these measures soon after Engineer's instruction.

When completed, the excavation slopes shall be true to the lines and levels as shown on the Drawing or directed by the Engineer. When completed, no point on slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock, no point shall vary more than 300 mm from the designated slope.

- (7) If slips, slides, over breaks or subsidence occur in cutting, they shall be removed. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction.
- (8) If water is encountered in excavations due to seepage, springs, or other causes such as marshy soil, it shall be removed by suitable diversions or bailing out and the excavation shall be kept dry. The drained water shall be discharged into suitable outlets as not to damage to the works, crops or any other property. If any such damage is caused due to any negligence of the Contractor, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.
- (9) Stones encountered during excavation/cutting of soil shall be removed and disposed as directed by Engineer. Removal of stone and their subsequent disposal shall be treated as separate item if mentioned in the BoQ, and shall be paid at unit rate provided in the BoQ.

305 EXCAVATION BELOW EMBANKMENTS

- (1) Where any unsuitable material below the natural ground level under proposed embankments is required to be excavated, it shall be removed to such depth and over such areas as shown on the Drawing or as directed by the Engineer. The excavated materials shall be disposed off as indicated on the Drawing or directed by the Engineer. The resultant excavation shall be backfilled with suitable material and shall be levelled and compacted to the density as specified for forming of the embankments.

Nevertheless, if such backfill has to be carried out in standing water, the Contractor shall use only an approved non-plastic well-graded granular material having maximum size of not greater than 75 mm. Such materials may be deposited in water without use of compaction equipment.

- (2) Where shown on the Drawing, approved, graded stones having size from 380 mm to 150 mm



and containing not more than 10 percent, below 150 mm in size shall be placed directly on the natural occurring unsuitable material. This type of rock fill material shall be deposited in accordance with the requirements of Clause 309 and compacted as per Clause 310 (standard specification for IRS, DoWRI, 2081).

- (3) If after the removal of material as specified in Sub-clause 306 (1) (standard specification for IRS, DoWRI, 2081), the Contractor allows the materials so exposed to reach a condition where compaction of back filling is impracticable, he shall make good at his own expense either by additional excavation and filling in the manner specified in this Clause, or by waiting until the condition of the exposed material is fit to receive the approved backfill.

306 EXCAVATION FOR FOUNDATION & Removal of Gravel Mixed Soil

(1) Slope

Excavation shall consist of the removal of material for the construction of foundations for drainage structures, retaining walls, head walls, cut off walls, culvert, bridges and other similar structures and removal and disposal of gravel-mixed soil from the stilling basin or stilling portion of hydraulic structures to the lines and dimensions shown on the Drawing or as instructed by the Engineer in accordance with the requirements of these specifications. The work shall include construction of the necessary cofferdams and cribs and subsequent removal of all necessary sheeting, shoring, bracing, diversion of water/flow, draining and pumping, the removal of all logs, stumps, grubs and other deleterious matters and obstructions necessary for placing the foundation; trimming bottoms of excavations; and cleaning up the site and the disposal of all surplus material.

(2) Excavation

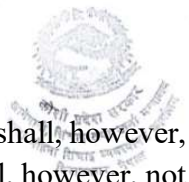
Excavation shall be taken to the length and width of the lowest step of the footing and the sides shall be left to plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench does not permit vertical sides, the Contractor at his own expense shall put up necessary shoring, strutting and planking or cut slopes to a safer to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the Drawing or as directed by the Engineer.

Where blasting is to be restored to, the same shall be carried out in accordance with Clause 304 (standard specification for IRS, DoWRI, 2081).

(3) Dewatering, Diversion of Flow and Protection

Normally, open foundation shall be laid dry. Where water is encountered in excavation due to stream flow, seepage, spring, rain or other reasons, the Contractor shall take adequate measure such as bailing, pumping, constructing diversion channels, drainage channels, bunds, cofferdams and other necessary works to keep the foundation pit or trenches dry, when so required and to protect the green concrete/masonry against damage by erosion, failure of cut slope or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice



of the Contractor, but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipment, etc., inside the enclosed area.

Cofferdam sheet-piling shall be carried down well below the bottom of the pile caps or footings, but without interference with any bearing piles. Cofferdams shall be rigidly constructed and efficiently braced to withstand external pressures when water is pumped out. Sheeting shall be reasonably watertight and all appreciable leaks encountered during the operations shall be stopped so that construction of pile caps can be carried out in the dry. The Contractor shall rectify any cofferdam which, for any reason, has moved, tilted, or changed its shape and/or size.

Pumping form, the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump and is separated from the concrete work by a watertight wall or other similar means.

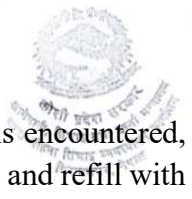
At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the area of excavation.

The Contractor shall take all precautions in diverting flow and in discharging the drained water as not to cause damage to the works, crops or any other property. If any such damage is caused due to any negligence of the Contractor, it shall be the sole responsibility of the Contractor to repair/restore to the original at his own cost or compensate for the damage.

(4) Preparation of Foundation Base

The bottom of the foundation pit shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed, if surface is not wet. In the event of excavation having been made deeper than that shown on the Drawing or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation grade at the cost of the Contractor. Ordinary filling shall not be allowed for the purpose to bring the foundation to level. When rock or other hard strata is encountered, it shall be freed of all soft and loose materials, cleaned and cut to firm surface either levelled or stepped as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of rock excavation, annular space around footing shall be filled with concrete of grade M 10 up to top level of rock.

After the excavation is completed, the Contractor shall inform the Engineer to that effect and no footing, bedding materials or structures shall be placed until the Engineer has approved the depth and the suitability of foundation material.



If, at any point, in any foundation excavation, material unsuitable for foundations is encountered, the Contractor shall, if so instructed by the Engineer, shall remove all such materials and refill with suitable materials thoroughly compacted by tamping or rolling in layers of not more than 150mm thick each.

(5) Slips and Blows

If there are any slips or blows in the excavation, these shall be removed by the Contractor at his own cost.

(6) Public Safety

Where required, trenches and foundations pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accident as per Sub- clause 102 (5) (standard specification for IRS, DoWRI, 2081).

The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures.

(7) Removal of Cofferdams

All cofferdams with all temporary sheeting and bracing shall be removed by the Contractor after the completion of the substructure unit. The removal shall be carried out in such a manner as not to disturb or damage the finished concrete. However, sheet piling below the top of the pile caps may be left in place at the Contractor's option and expenses.

No bracing no other material shall be left in cofferdam in such a way as to extend into the concrete of the structure.

Cofferdams located in a stream or lake and within the limits of low water shall be removed to the elevation of the stream or lake bed, except that in established navigation channels, they shall be removed to an elevation at least 600 mm below the established bottom of the channel.

307 REFILLING OF FOUNDATION PITS AND TRENCHES, REMOVAL OF SUPPORTS AND FILLING TO STRUCTURES

Refilling of foundation pits and trenches shall consist of previous backfill and/or common backfill as shown on the Drawing or as directed by the Engineer.

(1) Materials

(a) Pervious Backfill

Unless otherwise specified in the contract, it shall be of gravel, crushed gravel, crushed rock, natural sands, manufactured sands or combinations thereof. It shall conform to the grading limits set out in Table 3.1.

Table 3.1: Grading Limits of Pervious Backfill

Sieve Size (mm)	Percentage Passing by Weight
40	100
10	45-100



2.36	25-80
0.60	8-48
0.075	0-6

(b) Common Backfill

Common backfill materials other than pervious backfill shall be suitable material as defined in Sub-clause suitable material in clause above.

(2) Method of Filling

Backfilling material shall be placed and compacted in layers in compliance with the requirements of COMPACTION OF EMBANKMENT AND OTHER AREAS OF FILL/BACKFILL. Any support structures for the excavation shall be withdrawn as the filling proceeds unless described in the contract or ordered by the Engineer to be left in. The backfill shall be placed in by such methods which shall avoid loading the structure in any manner which may affect its stability or overload its underlying foundation material or substructure. The backfill in front of abutments and wing walls shall be placed first to avoid the Possibility of forward movement. Precautions shall be taken to prevent any wedge action against upright surfaces, and the slopes bounding the excavation shall be stepped as directed by the Engineer before backfill is placed. The backfill material around box culverts, piers and curtain walls shall be placed simultaneously on both sides of the structure. When the structure is so designed that its strength is dependent on the restraining effect of the superstructure (such as in portal frames and propped abutments), the backfill shall not be placed until the superstructure has been completed to the extent and strength necessary to provide the required restraint. When the Contract requires wedges between steel superstructure and the parapet of wing type abutments, the wedges shall be placed in advance of placing any fill above the lower 1/3 of the abutment and shall be removed when directed by the Engineer.

308 COMPACTION OF EMBANKMENT AND OTHER AREAS OF FILL/BACKFILL

- (1) The Contractor shall obtain the Engineer approval of all fill layers before covering with subsequent layers.
- (2) All fill shall be compacted to the depth and degree of compaction as specified in Table 3.2 or as shown on the Drawing. Formation level if this context shall mean top of subgrade.

Table 3.2: Compaction Requirements

Location	Depth below Formation Level (mm)	Minimum Compaction (%MDD Heavy Compaction)
Roadway Embankment	0-300	95
Roadway Cut	0-300	95
All other roadway fills and backfill not separately specified		93

- (3) Each layer of rock used to fill in embankments shall be spread and levelled and systematically



compacted.

- (4) Layers of material other than rock fill shall not exceed 150 mm compacted depth unless and until the Contractor can demonstrate to the satisfaction of the Engineer that he can successfully Compact layers of a greater thickness.
- (5) Each layer shall be constructed in lengths suitable to the compaction and working methods used. Materials of each layer shall be thoroughly mixed with water as necessary to facilitate its compaction to the specified density.
- (6) In cut areas, the subgrade shall be processed as necessary and compacted to the depth and compaction requirements as given in Table 3.2. In the event that the Contractor is unable to achieve the minimum compaction requirements below formation level he shall excavate and re compact in layer as necessary.
- (7) Where it may be impracticable to use conventional rollers, the compaction shall be carried out by appropriate mechanical means such as small vibratory rollers, power rammers or plate compactor. Care shall be taken to ensure that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to it.

309 PROCESS CONTROL

- (1) Throughout the works the Contractor shall perform tests to determine the suitability and compaction characteristics of soils to be used. The maximum dry density (MDD) and Optimum moisture content (OMC) test shall be conducted in accordance with IS 2720 Part 8 as specified in Table 8.8.
- (2) In addition to the foregoing tests, the Contractor shall carry out field density tests on the compacted fill materials in accordance with IS 2720 part 28/29. As specified in Table 8.8 and shall be carried out in each layer, including original ground surface on which embankment is to be constructed. If the result of any test shows that the minimum specified density has not been achieved, further compaction shall be executed to the area concerned and the layer re-tested. Unless the test results are satisfactory, the addition of another layer shall not be allowed.
- (3) The Contractor shall carry out tests for determination of moisture content at frequent intervals on all materials during the course of compaction as per Sub-clause 309 (5) (standard specification for IRS, DoWRI, 2081) to ensure that the requirements of Clause 310 (standard specification for IRS, DoWRI, 2081) are met with.

310 TEST FOR DISPERSIVE SOIL

Dispersive clays cannot be distinguished from nondispersive clays by conventional index tests such as gradation, Atterberg's limits, or compaction characteristics. The five laboratory tests most generally performed to identify dispersive clays are the crumb test (as specified in USBR 5400), the double hydrometer test (as specified in USBR 5405), the pinhole test (as specified in USBR 5410), the test of dissolved salts in the pore water, and the ESP (exchangeable sodium percentage) based tests.

However, results from the individual tests often do not agree, and the pinhole test is considered the



most reliable since it is a direct physical test. It is emphasized that all of the tests should be performed on each soil sample for the most complete information and most reliable identification.

The primary requirement for taking soil samples in the field for any method of dispersive testing whether in the United States or elsewhere is to ensure that there is no moisture loss from the sample. Samples should be shipped to the laboratory in airtight containers. It is important that all soil specimens be maintained and tested at their natural water content since drying, especially oven drying, may alter dispersive characteristics.

SECTION 400: COLLECTION AND PROVIDING OF MATERIAL

401. General Responsibilities

- The Contractor is responsible for selecting and securing sources of materials such as fine aggregate, coarse aggregate (river bed round materials, crushed/broken aggregates), rubble stone, and others needed for concrete, masonry, or related works.
- Material sources, including rock quarries and natural river beds, must be identified before the contract starts. The Engineer will specify which sources are approved for use during the project.

402. Definitions of Material Sources

- **Rock Quarry:** An open surface working in massive rock where stone is extracted by drilling and blasting for construction use.
- **Quarry:** An open surface working where stone or aggregates for sub-base, base, and surfacing are extracted.
- **River Bed:** Natural riverbeds supplying materials like sand, pebbles, and stones for construction.

403. Locating Material Sources

- The Contractor must locate all material sources and secure or rent any land needed for quarries and access.
- The proposed quarry location and size must be approved by the Engineer.
- The Contractor must submit detailed proposals within 30 days of receiving the work order, including:
 - A site plan of the proposed source
 - Laboratory test results of the materials
 - Any other relevant data
- If using quarries identified by the Engineer, the Contractor must get approval for the quarry and access roads.
- If a quarry lacks sufficient suitable material, the Contractor must immediately notify the Engineer. The Engineer may then require extending the quarry or finding new sources, which must follow the same approval process.

**404. Safety and Public Health**

- The Contractor must comply with all local laws and regulations regarding public safety and health related to quarry operations.
- Quarry areas must be drained and kept dry; if natural drainage isn't possible, pumping must be used.
- Work areas must be clearly demarcated with temporary or permanent fencing as directed.
- For quarry faces taller than 1 meter, stock-proof fencing and gates must be installed to prevent unauthorized access.

405. Access Roads

- The Contractor must construct and maintain access roads to quarries according to contract conditions and Clause 103 (standard specification for IRS, DoWRI, 2081).

406. Selection and Extraction of Materials

- Before opening a quarry, the Engineer will instruct on the type, area, and depth of material to be extracted.
- Specific equipment operations may be required based on raw material characteristics and final product specifications.
- Material quality must be tested according to relevant standards, and the Engineer may require quality control measures if standards are not met.

407. Storage and Handling of Materials

- Materials must be stored safely, dry, and properly covered:
 - Cement must be stored in waterproof, airtight buildings with floors raised at least 30 cm above ground, and bags stacked no higher than 2 meters. Open storage may be permitted for small works if protected adequately.
 - Coarse aggregates must be stockpiled in approved locations on cleaned and leveled ground to prevent segregation; stacks should be rectangular and no higher than 1 meter.
 - Stones must be stacked regularly on dry, firm ground in heaps no taller than 1 meter.
 - Bricks should be stacked on dry, firm ground in neat stacks for inspection and counting, with specific dimensions and spacing between stacks.

408. Measurement and Payment

- Measurement for collection, piling, staking, and other material handling tasks will be made according to contract units specified in the Bill of Quantities (BoQ).
- Payment will be made at the contract unit rates and will be considered full and final for completing the work as per these specifications.



SECTION 500: TRANSPORTATION OF MATERIAL

501. GENERAL

- The Contractor is responsible for transporting materials using trucks, labor (with doko-tokari or wheelbarrow), or mules as applicable.
- The Contractor must select sources of aggregates, stone, fill materials, gravel, and other suitable materials for embankments, sub-base, base, surfacing, and shoulders.
- Material sources include rock quarries, quarries, alluvial deposits, borrow pits, which may be pre-identified by the Engineer.
- The Contractor locates quarries, alluvial deposits, borrow pits, spoil and stockpile areas during the contract, subject to Engineer approval.

502. Definitions

- **Rock Quarry:** Open site with massive rock extracted by drilling and blasting.
- **Quarry:** Open site for stone or aggregate for sub-base, base, surfacing.
- **Alluvial Deposit:** Site extracting gravel and aggregates of alluvial origin.
- **River Bed:** Natural riverbed supplying sand, aggregates, pebbles, stones.
- **Borrow Pit:** Site for loose materials (not stone).
- **Stockpile Area:** Area where materials like topsoil or aggregates are stored before use.
- **Spoil Area:** Site where surplus or unsuitable materials are dumped.

503. Locating Material Sources

- Contractor is responsible for locating and acquiring land for all material sources and related areas.
- Proposed locations and sizes must be approved by the Engineer.
- Contractor submits detailed proposals within 30 days of work order, including site plans, lab tests, and other relevant info.
- Engineer approval required for quarry use and access road alignment.
- If material quantity or quality is insufficient, Contractor must notify Engineer immediately for directions on extending or finding new sources.

504. Safety and Public Health

- Contractor must comply with local laws and regulations on public health and safety for quarry and borrow pit operations.
- All work areas must be drained or pumped dry.
- Operations must be confined to designated areas with proper fencing.
- Stock-proof fencing and gates are required for faces taller than 1 meter to prevent unauthorized access.
- After completion, temporary structures and fencing must be removed, latrines filled, and sites left clean and landscaped.

**505. Access Roads**

- Contractor must build and maintain access roads to quarries, alluvial deposits, borrow pits, spoil, and stockpile areas per contract and Clause 103 (standard specification for IRS, DoWRI, 2081).

506. Site Clearance and Removal of Topsoil/Overburden

- Sites for quarries, borrow pits, etc., must be cleared per Section 200, with measurement/payment under this section.
- Existing vegetation or features directed by Engineer must be protected.
- Topsoil and overburden must be removed and either stockpiled separately or disposed as directed.
- Upon completion, unused topsoil and overburden must be spread back and landscaped.

507. Selection of Materials

- Before extraction, the Engineer will specify material types, areas, and depths.
- Equipment use may be specified based on material and final product needs.
- Material quality must be tested and controlled to meet specifications.

508. Measurement and Payment

- No separate payment for site clearance, overburden removal, access roads, and reinstatement unless otherwise stated.
- Costs for these are included in the Contractor's rates elsewhere.
- Where overburden or topsoil is reused, measurement/payment will follow relevant sections.
- Transportation of materials will be measured and paid by contract unit rates, which are considered full and final payment as per Clause 108.

SECTION 800 – CEMENT CONCRETE WORKS**801. SCOPE**

This Section named Cement concrete works covers the materials required, design of mixes, transport, placing, compaction and curing of concrete and mortar required for different concrete works for concrete structures. It also covers steel reinforcement for concrete.

802. DEFINITIONS

Structural concrete is any class of concrete which is used in reinforced, pre-stressed or unreinforced concrete construction which is subject to stress.

Non-structural concrete is composed of materials complying with the Specification but for which



no strength requirements are specified and which is used only for filling foundations and similar purpose where it is not subjected to significant stress.

A pour refers to the operation of placing concrete into any mould, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

803. MATERIAL FOR CONCRETE

(1) General

The Contractor shall submit to the Engineer full details of all materials which he purposes to use for making concrete. No concrete shall be placed in the works until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

(2) Cement

Cement shall be ordinary Portland cement and shall comply with following requirements.

Ordinary and High Strength Portland Cement (OPC and HSPC), Portland Slag Cement (PSC), Portland Pozzolana Cement (PPC) shall be sampled according to IS: 3535 and tested according to NS: 123/IS: 4031.

Chemical and physical requirements for Ordinary Portland Cement, High Strength Portland Cement, Portland Slag Cement and Portland Pozzolana Cement shall be in accordance with NS: 49/IS: 269, IS: 8112, IS: 12269, IS: 455, IS: 1489 respectively.

The requirements on their physical characteristics shall be as given in Table 6.2

Table 6.2: Requirement on the Physical Characteristics of Cement

S.N.	Physical Characteristics	OPC/ PSC	HSPC	Test Procedu re
i)	Fineness, m ² /kg: (by Blaine's Air Permeability method)	225	225	
ii)	Setting Time:			NS 123
	(a) Minimum Initial Setting Time (minutes)	45	45	
	(b) Maximum Final Setting Time (minutes)	600	600	
iii)	Soundness by Lechatelier Method, mm, maximum	10	10	NS: 123
iv)	Compressive Strength:			
	Minimum average Compressive Strength of three mortar cube (N/mm ²)			
	(a) 3 days	16	27	



(b) 7 days	22	37
(c) 28 days	33	53

Mortar shall comply with IS 2250-1981; Code of Practice for preparation and use of masonry mortar. The mortar used in work shall have the strength not less than 5 N/mm² or 7.5 N/mm² at 28 days as specified.

However, if provided in the Contract, cement and sand may also be mixed in specified proportions. Cement shall be proportioned only by weight, by taking its unit weight as 1440 kg/m³ and sand shall be proportioned by volume after making due allowance for bulking.

Cement used in the works shall be free-flowing, free of lumps, and supplied either in sealed manufacturer's bags or in bulk. Bagged cement must be transported in weather-protected vehicles, while bulk cement shall be transported in suitable containers or vehicles. On-site, bagged cement shall be stored in a dry, well-ventilated, weatherproof structure with the floor raised at least 30 cm above ground level. Stacks shall be closely packed, with a minimum 0.5 m clearance from walls, and shall not exceed eight bags in height. Different types of cement must be clearly marked and stored separately, and cement from broken bags shall not be used. Cement shall be used in the order of delivery, while bulk cement shall be stored in silos with clear identification of cement type, ensuring no mixing occurs. The Contractor shall provide sufficient storage capacity to prevent interruption of work. Cement for each structure shall, as far as possible, come from the same source. The manufacturer shall provide test certificates for each supply and for the previous six months of production, with each test relating to a single day's output. The Contractor shall also carry out testing in an approved laboratory if instructed, particularly for cement stored on site for over one month, testing every 200 tons or part thereof at monthly intervals. Full records of cement manufacture, delivery, storage, and testing shall be maintained and submitted to the Engineer.

(3) Fine Aggregate

Fine aggregate shall be clean hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with IS 383. All the material shall be in accordance Table 8.1.

Table 8.1 Grading Requirement for fine aggregate

IS sieve designation (mm)	Percentage passing
10	100
4.75	90-100
2.36	75-100
1.18	55-90
0.60	35-59



0.30	8-30
0.15	0-10

In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source. The deviation from the initial fineness modulus shall be not more than ± 0.30 for ordinary concrete and ± 0.20 for high quality concrete.

However, in respect of the presence of deleterious materials the fine aggregate shall not contain iron pyrites, iron oxides, mica, shale, coal or other laminar soft or porous materials or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in Table 8.4 and as per the direction of the Engineer, that presence of such materials does not affect the properties of the concrete.

(4) Coarse Aggregate

Coarse aggregate shall be clean, clear, dense, hard, strong and durable crushed rock, crushed gravel or natural gravel. As far as possible, flaky, coriaceous and elongated pieces should be avoided. Coarse aggregate shall be supplied in the nominal size called for in the contract and shall be of the grading as specified in Table 8.2.

Table 8.2 Grading Requirement for Coarse Aggregate

S.N	IS sieve Designation	Percentage Passing for Single Sized Aggregate of nominal Size						Percentage Passing for Graded Aggregate of Nominal Size			
		63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
i)	80 mm	100						100			
ii)	63 mm	85-100	100								
iii)	40 mm	0-30	85-100	100				90-100	100		
iv)	20 mm	0-5	0-20	85-100	100			30-70	90-100	100	100
v)	16 mm				85-100	100				90-100	
vi)	12.5 mm					85-100	100				90-100
vii)	10 mm	0-5	0-5	0-20	0-30	0-45	85-100	10-35	25-35	30-70	40-85
viii)	4.75 mm			0-5	0-5	0-10		0-5	0-10	0-10	0-10
ix)	2.36 mm										

Other properties shall be set out below:

For Ordinary Concrete

Not more than 25

For High Quality Concrete

Not more than 15

Flakiness Index: When tested in accordance with IS 2386 Part 1, the Flakiness Index of the coarse aggregate shall be as set out hereunder:



If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

Water Absorption: the aggregate shall not have a water absorption of more than 2 percent when tested as set out in IS: 2386 Part 3.

Los Angeles Abrasion (LAA): The aggregate shall have LAA not more than 50% for ordinary concrete, and not more than 30% for high quality concrete (wearing surface), when tested in accordance with IS: 2386 Part 4.

Aggregate Crushing Value (ACV): The aggregate shall have ACV not more than 30% for wearing surfaces such as road and pavement structure and not more than 45% for other structure when tested in accordance with IS: 2486 Part 4.

Alkali Aggregate Reactivity (AAR): Coarse aggregates having positive alkali-silica reaction shall not be used for concreting. The aggregate shall comply with IS 456 when tested in accordance with IS: 2386 Part 7.

(5) Testing Aggregate

(a) Acceptance Testing

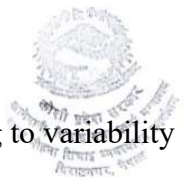
- Contractor shall provide samples of not less than 50 kg for any aggregate proposed for use.
- Samples must be labeled with origin and accompanied by relevant information per **IS: 2386 Parts 1–8**.
- Tests for compliance with grading, silt, clay, organic impurities, and other requirements shall be carried out in an **approved laboratory**.
- If initial tests fail, additional tests shall be conducted in the presence of Contractor and Engineer.
- Acceptance is based on **three consecutive sets of compliant test results** according to IS 2386.

(b) Compliance Testing/Process Control Testing

- Contractor shall conduct routine testing during concrete production.

		Test procedure	Frequency
Fine aggregate and	Grading Silt, Clay Contents and Organic Impurities	IS: 2386 Part 1	1 set (3 nos) test for each 10 to 50 cum and additional test for each 50 cum of concrete
		IS: 2386 Part 2	
Coarse Aggregate	Grading Silt, Clay Contents and Organic Impurities	IS: 2386 Part 1	1 set (3 nos) test for each 25 to 125 cum and additional test for each 125 cum
		IS: 2386 Part 2	

- Testing frequency shall increase if source is variable.
- **Chloride Content:** Tested as needed to ensure compliance with limits.



- **Sulphate Content & Alkali-Aggregate Reactivity:** Tested according to variability observed during mix design.

(6) Delivery and Storage of Aggregate

Aggregate shall be delivered to site in clean and suitable vehicles. Different type or sizes of aggregate shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that the contamination of aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

(7) Water for Concrete Mortar

Water shall be reasonably clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may deleterious to concrete or steel.

The Contractor shall carry out tests in compliance with IS 456 to establish compliance with Specifications.

(8) Admixture

(a) General

The use of admixtures in concrete may be required under the contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him in compliance with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it in the mix. The information provided shall include:

- (i) The typical dosage, the method of dosing, and the detrimental effects of an excess or deficiency in the dosage.
- (ii) The chemical names of the main active ingredients in the admixture.
- (iii) Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- (iv) Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so the extent to which it does so.

(v) Details of previous uses of the admixture in Nepal.

Admixture/additives conforming to IS 9103 may be used subject to approval of the Engineer. However, admixture/ additives generating hydrogen or nitrogen and containing chlorides, nitrates, sulphides, sulphates or any other material likely to adversely affect the steel or concrete shall not be permitted.

Compatibility of the admixtures with the cement and any other pozzolan or hydraulic addition shall be ensured by for avoiding the following problems.

- (i) Requirement of large dosage of superplasticizer for achieving the desired workability.



- (ii) Excessive retardation of setting
- (iii) Excessive entrainment of large bubbles
- (iv) Unusually rapid stiffening of concrete
- (v) Rapid loss of slump
- (vi) Excessive segregation and bleeding

(9) Curing Material

Curing of Concrete may be done by using water, steam and membrane forming compounds. Approved membrane forming curing compound consisting of waxes, resins, chlorinated rubbers etc may be used, which shall be applied to all exposed surface of the concrete as soon as possible after the concrete has set. Impermeable membrane such as sheet materials conforming to ASTM C 171 or polythene sheeting covering closely the concrete surface may also be used to provide effective barrier against evaporation.

804. DESIGN OF CONCRETE MIXES

(1) Classes of Concrete

The classes of structural concrete to be used in the works shall be as shown on the Drawing. Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table 8 of IS 456: 2000 may be assumed for design of mix in the first instance. As soon as the results of samples are available, actual calculated standard deviation shall be used and the mix designed properly for reference Table 8.3 may be used, in which the class designation include two figures. The first figures indicate the characteristic strength f_{ck} at 28 days expressed in N/mm^2 and the second figure is the maximal nominal size of aggregate in the mix expressed in millimeters. Letter M in the class designation stands for Mix, letter SM stand for Special Mix.

Consistence of the mix, assessed through the Slump Test where the slump is measured in millimeters, is designate as follows:

S: Stiff consistence, for slump ≤ 40

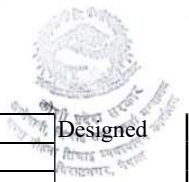
P: Plastic consistence, for slump > 40 and ≤ 90

VP: Very Plastic consistence, for slump > 90 and ≤ 150

F: Flowing consistence for slump > 150

Table 8.3: Concrete Classes and Strength

Classes of Concrete	Consistence	Type of uses	Characteristic Strength f_{ck} (N/mm^2)	Maximum Nominal Size of Aggregate mm	Trial mixes Minimal Target Strength $f_{ck} = f_{ek} + 1.65 \cdot S$ (N/mm^2)	Early works test cubes		Concrete mix
						Any one result (N/mm^2)	Average of 3 consecutive results (N/mm^2)	
M 10/75	S	Ordinary	10	75	16	7	14	Designed / Prescribed
M 10/40	S	Ordinary	10	40	16	7	14	
M 15/20	S	Ordinary	15	20	21	12	19	
M 15/40	S	Ordinary	15	40	21	12	19	



M 20/20	S	Ordinary	20	20	27	16	24	Designed
M 20/40	S	Ordinary	20	40	27	16	24	
M 25/20	S	Ordinary	25	20	32	21	29	
M 25/40	S	Ordinary	25	40	32	21	29	
M 30/40	P	High Quality	30	40	38	26	34	
M 30/20	P	High Quality	30	20	38	26	34	
M 30/12	P	High Quality	30	12	38	26	34	
M 35/40	P	High Quality	35	40	43	31	39	
M 35/20	P	High Quality	35	20	43	31	39	
M 40/20	P	High Quality	40	20	48	36	44	
M 45/20	P	High Quality	45	20	53	41	49	Designed
M 50/20	P	High Quality	50	20	58	46	54	
M 55/20	P	High Quality	50	20	63	51	59	
SM 30/40	VP	Underwater	30	40	38	26	34	
SM 30/20	VP	Underwater	30	20	38	26	34	
SM 30/20	F	Bored Piles	30	20	38	26	34	
SM 40/20	S	Precast Piles	40	20	48	36	44	
SM 45/20	S	Post-tensioned Girders	45	20	53	41	49	

(2) Design of Proposed Mixes

Concrete mixes shall comply with the following requirements:

Sampling and testing on concrete shall be carried out in accordance with the standard methods given in the Table 8.4

Table 8.4 Tests Procedures Applicable to Concrete

SN	Tests	Test Procedure
	Determination of:	
(i)	Air contents of fresh concrete	IS: 1199
(ii)	Density of hardened concrete	IS: 516
(iii)	Compressive strength of concrete cubes	IS: 516
(iv)	Tensile splitting strength	IS: 5816
(v)	Flexural strength	IS: 516
(vi)	Compressive strength of concrete cores	IS: 516
(vii)	Water absorption	
(viii)	Mixing and sampling fresh concrete in laboratory	IS: 516
(ix)	Normal curing of test specimens	IS: 516
(x)	Accelerated curing of test specimens	IS: 9013
(xi)	Marking test cubes from fresh concrete	IS: 516

Non-destructive tests shall be carried out in accordance with the standard method and recommendations given in Table 8.5 as and when required.

Table 8.5: Non-destructive Tests Applicable to Concrete

S.NO	Test	References to Test Procedures
(i)	ULTRASONIC PULSE VELOCITY (UPV))	IS: 13311 part-1
(ii)	Rebound hammer	IS: 13311 part-2
(iii)	Pull out test [method of testing bond in reinforcement concrete]	IS: 2720 part - 1
(iv)	RADIOGRAPHIC METHODS	BS: 1881 -205
(v)	BACKSCATTER RADIOMETRY (BSR) (Nuclear surface moisture density gauge)	ASTM C 1040



(vi)	IMPACT-ECHO	ASTM C 1383
(vii)	COVER METER and Bar locator	BS: 1881 204
(viii)	Core test	IS: 516
(ix)	Corrosion assessment/ Half-cell potential	ASTM C 876-9

The test specimens shall be cured at a temperature of $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$

Water used for concrete shall comply with all the requirement given in Table 8.6 Water to be used in concrete shall be tested as specified in IS: 3025

Table 8.6 Permissible limit for solids for water used in concrete

S.NO.	Permissible limit , Max	Test Procedure
(i)	200 mg/l	IS: 3025 part 18
(ii)	3000 mg /l	IS: 3025 part 18
(iii)	400 mg/l	IS: 3025 part 24
(iv)	2000 mg/l, for concrete not consisting embedded steel and 500 mg/l for RCC work	IS: 3025 part 32
(v)	200 mg/l	IS: 3025 part 17

The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weight of cement in the mix:-

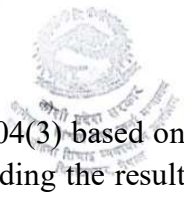
For pre-stressed concrete, steam cured concrete or concrete containing percent sulphate resisting or super sulphated cement -0.1

For any other reinforced concrete - 0.4 percent

The total sulphate content expressed as SO_3 of all the ingredients in a mix including cement water and admixtures shall not exceed 0.4 percent by weight of the aggregate or 4.0 percent of the weight of the cement in the mix, whichever is the lesser.

The contractor shall design all the concrete mixes called for in the Drawing using the ingredients which have been approved by the Engineer in accordance with Clause 803 (standard specification for IRS, DoWRI, 2081) and in compliance with the following requirements:

- (a) The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150-micron size.
- (b) The cement content shall be such to achieve the strength called for in Table 8.3 but in any case not less than the minimum necessary as shown in Table 8.7.
- (c) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.
- (d) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater than 0.5 for classes of concrete higher than M20 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.



- (e) For each class of concrete Contractor shall conduct laboratory trial as mentioned in 804(3) based on the results of these trials the contractor shall submit full details of his proposal including the result of test to the Engineer for approval.

However, Engineer's approval shall not relieve the contractor from his responsibilities for compliance with these specifications.

- (f) The cement content shall not be more than 450 kg/m^3 unless special consideration has been given in design to cover the risk of cracking due to drying and shrinkage in thin sections or to early thermal cracking and to the increased risk of damage due to alkali silica reactions.

Table 8.7: Minimum Cement Content and Maximum water cement ratio

SN	Exposure	Minimum cement Content in kg/cu.m.	Maximum free water cement ratio	Minimum Grade of Concrete
A. Plain Cement concrete				
1	Mild	220	0.6	
2	Moderate	240	0.6	M15
3	Severe	250	0.5	M20
B. Reinforced Cement concrete				
1	Mild	300	0.55	M20

Note:

1. The minimum cement contents shown in the above table are required in order to achieve impermeability and durability having 20 mm size aggregate, in case of 10 mm size add 40 kg/m^3 and in case of 40 mm size aggregate reduce up to 30 kg/m^3 . In order to meet the strength requirements in the Specification higher contents may be required.

2. Exposure can be classified as

Mild: Concrete surface protected against weather or aggressive conditions Moderate: Concrete surfaces sheltered from severe rain or freezing whilst wet concrete exposed to condensation and rain. Concrete continuously under water. Concrete in contact or buried under non-aggressive soil/ground water.

Severe: Concrete surface exposed to severe rain, alternate wetting and drying or occasional freezing whilst or severe condensation

(3) Prescribed Mixes

Prescribed mixes shall have the proportion mentioned below

Classes of concrete	Type of uses	Characteristic Strength f_{ck} (N/mm^2)	Concrete mix	Mix proportion in case of Prescribed mix
M 10/75	Ordinary	10	Prescribed	1:3:6
M 10/40	Ordinary	10		1:3:6
M 15/20	Ordinary	15		1:2:4
M 15/40	Ordinary	15		1:2:4

Concrete mix shall be proportioned by volume. The Engineer may instruct to slight adjustment in the proportioning to allow for variations in the specific gravity and grading of aggregates. Such variation shall not be deemed to vary the price of the concrete. The Engineer shall require the



contractor to make trial mixes and test work cubes to satisfy himself that the prescribed mix will give expected strengths. No concrete shall be placed in the works until the relevant mix has been approved by the Engineer and no variation shall be made in the mix after approval without the Engineer's consent, who may require further tests to be made.

(4) Laboratory Trial Mixes

For each mix of concrete the Contractor shall prepare three number of concrete batches with the proportion as per designed or prescribed mix as specified in the contract. The following test shall be carried out for each sample of each batch.

- Slump Test
- Compressive strength Test of each concrete cube. [six test cubes from each batch shall be prepared and 3 cubes shall be tested for 7 days and 3 for 28 days]
- Density Test (of Concrete cubes)

Modified compositions, the quantities of other constituents being unchanged:

Water	:	+10%	1 batch
Water	:	-10%	1 batch
Cement	:	+15%	1 batch
Cement	:	-15%	1 batch

Samples shall be taken from each batch and the following action taken, all in accordance with IS: 516.

(*) For "Smaller Contracts Works", the following composition are suggested as a

Concrete Class	Characteristic Strength N/mm ²	Cement (kg)	Total Aggregate (kg)	Fine aggr. / Total aggr. (%)	Water (max) (lit.)	Workability
M 15/40	15	250	1900	35-45	160	Stiff-Plastic
M 15/20						
M 20/20						
M 30/40						
M 30/20	20	300	1875	35-45	165-170	Stiff
M 30/20	30	350	1825	35-45	170	Stiff
M 30/20	30	350	1825	35-45	175	Plastic
M 35/20	35	350	1825	35-45	175	Plastic

starting basis for the Laboratory trials for one cu.m of concrete.

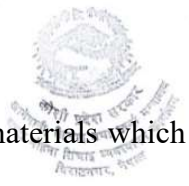
A "result" being the average strength of the three cubes from one batch, the average of the three results from tests at 28 days for the nominal composition shall not be less than the Minimal Target Strength shown in Table 8.3.

One result from the modified compositions shall not be less than the nominal strength as shown on Table 8.3.

(4) Site Trials

At least six weeks before commencing placement of concrete in the permanent works, site trials shall be prepared for each class of concrete specified.

For each mix of concrete for which the Contractor has proposed a design and successfully tested in



Laboratory, he shall prepare three separate batches specified hereunder using the materials which have been approved for use in the works and the mixing plant which he propose to use for the works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the action taken similar to the above Sub-clause 804 (2) (a) to (e) (standard specification for IRS, DoWRI, 2081).

The average of the three results of tests at 28 days shall not be less than the Minimal Target Strength shown in Table 8.3.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the Laboratory trial and site trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

(5) Quality control of Concrete Production

(a) Sampling

For each class of concrete in production at each plant for use in the works, samples of concrete shall be taken at the point of mixing or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in IS: 516 and with the further requirements set out below.

Six 150 mm or 200 mm cubes (1 Set) as appropriate shall be made from each sample and shall be cured and tested in accordance with IS: 516 three at seven days and the other three at 28 days. Where information samples are required, such as for post tensioning operations, three additional cubes shall be made.

The minimum frequency of sampling of concrete of each grade shall be as following:

For 1-5 m ³ quantity of work at one place	- 1 set of sample
For greater than 5-15 m ³ quantity of Work	- 2 set. of sample
For greater than 15-30 m ³ quantity of work	- 3 set. of sample
For greater than 30-50 m ³ quantity of work	- 4 set. of sample
For more than 50 m ³ quantity of work	4 set .of sample plus one additional foreach 50 m ³ or part



thereof.

At least one set of sample shall be taken from each shifts of work.

Until compliance with the Specification has been established the frequency of sampling shall be three times that stated above and not less than 3 samples/day for each class of concrete in production at each plant or such lower frequency as may be instructed by the Engineer.

(b) Testing

- (i) The slump of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the point of production and deposition or at the frequency instructed by the Engineer.

The slump of concrete in any batch shall not differ from the value established by the trial mixes by more than 25 mm or one third of the value whichever is the less.

- (ii) The air content of air entrained concrete in any batch shall be within 1.5 times of the required value and the average value of four consecutive measurements shall be within the required value expressed as a percentage of the volume of freshly mixed concrete while tested according to IS: 1199.

- (iii) **Early Works:** Until such times as sufficient test results are available to apply the method of control described in (iv) below, the compressive strength of the concrete at 28 days shall be such that no result (average of 3 cubes) is less than the characteristic strength f_{ck} as shown in Table 8.3 under the heading “early works test cubes” and also that the average of three consecutive results is not less than $f_{ck} + 4$ as shown in Table 8.3 under the same heading.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

- (iv) When at least 20 consecutive results on tested batches are available for any class of concrete mixed in any one plant, no single result shall be less than $f_{ck} - 4$ (N/mm^2) and also the average of any group of three consecutive results shall not be less than $f_{ck} + 4$ (N/mm^2).

In addition, the Coefficient of Variation shall be less than the figure given below:

Number of Batches	Maximum coefficient of variation	
	Ordinary concrete	High quality concrete
After 20 tested batches	18%	15%
After 50 tested batches	15%	12%

$$\text{Where the Coefficient of Variation} = \frac{\text{Standard Deviation of the results}}{\text{Average Value of the results}}$$

- (v) Failure to comply with requirements:

If any one result in a group of three consecutive results is less than $f_{ck} - 4$ (N/mm^2), but the other



results of group satisfy the strength requirement, then only the batch from which the failed result was obtained shall be deemed not to comply with the Specification.

If the average strength of the group is less than the strength requirement then all the batches between those represented by the first and the last result shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the production procedure or the mix design subject to the agreement of the Engineer to restore compliance with the Specification. If

Adjustment of the mix design is agreed, the Contractor shall again be required to comply with Sub-clauses 804 (3) and 804 (4) (standard specification for IRS, DoWRI, 2081).

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but not necessarily confined to the following:

Increasing the frequency of sampling until control is again established.

Carrying out non-destructive testing such as ultrasonic measurement, load test or other appropriate methods.

Cutting test scores from the concrete and testing in accordance with IS: 1199.

Carrying out strengthening or other remedial work to the concrete where possible or appropriate.

Removing the concrete.

805. MIXING CONCRETE

(1) Proportioning

Concrete mixes shall be proportioned according to the Design mix or prescribed mix as specified. All mixing operations shall be supervised by experienced supervisor. Cement and aggregate shall be batched by weight or by volume as specified in the contract. Water may be measured by weight or volume. The quantity of cement, each size of aggregate and water as indicated by the mechanism employed shall be within a tolerance of plus or minus three percent of the respective weight/ volume per batch agreed by the Engineer. The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer.

(2) Machine Mixing

Concrete for the works shall be batched and mixed in one or more plants or concrete mixer unless the Engineer agrees to some other arrangement. If concrete mixers are used, there shall be sufficient number of mixtures including standby mixers.

Batching and mixing plants shall be complying with the requirements of IS: 1791 and

capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixers shall comply with the requirements of IS: 4925 and shall only be used with the prior approval of the Engineer. If the plant proposed by the Contractor does not fall within the scope of IS: 1791 it shall have been tested in accordance with IS: 4634 and shall have a mixing performance within



the limits of IS: 1791.

All mixing operations shall be under the control of an experienced supervisor

The aggregate storage bins shall be provided with drainage facilities arranged so that the drainage water is not discharged to the weigh hoppers. Each bin shall be drawn at least once per week and any accumulations of mud or silt shall be removed

If bulk cement is used, the scale and weight hopper for cement shall be distinct from the scale and weight hopper for aggregates.

Cement and aggregates shall be batched by weight. Water may be measured by weight or volume.

The weighing and water dispensing mechanisms shall be maintained in good order

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or the pan.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed. Mixers shall be cleaned out before changing to another type of cement.

(3) Hand Mixing

Concrete for structural purposes generally shall not be mixed by hand. However, for small volumes of works and where non-structural concrete is required, hand mixing may be carried out subject to approved of the Engineer.

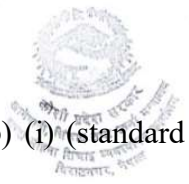
For making hand mixing concrete, cement, sand and aggregate shall be batched separately by volume or by weight as applicable. Then cement and sand shall be mixed dry to uniform colour. The aggregate shall be stacked in a proper shape upon which cement sand mix shall be spread and whole mix shall be mixed to uniform consistency.

For hand mixed concrete the specified quantities of cement shall be increased by 10

% and not more than 0.25 cubic meter shall be mixed at one time. During windy weather precautions shall be taken to prevent cement from being blown away in the process of gauging and mixing.

806. TRANSPORTATION OF CONCRETE

The concrete shall be discharged from the mixer and transported to the works by means which shall prevent adulteration, segregation or loss of ingredients, and shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the



mixer and placing shall be within the tolerances specified in Sub-clause 804 (5) (b) (i) (standard specification for IRS, DoWRI, 2081).

The capacity of the means of transport shall not be less than the full volume of a batch.

The time elapsing between mixing transporting placing and compacting altogether of a batch of concrete shall not be longer than the initial setting time of the concrete. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the works.

807. PLACING OF CONCRETE

(1) Consent for Placing

Concrete shall not be placed until the Engineer's consent has been given in writing.

The Contractor shall give the Engineer at least two full working day notice of his intention to place concrete.

If concrete placing is not commenced within 24 hours of the Engineer's consent the Contractor shall again request consent as specified above.

(2) Preparation of Surface to Receive Concrete

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 300.

Existing concrete surfaces shall be prepared as set out in Clause 812 (standard specification for IRS, DoWRI, 2081). Before deposition of further concrete, they shall be clean, hard and sound and shall be wet but without any free standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump or be removed by other suitable means which will prevent washing away the freshly deposited concrete or any of its constituents. Any under drain constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive prior coating of cement slurry or mortar mixed in the proportions similar to those of the fines proportions similar to those of the fines portion in the concrete to be placed. The mortar shall be kept ahead of the concrete. The mortar shall be placed into all parts of the excavated surface and shall not be less than 5 mm thick.

If any fissures have been cleaned out they shall be filled with mortar or with concrete as instructed by the Engineer.

The amount of mortar placed at one time shall be limited so that it does not dry out or set before being covered with concrete.

(3) Placing Procedures

Concrete shall be deposited as near as possible to its final position, placed in layers not exceeding 300 mm compacted thickness (and not thinner than four times the maximum aggregate size) to avoid segregation and displacement of reinforcement or formwork. **Placing shall begin from the**



lower end of slopes, with successive layers added before the initial set of the previous one to ensure proper bonding. Concrete shall be carefully worked around reinforcement, water stops, and embedded items to prevent honeycombing or voids, and no concrete that has begun to set or partially hardened in transit shall be used. Placement shall be continuous within each bay and shall not be carried out during heavy rain or into standing water; covers shall be provided in dry weather to protect fresh concrete. If concrete is placed from a height, chutes, pipes, or tremies shall be used to prevent segregation, with formwork provided with openings to ensure proper filling. Underwater concreting, if required, shall be executed using watertight bottom-discharging containers or continuously filled tremies, taking special care to prevent water entry and segregation. Dewatering or pumping nearby shall be suspended if it risks disturbing freshly placed concrete.

(4) Interruptions to Placing

- (5) If concreting is interrupted for a prolonged or uncertain duration, the Contractor shall immediately form proper construction joints to avoid feather edges or sloping surfaces, and thoroughly compact the concrete before its initial setting time. No disturbance shall occur once concrete has begun to set. Before resuming work, all damaged or loose concrete shall be removed, leaving a clean, sound surface. With the Engineer's approval, new concrete shall be properly compacted and integrated with the old to prevent cold joints. For long interruptions, resumption of concreting shall be carried out strictly as directed by the Engineer.

(6) Dimension of Pours

- (7) Concrete pours shall generally not exceed 2 m in height and should be placed to their full planned height with uniform thickness, unless otherwise permitted by the Engineer. The Contractor shall plan the size, sequence, and timing of pours to minimize the risk of cracking from thermal or shrinkage stresses.

(8) Placing Sequence

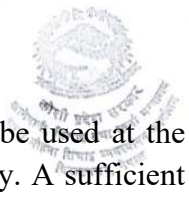
The Contractor shall arrange that the intervals between successive lifts of concrete in one section of the works are of equal duration. This duration shall not be less than three days or not more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.

Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.

Contraction gaps in concrete shall be of the widths and in the locations as shown on the Drawing and they shall not be filled until the full time interval shown on the Drawing has elapsed.

808. COMPACTION OF CONCRETE

Concrete must be fully compacted throughout the entire placed layer, ensuring it is thoroughly worked against the formwork and around reinforcement or embedded items without displacing them. Special care must be taken in confined spaces such as arises. Each successive layer of the same pour must be properly integrated with the previous one. Compaction shall be carried out using mechanical immersion vibrators unless an alternative method is approved by the Engineer. Both immersion and



surface vibrators must operate at frequencies between 70 and 200 hertz, and must be used at the manufacturer's recommended pressure and voltage to maintain compactive efficiency. A sufficient number of vibrators must be in operation to ensure that all concrete is adequately compacted, and standby units must be readily available at each pouring location. Vibration should continue at each point until the concrete stops contracting, air bubbles disappear, and a thin layer of mortar forms on the surface. Vibrators must not be used to move concrete laterally and should be withdrawn slowly to avoid creating voids. They should be inserted vertically into the concrete to penetrate the previous layer, spaced regularly and within the range of visibly effective vibration, with some overlap. Vibrators must not come into contact with reinforcement, sheathing ducts, or other embedded components.

809. CURING OF CONCRETE

(1) General

Concrete must be protected during early hardening from moisture loss and temperature differences that could cause cracking. Curing should use wet mats, approved sheet materials, or curing compounds that do not damage the concrete. Curing must begin as soon as the concrete can withstand it and continue for at least seven days or until it is covered by further construction, whichever is shorter. For large or continuous pours, curing should start on finished sections before the entire pour is complete. A single method may be used to meet both moisture retention and temperature control requirements, if suitable.

(2) Loss of Moisture

Exposed concrete surfaces must be covered with securely fastened impermeable sheeting, with sheet joints overlapped by at least 300 mm. If sheeting is not feasible, surfaces must be kept continuously wet using water spray or wet absorbent materials, unless restricted by Sub-clause 809(3) (**standard specification for IRS, DoWRI, 2081**). Curing water must be of the same quality as mixing water. Formed surfaces can be cured by leaving formwork in place, or by applying an approved curing compound. If directed by the Engineer, additional shading must be provided to protect concrete from direct sunlight for at least the first four days of curing.

(3) Limitation of Temperature Differentials

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

- (a)** limiting concrete temperatures at placing as set out in Sub-clause 811 (2) (standard specification for IRS, DoWRI, 2081);
- (b)** use of low heat cement for mass concreting, subject to the agreement of the Engineer;
- (c)** Leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;
- (d)** Preventing rapid dissipation of heat from surfaces by shielding from wind.

810. PROTECTION OF FRESH CONCRETE



Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

Concrete placed in the works shall not be subjected to any loading including traffic until it has attained at least its characteristic strength as defined in Clause 804 (standard specification for IRS, DoWRI, 2081).

811. CONCRETING IN HOT WEATHER

(1) General

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures, and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

(2) Concrete Placing in Hot Weather

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the works does not exceed 30°C and that the concrete does not lose any moisture during transporting and placing.

Such measures may include but are not necessarily limited to the following:

- (a)** Shielding aggregates from direct sunshine.
- (b)** Use of a mist water spray on aggregates.
- (c)** Sun shields on mixing plants and transporting equipment.

Surfaces in which concrete is to be placed shall be shielded from direct sunshine and surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.

After concrete has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

812. CONSTRUCTION JOINTS

When fresh concrete is to be bonded to hardened concrete, the contact surface is treated as a construction joint. These joints must be formed at locations shown on the drawings or approved by the Engineer, typically in vertical or horizontal planes, unless specified otherwise (e.g., in sloping slabs). Joints should minimize shrinkage effects and be positioned to reduce stress and allow staggered placement.

Feather edges must be avoided and cut back to sound concrete if they form. Joints at horizontal or near-horizontal surfaces should form straight, visible lines using guide strips or approved methods.



and must not exceed a 20% slope from the horizontal.

Fresh concrete surfaces at joints should be roughened using high-pressure water, air jets, or wire brushing once the concrete is strong enough. If too hard for this, surfaces must be scabbled (min. 10 mm depth, 40 mm from finished face) or sandblasted, then washed. If instructed, the surface should be brushed with a 1:2 cement-sand mortar before new concrete is placed, ensuring continuous vibration for full bonding.

No concrete or mortar may be placed until the joint is inspected and approved by the Engineer.

813. RECORDS OF CONCRETE PLACING

Records of the details of every pour of concrete placed in the works shall be kept by the Contractor in a form agreed by the Engineer. These records shall include class of concrete, location of pour, date and duration of pour, ambient temperature and concrete temperature at time of placing and all relevant meteorological information such as rain, wind etc., moisture contents of the aggregates, details of mixes batch numbers, cement batch number, results of all tests undertaken, part of the structure and place where test cube samples are taken from.

The Contractor shall supply to the Engineer four copies of these records each week covering work carried out the preceding week. In addition, he shall supply to the Engineer monthly histograms of all 28 day cubes strength results together with cumulative and monthly standard deviations, Coefficient of Variation, and any other information which the Engineer may require concerning the concrete placed in the works.

814. PLUM CONCRETE

(1) Materials

The size of the stone/rock shall not be larger than 200 mm measured in any direction. Concrete to be used in plum concrete shall be as specified in contract document.

(2) Construction

Composition of the plum concrete shall be 60 to 70 % M10 or M15 concrete and 40 to 30 % of stones by volume as specified in the contract document. The place to be filled up with the plum concrete shall be cleaned and chipped for adhesion with the concrete. Following completion of form work, a layer of concrete minimum 100 mm thick shall be laid upon over which clean and moist stones shall be placed at a distance of min 100 mm measured from face to face in any direction. The distance between the outer edge of the concrete mass and the nearest face of the stone to the edge shall not be less than 100 mm.

Then another layer of concrete having thickness not less than 100 mm measured from the top of the stone to the top surface of the layer shall be laid and compacted.

In case the proportion of concrete to stones is to be changed, the clear space between stones shall be adjusted as directed by the Engineer.

After compaction, again stones shall be placed on the layer as described above and the process shall be continued until the top layer of the concrete is completed. The placing of stones shall be



staggered both in horizontal and vertical directions.

(3) Tests and Standard of Acceptance

Stones shall be tested for specific gravity and water absorption test. The test result shall meet the requirements as specified in these Specifications.

Concrete shall be tested as specified in Section 800.

815. REINFORCEMENT

(1) General

Reinforcement, including plain bars, deformed bars, and steel fabric, must comply with relevant standards:

- NS: 191 / IS: 1786 for high-strength deformed bars and wires
- IS: 1566 for steel mesh fabric
- NS: 84 / IS: 432 for mild and medium tensile steel bars

All reinforcement must come from approved manufacturers. If requested by the Engineer, the Contractor must provide ISI certification or acceptable test certificates. Sampling and testing must follow NS: 84 and NS: 191. Any reinforcement not meeting specifications must be removed from the site.

(2) Storage of Reinforcement

Reinforcement must be delivered to the site either straight or pre-cut and bent—bent-over double bars are not allowed. Long-term stored reinforcement must be protected from weather to prevent corrosion or pitting. Any corroded or pitted bars that may affect performance, as judged by the Engineer, must either be removed or tested (at the Contractor's expense) per **Sub-clause 814(1)** (standard specification for IRS, DoWRI, 2081). Reinforcement must be stored at least 150 mm above ground on a clean, dry surface, and sorted by category, quality, and diameter.

(3) Bending Reinforcement

Unless specified otherwise in the drawings, bending and cutting of reinforcement must follow IS: 2502.

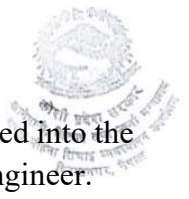
The Contractor is responsible for verifying bar bending schedules and ensuring reinforcement is cut, bent, and fixed as per the drawings. Bars must be mechanically bent using proper equipment and cold bent with steady pressure. If the temperature is below 5°C, the bending rate must be reduced to avoid steel fracture. Bending inside formwork is not allowed, except for mild steel bars ≤ 12 mm and only when absolutely necessary. After bending, bars must be securely bundled, tied, and clearly labelled as per IS: 2502.

(4) Fixing Reinforcement

Reinforcement shall be thoroughly cleaned. All dirt, scale, loose rust, oil and other contaminants shall be removed before placing it in position. If the reinforcement is contaminated with concrete from previous operation, it shall be cleaned before concreting in that section.

Reinforcement shall be securely placed and fixed in position as shown in the drawing or directed by the Engineer.

Unless otherwise agreed by the Engineer, all intersecting bars shall be either tied together with



not less than 1.6 mm diameter soft annealed iron wire and the end of the wire turned into the body of the concrete, or shall be secured with a wire clip of a type agreed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand by weight. Wires cast into the block for tying in to the reinforcement shall have not less than 1.6 mm diameter and shall be soft annealed iron.

Alternatively, another type of spacer block may be used subjected to the Engineer's approval.

All reinforcement shall be checked of shape, size, diameter and number where necessary. Reinforcement shall be rigidly fixed so that it remain intact during placing of concrete. Any fixers made to the formwork shall not remain within the space to be occupied by the concrete being placed.

No splices shall be made in the reinforcement except where shown on the Drawing or agreed by the Engineer. Splice lengths shall be as shown on the Drawing or directed by the Engineer.

Reinforcement shall not be welded except where required by the contract or agreed by the Engineer. If welding is employed, all welded splices shall be full penetration butt welds complying with the procedures set out in IS: 2751 or IS: 9417 as applicable. Mechanical splices shall not be used unless the Engineer agrees otherwise. Acceptance for welded or mechanical splices of approved design shall be based on qualification tests to be carried out by the Contractor prior to start of the work. Construction control testing as instructed by the Engineer shall be also carried out.

The Contractor shall ensure that reinforcement left exposed in the works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars of six times the bar diameter for high yield bars. Such bends shall be carefully straightened without leaving residual kinks or damaging the concrete round them before concrete placing. In no circumstances heating and bending of high yield bars shall be permitted.

Bars complying with IS: 1786 or other high tensile bars shall not be bent after placing in the works.

816. TEST AND STANDARD OF ACCEPTANCE

(1) General:

Concrete shall conform to the surface finish and tolerance as prescribed in these specifications for respective components.

Random sampling and lot by lot of acceptance inspection shall be made for the 28 days' cube strength of concrete.

Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The basis of delimitation of lots shall be as follows;

- i. No individual lot shall more than 30 cu.m. in volume



- ii. Different grades of mixes of concrete shall be divided into separate lots
- iii. Concrete of a lot shall be used in the same identifiable component of the structure

(2). Sampling and testing

Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction, according to procedure laid down in IS: 1199.

A random sampling procedure to ensure that each of the concrete batches forming the lot under acceptance inspection has equal chance of being chosen for taking cubes 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS: 516. The 28-day test strength result for each cube shall form an item of the sample. Test at other age also shall also be performed, if specified.

Where automated batching plant/ Ready Mixed Concrete Plant is located away from the place of use and the time gap between production and placement is more than initial setting time or where any ingredients are added subsequent to mixing, separate set of samples shall be collected and tested at batching plant and at location of placement. The results shall be compared and used to make suitable adjustment at batching plants so that properties of concrete at placement are as per the requirements.

(3) Test specimen and sample strength:

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes maybe required for various purposes such as to determine the strength of concrete at 7 days or for any other purpose.

The test strength of the sample shall be the average of the strength of 3 cubes. The individual variation should not be more than ± 15 per cent of the average. If variation is more, the test results of the sample are invalid.

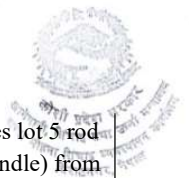
The minimum frequency of sampling of concrete of each grade shall be in accordance with Table 8.8.

Table 8.8: Control Test and their Minimum Frequency for Road and Bridge

S No	PART OR COMPONENT OF THE WORKS	Section/ Clause No.	TESTS	FREQUENCY
19	CONCRETE	2000	- Cements: Acceptance tests - Control tests: Chemical	
	MATERIALS			- Conservative samples for each supply and not less than every 200 t or part of it - Testing in case of noncompliance of



			Composition Physical	
			Properties	the mixes or storage on site for longer than 1 month
			• <u>Aggregates:</u> • <u>Acceptance tests:</u> • <u>CONTROL TESTS:</u> - Grading - Silt & clay content: - Organic Impurities - Chloride content, sulphate content, - Alkali reactivity, - Water, Admixtures	• 1 set (3 nos) testfor each 10 to 50 cum and additional test foreach 50 cum of concrete t for fine aggregate • 1 set (3 nos) testfor each 25 to 125 cum and additional test foreach 125 cum and 250 t part of it for coarse aggregate • As frequently asRequired • Sub-Clause 2004(7) and(8) • Sub-Clause2004(3) • For 1-5 cum quantity of work at one place 1 set, • For 5.1-15 cum quantity of work at one place 2 set • For 15 .1 to 30 cum quantity of work at one place3 set • For 30 .1 to 50 cum quantity of work at one place4 set • For more than 50 cum quantity of work at one place 4 set .of sample plus one additional for each50 cum or part thereof • Early works every 6 cum orpart of it
			• CONCRETE ✓ LAB. TRIALS ✓ SITE TRIALS ✓ CONTROL TESTS ✓ COMPRESSIVE	• For 1-25 bundleslot 3 rod (one from each bundle) from randomly selected 3 bundles. • For 26-65 bundles lot 4 rod(one from each bundle) from randomly selected 4 bundles



			• <u>REINFORCEMENT</u> ✓ Mechanical properties 0.2 percent proof stress/ yield stress, ✓ Tensile strength/ yield strength ratio, Elongation	• For 66-180 bundles lot 5 rod (one from each bundle) from randomly selected 5 bundles • For 181- 300 bundles lot 7 rod (one from each bundle) from randomly selected 7 bundles - For > 300 bundles lot 10 rod (one from each bundle) from randomly selected 10 bundles
21	<u>BRICK WORK FOR STRUCTURES MATERIALS</u> MORTAR	2502 2511	• Quality of Bricks • Quality of cement and sand • Control tests • Compressive strength of mortar	• As required • Every 10 cum of brick work or part of it.
22	MASONRY FOR STRUCTURES MATERIALS MORTAR	2602 2610	• Quality of cement and sand • Control tests • Compressive strength of mortar	• As required • Every 10 cum of masonry of part of it

(4) Acceptance criteria

(a) Compressive Strength

I Cubes



The concrete shall be taken as having the specified compressive strength when both the following conditions are met:

- i. The mean strength determined from any group of four consecutive non-overlapping samples exceeds the specified characteristic compressive strength by 3 MPa.
- ii. Strength of any sample is not less than the specified characteristic compressive strength minus 3 MPa.

The quantity of concrete represented by the test results include the batches from which the first and last samples were taken, together with all intervening batches

II Cores

If concrete fails to meet the specified strength criteria, core samples must be extracted and tested as per IS: 1199 and IS: 516 to verify compressive strength. Core testing may also be conducted if there's doubt about concrete quality due to poor workmanship or low cube test results. The number and location of cores must represent the entire concrete area in question, with a minimum of three cores required. The concrete is considered acceptable if the average core strength is at least 85% of the specified grade strength, and no single core is below 75% of the specified strength.

(b) Chloride and Sulphate Content

Where Chloride and Sulphate is specified, the total chloride and sulphuric anhydride (SO₃) content of all the constituents of concrete as a percentage of mass of cement in the mix shall not exceed the values given in this Section of the specifications.

(c) Density of Fresh Concrete

Where minimum density of fresh concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent of the specified value.

(d) Density of Hardened Concrete

Where minimum density of hardened concrete is specified, the mean of any four consecutive non-overlapping samples shall not be less than the specified value and any individual sample result shall not be less than 97.5 per cent of the specified value.

(e) Permeability Test

Where Permeability of concrete is specified, water Permeability test as per DIN:1048 Part 5 – 1991 shall be carried out as described below

- i. A cylindrical test specimen 150 mm dia and 160 mm high shall be prepared.
- ii. After 28 days of curing, the test will be conducted between 28 and 35 days. The test specimen shall be fitted in a machine such that the specimen can be subjected to a water pressure upto 7 bars.
- iii. The concrete specimen shall be subjected to a water pressure of 0.5 N/mm² from



the top for the period of 3 days. The pressure shall be maintained constant throughout the test period. If the water penetrates through to the underside of the specimen, the test may be terminated and the specimen rejected as fail.

- iv. After 3 days, the pressure shall be released and the sample shall be taken out. The specimen shall be split in the middle by compression applied on two round bars on opposite sides above and below.
- v. When the split faces show signs of drying (after 5 to 10 minutes) the maximum depth of penetration in the direction of height shall be measured with the scale and extent of water penetration established.
- vi. The mean of maximum depth of penetration obtained from three specimens thus tested, shall be taken as the test result and it shall not exceed 25 mm

If the concrete is not able to meet any of the standards of acceptance as prescribed, the effect of such deficiency on the structure shall be investigated by the Contractor as directed by the Engineer. Any additional work required by the Engineer for such acceptance shall be carried out by the Contractor at his cost. In such case payment for such work shall be made at reduced rate proportional to reduced strength rate. In case the concrete is not found to be acceptable even after investigation, the Contractor shall remove the rejected concrete forthwith.

817. MEASUREMENT

(1) Concrete

Concrete laid in place as specified in the Drawing or directed by the Engineer shall be measured in cubic metres separately for each class. No deduction shall be made in the measurement for:

- (a) bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.15 cubic metres;
- (b) mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 100 mm total width or less;
- (c) reinforcement

(2) Blinding Concrete/Non Structural Concrete

Blinding concrete laid in place shall be measured in cubic meter. No deduction shall be made for openings provided that the area of each is less than 0.5 square metres. Blinding concrete over hard material shall be measured as the volume used provided that the maximum thickness of 150 mm allowed for over break is not exceeded.

(3) Admixtures, Workability and Hardening Agents and Curing Compounds

Unless stated otherwise, rate of concrete shall be deemed to include admixture, workability, hardening agent and curing compounds.

(4) Plum Concrete

Unless specified otherwise plum Concrete shall be measured in cu.m. Form work struts, bracing



supports etc. shall be measured separately as it is not deemed to be included in the measurement of plum concrete.

(5) Reinforcement

All types of reinforcement shall be measured in length including hooks, if any, separately for different diameters as actually used in works or as directed by the Engineer, excluding overlaps. From the length so measured, the weight of reinforcement shall be calculated in ton on the basis of IS: 1732.

Wastage, overlaps, couplings, welded joints, spacer bars, chairs, stays, hangers and annealed steel wire or other method for binding and placing shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.

An average weight of at least 5 samples each one metre length shall be determined by the laboratory approved by the Engineer. The weight of each type of the reinforcement shall be determined by multiplying average weight of the respective reinforcement by its length.

(6) Fabric Reinforcement

Fabric reinforcement laid as per Drawing or as directed by the Engineer shall be measured in square meter. No allowance shall be made for laps and wastage.

818. PAYMENT

(1) Concrete

Every class of concrete shall be paid as per respective contract unit rate. In addition to those specified in Clause 108 the respective rate shall also include the cost of:

- (a) All materials including admixture and workability agent, curing agent, labour, Tools, Plants and equipment required for mixing, transporting and placing in position, vibrating and compacting, finishing and curing including all incidental expenses.
- (b) Unless mentioned separately as an item in contract sampling and testing, quality assurance and supervision
- (c) Unless mentioned separately as an item in contract, cost of providing, fixing, and removing formwork, Staging required for concrete work as per Section 1800 of these specification.
- (d) Placing and compacting against excavated surfaces where required including any additional concrete to fill over break and working space.
- (e) Complying with the requirements of Clauses 801 to 813 (standard specification for IRS, DoWRI, 2081).

(2) Plum Concrete

Plum concrete shall be paid as per contract unit rate of the respective item which shall be the full and the final compensation to the Contractor as per Clause 108 to complete the works as per these Specifications.



(3) Reinforcement

The reinforcement shall be paid at contract unit rate. In addition to those specified in Clause 108 the rate shall also include compensation for the cost of providing, cutting to length, splice lengths additional to those shown on the Drawing, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of support, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily, and straightening, place and compacting concrete around reinforcement and for complying with Clause 814 (standard specification for IRS, DoWRI, 2081).

(4) Fabric Reinforcement

The fabric reinforcement shall be paid at contract unit rate which shall be also inclusive of compensation for wastage and laps.

SECTION 900: FORMWORK

901. GENERAL

The Contractor is responsible for the design and construction of formwork and falsework to safely support all loads from fresh concrete, vibration, and construction traffic, ensuring that hardened concrete surfaces meet the required positions and tolerances specified in Clause 905 (standard specification for IRS, DoWRI, 2081).

Before starting work, the Contractor must submit detailed drawings of the proposed formwork and falsework for the Engineer's approval, in line with this section and other relevant specifications.

902. FORMWORK FOR CONCRETE

(1) Construction of Formwork

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous in a regular pattern.

All joints in formwork shall be water tight. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position, if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Surfaces at slopes less than 20° may be formed by screeding. Surfaces at slopes between 20° and 30° shall generally be formed if the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against



uplift due to the pressure of fresh concrete. Formwork shall also be tied down or otherwise secured against floating within the body of the concrete.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the Drawing unless otherwise instructed by the Engineer.

Supports for formwork may be bolted to previous placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be close to the face of the concrete by less than 50 mm.

Formwork shall not be re-used after it has suffered damage as it will impair the finished surfaces of the concrete. Where circumstances prevent easy access within the form, temporary openings shall be provided through the formwork for cleaning and inspection.

Shear keys of the size and shape as indicated on the Drawing shall be provided in all construction joints.

Where precast concrete elements are specified for use as permanent formwork, or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of formwork as specified in the Specification in respect of surface finish, strength and rigidity. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish in Clause 906(standard specification for IRS, DoWRI, 2081) and fixed so that they cannot move when concrete is placed against them.

(2) Preparation of Formwork

Before any reinforcement is placed into position within formwork, the formwork shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either a suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or a low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete or affects the strength of concrete.

In order to avoid colour differences on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The Contractor shall not allow reinforcement or pre-stressing tendons to be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs. If any movement noticed, the formwork shall be set right immediately.

(3) Removal of Formwork

Formwork must be removed carefully and without disturbing the concrete, only after it has gained enough strength to withstand stress safely. Minimum removal times are specified in Table 9.1 for



temperatures above 10°C; at lower temperatures or with non-OPC cement, longer times may be required by the Engineer. Alternatively, formwork can be removed earlier if test cubes, cured under identical conditions, confirm the required strength has been achieved.

Meeting these conditions does not relieve the Contractor of responsibility for ensuring removal causes no damage. If early stripping of formwork under slabs, beams, or arches is desired, it must be done without disturbing the supports, and temporary removal of supports is not allowed.

After formwork removal, any unneeded bolt holes must be filled with a dry mortar mix matching the surrounding concrete in materials and proportions, and finished flush. Additionally, the date of concrete casting must be marked on the surface using waterproof paint or marker to track curing and formwork removal timelines.

Table 9.1: Minimum Periods for Formwork Removal

Position of Formwork	Minimum period for Temperatures over 10o C	Strength to be attained
Vertical or near vertical faces of mass Concrete	24 hours	0.2 f _{ck}
Vertical or near vertical faces of reinforced	48 hours	0.3 f _{ck}
Underside of arches beams and slabs (formwork only)	4 days	0.5 f _{ck}
Supports to underside of arches, beams and slabs	14 days	f _{ck}
Arched linings in tunnels and underground works	24 hours	4 N/mm ²

Note: f_{ck} is the Characteristic Strength for the class of concrete used.

903. FALSEWORK

(1) Design and Drawing

For structures with spans of **6 meters or more** or involving **traffic openings**, falsework must meet specific design requirements under this clause. The Contractor must submit **three sets of detailed drawings and design calculations** to the Engineer for review and **approval before starting construction**. A **minimum of two weeks** must be allowed for the Engineer's review, depending on the design's complexity. If the Contractor revises the drawings, **sufficient time** must again be provided for approval before work on the revised design begins.

(a) False work Drawing

The false work drawing shall include but not limited to the following: -

- (i) The traffic openings.
- (ii) A superstructure placing diagram, showing proposed concrete placing sequence and construction joints location.
- (iii) Assumed values of soil bearing capacity for both wet and dry conditions, as



determined by the Contractor.

- (iv) Anticipated total settlements of false work and forms.
- (v) Details of drainage, if any.
- (vi) Details of drainage protection (or scouring/undermining protection) of footing and/or foundations, including locations of existing utilities, excavations, recent fills if any.
- (vii) Details of all elements required to insure the free movements of concrete due to shrinkage.
- (viii) Proposed cambers to compensate deflections, and false adjustments according to the various stages of the construction and the concrete placing sequence.
- (ix) Details of joints, bracing and major arrangements to insure vertical and horizontal stability in all direction and at all stages of operations.
- (x) Manufacture's recommendations and/or other operating recommendations as required for the justifications for the design.

When a schedule for placing concrete is shown on the contract plans, no deviation shall be permitted there from unless approved in writing by the Engineer.

Anticipated total settlement shall not exceed 25 mm. This shall include false work footing settlement and joints take-up. Deck slab forms between girders shall be constructed with no allowance for settlement relative to the girders.

(b) False work Calculation

The falsework design must include calculations showing stresses and deflections of all supporting members and must be based on maximum loads, stresses, and deflections, using high-quality materials. If lower quality materials are used, stresses must be reduced accordingly. The Contractor is fully responsible for evaluating materials and ensuring the design safely supports all actual loads.

Key design requirements include:

- Design Loads: Must include the sum of dead, live, and horizontal loads.
- Minimum Vertical Load: Combined dead and live loads must be $\geq 0.5 \text{ t/m}^2$, allowing for dynamic effects.
- Dead Load: Includes weight of concrete, reinforcement, forms, and falsework.
- Live Load: Includes actual weight of equipment as concentrated loads, plus 0.1 t/m^2 uniform load over supported area, and 0.11 t/m at deck overhang edges.
- Horizontal Load: Must be resisted by bracing or ties and be $\geq 2\%$ of the total dead load.
- Footings: Must be designed to carry loads without exceeding soil bearing capacity or causing unacceptable settlement.
- Pre-stressed Concrete: Falsework must accommodate additional or shifted loads and allow



for free movement during pre-stressing.

- Joists: Treated as falsework and must meet deflection limits ($< 1/270$ of clear span) and manufacturer's specifications for jacks, brackets, and columns.
- Manufacturer Data: If required, the Contractor must provide catalog data or perform tests to prove adequacy of any manufactured devices used.
- Footing Foundations: The soil bearing capacity must be determined via the Plate Load Test, conducted on properly prepared surfaces in both dry and wet conditions.

If requested by the Engineer, the Contractor shall furnish catalogue data listing the manufacturer's recommendations for manufactured devices and perform tests as necessary to demonstrate the adequacy of any such device proposed for use.

False work designed for pre-stressed concrete shall allow for the required free movements during pre-stressing operations.

When footing foundations are to be used, the bearing capacity of the soils shall be determined by the Contractor using the Plate Load Test method. The soil surface must be prepared adequately to allow for a relevant implementation of this test. Tests shall be carried out in both dry and wet conditions.

(c) False work over or Adjacent to Roadways

In addition to the minimum requirements specified above, false work over or adjacent to roadways, where false work opening is specified, shall be designed and constructed so that the false work will be stable if subjected to impact by vehicles. The false work design in such cases shall include, but not be limited to the following minimum provisions:

- (i) The vertical design load of false work bents, including footing and caps which support the portion of the false work over openings shall be increased to not less than twice the design load calculated in accordance with Sub-Clause 904 (1) (b) (standard specification for IRS, DoWRI, 2081).
- (ii) Each false work post adjacent to openings shall be securely anchored to its withstand footing or otherwise laterally restrained at its base so as to withstand a 0.9t force applied at the base of the post in any direction except toward the road track.

(2) Construction

Falsework must be built to closely match the approved falsework drawings using materials strong enough to withstand the designed loads. Construction workmanship must ensure the falsework supports imposed loads without excessive settlement beyond what is specified.

Falsework must be placed on stable, secure foundations protected from undermining and softening. If supported by piles, they must be driven in line with IS 2911.

For falsework near roadways or waterways, all elements contributing to horizontal stability and impact resistance must be installed during erection and remain in place until removal.



Jacks or wedges should be used to adjust form levels and manage settlement before or during concrete placement. Comber strips, approved by the Engineer, must be used to account for falsework deflection and structural alignment. Tell-tales (indicators) must be attached to monitor settlement, visible from the ground and placed systematically.

If unexpected events like settlements over ± 10 mm from those on the drawings occur and may affect structural integrity, concrete placement must stop until approved corrective measures are taken. If no satisfactory solution is provided before concrete sets, the pour must stop at a location chosen by the Engineer, and unacceptable concrete must be removed.

The Contractor is fully responsible for maintaining the falsework throughout construction.

(3) Removal

False work shall not be released before the requirements of Sub-clause 903 (3) (standard specification for IRS, DoWRI, 2081) are fulfilled. False work for cast-in-situ pre-stressed concrete shall be released according to the pre-stressing sequences shown on the Drawing. False work shall be removed uniformly and gradually to permit the structure to take its load slowly and evenly.

All false work material shall be removed. False work pilling shall be removed up to at least 600 mm below the surface of the original ground or the bottom or side slope of excavated areas.

(4) False work for Steel Structures

Falsework for steel structures must meet the general falsework requirements (Sub-clauses 904(1) to 904(4)) (standard specification for IRS, DoWRI, 2081) plus these additional rules: Loads applied to girder webs must be positioned near a flange or stiffener approved by the Engineer and distributed to avoid local distortion. Temporary struts and ties must be used as needed to resist lateral loads on girder flanges and prevent significant vertical movement between deck form edges and steel girders.

904. SURFACE FINISH ON FORMED SURFACES

Class of Finish

1. Class F1 Finish:

- For surfaces that will be backfilled or covered by more concrete.
- Formwork can be sawn boards, sheet metal, or any material that prevents loss of laitance.

2. Class F2 Finish:

- For surfaces permanently exposed but not requiring a high-quality finish.
- Formwork made of tongued and grooved boards or suitable sheet material, arranged uniformly with close joints.
- Minor surface defects like pitting or discoloration should be fixed as approved by the Engineer.

3. Class F3 Finish:



- For surfaces exposed to fast-flowing water or prominent visible surfaces needing high-quality appearance.
- Formwork faced with plywood or equivalent in large sheets, joints aligned with architectural features.
- No board marks allowed; surface must be protected from rust, stains, and spills.

4. Curved Surfaces:

- For F2 or F3 finishes on curves, formwork should be made with splines or lined with plastic/plywood that resists deformation.

5. Tolerances:

- Concrete surfaces must be within specified tolerances (Table 9.2) depending on finish class.
- Tolerances A (abrupt irregularities), B (gradual deviations), and C (displacement from position) vary by class with tighter controls for higher finish classes.
- Drawings override these tolerances if otherwise specified.
- Precast units must be aligned and fixed securely after approval.

Table 9.2: Tolerances

Class of finish	Tolerances in mm (See Note)		
	A	B	C
F1	10	10	+25 to – 10
F2	5	10	±15
F3	2	5	±10

Note: The tolerances A, B and C given in the table are defined as follows:

- A* Is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork
- B* Is gradual deviation from a plane surface as indicated by a straight edge 3 m long. In the case of curved surfaces, the straight edge shall be replaced by a correctly shaped template.
- C* Is the amount by which the whole or part of a concrete face is displaced from the correct positions shown on the Drawing

In essence, the finishes range from basic (F1) to high-quality, visually critical (F3), with strict formwork and tolerance requirements increasing accordingly.

905. FINISHES ON UNFORMED SURFACES

Horizontal or nearly horizontal surfaces which are not cast against formwork shall be finished to the class shown on the Drawing and defined hereunder.

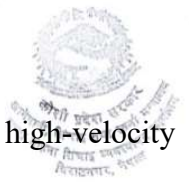
1. UF1 Finish

- Basic finish for general surfaces where no higher finish is specified.
- Concrete is leveled, screeded, and excess is removed immediately after compaction.

2. UF2 Finish

- For roof/floor slabs where a smooth but not hard-trowelled finish is required.
- Starts as UF1, then lightly floated (manually or mechanically) to produce a uniform surface free of screed marks.

3. UF3 Finish



- High-quality hard-trowelled finish for surfaces exposed to weather, visible areas, or high-velocity water.
- Begins as UF2, then steel-trowelled under firm pressure to produce a dense, smooth, and mark-free surface.

4. Bridge Deck Finish

- Must have a smooth, true surface with consistent texture and cross-section.
- Requires Engineer approval of equipment and skilled personnel before placing concrete.
- Tolerances must match UF3 standards, and surface variation must not exceed **3 mm** under a 3 m straightedge (if not covered by bitumen or similar).

5. Tolerances

- All unformed surfaces must conform to positions and tolerances shown in the drawings.
- If specific tolerances are indicated on the drawing, they take precedence over general table values.

Table 9.3: Tolerances

Class of finish	Tolerances in mm (See Note)			
	A			C
UF1	Not applicable			+20 to – 10
UF2	Nil			+20 or – 10
UF3	Nil			+12.5 or – 7.5

Note: The tolerances A, B and C given in the table are defined as follows:

A is the maximum allowable value of any sudden change of level in the surface.

B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three-meter-long straight edge or correctly shaped template placed on the surface.

C is the maximum allowable value of the in level or position between a three-meter-long straightedge or correctly shaped template placed on the surface and the specified level or position of that surface.

This classification ensures that surface quality matches structural or aesthetic needs, ranging from basic leveling (UF1) to precision finishes (UF3) and critical surfaces like bridge decks.

906. REMEDIAL WORK TO DEFECTIVE SURFACES

• No Repairs Before Inspection:

If defects are found after formwork removal, the Contractor must not repair them until inspected and instructed by the Engineer.

• No Plastering:

Plastering to fix defective surfaces is not allowed.

• Honeycombing Repairs (Concrete $\leq$ 3 Days Old):

- Cut back to sound concrete with cavity sides perpendicular to the surface.
- Avoid damage to reinforcement or ducts.
- Clean cavity with water and air, apply cement grout, then fill with concrete of the same class.



- Use aggregate size $\leq 0.5 \times$ cavity depth or 20 mm.
- Use a form with a lip; break lip off after 7 days and grind smooth.
- **Honeycombing Repairs (Concrete > 3 Days Old):**
 - Use epoxy bonding agent with Engineer-approved method.
- **Other Surface Issues:**
 - Irregularities beyond tolerance must be ground down as per Engineer's instructions.
 - Blowholes in vertical faces to be filled with fine mortar and finished with a rubber float and polythene.
- **All Other Defects:**
 - Must be handled according to specific instructions from the Engineer.

907. MEASUREMENT

Unless stated otherwise, the formwork for concrete in Plain Concrete or Reinforced Concrete or Pre-stressed Concrete shall be measured for payment in square meter of the surface area of concrete which is in contact with formwork in accordance with this Section. Similarly, Falsework shall be measured in square meter for payment.

908. PAYMENT

The formwork and false work specifically provided as a separate item, shall be paid as per the contract unit rate. The Contract unit rate shall be the full and the final payment to the Contractor as per Clause 108 to complete the work as per these Specifications.

SECTION 1500 – RIVER TRAINING AND PROTECTION WORKS

1504. GEOTEXTILES FOR FILTRATION AND DRAINAGE

(1) Scope

The work covers the use of geotextile materials for drainage, filtration and erosion control works including supplying and laying as per design, drawing and these specifications. For drainage/filtration function, geotextile shall be able to convey water across the plane of the fabric throughout its design life. For separation function the geotextile shall prevent intermixing of two layers of dissimilar materials, throughout the design life of the structure. The geotextile as a filter material below erosion control measures like stone pitching or stone filled mattresses over the slopes, shall allow the water to flow out and at the same time prevent the loss of soil under the protective measures.

(2) Material

**(a) Strength Requirement**

The minimum strength of geotextile in terms of MARV under different installation conditions shall be as specified in Table 15.8

Table: 15. 8: Minimum Geotextile Strength Property Requirements

Installation condition	Type	Strength Property Requirement (MARV)							
		Grab Strengthin Newton (N)as per IS: 13162 Part 5		Tear Strength in Newton (N)as per IS: 14293		Puncture Strength in Newton(N) as per IS: 13162 Part 4		Burst Strengthin Newton (N)as per IS: 1966	
		Elongation at Failure							
		<50%	>50%	<50%	>50%	<50%	>50%	<50%	>50%
Harsh installation condition	Type I	1400	900	500	350	500	350	3500	1700
Moderate Installation condition	Type II	1100	700	400	250	400	250	2700	1300
Less Severe Installationcondition	TypeIII	800	500	300	180	300	180	2100	950

Note:

- (1) All numeric values in the above table represent Minimum Average Roll Value (MARV) in weaker principal direction. The MARV is derived statistically as the average value minus two standard deviations.
- (2) When the Geotextile are joined together by field sewing, the seam strength shall be at least 60 percent of the material's tensile strength. All field seams shall be sewn with thread as strong as the material in the fabric.
- (3) The puncture strength if determined in accordance with ASTM D 6241, the minimum requirement in terms of "Newton (N)" shall be as follows:

The Installation condition	Strength property requirement (MARV)	
	Puncture Strength in Newton (N) as per ASTM D 6241.	
	Elongation at Failure	
	< 50 %	> 50 %
Harsh installation condition	2800	2000
Moderate Installation condition	2250	1400
Less Severe Installation condition	1700	1000

(b) Ultraviolet Stability Requirements

The material shall satisfy the ultraviolet stability requirements specified in Table: 15.9.

Table: 15.9: Requirements for Ultra Violet Stability



S.No	Properties of Fabric	Requirements(Retained Strength)
1	Grab Strength	Not less than 70% after 500 hours of exposure
2	Tear Strength	
3	Puncture Strength	
4	Burst Strength	

(c) Hydraulic Requirements for various applications

i. Subsurface Drainage and filtration

The geotextile shall conform to the physical requirements specified in Table 15.10.

Table: 15.10: Geotextile Requirements for Subsurface Drainage

In-situ passing 0.075 mm sieve (%)	Permittivity, per sec, as per ASTM D 4491/ IS 14324 : 1995	Maximum Apparent opening size, mm ASTM D 4751/IS 14294 : 1995
< 15	0.5	0.43
15 to 50	0.2	0.25
> 50	0.1	0.22

The type of geotextile shall be decided by the Engineer depending upon the installation conditions.

ii. Separation

The geotextile for different subgrade soil conditions shall conform to the requirements given in Tables 15.11 and 15.12

Table: 15.11: Geotextile Requirements for Separation (Subgrade Soaked CBR >3)

S. No.	Geotextile Property	Requirement
1.	Permittivity as per ASTM D 4491	0.02 sec ⁻¹ (per sec)
2.	Maximum Apparent Opening Size as per ASTMD 4751	0.60 mm

Table: 15.12: Geotextile Requirements for Separation (Subgrade Soaked CBR ≤3)

S. No.	Geotextile Property	Requirement
1.	Permittivity as per ASTM D 4491	0.05 sec ⁻¹ (per sec)
2.	Maximum Apparent Opening Size as per ASTM D4751	0.43

iii. Erosion Control

The geotextile for erosion control shall conform to requirements given in Table 15.13.

Table: 15.13: Geotextile Requirements for Erosion Control



In-situ soil passing 0.075 mm sieve (%)	Permittivity, per sec ASTM D4491	Maximum Apparent opening size, mm ASTM D 4751
<15	0.7	0.43
15 to 50	0.2	0.25
>50	0.1	0.22

(3) Construction

(a) General requirement

Geotextile exposure to weather conditions between placement and covering shall not exceed 14 days to minimize the risk of damage. In trench applications, once the backfill material is placed, the geotextile shall be folded over the top of the filter layer to ensure a minimum overlap of 300 mm for trenches wider than 300 mm. For trenches less than 300 mm wide, the overlap shall be equal to the trench width. The geotextile must then be immediately covered with the next layer of material. At roll ends and adjacent sheet joints, a minimum overlap of 450 mm is required, except when placed underwater, where the overlap shall be at least 1 meter. In the longitudinal direction of trenches, seams may be formed either by overlapping or sewing, with all methods subject to the Engineer's approval. During installation, care shall be taken to prevent any damage to the geotextile. If damage occurs, it must be repaired by placing a geotextile patch over the affected area, extending at least 1 meter beyond the edges of the tear or as otherwise approved by the Engineer.

(b) Separation

In road construction, geotextiles may be used as a separation layer over the prepared subgrade. The fabric is rolled out smoothly along the road alignment as shown in the drawings, with wrinkles and folds removed by stretching. Adjacent rolls must be overlapped, sewn, or joined, especially on curves where folding or cutting and overlapping in the direction of construction is required. Folds should be stapled or pinned at 0.6 m intervals. The geotextile must be inspected for damage before being covered. A 100-meter trial stretch should be conducted to develop a method of placing and compacting the granular sub-base without damaging the geotextile.

(c) Filter Layer under Stone Pitching for Erosion Control

The geotextile must be placed in close contact with the soil under slight tension to avoid wrinkles or folds and anchored on a properly shaped surface as shown in the drawings. Care must be taken during placement of overlying materials to prevent tearing or puncturing. Terminal ends should be anchored using key trenches or aprons at the slope's crest and toe. The geotextile should be aligned parallel to the direction of water flow, and adjacent sheets must be joined by sewing or overlapping. Pitching should start from the toe and move up the slope, with large boulders prevented from rolling down. Any damage to the geotextile must be repaired or replaced by the contractor as directed by the Engineer.

(4) Measurement



The geotextile shall be measured in square metres as per planned dimensions with no allowance for overlapping at transverse and longitudinal joints. Excavation, back fill, bedding and cover material shall be measured separately as per relevant Clauses of the Contract.

(5) Payment

Geotextile shall be paid at the respective contract unit rate which shall be full and final compensation for the cost of compliances of all requirements specified in Clause 108.

1901. DRAINAGE ARRANGEMENT FOR PORE WATER PRESSURE RELEASE

(1) Pressure release safety valve

Unplasticised Polyvinyl Chloride (uPVC) pressure release valves are to be installed at specified intervals in concrete-lined canals and RCC structures to support subsurface drainage. These valves must match the sizes shown in the drawings and be connected using appropriate T-joints with secure joints to prevent soil intrusion. Sample valves must be provided in advance for testing and approval, sourced from reputable manufacturers with test certificates and specifications. The valves must be tested under different pressure heads and meet the requirements of Clause 8 of IS 4558:1995.

(2) Gravel Filter

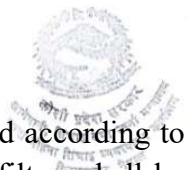
Unless otherwise directed by the Engineer, gravel filter shall be placed and compacted under the lining and boulder pitching. The filter shall be as specified in the Drawings or as directed by the Engineer.

The granular material used for the graded filter shall be obtained from the sources approved by the Engineer, and be hard, dense and free from clay and other foreign matters. It shall be well graded in accordance with the following limits:

- Maximum size shall be 40 mm.
- Grading coefficient (60% size/10% size) shall be greater than 4.
- The 15% size shall be less than 5 times the 85% size of the soil to be protected.
- The 15% size shall be less than 20 times the 15% size of the soil to be protected.
- The 50% size shall be less than 25 times the 50% size of the soil to be protected.
- The 15% size shall be greater than 5 times the 15% size of the soil to be protected.

The grading of the soil to be protected shall be determined by the Contractor at locations directed by the Engineer.

The filter shall be placed in two equal layers. The lower layer shall contain finer material and the upper layer the coarser material. The filter shall be designed and compacted as approved or directed by the Engineer.



Measurement for payment of gravel filter shall be made in cubic metres as placed according to the Drawings, or as instructed by the Engineer. Payment for the graded gravel filters shall be made at the contract unit rate as per the Bill of Quantities. The unit rate shall include all costs of extracting, loading onto trucks, hauling, unloading, storing, testing, placing, mixing of different grades, spreading and compacting of the graded filter gravel.

(3) UPVC perforated pipe

Unplasticised Polyvinyl Chloride (UPVC) pipes of 100 & 140 mm outer diameter shall be provided as pressure relief pipes in downstream floor and piers in under sluice and barrage main bays portion. The uPVC pipes shall be manufactured as per NS 206/046 or relevant IS Standard. The pipes should withstand a pressure of 4 kg/cm². The vertical and horizontal perforated UPVC pipes shall be laid as shown on the Drawings, or as directed by the Engineer. The horizontal pipes shall be perforated uPVC pipes and the perforation area shall be as specified in the Drawings, or as directed by the Engineer.

The horizontal UPVC pipes shall be laid on as shown in the Drawings. The specification of the gravel filter as required and shown in the Drawings shall be as specified in the **Clause above**. Measurement for payment of gravel filter shall be made at the unit rate per cubic metre for Item No. B-1 of the Bill of Quantities.

The horizontal and vertical UPVC pipes shall be connected by the UPVC T junction and uPVC pipe 90° bends, of 100 mm and 140 mm internal dia fitting the pipes to inserted as specified in the Drawings, or as directed by the Engineer. Joints shall be made in such a way that they do not permit entry of soil into the pipe.

Measurement and payment for the pipes is made per linear metre and includes all costs such as supplying, transporting, cutting perforations, and installation, while fittings are paid per unit, covering supply, transport, and jointing. Gravel filters are paid per cubic metre. All installation must follow the specified drawings and directions from the Engineer to ensure proper function and durability.

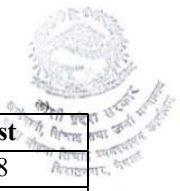
1902. JOINTS SEALING WORKS

(1) Sealing compound

This section specifies requirements for sealing compound for joints in concrete lining canals. The sealing process should be taken up after concrete curing period is over. The joints should be thoroughly cleaned of dust and grit before the sides are primed by a portable air blow or brush. Before applying the sealing compound the sides should be sprayed or brushed with a primer conforming to IS 3384: 1985. The primer should be allowed 4 to 12 hours to dry out thoroughly before sealing compound is poured into the joints. One liter of primer should be used for a length not more than 80 running metre of joints of depth of 25 mm.

The physical requirements of the sealing compound shall conform to those given in Table below:

Table 1: Physical Requirements of Sealing Compound



SN	Characteristic	Requirement	Method of Test
1	Softening point, Min	85°C	IS 1205 : 1978
2	Penetration at 25°C, 100 g, 5 s, 1/10	15 (Min) 30 (Max)	IS 1203 : 1978
3	Flash point, Min	200°C	IS 1209 : 1978
4	Pour point, Max	170°C	IS 1834 : 1984
5	Increase in softening point after heating to 20°C above the maximum pour point for three hours, Max	5°C	IS 1205 : 1978
6	Extensibility at 0°C, Min	6 mm	Appendix C of IS 1834 : 1984
7	Water content, percent by weight, Max	0.5	IS 1211 : 1978

The sealing compound should be heated (working temperature 175° to 185°C) in a suitable heater-boiler vessels. The sealing compound is cut in pieces smaller than 15 cm cube by a wetted axe prior to heating. Molten sealing compound poured into the joints with minimum loss of temperature after transferring to a molten pourer from main heater boiler. In the absence of molten pourer, pouring may be done by suitable cans with extended spouts. For a length of 100 running meter of joint of 12 mm thickness and 75 mm depth not less than 40 kg of sealing compound should be used.

It will be helpful if suitable size of wooden or metallic pieces are laid on each side of the joint in the sealing compound. The sealing compound should be poured till the horizontal joints are filled up to the lower edge. The wooden board or metallic pieces are removed after sealing compound starts hardening.

Precautions must be taken as Primer is inflammable and should not be placed near a naked flame and temperature in boiler should be carefully controlled.

(2) Bituminous Material Filler

The bitumen used shall conform to S 35 of IS: 73-1961 or 85/25 specified in IS: 702-1961.

(3) Compressible Fiber Board Filler

(a) General

This section lays down the specification for bituminous boards (bitumen impregnated fiber fillers) used for filling expansion and construction joints in concrete structures.

(b) Materials

Bituminous board shall be of Shalitek or equivalent conforming to IS: 73-1961 or IS: 702-1961. Fiber shall be either soft board, or fiber board, or cane or any other suitable fiber of cellular nature.

(c) Tests and Standard of Acceptance

The length, width and thickness of the preformed strips shall be as per contract or the specifications when measured in accordance with the method given in IS: 10566-1983.

The tolerances on the average dimensions shall be ± 5 mm on length, ± 3 mm on width and ± 1.5 mm on thickness.



(d) Measurement and Payment

Providing and fixing of bituminous board shall be measured in square meter in accordance with the Drawing, or as directed by the Engineer.

Payment for providing and fixing of bituminous board shall be made at the contract unit rate in Bill of Quantities. The unit rate shall include all costs of labour, materials and equipment required for the work. The contract unit rate shall be the full and the final payment to the Contractor as per Clause 108 to complete the work as per these Specifications.

(4) Backer rod Filler

Backer Rod is an ideal non-absorbent compressible backup material inserted into a joint to control sealant depth, creating a backstop to allow proper sealant tooling. It can also be used as a temporary joint seal. It is an extruded round, closed cell, low density polyethylene foam material with skin-like outer texture. It is highly flexible and compressible for easy installation. Backer Rod meets a wide range of chemical resistance.

Before installation, joint shall be kept clean, dry and free of obstructions. Proper rod diameter shall be selected and cut to length or use directly from spool. With a blunt instrument or roller, rod shall be uniformly installed at the level recommended by the Engineer.

High Performance joint sealing compound

SECTION : REPAIR WORKS

1. DISMANTLING OF CONCRETE WEARING COAT

(6) General

- i. Only those structures designated by the Engineer, or shown on the Drawings, shall be demolished or removed.
- ii. Dismantling and removal operations shall be carried out in such a way that the adjacent structures beyond the canal right of way are left intact and in place. All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to start of new work.
- iii. Existing culverts, bridges, buildings and other structures which are within the canal way and which are designated for removal, shall be removed up to the limits and extent specified on the Drawing or as indicated by the Engineer.
- iv. Materials that are to be salvaged shall be carefully removed and stockpiled near the site at a location designated by the Engineer. The cost of Materials which are to be salvaged or used in the reconstruction work, if found damaged or destroyed as a result of the Contractor's operations, shall be borne by the Contractor. Materials that are not to be salvaged and stockpiled, shall be removed and disposed away from the site by the contract or at his own expenses. Existing reinforcement that is to be incorporated in new work shall be protected from damage and shall be thoroughly cleaned



of all adhering material before being embedded in new concrete.

- v. When pipe culverts, wooden culverts, gabion walls or other structures with a salvaged value are removed, care shall be exercised in their safe removal. The material involved shall be kept intact without damage. The Contractor shall be responsible for the satisfactory removal of such structures in a usable condition.
- vi. Salvaged reinforced concrete pipes, corrugated steel pipes, wooden boxes or other structures shall be stored at places as directed by the Engineer or shown on the Drawing. Structures or portions thereof which are specified in the contract for re erection shall be stored in separate piles.
- vii. Timber or lumber from old structures which is designated by the Engineer as materials to be salvaged shall have all nails and bolts removed there from and shall be stored in neat piles in locations suitable for loading.
- viii. All operations necessary for the removal of any existing structure which might endanger new construction shall be completed prior to the start of new work.
- ix. All salvaged materials shall be the property of the Employer.
- x. All materials obtained from dismantling operations which, in the opinion of the Engineer, cannot be used or auctioned shall be disposed off.

(7) Commencement of Dismantling

- i. Before commencing dismantling, the nature and condition of concrete, the condition and position of reinforcement shall be ascertained. The Contractor shall familiarise himself with the structural design and ensure that the overall stability of the structure is not affected.
- ii. The existing expansion joint assemblies shall be removed carefully along the entire width of the structure..
- iii. The service lines, if any, shall be disconnected/diverted before the dismantling work starts.

(8) Safety of Existing Structures

Dismantling of concrete wearing coat shall be carried out using jackhammers or suitable manual methods as approved by the Engineer. Care shall be taken to avoid any damage to the existing structure including reinforcement or prestressing anchorage for cables if any, located in the deck slab.

(9) Precautions During Dismantling Work

Dismantling work shall not be carried out at night, or during storm or heavy rain. A warning device shall be installed in area to be used to warn the workers in case of mishap/emergency.

Safety helmets conforming to IS: 2925 shall be used by the workmen engaged in dismantling work. The sheds and tools boxes shall be located away from the work site. Goggles preferably made up of celluloids and gas masks shall be worn at the time of dismantling, especially where tools like jack hammers are deployed to protect eyes from injuries from flying pieces, dirt, dust etc. Leather or rubber gloves shall be worn by the workers during the demolition of RCC work. Screens made up of GI sheets shall be placed wherever necessary to prevent the flying pieces from injuring the workers.



Water shall be sprayed to reduce the dust while removing concrete wearing course with jack hammer. No other work shall be taken up under the span when dismantling work is in progress.

2. EPOXY BONDING OF NEW CONCRETE TO OLD CONCRETE

a. General

This work consists of supplying, preparing, and applying a two-component epoxy bonding agent to ensure proper adhesion of new concrete to old (hardened) concrete surfaces in repair and rehabilitation works such as overlays, jacketing, structural strengthening, patch repairs, anchorage zones, spillways, headworks, and other civil engineering structures. The objective of the bonding agent is to achieve a monolithic bond between the fresh and hardened concrete, preventing delamination, seepage, or premature failure.

b. Materials

The epoxy bonding system shall be a **two-component, 100% solids, solvent-free epoxy resin** composed of a base (resin) and a hardener. Both components shall be supplied by the manufacturer in pre-measured, sealed containers to ensure correct proportioning.

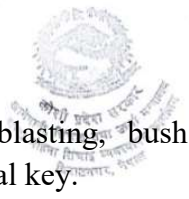
Requirements:

- **Compliance Standards:** Shall meet **ASTM C881, Type II, Grade 2, Class B & C**, or equivalent IS/EN standards.
- **Pot Life:** Not less than 30 minutes at 25°C.
- **Bond Strength:** ≥ 3 MPa (ASTM C882), with failure occurring in the concrete substrate.
- **Compressive Strength:** ≥ 70 MPa at 7 days (ASTM C579).
- **Tensile Strength:** ≥ 20 MPa (ASTM D638).
- **Flexural Strength:** ≥ 25 MPa (ASTM C580).
- **Viscosity:** Low-viscosity, capable of penetrating fine surface pores.
- **Cure Time:** Tack-free within 4–6 hours, full cure within 7 days at 25°C.

The material shall have excellent adhesion to both dry and damp (saturated surface dry) concrete, resistant to moisture, mild chemicals, abrasion, and thermal stresses.

c. Surface Preparation of Old Concrete

- All surfaces shall be sound, structurally stable, and free from laitance, dust, dirt, curing compounds, grease, oils, paints, efflorescence, algae, moss, or loose material.
- Weak or deteriorated concrete shall be removed until sound substrate is achieved.



- Surface profile shall be roughened using mechanical scarification, grit/sand blasting, bush hammering, or high-pressure water jetting to expose aggregate and create a mechanical key.
- Substrate shall be cleaned using compressed air or industrial vacuum to remove debris and dust.
- Moisture content in the substrate shall not exceed **5%**, and the surface shall be in a **Saturated Surface Dry (SSD)** condition at the time of application. Standing water shall not be permitted.

d. Mixing of Epoxy Bonding Agent

- The resin and hardener shall be mixed strictly in the proportions recommended by the manufacturer.
- Mixing shall be done with a **slow-speed mechanical stirrer (300–400 rpm)** to avoid entrapped air and to ensure a homogenous blend.
- The mixture shall be uniform, streak-free, and workable within the prescribed pot life.
- Mixing shall not be carried out by hand.
- Partial packs shall not be used unless specifically allowed by the manufacturer.

e. Application Procedure

- The prepared epoxy bonding agent shall be applied immediately after mixing onto the old concrete surface using a stiff brush, roller, or airless spray, ensuring complete and uniform coverage.
- The application thickness shall typically be **0.3 mm to 0.5 mm**, depending on surface condition.
- Fresh concrete shall be placed while the epoxy is still in a **tacky condition** (not fully cured, not wet).
- The maximum allowable open time (interval between epoxy application and concrete placement) shall be as per manufacturer's guidelines (generally 1–2 hours at 25°C).
- If the epoxy coat hardens before new concrete is placed, the entire coat shall be removed mechanically and reapplied to ensure bonding integrity.
- During placement of new concrete, care shall be taken not to displace the epoxy layer. Concrete shall be carefully vibrated to achieve full compaction without disrupting the bond line.

f. Curing and Protection

- The epoxy itself does not require curing; however, once new concrete is placed, curing of new concrete shall be carried out as per IS 456/ACI 308 or project specifications.
- Surfaces with applied epoxy (but not yet overlaid with new concrete) shall be protected from dust, rain, direct sunlight, and contamination.
- The work shall not be carried out under adverse weather conditions (heavy rain, high humidity > 90%, or substrate temperature below 10°C).

g. Quality Assurance and Testing



- The contractor shall submit manufacturer's product data sheets, technical literature, and compliance certificates before use.
- Trial applications (mock-up panels) may be required to demonstrate workmanship, coverage rate, and tack-time.
- Bond strength tests (pull-off tests as per ASTM C1583) may be conducted at site to verify adhesion. Minimum pull-off strength shall be **1.5 MPa**, with failure occurring in concrete substrate.
- Any delaminated or defective areas shall be rectified by removal and reapplication at the contractor's cost.

h. Health and Safety

- Epoxy resins and hardeners may cause skin and respiratory irritation. All workers shall wear **PPE** including gloves, goggles, face masks, and protective clothing.
- Adequate ventilation shall be ensured in enclosed spaces.
- In case of skin contact, the affected area shall be washed immediately with soap and water (not solvents).
- All work shall conform to **OSHA/IS safety standards** for handling epoxy resins.

i. Measurement

The epoxy bonding agent shall be measured in terms of **square meters (m²)** of surface area of old concrete coated and bonded with new concrete.

No separate measurement shall be made for overlaps, reapplication due to delayed concrete placement, or wastage.

j. Payment

The payment for this item shall be made at the contract unit rate (per m²) and shall be deemed to include:

- Supply and delivery of epoxy bonding agent.
- Storage, handling, and mixing.
- Surface preparation of old concrete including cleaning and roughening.
- Application of epoxy bonding coat as specified.
- Labor, tools, equipment, scaffolding, safety gear, and incidentals necessary for completing the work.

No extra payment shall be made for rework caused by improper handling, curing delays, or failure to follow manufacturer's instructions.



3. Epoxy Bonding Agent and High Performance Abrasion Resistant Epoxy Bedding Mortar

a. General

The item covers supply, delivery to site, surface preparation, and application of a two-component epoxy bonding agent followed by a 10 mm thick layer of three-component high-performance abrasion-resistant epoxy bedding mortar. The system is intended for application in hydraulic structures, spillways, headworks, canal linings, stilling basins, energy dissipators, and other civil works subjected to high-velocity water flow, cavitation, and abrasion from sediment-laden currents. The work shall be executed in accordance with this specification, approved drawings, and the manufacturer's recommendations.

b. Materials

i. Epoxy Bonding Agent

The epoxy bonding agent shall be a two-component, solvent-free, low-viscosity epoxy resin system comprising a base resin and a hardener. The product shall be cold-curing, moisture-tolerant, and capable of penetrating into the prepared substrate. The epoxy bonding agent shall comply with **ASTM C881, Type I & II, Grade 2, Class B & C**, or equivalent international standard.

Properties:

- Pot life: Minimum 30–60 minutes at 25°C.
- Bond strength to concrete: ≥ 3 MPa, with failure occurring in concrete rather than at the bond line (ASTM C882).
- Tensile strength: ≥ 20 MPa (ASTM D638).
- Compressive strength: ≥ 70 MPa (ASTM C579).
- Consistency: Brushable or rollable.
- Adhesion: Excellent to dry or damp concrete surfaces.

The bonding agent shall be supplied in manufacturer-sealed containers with labels, batch numbers, and expiry dates.

ii. Epoxy Bedding Mortar

The bedding mortar shall be a three-component system consisting of epoxy resin (base + hardener) and graded silica/quartz filler. It shall be designed to provide a dense, impermeable, abrasion-resistant overlay suitable for use in hydraulic and civil engineering structures.

Properties:

- Mix ratio: Typically 1 part epoxy resin (base + hardener) to 3–5 parts graded filler, by weight (as per manufacturer's instructions).
- Thickness: 10 mm $\pm$ 2 mm in finished compacted state.



- Compressive strength: $\geq 70\text{--}90$ MPa at 7 days (ASTM C579).
- Flexural strength: $\geq 25\text{--}30$ MPa (ASTM C580).
- Tensile strength: $\geq 15\text{--}20$ MPa (ASTM D638).
- Bond strength to concrete: ≥ 3 MPa, failure in substrate concrete (ASTM C882).
- Abrasion resistance: Weight loss < 100 mg after 1000 cycles, CS-17 wheel, 1 kg load (ASTM D4060).
- Water absorption: $\leq 0.1\%$ (ASTM D570).
- Service temperature resistance: Continuous service up to $60\text{--}70^\circ\text{C}$.
- Appearance: Trowelable, non-slump, smooth mortar finish.

The filler (silica/quartz sand) shall be clean, hard, angular, and dust-free, conforming to **IS 383/ASTM C33** standards, with a particle size range of 0.1 mm to 3 mm.

c. Surface Preparation

- The concrete substrate shall be structurally sound, clean, and free from laitance, oil, grease, dirt, curing compounds, and loose materials.
- Surface roughening shall be carried out using mechanical scarification, grit/sand blasting, or high-pressure water jetting to achieve an adequate mechanical key.
- All laitance and weak surface layers shall be removed until sound concrete is exposed.
- Moisture content in the concrete shall not exceed 5% at the time of application.
- Surface temperature shall be at least 3°C above the dew point to prevent condensation.
- Prepared surfaces shall be inspected and approved prior to application.

d. Mixing Procedure

- Epoxy resin and hardener shall first be mixed thoroughly in the correct proportions using a low-speed mechanical stirrer (300–400 rpm) to avoid entrainment of air.
- Once a homogeneous mix is obtained, the graded silica filler shall be added gradually while continuing to mix until a uniform, lump-free paste is achieved.
- Mixing shall follow the manufacturer's recommended procedure strictly.
- No additional solvents, thinners, or water shall be added.
- Mixed material shall be used within the pot life period (not less than 30 minutes at 25°C).

e. Application



- A coat of epoxy bonding agent shall first be applied uniformly onto the prepared concrete substrate by brush or roller to ensure full surface coverage. The bonding agent shall be in a tacky condition at the time of applying mortar.
- The epoxy mortar shall then be placed over the tacky bonding coat, spread, and compacted to an average thickness of **10 mm** using trowels or screeds.
- The material shall be applied in continuous operations to avoid cold joints.
- The finished surface shall be free from voids, pinholes, or delamination and shall have a smooth finish.
- For areas requiring thickness greater than 10–15 mm, multiple layers may be applied, ensuring proper surface preparation between successive applications.
- Newly applied epoxy mortar shall be protected from rain, running water, dust, and mechanical disturbance for at least **24–48 hours** after placement.

f. Curing and Protection

- The epoxy mortar is a self-curing material; however, it must be protected from direct sunlight, water spray, or any external loads during curing.
- Curing time before light traffic shall not be less than 24 hours; full mechanical and chemical resistance shall be attained within 7 days at 25°C.

g. Quality Control and Testing

- All materials shall be sourced from approved manufacturers and delivered in sealed containers with proper identification.
- Test certificates for mechanical and physical properties of epoxy bonding agent and mortar shall be furnished.
- Trial applications on mock-up panels may be required to demonstrate material performance and workmanship quality.
- Field tests shall include checks for surface thickness, bond adhesion (pull-off test), visual defects, and uniformity.
- Any defective or delaminated areas shall be cut out and replaced at the contractor's expense.

h. Health and Safety

- Epoxy resins and hardeners shall be handled with care. Appropriate personal protective equipment (PPE) such as gloves, masks, goggles, and protective clothing shall be used.
- Work areas shall be properly ventilated.



- Direct skin contact with uncured epoxy shall be avoided. In case of accidental contact, affected areas shall be washed with soap and water immediately.
- Fire safety measures shall be observed as per safety regulations.

i. Measurement

Measurement shall be made on the basis of the actual finished **surface area (in square meters)** of epoxy mortar applied at the specified 10 mm thickness, including epoxy bonding coat and all surface preparation. No extra payment shall be made for wastage, overlaps, or additional thickness applied unless otherwise directed.

j. Payment

The unit rate quoted shall be deemed to include:

- Supply and delivery of epoxy bonding agent and three-component epoxy mortar.
- Storage, handling, mixing, and preparation of materials.
- Complete surface preparation of substrate.
- Application of bonding coat and mortar to the specified thickness.
- Curing, protection, and finishing.
- Provision of all labor, tools, equipment, scaffolding, safety measures, and incidental works required for completion of the job.

Payment shall be made under the relevant BOQ item on a **square meter basis** for completed and accepted work.

4. Z-Type Steel Sheet Pile

a. General

This work consists of providing, handling, aligning, and driving **Z-Type Steel Sheet Piles** to the specified depth and alignment as shown on the drawings or as directed by the Engineer. Steel sheet piles act as a cutoff structure in hydraulic works, excavation supports, and earth-retaining structures, reducing seepage and increasing the creep length of hydraulic structures.

The piles shall be installed in proper sequence to the design depth, ensuring that the interlocks are fully engaged and continuous over the full length. The completed pile wall shall form an effective and water-tight barrier capable of resisting the design earth and hydrostatic pressures.

b. Materials



- The sheet piles shall conform to the requirements of **IS 2314:1986** or equivalent international standards (ASTM/AISI/EN).
- The steel shall contain **0.20–0.35% copper** to provide resistance against corrosion.
- The surface of the steel shall be free from cracks, laminations, blisters, scale, harmful rust, or other defects.
- The steel sheet pile shall be of **Z-type section** with the following minimum properties:

Parameter	Requirement
Section Depth	185 mm
Web Thickness	9.8 mm
Flange Thickness	9.8 mm
Weight per meter (not less than)	49.25 kg

- The interlocks shall be continuous, water-tight, and shall allow adequate free play to permit easy driving and engagement, while ensuring a firm lock after driving.

c. Dimensions and Tolerance

- Profile and nominal dimensions shall conform to **IS 2314:1986**.
- Tolerances on width, height, and thickness shall be as per **Table 5 of IS 2314:1986**.
- Tolerance on interlocks shall be as per **Table 6 of IS 2314:1986**, ensuring firm engagement without excessive tightness.
- Tolerance on weight shall be **+4% to –2.5%** of the specified mass.

d. Installation / Workmanship

- Sheet piles shall be handled and lifted carefully to prevent damage, bending, or distortion of the interlocks.
- The piles shall be driven by **vibratory hammer, drop hammer, hydraulic press-in method, or approved equipment** to the specified depth and line, ensuring verticality and proper alignment.
- Driving shall be carried out without damaging the pile section or interlocks. Piles found damaged or distorted shall be replaced at the Contractor's expense.
- Splicing of piles (if required) shall be carried out by **welding or bolting**, conforming to IS 9595 (for welding) or approved equivalent standards.
- After driving, the pile tops shall be cut off to the required level as per drawings.
- All exposed heads of sheet piles shall be **painted/coated** with approved anti-corrosion paint or epoxy system as specified.



e. Measurement

- Measurement shall be taken in **Metric Tonnes (MT)** of steel sheet pile provided and driven to the specified alignment and depth, or alternatively in **linear meters (m)** of pile wall installed, as indicated in the Bill of Quantities.
- Measurement shall include the total length of sheet pile driven below the ground level, plus any portion projecting above ground as per drawings.
- No separate measurement will be made for wastage, overlaps, splices, or rejected/damaged piles.

f. Payment

- Payment shall be made at the **contract unit rate** per MT or per linear meter as specified in the Bill of Quantities.
- The unit rate shall be deemed to include:
 - Supply and transportation of Z-type steel sheet piles of required dimensions and weight.
 - Handling, storing, lifting, aligning, and driving of piles to specified depth and alignment.
 - Welding/bolting for splicing, if required.
 - Cutting, trimming, and finishing the pile heads to required levels.
 - Surface preparation and protective painting/coating.
 - All labor, materials, tools, equipment, fuel, power, scaffolding, and incidentals to complete the work in accordance with specifications.

The contract unit rate shall be full and final payment for completing the work to the satisfaction of the Engineer-in-Charge.

5. Diversion Work for Repair

a. General

The work under this item includes **planning, construction, and maintenance of temporary diversion arrangements** required for facilitating repair and rehabilitation works of undersluices and weir structures. The diversion shall be designed and executed in such a manner that the flow of water is effectively diverted, construction areas are kept reasonably dry, and downstream flow conditions are not adversely affected.

The Contractor shall carry out all works including design, layout, excavation, filling, embankment construction, cofferdams, channelization, protection measures, and maintenance of the diversion during the construction period. The diversion shall be safe, stable, and capable of withstanding the expected river flows during the working season.

b. Materials



- **Earth Materials:** Suitable soil, clay, sand, or local materials available at site, free from organic matter, roots, or deleterious substances, shall be used for temporary bunds or cofferdams.
- **Rock/Rubble/Stone:** Stone boulders or rubble, if required for slope pitching and protection against erosion.
- **Geo-materials:** Geo-bags, sandbags, geotextiles, or bamboo matting may be used for providing additional support and to minimize seepage through the cofferdam.
- **Timber/Steel Sheets:** Timber piles, planks, or steel sheet piles may be used if required for strengthening or ensuring water-tightness.

All materials shall be subject to approval of the Engineer before use.

c. Method of Work

- The diversion alignment and method shall be approved by the Engineer before commencement.
- **Cofferdams/Bunds** shall be constructed upstream and downstream of the work site with suitable earth, rockfill, or sheet piles to isolate the construction area.
- Adequate **freeboard** shall be maintained considering design discharge, afflux, and safety against wave action.
- The diversion channel, if constructed, shall have sufficient cross-sectional area to safely pass the expected discharge without overtopping or excessive velocity.
- **Seepage control** shall be provided through puddle clay core, geo-bags, or polythene/geotextile lining as directed.
- **Erosion protection** using stone pitching, boulder apron, sandbags, or bamboo cribs shall be provided along exposed faces.
- Adequate arrangements for **dewatering** (pumps, sump wells, drainage channels) shall be made to keep the work site dry.
- The diversion structure shall be regularly inspected and maintained throughout the construction period and promptly repaired in case of damage, leakage, or overtopping.
- After completion of repair works, the diversion bunds/cofferdams shall be **removed or leveled**, and the river section restored to its original flow condition as directed.

d. Measurement

- Diversion works shall be measured on a **lump sum basis** for the complete item, including all temporary works necessary for the safe execution of repair works.
- No separate measurement shall be made for earthwork, stone pitching, dewatering, protective works, or removal of diversion structures.



e. Payment

- Payment shall be made at the **contract lump sum rate** quoted in the Bill of Quantities.
- The rate shall include:
 - Surveying, layout, and design of diversion works.
 - Construction, maintenance, and removal of cofferdams, bunds, or diversion channels.
 - Supply of all materials (earth, stone, geo-bags, timber, sheet piles, pumps, etc.).
 - Dewatering, pumping, and drainage arrangements.
 - Restoration of river section after completion.
 - All labor, equipment, tools, transport, supervision, and incidental costs.

The lump sum payment shall be full and final compensation to the Contractor for carrying out diversion works as per the drawings, specifications, instructions, and to the satisfaction of the Engineer.

6. Dewatering Work

a. General

The work under this item includes **providing, operating, and maintaining dewatering systems** to keep the worksite free from water during construction of undersluice, weir, foundations, excavation, concreting, or any other works. The Contractor shall make all necessary arrangements to remove accumulated water from seepage, rainfall, river flow, or other sources to ensure safe, dry, and workable site conditions.

All dewatering operations shall be executed in accordance with the best engineering practices, with due consideration for safety, environmental requirements, and to the satisfaction of the Engineer.

b. Materials and Equipment

- **Pumps:** Centrifugal, submersible, or diesel/electric driven pumps of adequate capacity shall be provided, along with standby units for emergency use.
- **Pipes and Hoses:** Suitable suction and delivery pipes/hoses with sufficient length and strength to withstand pumping pressures.
- **Power Supply:** Generators or electricity connections to ensure uninterrupted pump operation.
- **Sump Wells and Drainage Channels:** Excavated sumps, wells, or trenches shall be constructed at appropriate locations to collect water and facilitate pumping.
- **Other Accessories:** Valves, strainers, anchors, fuel, lubricants, and fittings as necessary for smooth functioning of the system.



All equipment and materials shall be of approved make, maintained in good working condition, and inspected by the Engineer prior to use.

c. Method of Work

- The Contractor shall **design and install** dewatering arrangements to suit site conditions and anticipated inflow of water.
- **Sump pits** or wells shall be provided at low points within the excavation for efficient collection of water.
- **Pumping operations** shall be carried out continuously as required, including standby operation during heavy inflow or rainfall.
- Measures shall be taken to **prevent erosion, undermining, or collapse** of excavation sides during dewatering.
- The pumped water shall be **safely discharged** into drains, rivers, or designated disposal areas without causing erosion, flooding, or environmental damage.
- In case of cofferdams or bunds, seepage/leakage water shall be collected and removed promptly.
- Dewatering shall continue until construction activities are completed, foundations gain strength, and the Engineer approves cessation.
- The Contractor shall make provisions for **round-the-clock operation**, including fuel, manpower, and maintenance during the entire construction period.

d. Measurement

- Dewatering work shall be measured on a **lump sum basis** covering all operations necessary to keep the site dry during the entire construction period.
- No separate measurement shall be made for pumps, pipes, sump wells, fuel, labor, or standby arrangements.

e. Payment

- Payment shall be made at the **contract lump sum rate** entered in the Bill of Quantities.
- The rate shall be deemed to include:
 - Supply, installation, operation, and removal of pumps, pipes, sump wells, channels, generators, and accessories.
 - Cost of fuel, lubricants, electricity, and maintenance.
 - Continuous operation including night shifts and emergency arrangements.
 - Labor, supervision, safety, and environmental compliance.



- All incidental expenses required for proper and complete dewatering to the satisfaction of the Engineer.

The lump sum payment shall be full and final compensation for completing dewatering works as per specifications and instructions of the Engineer.

7. Site Clearance Before and After Construction

a. General

This item covers **complete site clearance** required **before commencement** of construction works and **after completion** of all works, including removal and disposal of unwanted materials, vegetation, debris, temporary structures, and other obstructions. The Contractor shall ensure that the site is cleared, leveled, and left in a tidy and safe condition to the full satisfaction of the Engineer.

b. Scope of Work

The site clearance shall include, but not be limited to:

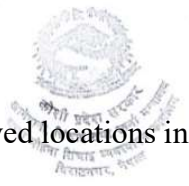
1. Removal of shrubs, bushes, trees, roots, stumps, grass, weeds, and other vegetation.
2. Clearing of topsoil, debris, loose stones, construction waste, or any unsuitable material.
3. Removal of temporary works such as scaffolding, formwork, diversion structures, pumps, pipes, and other site installations.
4. Filling, leveling, and compacting areas disturbed during construction, excavation, or temporary works.
5. Cleaning of drainage channels, access roads, and work areas to restore original flow or usability.
6. Proper disposal of all cleared material at designated areas without causing nuisance, pollution, or environmental damage.

c. Materials and Equipment

- Tools and equipment such as bulldozers, excavators, chainsaws, hand tools, trucks, and loaders may be used to facilitate efficient clearance.
- Materials removed from the site shall be sorted and transported for **reuse, recycling, or approved disposal**.

d. Method of Work

- The site shall be cleared progressively in coordination with construction activities to avoid obstruction of work.
- Vegetation removal shall include **uprooting and cutting of trees and shrubs**, ensuring that roots and stumps are removed to prevent future regrowth.



- Debris and waste shall be **collected, loaded, transported, and disposed** at approved locations in accordance with environmental regulations.
- Any areas excavated or disturbed shall be **backfilled, leveled, and compacted** as directed by the Engineer.
- Special care shall be taken near structures, waterways, or sensitive areas to avoid damage.

e. Measurement

- Site clearance shall be measured on a **lump sum basis**, covering the complete area of the construction site before and after works.
- No separate measurement shall be made for removal of individual items or temporary works.

f. Payment

- Payment shall be made at the **contract lump sum rate** in the Bill of Quantities.
- The rate shall be deemed to include:
 - Clearing of vegetation, debris, and temporary works.
 - Loading, transport, and disposal of removed materials.
 - Filling, leveling, and compaction of disturbed areas.
 - Supply of all labor, equipment, tools, and supervision required.
- The lump sum payment shall be full and final compensation for completing all site clearance works to the satisfaction of the Engineer.

8. Drilling Holes on Existing Concrete Surface for Fixing Anchor Bars

a. Description of Item

Drilling of holes of a mm diameter and b mm depth in existing concrete surface including all labor, tools, plant, provision of power supply, cleaning of holes, and preparation for fixing anchor bars as per drawings, specifications, and instructions of the Engineer, all complete.

b. Materials

Bonding material: Approved epoxy resin or cementitious grout for fixing anchor bars.

Cleaning materials: Compressed air, wire brushes, water jet, and lint-free cloths for dust/moisture removal.

Electricity supply: Contractor shall arrange provision of electricity at drilling site.

c. Workmanship



- Holes shall be drilled using rotary hammer drill or approved drilling equipment ensuring minimal vibration and no damage to surrounding concrete.
- Hole dimensions (diameter, depth) and spacing shall strictly conform to drawings or Engineer's instructions.
- Each drilled hole shall be thoroughly cleaned by compressed air and wire brushing to remove dust, laitance, and moisture before fixing anchor bars.
- Anchor bars shall be installed vertically or at an angle as required, using epoxy resin or cementitious grout as approved.
- All works shall be executed under supervision and shall meet the Engineer's satisfaction.

d. Measurement

Measurement shall be taken as number of holes drilled of specified diameter and depth, completed in all respects and approved by the Engineer.

Partially drilled or rejected holes shall not be measured for payment.

e. Payment

Payment shall be made at the unit rate per drilled hole (of specified diameter and depth) as entered in the BOQ.

The rate shall be inclusive of all labor, materials, equipment, power supply, cleaning, bonding material, and incidental works required for proper completion.

9. Filling Drill Holes with Epoxy Grout / Free Flow Epoxy Resin Anchor Grouts

a. Description of Item

Providing, mixing, and filling drilled holes with high-performance, free-flow epoxy resin anchor grout (such as A&A Anchorgrout EP System or equivalent) between reinforcing bars/anchor bars and the drilled holes, including surface preparation, cleaning, and all precautions for safe handling of epoxy materials, complete as per the drawings, technical specifications, and instructions of the Engineer

b. Materials

i. Epoxy Resin Anchor Grout

- The grout shall be a **pre-packed, two-component or three-component system** consisting of:
 - **Base Resin** (epoxy)
 - **Hardener** (curing agent)
 - **Filler/aggregate** (for thixotropy and strength, if required)
- The grout shall be **free-flowing, solvent-free, non-shrink**, and specifically formulated for anchoring reinforcement bars, foundation bolts, and other inserts into concrete.
- The grout shall conform to relevant international/national standards such as:
 - ASTM C881 (Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete)



- IS 9103 (Specification for Concrete Admixtures – guidance reference)
- Manufacturer's own performance standards.

Technical Properties (Typical Requirements):

- Compressive Strength: $\geq 80 \text{ N/mm}^2$ at 7 days (ASTM C109 / IS 4031)
- Bond Strength to Steel: $\geq 12 \text{ N/mm}^2$
- Bond Strength to Concrete: $\geq 3 \text{ N/mm}^2$ (failure in concrete preferred)
- Pot Life (at 30°C): 30–45 minutes (depending on grade)
- Shrinkage: Nil (non-shrink formulation)
- Application Temperature: 10°C to 40°C
- Chemical Resistance: Resistant to oil, mild acids, alkalis, and water.

ii. Anchor Bars / Reinforcement Steel

- Steel bars shall be of **Fe 500/Fe 500D grade HYSD reinforcement** or as specified in drawings.
- The bars shall be **straight, clean, free from rust, scale, oil, paint, and grease** to ensure proper bonding with epoxy grout.
- Bars shall be cut to the required length with square ends and cleaned by wire brushing or sand blasting before installation.

iii. Drilled Hole Preparation Materials

- **Compressed Air:** Oil-free and moisture-free compressed air to blow out all dust and loose particles.
- **Wire Brushes:** Appropriately sized steel brushes for scrubbing drilled hole surfaces.
- **Cleaning Solvents:** Acetone or approved solvent for final wiping of hole surfaces and reinforcement.
- **Lint-free Cloths:** For wiping bars and holes after solvent cleaning.

iv. Safety and Handling Materials

- **Protective Gloves:** Nitrile or chemical-resistant gloves to handle epoxy components.
- **Safety Goggles and Masks:** To prevent skin/eye contact and inhalation of fumes.
- **Mixing Tools:** Slow-speed drill with paddle mixer for uniform blending of epoxy resin and hardener.
- **Containers:** Clean, dry mixing containers (plastic or steel) – no contamination with water or dust.

v. Water and Moisture Control



- No free water shall be present in the holes.
- If moisture is unavoidable (submerged or wet conditions), a **moisture-tolerant epoxy grout** approved by the Engineer shall be used.

c. Workmanship

- Ensure drilled holes are free from dust, oil, grease, standing water, or laitance before filling.
- Mix epoxy grout strictly in accordance with manufacturer's instructions, ensuring correct proportions and homogeneous mixing.
- Place the grout immediately after mixing to avoid setting before installation.
- Fill holes **completely from bottom to top** to avoid voids and ensure full encapsulation of the anchor bars.
- Bars shall be inserted slowly with a twisting motion to avoid air entrapment.
- All necessary precautions such as protective clothing, gloves, and masks shall be taken while handling epoxy materials.
- Curing period shall follow manufacturer's recommendations before load application.

d. Measurement

- Measurement shall be taken as **number of holes filled with epoxy grout** for the specified bar diameter and depth, completed and approved by the Engineer.
- No extra payment will be made for wastage, spillage, or rejected works.

e. Payment

- Payment shall be made at the **unit rate per filled hole** as entered in the BOQ.
- The rate shall be inclusive of all labor, materials (including epoxy grout and consumables), equipment, safety measures, cleaning, and incidental works required to complete the job to the satisfaction of the Engineer.