

DETAILED TECHNICAL SPECIFICATIONS

CONTENTS

Section No.	Particulars
SECTION I	EXCAVATION FOR CANAL AND STRUCTURES
1.1	Scope of work
1.2	Indian Standards for Reference
1.3	Setting out works
1.4	Preparation of Site
	1.4.1 Jungle Clearance
	1.4.2 Stripping
1.5	Recording of Cross Sections
1.6	Planning
1.7	Drilling and Blasting
	i. General
	ii. Explosive
	iii. Explosive and blasting
	iv. Materials
	v. Personnel
	vi. Storage of Explosive
	vii. Use of Explosive
	viii. Disposal of Deteriorated Explosive
	ix. Preparation of Primers
	x. Charging of Holes
	xi. Blasting
	xii. Electrical Firing
	xiii. Precautions after Blasting
	xiv. Misfires
	xv. Safety of Public and Property
	xvi. Controlled Blasting
1.8	Classification of Excavated Materials
	1.8.1 Classification
	1.8.2 Authority of Classification
1.9	Excavation of Canal
	1.9.1. General
	1.9.2 Conveyance and Disposal of Excavated Materials
	1.9.3 Dewatering Canal Trenches and Excavation under wet condition
	1.9.4 Over Excavation
	1.9.5 Tolerance in Alignment and Grade
	1.9.6 Pay Line
	1.9.7 Measurement and Payment
1.10	Excavation of Structures
	1.10.1 General
	1.10.2 Over Excavation
	1.10.3 Pay Line
	1.10.4 Measurement and Payment
1.11	Slips
1.12	Monsoon Damages

A. SECTION-II	B. EMBANKMENT
2.1	Scope of work
2.2	Indian Standards of reference
2.3	Stripping
	2.3.1 General
	2.3.2 Recording of Cross Sections
	2.3.3 Measurement and Payment for the seat of Embankment
2.4	Preparation for Foundation Under Embankment
	2.4.1 Backfilling of cut – off Trenches
2.5	Borrow Areas
	2.5.1 General
	2.5.2 Stripping of Borrow Areas
	2.5.3 Borrow Area Watering
	2.5.4 Measurement and Payment
2.6	Embankment
	2.6.1 General
	2.6.2 Earth fill
	2.6.3 Moisture Control
	2.6.4 Compaction
	2.6.5 Compaction of All in fill
	2.6.6 Laying and Compacting Cohesive Non-Swelling Material
	2.6.7 Measurement and Payment
2.7	Rock Fill
	2.7.1 General
	2.7.2 Measurement and Payment
2.8	Rock toe
	2.8.1 Measurement and Payment
2.9	Laying of Filters
	2.9.1 Filter Drains
	2.9.2 Filter Materials
	2.9.3 Measurement and Payment
2.10	Back fill in foundation Trenches and around structures
	2.10.1 General
	2.10.2 Compaction of Back fill
	2.10.3 Measurement and Payment
2.11	Weather Conditions
2.12	Inspection and Tests
	2.12.1 General
	2.12.2 Before Compaction
	2.12.3 During Compacting
	2.12.4 After Compaction
	2.12.5 Frequency of Testing
	2.12.6 Record and Report
2.13	Protection
2.14	Turfing
SECTION-III	CONCRETE LINING
3.1	Scope of Work
3.2	Applicable Publications
	3.2.1 Indian Standards for Reference
	3.2.2 Other Publications
3.3	Clearing Site
3.4	Preparation of Sub – grade for concrete Lining
	3.4.1 General
	3.4.2 Tolerance in Preparation of Sub – Grade

- 3.5 Materials Concrete Lining
 - 3.5.1 Cement
 - 3.5.2 Fine Aggregate
 - i. General
 - ii. Quality
 - iii. Grading
 - iv. Storage
 - 3.5.3 Coarse Aggregate
 - i. General
 - ii. Grading
 - iii. Storage
 - 3.5.4 Water
 - 3.5.5 Air Entraining Admixtures
 - i. General
 - ii. Tests
- 3.6 Cast-in-situ Concrete Lining
 - 3.6.1 General
 - 3.6.2 Batching
 - 3.6.3 Mixing
 - 3.6.4 Consistency
 - 3.6.5 Conveyance
 - 3.6.6 Placing and Compacting
 - 3.6.7 Slip form for the side slope of the canal
 - 3.6.8 Finishing
 - 3.6.9 Curing
- 3.7 Tests of Concrete and Acceptance Criteria
 - 3.7.1 General
 - 3.7.2 Sampling Procedure and Frequency
 - 3.7.3 Sampling and strength test of concrete
 - 3.7.4 Test Specimen
 - 3.7.5 Standard Deviation
 - 3.7.6 Acceptance Criteria
 - 3.7.7 Core Test
- 3.8 Joints
- 3.9 Dewatering
- 3.10 Desilting
- 3.11 Measurement and Payment
 - i. Plain cement concrete lining
 - ii. Concrete lining with normal reinforcement
- 3.12 Kilometer Stones and Hectometer Stones
 - 3.12.1 Measurement and Payment
- 3.13 Boundary Stones / Canal bed stones
 - 3.13.1 Measurement and payment
- SECTION – IV C. PLAIN AND REINFORCED CONCRETE**
 - 4.1 Scope of work
 - 4.2 Applicable Publications
 - 4.2.1 Indian Standards for Reference
 - 4.2.2 Other Publications
 - 4.3 Composition

4.4	Materials
4.4.1	Cement
4.4.2	Fine Aggregates
4.4.3	Coarse Aggregates
4.4.4	Reinforcing Steel
4.4.5	Water
4.4.6	Admixtures
4.4.7	Epoxy
4.5	Concrete for Structures
4.6	Strength Requirement of Concrete
4.7	Proportioning Concrete
4.8	Production of Concrete
4.8.1	Production of Aggregates
4.8.2	Batching
4.8.3	Mixing
4.9	Temperature of Concrete, and Weather Conditions
4.10	Transporting Concrete
4.11	Preparation for Placing Concrete
4.11.1	General Requirement
4.11.2	Foundation Surfaces
4.11.3	Surface of Construction and contraction Joints
4.12	Placing and Compacting Concrete
4.13	Formwork
4.13.1	General
4.13.2	Materials to be Used
4.13.3	Form, Centering and Temporary Works
4.13.4	Cleaning and Treatment of Forms
4.13.5	Removal of Forms
4.14	Finishes and Finishing of Concrete Surface
4.14.1	Formed Surfaces
4.14.2	Unformed Surfaces
4.15	Repairs of Concrete
4.15.1	General
4.15.2	Methods of Repairs
i.	Dry Pack Method
ii.	Concrete replacement method
iii.	Mortar Replacement method
iv.	Epoxy Method
4.15.3	Preparation of Concrete for repair
i.	Dry packing concrete
ii.	Concrete Replacement
iii.	Mortar Replacement
iv.	Use of Dry Pack Mortar
4.16	Curing of Concrete.
4.16.1	General
4.16.2	Water Curing
4.16.3	Membrane Curing
4.17	Requirement of Concrete Construction
4.17.1	General
4.17.2	Concrete in various components of bridges, Drainage siphon, aqueducts, etc
4.17.3	Concrete in Block – outs
4.17.4	Embedment in Concrete

4.18	Construction Joints in unreinforced concrete walls
4.19	Test and acceptance criteria
4.20	Steel Reinforcement
4.21	Tolerance in concrete construction
	4.21.1 General
	4.21.2 Tolerance for Canal structures
	4.21.3 Concrete surface Irregularities
4.22	Unacceptable work
4.23	Measurement and Payment
SECTION – V	REINFORCEMENT
5.1	Scope of Work
5.2	Indian Standards for Reference
5.3	Steel Reinforcing Bars
	5.3.1 General
	5.3.2 Cutting, bending and binding
	5.3.3 Splicing
	5.3.4 Care of placed reinforcement and concrete
5.4	Measurement and Payment
SECTION – VI	GATES
6.1	Radial Gates for regulator and escapes
	6.1.1 Approval of Designs and Drawings
	6.1.2 Design procedure for gate and hoists
	6.1.3 Materials
	6.1.4 Anchorages and Hoisting arrangements
	1. Fabrication
	2. Transportation
	3. Schedule of Supplies
	4. Erection
	5. Painting
	6.1.5 Test Operation
	6.1.6 Measurements and Payments
6.2	Vertical Lift Slide gate
	6.2.1 Measurements and Payments
SECTION – VII	RUBBLE MASONRY
7.1	Scope of work
7.2	Indian Standards for Reference
7.3	Materials
	7.3.1 Cement
	7.3.2 Water
	7.3.3 Sand
	7.3.4 Rubble (Stones)
7.4	U.C.R.S. Masonry
	7.4.1 Mortar
	7.4.2 Mixing
	7.4.3 Mode of Laying
	7.4.4 Measurement and Payment
7.5	Pointing
	7.5.1 General
	7.5.2 Measurement and Payment
7.6	Tests for Mortar for construction of Masonry
	a. Controlling Payment

SECTION – VIII REVETMENT AND PITCHING

SECTION – IX SUPPLYING AND LAYING AND JOINTING HUME (PRECAST) PIPE AND MISCELLANEOUS

SECTION X– WATER STOPPER

CONTRACTOR

EXECUTIVE ENGINEER

SECTION – I

1.0 EXCAVATION FOR CANAL AND STRUCTURES

1.1 SCOPE OF WORK:

- (a) The work to be done under these specifications consists of the excavation in various strata, and the conveyance and disposal of the excavated stuff for canals (including distributaries, laterals etc.) for cut-off trenches of embankment, for diversion channels, drains and ditches, for the trenches of pipe laying, for training of nallas, for catch water drains, for service road and inspection path and for structures. The contractor shall furnish all tools, plant, labour and materials and execute the work satisfactorily.
- (b) When existing public facilities like road drainage, drinking water supply pipe lines, telephone lines and power lines etc. are to be disturbed for constructions activities, the contractor shall, after due approval of the Engineer, provide and maintain in satisfactory condition at his cost, temporary structure like diversion roads for ensuring uninterrupted and satisfactory functioning of the facilities. Precautionary measures like signal, night lamps, fencing and barricading etc. will also be provided by him at his cost.

1.2 INDIAN STANDARDS FOR REFERENCE

- | | | |
|-----|---|---|
| 1. | IS: 1498-1970 | Classification identification of soils for general Engineering purpose. |
| 2. | IS: 2720-1983
(part-I to X and part XIV) | Method for test for soils |
| 3. | IS: 3764-1966 | Safety code for excavation work. |
| 4. | IS : 4081-1967 | Safety code for blasting and related drilling operations. |
| 5. | IS : 4668-1967
(Reaffirmed 1978) | Ammonium nitrate for explosive |
| 6. | IS: 4701-1968 | Code of practice for earthwork on canals. |
| 7. | IS : 5441-1969 | Pneumatic portable drilling machine. |
| 8. | IS: 6609
(part-I to V) | Method of test for commercial blasting explosives and accessories. |
| 9. | IS: 7209-1974 | General requirements for blast hole drilling rigs |
| 10. | IS: 7293-1974 | Safety code for working with construction machinery. |
| 11. | IS: 7632-1975 | Detonators |
| 12. | IS: 3696-1966
(Part – I) | Safety code for scaffolds and ladders part 1 Scaffolds. |
| 13. | IS: 3696-1966
(Part – II) | Safety code for scaffolds and ladders - part II Ladders. |

1.3 SETTING OUT WORKS

- (a) In the vicinity of the Canal Distributaries, temporary Branch Marks are established by the, which the contractor shall use as control points, for the entire length of the canal. The contractor shall establish sufficient number of reference Bench Marks for facilitating setting out of works and taking levels for purpose of measurements.
In setting out levels for the canals and structures, the contractor is responsible to check all levels against the Bench Mark at the head of the respective canal, with the precision specified for second order surveys.
- (b) Before starting any work, the contractor shall erect permanent Bench Marks, reference lines and check profiles at convenient locations - approved by the Engineer-in-charge. The Bench Mark shall be 20 cms. X 20cms. X 60 cms. With- 40 cmsw, embedded under firm ground and 20 cms. Projecting above ground. The word B.M. showing value of R.L. shall be conspicuously pointed on the Bench Marks. The reference line shall comprise the base line properly dog belled on the ground with the numbered concrete masonry pillars, suitably spaced.
- (c) The check profiles shall be located 30 meters apart or closer as directed by the Engineer-in-charge so as to ensure execution of all slopes, steps and elevation, to the profile or profiles indicated in the approved drawings. All important levels and all control points with respect to Bench Marks and reference lines shall be fixed and got correlated by the Engineer-in-charge.
- (d) All materials and labour for setting out works including construction of Bench Marks, reference line, check profiles and surveys, as may be required at the various stages of constructions, shall be supplied by the contractor at his cost. The cost of such work shall be deemed to have been included in the costs of the items in the schedule - B.

1.4 PREPARATION OF SITE

1.4.1 CLEARING THE SITE:

- (a) The contractor shall clear the entire area, required for setting out, of all jungle, tree stumps, roots, brush wood, rubbish of all kinds, loose stones and all other objectionable materials. The ownership of the useful materials so removed from clearing site and / or excavation shall rest with the department. Cutting of trees, covered under this item shall not be resorted to without the permission of the Engineer -in-charge. The contractor shall remove all the stumps and roots of trees. The roots of trees shall be: rubbed to a depth of 100 cms. The contractors shall dispose off all such materials as directed by the Engineer-in-charge.
- (b) **Measurement and Payment:** The measurement for payment purpose will be the area over which the jungle has been cleared and the area will be in

square meters. The rate will be per Square meter of the area cleared of **Jungle. No**
separate payment will be made for cutting trees and grubbing of **roots. The unit rate**
for clearing Jungle includes all the above operations.

1.4.2 STRIPPING

Before commencing the excavation for canal, the stripping shall be carried out as specified in Para 2.3 of section - II. Measurement and Payment shall be as mentioned in Para 2.3 of section II.

1.5 RECORDING OF CROSS SECTIONS

- (a) After clearing the site prior to the beginning of excavation, initial cross sections of existing ground shall be taken at every 5 mtrs. interval or closer, depending on the nature of ground, normal to axis of canal upto sufficient distance outside the limits of the work. Levels on these cross sections shall be taken at 5 mtrs. or closer intervals for canal works, while for structure works, they shall be taken at 3 mtrs. or closer intervals as directed by Engineer-in-charge and entered in the field books by the Engineer-in-charge in the presence of the contractor or his authorised agent if he so desires and these shall be binding on the contractor. The contractor or his authorised agent shall sign the field book in token of acceptance. These cross sections shall form the basis of all future measurements and payments. The original cross sections duly signed by the contractor and the Engineer-in-charge shall be preserved.

- (b) No separate payment will be made to the contractor for the labour and materials required for taking the cross sections.

1.6 PLANNING

Prior to the commencement of the work, all relevant data shall be collected by the contractor for planning (i) the excavation, (ii) the disposal of the useful materials of the excavation and (iii) the disposal of the remaining excavated stuff. He shall prepare drawings showing therein the location and quantities of excavation and bank work in different kinds of material and the location of canal structures along with their requirement of rubble, broken stone, filling around foundations etc. based on the data, a scheme for disposal of the excavated materials shall be evolved and shown in the same drawing. If within the reach, there is a surplus of useful excavated material the disposal of the same in separate heaps/stacks for being used in other reaches in the neighborhood may also be thought of and provided for in the scheme. The drawing shall be submitted to the Engineer within 15 days before starting the work and got approved.

1.7 DRILLING AND BLASTING

I. GENERAL

The Blasting operation if required be started only after written approval of the executive Engineer. Blasting where required will be permitted only when proper precautions have been taken for the protection of persons and property in accordance with IS : 4081-1967 (Indian Standard specification for the safety code for blasting and related drilling operations). While carrying out excavation, adequate precautions in accordance with, IS: 3764-1966 (Indian Standard specifications for safety code for excavation work) shall be taken.

II. EXPLOSIVES

It shall be the responsibility of the contractor to procure the explosives required for the work.

III. EXPLOSIVES AND BLASTING

The contractor shall acquaint himself with the applicable laws and regulations concerning acquiring, storing, handling and the use of explosives. All such laws, regulations and rules, as prevalent from time to time shall be binding upon the contractor.

The provisions detailed in the specifications are supplementary to the above laws and regulations and are also applicable except where they conflict with the aforementioned laws, from time to time. Further, the Engineer-in-charge may issue modifications, alterations and new instructions from time to time. The contractor shall comply with the same without these being made a cause for any claims.

IV. MATERIALS

All the materials such as explosives, detonators, fuse coils, tamping materials etc., that are proposed to be used in the blasting operations shall have the prior approval of the Engineer-in-charge. Only explosives of required make and strength are to be used.

Black powder and safe explosive (as commonly current in India) shall be used wherever possible. Explosives with nitro-glycerin shall be used where the above-explosives are not effective.

The use of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. Rate of burning of the fuse shall be uniform and not less than 4 seconds per 25 millimeters of length with 10% tolerance on either side. The fuse known as instantaneous fuse shall not be used.

Before use, the fuse shall be inspected and moist, damaged or broken once discarded. The rate of burning of all new types of fuses or when they have been in stock for long shall be tested before use. The detonators used shall be capable of giving an effective blasting of the explosives.

V. PERSONNEL

Excavation by blasting will be permitted only under the personal supervision of competent and licensed persons and trained workmen employed by the contractor at his cost. All supervisors and workmen in-charge of make up, handling, storage and blasting work shall be adequately insured by the contractor.

The storage shall be in-charge of a very reliable person approved by the Engineer-in-charge, who may, if necessary cause police enquiry being made as to his reliability, antecedent etc. the contractor shall have to produce security for the person-in-charge of the explosives, if and required by the Engineer-in-charge or the civil authorities of the District.

The contractor shall make sure that his supervisor workmen are fully; conversant with all the rules to be observed in storing, handling and use of the explosives'. It shall be assured that the supervisor-in-charge is thoroughly acquainted with all the details of the handling and the blasting operations.

VI. EXPLOSIVES

The location and design of stores for explosives, method of their transport and general precautions to be taken by the contractor to prevent accident shall be in accordance with the provisions of Indian Explosive Act and the regulations and rules framed there under.

The contractor shall provide portable magazine for storing the explosive at work spot. The site of the portable magazine shall be subject to approval by the Engineer-in-charge and the , Inspector of Explosives.

A careful and day to day account of the use of explosives shall be kept by the contractor in register in a manner approved by the Engineer-in-charge. The Engineer-in-charge may also pay surprise visits to the storage magazine. In case of any unaccountable storage of the explosives, or if the account is not found to have been maintained in a manner approved by the Engineer-in- charge, the contractor shall be liable to be panalised in which case, he shall not be entitled to any compensation for the losses etc. The action taken under this clause shall be in addition to that which might be taken by the competent civil authorities in the court of Law.

VII. USE OF EXPLOSIVES

For the transport of the explosives and detonators between the store and the site, closed and strong containers made of soft materials such as timber, zinc, copper, leather shall be used.

Explosives and detonators shall be carried in separate boxes, for the conveyance of primer, special container shall be used.

The boxes and containers used shall be kept closed. Explosive shall be stored and used chronologically to ensure the ones revived earlier being used first. A makeup house shall be provided at each working place in which cartridges will be made up by competent and licensed men as required for the work. The make up house shall be separated from other buildings. Only electric storage lamps will be used in this house.

VIII. DISPOSAL OF DETERIORATED EXPLOSIVES

All deteriorated explosives shall be disposed off in an approved manner; the quantity of deteriorated explosives to be disposed off shall be intimated to the Engineer-in-charge prior to its disposal.

IX. PREPARATION OF PRIMERS

The primers shall not be prepared near open flames or fire. The work of preparation of primers shall always be entrusted to the same personnel. Primers shall be used as early as possible after they are ready.

X. CHARGING OF HOLES

The work of charging of holes shall not commence before all the drilling work at the site is completed and the contractor's supervisor satisfies himself to that effect by actual inspection. While charging open lamps shall be kept away. For charging with powered explosives, naked, flame shall not be-allowed. Only wooden tamping rods without any kind 'of metal on the rod shall be allowed to be used. The tamping rods shall have cylindrical ends. Bore hole must be of such size that the cartridges can easily pass down them; they shall not however be too big.

Only one cartridge snail be inserted at a time and gently pressed into the hole with the tamping rods. The sand clay or other tamping materials used for filling the holes completely shall not be tamped too hard.

XI. BLASTING

Blasting shall be carried out during fixed hours of the day, which shall have the approval of the Engineer-in-charge. The hours once fixed shall not be altered without prior written approval of the Engineer-in-charge. The site of blasting operations shall be prominently demarcated by red danger flags. The order to fire shall be given only by the contractor's supervisor-in-charge of the work and this order shall be given only after giving the warning signal three times, so as to enable all the labour, watchman etc. to reach safe shelters.

A whistle / bugle with distinctive note shall be used to give warning signals. The bugle shall not be used for any other purposes. All the labour shall be made acquainted with the sound of the bugles and shall be strictly warned to leave their work immediately at the first warning signal and to move for safe shelters. They are not to leave the shelters until the all clear signal has been given.

All the roads and footpaths leading to the blasting area shall be watched.

In special cases, suitable extra precautions shall be taken. The Engineer-in-charge may however permit blasting for underground excavation, without restriction of fixed time, provided that he is satisfied that proper precautions are taken to give sufficient warning to all concerned and that the work of other agencies on the site is not hampered. For lighting the fuse, a lamp with a strong name such as carbide lamp shall be used.

The contractor's supervisor shall watch the required time for the firing of the fuses and shall see that all the workmen are under safe shelters in good time.

XII. ELECTRICAL FIRING

Only the contractor's supervisor of in-charge shall possess key of the exploder and short firing accessories and he shall keep it always with himself. Special apparatus shall be used as a source of current for the blasting operations, power lines shall not be tapped for the purpose.

m

The detonators shall be checked before use for blast in series, only detonators of the same manufacture of the same group of electrical resistance shall be used.

Such of the electrical lines as could constitute danger for work of charging shall be removed from the site.

The firing cables shall have a proper insulating cover so as to avoid short circuiting due to contact with water and metallic parts of rock.

The use of the earth as a return line shall not be permitted.

The firing cables shall be connected to source of current only when nobody is in the area of blasting. Before firing, the circuit shall be checked by a suitable apparatus. After firing whether with or without an actual blast the contact between the firing cable and the source of current shall be cut off before anyone is allowed to leave the shelters.

During storms, charging with electrical detonators shall be suspended. The charges already placed in the holes shall be blasted as quickly as possible but taking all the safety precautions, and giving necessary warning signals. If this is not possible the site shall be abandoned till the storm has passed.

XIII. PRECAUTIONS AFTER BLASTING

After the blast, the contractor's supervisor must carefully inspect the work and satisfy himself that all the charges have exploded. After the blast has taken place in underground works, workmen shall not be allowed to go to the place till all the toxic gasses are evacuated from the place.

XIV. MISFIRES

If it is suspected that part of the blast has failed to fire or is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used a safe. Time should be allowed and then the contractor's supervisor alone shall leave the shelter to see.

None of the drillers are to work near this hole until one of the two following operations have been carried out by the supervisor.

Either (i) the supervisor should very carefully (when the tamping is on damp clay) extract the tamping with a wooden scraper or jet of water or compressed air (using pipe of soft materials) and withdraw the fuse with the primer and detonator attached after which a fresh primer and detonator with fuse should be placed in this hole and tamped out or (ii) the hole may be cleared of 300 mm. of capping and the direction then be ascertained by placing stick in the hole. Another hole may be drilled at least 225mm. away and parallel to it. This hole should then be

charged and fired. The balance of the cartridge and detonators found in the muck shall be removed.

Before leaving his work, the contractor's supervisor inform the supervisor of the relieving shift of any case of misfires and should point out the position with red cross denoting the same, also stating what action if any, he has taken in the matter. A register of misfires and their location and how they were dealt with shall be maintained by the contractor.

The contractor's supervisor should also at once report at the contractor's office all cases of misfires, the cause of the same and what steps were taken in connection therewith. The names of the day and night shift supervisors of the contractor must be noted daily in the contractor's office. If misfire has been found to be due to a defective detonator, or dynamite:" the contractor's office for inspection and shall be disposed off.

Drilling in holes not completely exploded by blasting shall not be permitted for underground excavation The contractor should produce the firer's licence and furnish the particulars in the following statement

SI. No:	Name	No. of firer's Licence& Date	Validity period
---------	------	------------------------------	-----------------

XV. SAFETY OF PUBLIC AND PROPERTY

Blasting operation, when considered necessary shall be resorted to only with the written permission of the Engineer-in-charge. Prior inspection shall be carried out for the safety and stability of the public and property. Blasting operations in the proximity of over head power lines, communication lines, utility lines or other structures shall not be carried on until the operator or the owner or both of such lines have been notified and precautionary measures deemed necessary have been taken.

The drilling pattern, the method of blasting, the charge per hole, the finishing order etc., shall also be suitably designed to the satisfaction of the Engineer.

XVI. CONTROLLED BLASTING

(I) THE OBJECTIVES OF CONTROLLED BLASTING TECHNIQUES INCLUDE

- a) Minimization of overbreaks and or fracturing of rock beyond the designed boundary of excavation so as to achieve smooth post blast surface for the canal and a sound foundation for the canal structure.
- b) Control of fly rock and or ground vibration within permissible limits and
- c) To serve both the above purposes.

(2) TECHNIQUES FOR MINIMISING ROCK DAMAGE

The main purpose of controlled blasting is to minimize fracturing and loosening of the rock mass beyond the predetermined excavation line / profile. The objective is normally achieved by minimizing and judicious use of explosives in the blast holes. Several controlled blasting techniques such as line drilling, presplitting, smooth blasting, cushion blasting and buffer blasting are used to achieve the objective.

LINE DRILLING

The line drilling; may be one of the technique used for over break control. In line drilling, a single row of closely spaced, unloaded, small diameter holes is drilled along the neat excavation line. This provides a plane of weakness to which the primary blast can break and to , some extent reflects the shock waves created by the blast, reducing the shattering and stressing in the finished wall. Line drilling is best suited to homogenous formations where bedding planes, joints and seams are at a minimum.

Line drilling has very limited application. The only place where it is applicable is in areas where even in the light explosive loads associated with other controlled blasting techniques may cause damage beyond the excavation limit, or where line drilling is used between loaded holes to promoted shearing and guide the presplit line.

PRESPLITTING

Presplitting involves a single row of holes drilled along the excavation line. Persplit in the rock forms a discontinuous zone, which minimizes or eliminates over break from the subsequent primary blast and produces a smooth, finished rock wall. Presplitting is also used to reduce ground vibration in some critical cases.

SMOOTH BLASTING

Smooth blasting is sometimes referred to as contour blasting, perimeter blasting, or sculpture blasting. This method is widely accepted method for controlling overbreak in canal, underground headings and slopes. In smooth blasting the holes are drilled along the excavation limits, lightly loaded with well distributed charges and fired after the main excavation is removed. By firing instantaneously or with minimum delay between the holes, a shearing action is obtained which gives smooth walls with minimum overbreak.

Smooth blasting, presplitting etc., techniques differ mainly from the line drilling principle in that some or all of the holes are loaded with relatively light, well distributed charges of explosives. The fact that the firing of these charges tends to crack or split the rock between the holes permits wider hole spacings than when line drilling. Consequently drilling costs are reduced and in many cases better control of overbreak is obtained. However in the case of presplitting, it is difficult to determine results until excavation of the primary blast is complete to the finished wall.

CUSHION BLASTING

Cushion blasting is sometimes referred to as trimming, slabbing or slashing, line smooth wall blasting, a single row of holes is drilled along the excavation line, loaded with light, well distributed charges, and fired after the main excavation is removed. In cushion blasting, the charged holes are further decoupled by reducing the diameter or using stemming materials of crushed stone or sand to provide cushioning effect. This cushions shock from the finished wall as the holes are detonated and minimizes the stresses and fractures in the finished wall. This technique is rarely used today because the reduction in decoupling could be achieved by the use of small diameter explosive cartridges, which serves the same purpose. The holes are blasted using the last delay number in the same blasting round preferably with jumping delay of 50 Ms.0

The suitable parameters for controlled blasting for minimizing rock damage shall be established through trial blasts. Usually it needs to establish the optimum hole spacings and the charge per hole. Slopes of the canals are designed and prescribed by the Engineer in accordance with the geology of the rock. The controlled blasting methods shall be such as would enable maintain the prescribed slope .

3) GROUND VIBRATION CONTROL TECHNIQUE

When an explosive charge is detonated inside a blast hole it is instantly converted into hot gases and the expanding gases exert intense pressure on the blasthole walls. A high intensity shock wave travels through the rock mass which attenuates sharply with distance. Simultaneously the rock around the blast hole up to twice the radius of the original hole gets completely crushed. Expanding gases continue to work on the rock, extending the cracks and moving the rock outward and upward. These activities consume a major part of the explosive energy. However a small left over portion passes beyond the zone of intended work in the form of elastic ground vibrations. As seismic waves travel through the rock mass, they generate particle motions which are termed as ground vibrations. The velocity of oscillation of rock particles is called "particle velocity" and its maximum value is called "peak particle velocity (PPV)" Internationally, peak particle velocity is used to express the intensity of ground vibrations from blasting. Damage caused by ground vibration is dependent on the ground velocity and on the frequency of the ground motion. Even though, the use of explosives has unwanted side effect in the form of vibration, explosive provide an inexpensive source of energy for rock excavation in mining and civil engineering projects.

The principal factors that effect vibration level at a given point of interest are the maximum charge per delay, the distance from the blast, the delay period used and the blast geometry.

SAFE LIMITS OF VIBRATION

The permissible peak velocity (mm/s) at the foundation level of structures is as follows:

Type of structures	Dominant Excitation frequency, Hz		
	<8 Hz	8 – 25 Hz	> 25 Hz
(a) Building/structures not belonging to the owner			
(i) Domestic houses / structures (Kutchha, Brick and Cement)	5	10	15
(ii), Industrial Buildings (R.C.C. & framed structures)	10	20	25
(iii) Objects of historical importance & sensitive structures	2	5	10
(b) Buildings belonging to the owner with limited span of life			
(i) Domestic houses / structures (Kutchha, Brick and cement)	10	15	25
(ii) Industrial Buildings (R.C.C. & Framed Structures)	15	25	50

VIBRATION CONTROL PROCEDURES

1. The most common method of controlling ground vibration is by minimizing the charge weight per delay. Delay blasting permits to divide total charge into smaller charges which are detonated in a predetermined sequence at specified intervals. Blasting without delay or sufficient delay numbers increases ground vibrations due to increases in maximum charge per delay.
2. Vibration can be significantly reduced by optimizing blast design parameters. The contractor shall establish optimum burden, hole spacing, powder factor and hook up to control vibration in the vicinity of the existing structures.

(4) FLY ROCK CONTROL TECHNIQUES

The rock fragments ejected from the blast called "flyrock" is a serious hazard of blasting operations, particularly when the blast is conducted in the vicinity of village and structures. The factors which influence the flyrock distance include:

- 1) Height of stemming column In the blast holes and type / quality of stemming materials.
- 2) Irregular shape of free face
- 3) Excessive large burden or blasting without free face
- 4) Muffling of the blast area and the muffling material type
- 5) Scattering and overlapping of delay timings of the delay detonators/relays.
- 6) Presence of water in blastholes.

The first four parameters can' be controlled by properly designing the blasting pattern whereas the last two parameters are not easily controllable.

Flyrock shall be controlled by proper blast design and by muffling / covering. From the experience it is found that unless blast design is proper, muffling will not be effective. Proper blast design and accurate implementation of the blast are the two areas of fundamental concern for controlling the flyrock. The third important parameter is understanding the local geology and adjusting the explosive charge with regard to the geological features.

The reliable and effective method of controlling flyrock fragments from the mouth of the blast holes (vertical flyrock on the rear side) is the height of stemming column. It has been observed that the flyrock, particularly towards the rear side, was effectively controlled by maintaining the height of stemming column in all holes greater than the burden. The height of stemming column should be 1.2 to 1.5 times the true burden in all holes.

A good stemming material should retain bore hole pressure till the burden rock starts to move. Dry angular materials under the effect of the impulsive gas pressure tends to form a compaction arch which locks into the wall of a blast hole, thus increases its resistance to ejection. In general drill cutting is better stemming material as compared to sand and should be preferred except in case of watery holes. In case of watery holes only sand free of clayey materials should be used as stemming material.

If flyrock is originating from the face and flying far distance, it could be an indication that too little burden is used or that mud seams or other geological discontinuity are prevalent. Most flyrock however, is not produced from the face., It is produced from the top.

When the flyrock towards the face side is also to be contained, the blasting should be done using the technique of buffer blasting along with muffling. Buffer blasting is a technique in which a buffer of blasted rock of 4 to 6m thick should be left against the next round of blast.

Muffling or covering of holes including entire area to be blasted is one of the most common method to contain the distance of travel of flying fragments particularly when blasting is done within the danger zone.

In mining blasts, the most common practice is cover the blast using wire mesh of 50 mm x 50 mm to 75 mm x 75 mm. Gunny bags and cartridge empty boxes 4 to 5 numbers are filled with sand or drill cutting and place over the wire mesh. Sometimes the entire area to be blasted is covered by old belt conveyors over the wire net, which was found to be more effective as compared to wire nets alone. Gunny bags filled with sand, free of pebbles, weigh in at least 30 to 40 kg are placed over the belt conveyor, which is placed over the wire nets at an interval of 2 in between and within the rows. This method will contain the vertical fly to a great extent.

Flying fragments is excessive when blasting is done in shallow holes and where bench height or hole depth is less than two times the burden. Therefore for controlling flyrock, the bench height must be greater than two times the true burden and preferable three times the burden. The fly rock is also excessive in watery holes.

The contractor shall establish by trial blasting suitable technique for the control of flyrocks wherever necessary. The technique adopted shall be got approved from the Engineer. For excavation within the danger zone, the prior approval of the blasting methods shall be obtained from the chief Engineer

(5) ALL ITEMS OF ROCK EXCAVATION RATES TO INCLUDE COST OF CONTROLLED BLASTING FOR MINIMISING ROCK DAMAGE.

The contractor shall quote his rates for items of rock excavation in schedule B inclusive of the cost of controlled blasting to minimize rock damages as per the technique described in Para (2) above. The payment for carrying out controlled blasting for minimising the rock damages will not be made separately. The controlled blasting to minimize the rock damages all along the canal in all chainages and in all foundation excavations of structures shall be deemed as part of excavation itself.

(6) PAYMENT FOR CONTROLLED BLASTING TO CONTROL VIBRATION AND FLY ROCK IN CERTAIN SPECIFIED REACHES.

The additional earth work item towards hard rock excavation under controlled blasting(HRCB) to control vibration and fly rocks in the vicinity of the high tension power lines structures and village/town

CONTRACTOR

EXECUTIVE ENGINEER

limits in respect of main canals, large distributaries and foundations . and structures, is provided for in

Schedule B. The chainages of canal and foundations reaches between which HRCB is to be executed shall be mentioned and shown in tender drawings. The contractor shall quote his rates for excavation in hard rock requiring control blasting considering all the necessary controls and precautions to be taken. This item related payment is admissible for excavation in hard rock only. It is not permissible in soft rocks excavated with or without blasting notwithstanding the fact that the control of blasting to control vibration & fly rocks might have been involved.

Even in the chainages specified in schedule B, the controlled blasting to control fly rocks and vibrations shall be taken up only after obtaining prior approval of the Chief Engineer.

CLASSIFICATION OF EXCAVATED MATERIALS.

1.8.1 CLASSIFICATION

All materials of excavation shall be classified by the Engineer-in-charge in the following groups.

(a) SOIL

This shall include the following:

- I. Ordinary soils, viz. vegetable or organic soil, turf, sand, silt, loam clay, mud, peat, black cotton soil, soft shale, loose murrum, a mixture of all these and similar materials which yield to the ordinary application of pick and shovel rake or other ordinary digging "implement. Removal of gravel or any other nodular material having diameter in anyone direction not exceeding 75 mm. occurring in such strata shall be deemed to be covered under this category.
- II. Hard soils viz. stiff / heavy clay, soft shale, or compact murrum requiring grafting tool or pick or both shovel, closely applied.
- III. Gravel, cobble stone, soft laterite, kanker and boulders having maximum diameter in anyone direction up to 520 mm.
- IV. Soft conglomerate, where in stones may be detached from the matrix with picks;
- V. Soling of roads, water bound macadam layers, asphalted roads.
- VI. Lime concrete and stone masonry in lime mortar or in lean cement mortar.
- VII. Marshy soil excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing of water.
- VIII. Generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than any item mentioned in (I) to (VII) above.

(b) **SOFT ROCK WITH OR WITHOUT BLASTING**

This shall include

- i) Highly disintegrated granite, trap or limestone where the rock material is completely disintegrated except for a few unweathered rock fragments.
- ii) Sand stone, hard laterite, laminated limestone, heavily jointed trap, breccia,; red bole, hard shale, hard conglomerate and moderately to highly weathered granite.
- iii) Closely jointed fissured and fractured hard rocks
- iv) Unreinforced cement concrete beds of lean proportions up to and including C.C. 1: 3: 6 and stone masonry in C. M. 1: 3 or of richer mix laying below ground level.
- v) Generally any material or combination of materials which requires excavating efforts similar to excavation of items (i) to (iv) above.
- vi) Soft rocks are of such hardness that they can not be excavated by picks and hand shovels. They may be either (a) quarried or split with crow bars, or (b) excavated by drilling and blasting, depending upon jointing pattern, the degree of weathering and moisture content.

(c) HARDROCK WITH BLASTING / CONTROLLED BLASTING

This shall include

- i) Massive and sheet rock formations of lime stone, granite, quartzite, trap, dolerite and pegmatite.
- ii) slightly weathered to fresh hard rock formation of solid- rock of trap, lime stone, granite and quartzite & dolerite pegmatite, gneiss and any other hard rock formation.
- iii) The hard rock boulders of size more than 520mm (0.14 cum) requiring blasting for removal surrounded by sand or by soft material.
- iv) C. C. of 1 : 2 : 4 proportion or of richer proportion and R. C. C.
- v) Any material requiring excavating efforts similar to items i) to iv) above

1.8.2 Under the hard rock, there may be one more classification for the purpose of measurements and payments, when the schedule - B provides for an item of payment for controlled blasting to control fly rock and vibrations vide para 1.7 (xvi) above.

1.8.3 AUTHORITY FOR CLASSIFICATIONS

The classification of excavation shall be decided by the Engineer-in-charge 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-in-charge.

The excavated materials from hard rock shall be stacked on the site as directed by the Engineer-in-charge for facilitating measurements. The stacks shall be measured and 40% deducted for voids. The quantity arrived at by section measurement shall be verified with the quantities of stacks.

1.9 EXCAVATION FOR CANAL

1.9.1 GENERAL

(a) Excavation for canals in rock shall be to the underside of the lining shown on the drawings. Excavation for canals in materials other than rock shall be left 200mm. above the underside of the concrete lining until immediately before placing the concrete lining. Before

placing the concrete lining the sub-grade shall be wetted if necessary and compacted at optimum moisture content and carefully excavated to the underside of the grade M 15 concrete lining. The employer reserves the right, during the progress of the work, to vary slopes of excavation and the dimensions dependent thereon.

(b) Blasting shall be done in such a manner so as not to, cause over breakage which in the opinion of the Engineer-in-charge is excessive. Special care shall be, taken to prevent overbreakage or loosening of material on bottom and side slopes against which concrete lining is to be placed. To achieve this techniques for minimising rock damage as specified in para 1.-7 (xvi) shall be followed for the sides and bed of canal. The smooth blasting shall be such that on the finished surface at least 50% of the drill hole surfaces could be seen. If satisfactory rock surface is not obtained through controlled blasting the final cutting may be by chiseling or with the help of pavement breakers. All these operations shall be carried out at contractor's cost without any claim for separate payment.

If excavation is required to be done within 50 meters from existing transmission / power lines or 300meters from village limits and if it is not considered expedient by the to shift the power lines or the village to safer distances or otherwise extend' protection, the excavation shall be carried out with extra care to control vibrations and fly rocks as specified in paras 1.7. xvi(3) and 1.7 xvi(4) and the payment are regulated as in para 1.7xvi(6).

(c) Except the areas of rock, all areas to be excavated for canal sections shall be prewetted so that at the time of excavation moisture content shall be about optimum. However, in case the excavated materials from canal are not to be used for embankment, such prewetting need not be done.

(d) The contractor shall not be entitled to any additional rate above the rates quoted in schedule-B on account of the requirement for allowing additional time for drying, stockpiling and rehandling the

CONTRACTOR

EXECUTIVE ENGINEER

excavated material which have been deposited temporarily and stock-piled for re-use.

1.9.2 CONVEYANCE AND DISPOSAL OF EXCAVATED MATERIALS

The usable excavated material available from the canal excavation shall be used in the appropriate zone of the canal embankment by conveying the same with all leads-and lifts. Lead charges for 50 mtrs., are included in the excavation items and the additional lead charges, if any, shall be included in the respective items of embankment. If usable excavation material is in excess of the requirements of banking the same shall be used for the construction of approaches to the road bridges and for selected bedding materials and backfill around structures for which payment will be made at the rates entered in schedule-B, remaining material from the excavation shall be used to strengthen the embankment on either side of canal, or deposited in low areas on either side of canal to backfill borrow pits or spread in other approved location as directed by the Engineer-in-charge. Usable rubble available from hard rock excavation shall be sorted out and arranged in separate regular stacks without any extra charges as and where directed by the Engineer-in-charge. The balance excavated stuff will be deposited in spoil banks. The spoil banks shall not be constructed continuous. A gap of 10 mtrs., shall be provided at 150 mtrs interval. Spoil banks shall not be allowed within 30 mtrs., on either side of the structure on both the banks of canal unless otherwise directed by the Engineer-in-charge.

1.9.3 DEWATERING CANAL TRENCHES AND EXCAVATION UNDER WET CONDITIONS

Water encountered in canal excavation shall be diverted to nearby drain and nalas by cutting an open channel within the canal section to be excavated. When the drain / nala bed is higher than the encountered water level this water shall be evacuated into the nala by pumping and no separate payment will be made for dewatering by pumping. No distinction shall be made in payment whether the material being excavated is dry, moist or wet. Removal of accumulated silt, slush and dewatering shall be done by the contractor, without any extra cost till the work is finally handed over to the or till the expiry of the contract period, whichever is earlier.

1.9.4 OVEREXCAVATION

Over excavation caused by the contractor beyond the limits shown in the drawings for any purpose or reason, except as directed by the Engineer-in-charge shall not be measured and paid for. The over excavation shall be rectified at the expense of the contractor by filling and compacting with suitable soil in the case of excavation in soils. The over excavation in rock of canal bed and side slopes shall be back filled with cement concrete 1:5:10, if the over excavation is within 15 cms and with U.C.R. masonry in C.M. 1:5 proportion, if the over excavation is more than 15 cms. The over excavations in case of canal embankment should be filled with respective materials excavated and should be compacted. The cost of back filling the over excavation will be considered as included in the rate quoted for excavation items and no separate payment will be made for this.

1.9.5 TOLERANCE IN ALIGNMENT AND GRADE

Departure from established alignment:	+ 20 mm on straight section.
	± 50mm on tangents.
	± 100 mm on curves.
Departure from established grade	± 20 mm

1.9.6 PAY LINE

(a) Pay line is the limit of excavation as required by design without any allowances for over breaks. The canal shall be excavated as indicated all drawing or as directed by the Engineer-in-charge excavation.

(b) In case of changes in canal section and side slopes, the contractor shall carry out work at the rates quoted for the item without claiming any extra rate because of these changes. Modifications in the slopes prescribed will however, be intimated to the contractor in writing by the Engineer-in-charge.

1.9.7 MEASUREMENT AND PAYMENT

The-payment will be made on volumetric basis for the quantities excavated to the required extent before commencement of excavation. The cross sections shall be taken and plotted. On this cross sections the section of the excavation as approved shall be plotted. As excavation progress at the time of preparation of each RA bill, the measurement taken shall be plotted on the cross section. Quantities of excavation for the purpose for payment shall be limited to approved cross section. On the completion of the excavation, measurement shall be taken of the excavation done and plotted on the cross section. The payment shall be limited to the quantities worked out based on the approved section of excavation. In this cross sections, classifications of STRATA as - I actually done for the purpose of measurements shall be shown marked in different colors. The quantities of excavation done beyond the approved section shall be treated as over excavation and dealt with accordingly. The payment shall be made for the quantities of excavation limiting to approved section and as for quoted rates in schedule B. The rates for excavation of canal is inclusive of dewatering and desilting the canal section during excavation till the final profile is excavated. The rate for excavation includes the conveyance and deposition of excavated materials for use in the works and / or for disposal in spoil banks and where so directed, placing the materials for bank work in layers of specified thickness within leads upto 100 mtrs. and all lifts, ... and all incidental charges. It also includes cost of backfilling over excavation if any. The payment for excavation will not be made in full until over excavation are satisfactorily backfilled.

1.10 EXCAVATION FOR STRUCTURES

1.10.1 GENERAL

(a) The foundation levels shown on the plans accompanying the tenders or in the detailed drawings furnished at the commencement of work are tentative and the actual levels will be decided by the Engineer-in-charge on the basis of actual site conditions revealed after opening of the foundation.

(b) Blasting shall be done in such a manner as not to cause over breakage which in the opinion of the Engineer-in-charge is excessive. Special care shall be taken to prevent over breakage or loosening of material on bottom and side slopes against which concrete is to be placed. To achieve this technique for minimising rock damages as specified in Para 1.7.xvi (2) shall be followed on the sides and if found necessary the final cutting in foundation bed shall be carried out by chiseling or with the help of pneumatic pavement breakers for which no extra rate will be payable.

(c). for excavation of hard rock under control blasting (HRCB) to control vibration and fly rock while blasting in the vicinity of high tension power line and village / town limits the procedure detailed under Para 1.7(6) holds good for this case also

(d) The quantities to be paid will be to the dimensions shown on the drawings or instructed in writing by the Engineer-in-charge.

(e) **The** recommended side slopes for pay lines are considered safe without shoring and strutting. However, if necessary arises the contractor shall provide shoring and strutting without extra costs.

(f) Whenever water is met with during excavation for structures, dewatering shall be resorted to by the contractor. The rate for the excavation for structures includes the cost of dewatering and desilting. No extra claim for dewatering and desilting will be entertained.

(g) Usable material removed from the excavation for structures shall be used for backfill and embankment, otherwise it shall be disposed of as directed by the Engineer-in-charge.

1.10.2 OVER EXCAVATION

(a) Over excavation performed by the contractor beyond the limits shown on the drawings for any purpose or reason, except as directed by the Engineer-in-charge shall not be measured. The over excavation in the bed shall be rectified at the expense of the contractor by filling back with same grade of concrete as that specified for leveling course: In the case of over " excavation of the sides, the same shall be filled back with suitable soil at the expense of contractor to the same specification as that for the item of back filling in foundation trenches.

1.10.3 PAY LINE

(a) Regardless of whether the excavation for construction of any structure preceeds or follows the excavation of the canal at the site of structure, measurement for excavation for structures shall include only the required excavation outside the pay lines for the canal excavations and below the original ground surface, measured to the dimensions and slopes specified below:

SI. No.	Strata of Excavation	Slope for pay line
1.	Soil, murrum	1 to 1
2.	Soft rock	0.5 to 1
3.	Hard rock	0.25 to 1

(b) The pay line for excavations of foundations of structures, shall be determined from" the bottom edge of the foundations based on the slopes given in sub" para (a) above. alternatively, steeper slopes can be retained by providing shoring and strutting for which no separate payment will be made. In all cases payment will be regulated for the slopes as mentioned in the sub-para (a) above.

1.10.4 MEASUREMENT AND PAYMENT

(a) Excavation ordered by the Engineer will be paid for at the appropriate rates quoted by the contractor in the schedule-B.

(b) The quantity of excavation shall be computed from the initial and final cross section of excavation except that when shoring and strutting are resorted with steeper side slopes than given in para 1.1 0.3(a), the payment will be regulated as if this excavation is done to the pay line. slopes given in that Para. The rates include providing all the materials, tools, plants and labour required for pre-splitting and resorting to controlled blasting technique for hard rock excavation.

(c) **The** rates for excavation include all excavation clearing of site, all leads and all lifts, disposal of excavated stuff /material as per the, specifications, providing an tools, plants, machinery, material, preparation and maintenance of haul roads, transport material to temporary stockpiles, rehandling of excavated material temporary deposited in stockpiles to disposal areas or points of final use, disposal of excavated waste materials, maintaining excavated slopes and trenches including dewatering and desilting, diverting surfaces flows etc., the cost of sorting and stacking useful excavated material above high flood levels and an incidental operations required for carrying out the work in accordance with the specifications.

The rate shall also include cost of controlled blasting to minimize rock damages and obtain sound foundation and to control vibration and fly rock except-that in certain specified reaches of canal vide para 1.7 xvi(6) and payment towards control of vibrations and flyrock would be paid at the rate quoted for the reach in schedule - B. –

1.11 SLIPS

Slips shall be avoided but if any slip occurs in account of nature of soil or due to failure of slopes in the opinion of the Engineer-in-charge, extra excavation shall be done as directed by the Engineer-in-charge to restore stability. In such case payment for necessary excavation and back filling will be made for this extra work under relevant items.

1.12 MONSOON DAMAGE

Damages due to rain or flood either in cutting or in banks shall be repaired by the 'contractor till the final section is handed over to the responsibility of desilting and repairing damages due to rain or flood rests with the contractor. No extra cost is payable for such operation and the contractor shall take the necessary precautions to protect the work done during the construction and prescribed maintenance period.

SECTION – II

2.0 EMBANKMENT

2.1 SCOPE OF WORK

The work to be done under these specification consists of all canal embankments, rockfill embankments, CNS layers backfilling of cut-off trench, earth work for approaches to the road bridges, dyke embankment for nalas/drains, back filling around the canal structures rock toe and filters of different type and sizes. The contractor shall furnish all materials, tools and plants, labour and execute the work satisfactorily.

2.2 INDIAN STANDARDS FOR REFERENCE

- | | | |
|-----|--|--|
| 1. | IS : 1888-1971 | Method of load test on soils. |
| 2. | IS : 2131-1963 | Method for standard penetration test for soils . |
| 3. | IS : 2809-1972 | Glossary of terms and symbols relating to soil Engineering. |
| 4. | IS :4332-1967
(Part-I) (reaffirmed
1978) | Method of sampling and preparation of
stabilized soils for testing |
| 5. | IS : 4558-1983 | Code of practice for under-drainage of lined canals |
| 6. | IS : 5529-1969 | Method of test for in-situ permeability test,
code of practice for Part-I is over burden. |
| 7. | IS : 7894-1975 | Code of practice for stability analysis of earthen dams |
| 8. | IS : 8237-1976 | Code of practice for protection of slope for reservoir
embankments. |
| 9. | IS : 8419-1977 | Guidelines for design of under seepage control
measures for earth and rock fill dams. |
| 10. | IS : 8419-1977 | Filtration media – sand and gravel. (Part I) |
| 11. | IS: 8826-1978 | Guidelines for design of large earth and rock fill
dams. |

In addition to the above, Indian Standards mentioned under para 1.2 of section -I may also be referred to, where relevant. --

2.3 STRIPPING

2.3.1 GENERAL

Before the embankment works commence, the base shall be stripped of unsuitable surface soil, including all vegetation, grass, organic matter, bushes, roots and other unsuitable matter and shall dispose off the same as directed with. a lead. and all lifts. Similar operations shall be done in the borrow areas and in such cutting reaches of canal which yield useful embankment materials. Stripping shall be done as per IS code 4701 -1982 or its latest version. (as per IS the depth for stripping for soil containing light grass cover is 5 to 7.5 Cm and for agricultural land 15 to 22.5 Cm.

2.3.2 RECORDING OF CROSS SECTION

(a) After clearing the site for embankment and prior to stripping the natural ground surface cross sections shall be surveyed (as described in para .1.5)

(b) After stripping is completed, the initial cross section shall be taken as described in Para 1.5. The natural ground surface cross sections and initial cross sections shall form the basis for arriving at the quantities of excavation for stripping.

2.3.3 MEASUREMENT AND PAYMENT FOR THE SEAT OF EMBANKMENT.

The payment will be done on the basis of the volume of excavation involved in stripping at the contract price quoted in scheduled-B which includes cost of all labour, implements and plants and all incidental expenses involved in the work. No payment shall be made for the stripping of borrow areas. .

CONTRACTOR

EXECUTIVE ENGINEER

2.4 PREPARATION OF FOUNDATION UNDER EMBANKMENT

(a) No materials shall be placed for the earth fill of the embankment-until the foundation of the embankment has been dewatered, suitably prepared and approved by the Engineer-in. charge. All portions of excavation made for test pits or other sub-surface investigations and any existing cavities below-the foundations of the embankment shall be filled with soil of same quality as specified for the earth fill and suitably compacted.

(b) Pools of water shall not be permitted in the foundation of the embankment and any water shall be drained off and cleared prior to placing the first layer of embankment materials.

(c) SOIL FOUNDATION

Soil foundations of the embankment shall be scarified and loosened by means of a plough, ripper or any other means to depth' of about 15 cms to 20 cms to the satisfaction of the Engineering-charge. Roots or other debris turned up during scarifying shall be removed from the foundation area which thereafter shall be moistened to slightly above the optimum moisture content of the foundation soil and shall be compacted by the compaction equipment to the same degree of compaction as that of the embankment. The purpose of using higher moisture than optimum is to ensure forcing of the soil into any soft zones existing below the surface. The first four layers of the fill for the embankment shall be 10 cms. to 15 cms thick and shall be carefully placed and uniformly compacted to form satisfactory bond between the foundation and the fill. These layers in the hearting zone should be composed of most impervious materials. Sheep foot roller shall preferably be used for the compaction of impervious soil and vibratory type rollers for compaction of pervious and semi pervious soils and rock.

(d) ROCK FOUNDATION

i. The treatment of the rock surface under the embankment shall be so done as to ensure a tight bond between embankment and the foundation. This shall be attained by the following procedure.

ii. The area of the rock surface which is to be in contact with the embankment shall be fully exposed by removing all the loose and disintegrated rock leaving a rugged rock surface. Hard rock projections and overhang shall be knocked off and removed. If blasting is to be restored to care shall be taken to avoid objectionable shocks to foundation rock. As far as possible the whole contact area shall be exposed at one time to enable examination of the surface characteristics of the rock and for planning the method of treatment.

iii. If the foundation rock is fairly impervious but has a highly rugged surface, it shall be treated by laying embankment material in 10 cms thick layers at a moisture content slightly above the O.M.C. and compacted with mechanical equipment / pneumatic tampers to ensure that all irregular depressions in the rock surface are filled with soil to create an effective and complete bond.

(e) SAND FOUNDATION

Sand encountered in foundation shall be tested for its natural relative density. It shall be compacted by any approved methods to obtain a minimum relative density of 70% before the filling commences

(f) PAYMENT

No separate payment will be made for the preparation of the foundation under embankment as cost of this operation is deemed to have been included in the respective embankment items.

2.4.1 BACK FILLING OF CUT-OFF TRENCHES

(a) The cut-off trench shall be backfilled with same kind of materials and in same manner, as the earthfill of the impervious core of the canal embankment. Each layer of the fill shall be continuous and approximately horizontal layer of specified thickness and compacted under optimum moisture content to the specified degree of compaction.

(b) During placing and compaction of impervious materials in the cut-off trench where dewatering is involved, the sub-soil water level at every point in the cut-off trench shall be maintained below the

bottom of the earthfill until the compacted fill in the cut-off trench at that point has reached a height of 3 mtrs.; after which the water level shall be maintained at least 1.5 mtrs., below the top of compacted fill.

2.5 BORROW AREAS

2.5.1 GENERAL

(a) All materials required for the construction of impervious or pervious zones of embankment and back fill for cut-off trench and structures which are not available from canal excavation, excavation for structure or from excavation of other ancillary works, shall be obtained from the designated borrow areas or as designated by the Engineer-in-charge in consultation with field laboratory. The depth of cut in all borrow areas shall be designated by the Engineer-in-charge and the cut shall be made to such designated depth only. Each designated borrow area shall be fully exploited before switching over to the next designated borrow area. Haphazard exploitation shall not be permitted. The type of equipment used and the operations in the excavation of materials and borrow area's shall be such as to produce the required uniformity of the mixture of materials for the embankment/CNS layer.

2.5.2 STRIPPING OF BORROW AREAS

(a) Borrow areas shall be stripped of topsoil and any other objectionable materials to the required depth. Stripping operations shall be limited only to designated borrow areas. Materials from stripping shall be disposed of in the exhausted borrow areas or in the approved adjacent areas.

(b) Stripping of borrow area shall not be measured and paid for separately. The cost of stripping is to be included in the unit rate for the respective embankment/CNS layer item in schedule B.

2.5.3 BORROW AREA WATERING

(a) Borrow areas watering shall be done by the contractor wherever necessary and in the manner specified by the Engineer-in-charge.

(b) The initial moisture content of the material in the borrow areas shall be estimated, with the help of laboratory test. The optimum moisture content for the material in the particular borrow areas shall be determined by field tests. The additional moisture requirements if any shall be introduced into the borrow areas by watering well in advance of the excavation to ensure uniformity of moisture content. All care shall be taken to reduce excessive moisture in any of the locations of a borrow area before or during excavation to secure the materials with moisture contents close to the optimum to avoid formation of pools in the borrow areas during excavation operation. Drainage ditches from borrow areas to suitable outlets shall be excavated, wherever necessary. On exhausting all useful materials or abandoning borrow areas the pits shall be fully drained to ensure no ponding of water.

2.6 EMBANKMENT

2.6.1 GENERAL

The embankment may comprise of different zones viz.

- (i) Impervious zone of earth fill of controlled compaction at controlled moisture content.
- (ii) Semipervious/pervious earth fill of controlled compaction at controlled moisture content, and (iii) All in fill of controlled compaction at random Moisture content.

2.6.2 EARTH FILL

1. Bushes' roots, sods or other organic or unsuitable materials shall not be placed in the embankment. The suitability of each part of the foundation for placing embankment materials thereon and of all materials for use in embankment construction will be determined by the Engineer-in-charge on the basis of field laboratory tests. As far as possible levels of embankment along with the cross-section shall be the same. Any difference in levels between zones if unavoidable shall not exceed the thickness of one layer. Placing of the layers for the embankment portion programmed for construction in the season shall be continuous and approximately horizontal.

2. Placement of fill within the zones as shown on the drawings shall be performed in an orderly sequence and in an efficient and workmanlike manner.

3. **Chemical** and physical tests of the soil in the embankment shall be carried out by the quality control organization of the to ensure that the soil does not contain soluble lime, soluble salts or cohesionless fines and unsound materials in quantities harmful to the embankments. Useful materials

from canal excavation and excavation of structures and from borrow areas shall be classified. transported and placed in the specified zones of embankment as directed by the Engineer-in-charge.

4. Normally, the contractor shall utilize not less than 80% of suitable excavated material from the canal and structures to construct embankment, whenever such utilization is economical in the opinion of the Engineer by conveying from the spoil heaps with all leads and lifts as mentioned in schedule B and he will not be authorized to obtain material from borrow areas until he does so. The balance of soils shall be obtained from borrow areas approved by the Engineer-in-charge. If the contractor fails to utilize atleast 80% of the usable excavated materials from the: canal and structures and obtains instead material from the borrow area, payment for this material shall be made as if obtained from canal excavation within the leads mentioned in Schedule -B. The decision of Engineer about the usability of soils available from r the canal excavation is final and binding upon the contractor.

5. Embankment materials shall be spread in successive horizontal layers extending to full width of the embankment plus 45 cms on either side to facilitate satisfactory compaction in the full designed width. No payment shall be made for placing the additional 45 cms. widths or for their subsequent removal. No addition shall be allowed to the slopes of the bank after the bank is raised. Trimming of inside slopes to final dimensions, lines and grades shall precede the lining work. This shall be done not more than two days prior to lining.

6. Thickness of embankment layers may be adjusted by the Engineer-in-charge if the contractor by carrying out trial compaction and requisite tests satisfies the that the type of compactors used by him provide required density. The thickness of loose layers in embankment shall be normally as under:

Sl No.	Type of Compaction Machine	Weight	Thickness of Loose layer
1	1.5 MtrsDia drum sheep foot rollers	6000 kgs/ running mtrs	25 cms. To 30 cms
2	1 Mts. Dia drum sheep foot rollers	3000 kgs/running mtrs.	20 cms to 22 cms.
3	Pneumatic Tamper	-----	7.5 cms to 10 cms.
4	D.R.R.	10,000 kgs	20 cms to 25 cms.
5	Vibratory roller	-----	30 cms to 45 cms.

7. No embankment layer shall be laid until the previous layer is properly watered, compacted .and tested as per requirement. The work of spreading and compaction shall be so adjusted as not to interfere with each other and in such a way that neither of the operations is held up because of non-completion of the rolling and watering. If the work is held up due to failure of machinery, no claim whatsoever will be entertained even in case of machinery is supplied by the department. The surface of embankments shall at all time of construction be maintained true to required cross section.

8. **The** distribution of materials in each layer shall be such that the compacted materials will be homogeneous and free from lenses, pockets or other imperfections. The excavating and placing operations shall be such that the materials when compacted will be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability.

9. The material of the earth fill zones of controlled -compaction and moisture content shall be compacted to a density as specified on the -drawings but not less than 96% of the standard proctor density.

10. In the above zones, no lumps or stone or pebbles having larger dimension than 7.5 cms in impervious core and 13 cms. in pervious / semipervious zones shall be permitted. The total percentage of lumps or stones or pebbles of permissible size shall not exceed 5% in the case of impervious core and 15% elsewhere. The percentage is in respect of every 3 cubic metre of batch material conveyed to the site of placement.

11. The homogeneous section for canal embankment shall be provided in the reaches where design requirements are met with without hearting. The soil for the embankment shall . generally be in accordance with recommendations contained in IS : 8826-1978 (para 8). The available coarser and more pervious material shall be placed near the outer slopes in order to have increasing permeability from inner

to outer side.

12. The impervious hearting zone wherever shown in the drawings shall be constructed of material having required percentage of clay so that it can be compacted at optimum moisture content by suitable compacting equipment to achieve not less than 96% of the standard Proctor density. Water tightness of material shall be checked by carrying out permeability tests both at the site and laboratory. Permeability of impervious - materials' shall not be greater than 30 cms/year.

13. The casing zone shall consist of material which provides support to impervious core under various conditions of saturation and draw down. The distribution of material shall be such that the compacted material shall be homogeneous, free from cracks, pockets or other imperfections. The excavating and placing operations shall be such that the material when compacted shall be blended sufficiently to secure the best practicable degree of compaction, impermeability and stability. The casing material should normally have a standard Proctor density not less than 1.75 gms/cc.

14. All suitable material with dry density greater than 1.35 gms/cc. Shall be used in all-in-fill Zone. Suitable sub-zones shall be formed within the all-in-fill if so directed by the Engineer-in-charge, by depositing materials of different type, texture and particle size in different sub-zones. In general, fragments of smaller size shall be deposited towards the inner slope and larger fragments towards the outer slope of an-in fill. Formation of service roads and inspection paths in reaches of full cutting will be treated as all in-fill and will be paid for accordingly.

15. The top surface of the bank shall be leveled with a gradient of 1 to 80 away from the inner edge to facilitate proper drainage. The canal embankment shall be constructed to the top width and height equal to designed height shown on the drawing, plus 2.5% of the designed height to allow for settlement. The embankment width, at various levels should be regulated accordingly. However, the bottom width of embankment shall as shown on the drawing or as directed by the Engineer-in-charge.

16. For proper bond between embankment placed in a previous season with the current embankment, work shall be carried out and finished as under:

i. Where an existing embankment is to be extended horizontally it shall be cut to a slope not steeper than 1 in 3 and the surface so prepared shall be scarified-loosened atleast to a depth of 15 cms and wetted. Following, the embankment material shall be laid in layer and compacted to the required degree of compaction.

ii. If the old bank is to be raised vertically, vegetation shall be cleared followed by scarifying, and watering and placing of the new earth layer as specified above. Raising shall be done after the bottom layer is tested. No extra payment will be made in this regard for the operations of clearing, scarifying and watering etc.

iii. The surfaces which are damaged due to rain shall be repaired by filling with proper material duly compacted by tampers.

17. The finished fill shall be free from lenses, pockets, streak of layers of materials differing substantially in texture or gradation from the surrounding materials. Successive loads of the materials shall be dumped on the earthfil so as to produce best practicable distribution of the materials subject to the approval of the Engineer-in-charge.

2.6.3 MOISTURE CONTROL

i. Prior to and during compacting operations the material in each layer of earthfill zones of controlled compaction and moisture content shall have optimum moisture content. The permissible variation in the OMC is ± 3 .

ii. As far as possible, the material excavated from the borrow area shall have adequate moisture content. If additional moisture is required, it shall be added 'preferably at the borrow area and

only to a limited extent, if required, on the embankment by sprinkling water before placement. If moisture content is more than required, the material shall be allowed to dry before compaction. The moisture content shall be uniform throughout the layer of material for which plough, disc harrowing or other methods of mixing shall be applied. If the moisture content is more than the required moisture content specified above or if it is not uniformly distributed throughout the layer, rolling shall be stopped and shall be started again only when the above conditions are satisfied.

2.6.4 COMPACTION

i. Material shall be placed in layers of specified thickness as shown in the table under para 2.6.2(6). the proper moisture content where prescribed shall be uniformly distributed through out the material, before it is compacted. Compaction shall be done in strips overlapping not less then 0.30 mtr. The compacting equipment shall travel in a direction parallel to the axis of the canal. Turns shall be made carefully to ensure uniform compaction. Each layer of soil placed in the bank as specified above shall be compacted with 8 to 10 tonnes power rollers or suitable crawler tractor drawn, heavy sheep foot rollers. The compaction shall have to be uniform over the full width of the bank. The roller shall be made to travel over the entire designed width of each layer so that the soil is uniformly compacted to the required degree and it leaves no visible marks on the surface. Where flat roller are used, the surface of each layer of compacted materials shall be roughened with a harrow or thoroughly furrowed/pick-marked as directed before depositing the succeeding layer of materials and care shall be exercised to avoid the occurrence of horizontal seams.

ii. In those parts of the structure which are inaccessible to the specified rolling equipments, or around and in contact with structures and in proximity to structures, where the rolling equipment is not permitted to operate, compaction shall be accomplished by mechanical or pneumatic rammers of approved type as directed. Rollers shall not be permitted to operate within 0.60 metre of concrete or masonry structures and the earth fill within this distance shall be tamped by mechanical or pneumatic rammers. All materials to be so tamped shall be spread in layers. 7.5cms to 10 cms. thick when loose and the moisture content of the material and the amount of tamping shall be such as to produce a degree of compaction equal to the specified degree of compaction for rolled fill portion. Special care shall be exercised to obtain good contact and bond with surface of concrete or masonry structures.

iii. Where canal embankment covers barrels of cross drainage structure first 45 cms. of the embankment shall be compacted with pneumatic hand tampers in loose layers 7.5 cms. to 10 cms. thick. Further fill shall be compacted by using suitable light rollers to avoid damage to the structures, by adjusting the thickness of layers until sufficient height is achieved to permit compaction by heavy rollers. Density test shall be conducted from time to time on site to ascertain whether the compaction is attained as specified above. Separate tests shall be conducted for each layer of hearting and casing zone of embankment at least one field density test shall be taken in each zone for every 30 mtrs. or less of compacted earth work. A minimum of three density tests one is hearting one in inner casing and one on outer casing shall be taken per day. In case the specified densities are not attained, suitable measures shall be taken by the contractor either by moisture correction or by removal and relaying of layer or by additional rolling so as to obtain the specified density which shall be checked again at the same locations. In addition, tests shall also be carried out at the limits of the embankment and adjacent to filters at the discretion of the Engineer-in-charge. Necessary unskilled labour required for collection of samples shall be provided by the contractor at his cost. However, testing charges shall be borne by the department.

iv. At least three standard proctor tests shall be carried out at regular intervals for the material to be used to account for variation in the borrow area material as well as excavated material. Wherever material from different sources are used for embankment i.e. material from borrow areas or from excavation, atleast three tests shall be carried out to determine standard proctor density of each material.

v. The might review the design if necessary on examination of density and other test results and the contractor shall have no claim arising out of such a review and consequent change if any in the design.

vi. Where compaction of cohesionless free draining materials such as gravel is required, the

materials shall be deposited in horizontal layers and compacted to the specified relative density. The excavating and placing, operations shall be such that the material, when compacted, shall be blended sufficiently to secure the highest practicable unit weight and best stability. Water shall be added to the materials as may be required to obtain the specified density by method of compaction being used.

2.6.5 COMPACTION OF ALL-IN FILL

The all-in-fill zone of the bank wherever shown in the drawings or instructed to provide, shall be formed in layers, of uniform thickness and for the full width of zone. The thickness of loose layer shall not be more than that given in the table in para 7 in clause 2.6.2. When construction of controlled earth fill zone proceeds the formation of the all-in fill zone, the slope of the earth till zone at the junction shall be stepped if so directed to ensure proper bonding between the two zones. All clods and lumps of soil shall be broken to a size not exceeding 7.5 cms. The finer of the materials available shall be deposited on the inner side and the coarser materials towards the outside of the embankment. Each layer shall be well compacted by the flat rollers, sheep foot roller vibratory rollers, crawler tractor or by combination of any of the above as is best suited to the type of the fill material, as directed. The minimum relative density of the compacted material shall not be less than 70% of the dry density as determined in laboratory tests in the case of cohesion less materials. In the case of cohesive materials, the degree of compaction should not be less than 96% of the proctor's density. A minimum number of passes of the compacting equipment would be prescribed and followed to obtain optimum compaction.

2.6.6 LAYING AND COMPACTING COHESIVE NON-SWELLING MATERIAL

i. Where the canal is excavated through soils, a layer of cohesive non-swelling (CNS) material shall be placed between the expansive soil and the concrete lining in accordance with paragraph 5.2 of IS : 9451 -1985. The CNS material shall have the following properties:

- Gradation

Clay (less than 2 micron)	15 to 20%
Silt (0.06 mm.- 0.002 mm.)	30 to 40 %
Sand (2mm.-0.06.)	30 to 40 %
Gravel (Greater than 2 mm.)	0 to 10%

- Index properties

Liquid limit	-	less than 55% but greater than 30%
- Plasticity Index	-	less than 30% but greater than 15%

ii. If the CNS material does not conform to above properties, it should be suitably blended with suitable soils to achieve the properties as directed by the Engineer-in-charge.

iii: Immediately prior to placing the first layer or CNS material, the surface of the excavation and embankment to receive the material shall be adequately wetted, as approved by the Engineer-in-charge.

iv. After the canal prism has been shaped to a reasonably true and even surface, CNS material shall be placed compacted to not less than 96% of standard proctor density unless otherwise specified, on adequately wet surface in specified layers depending upon the type of compacting equipment deployed. Each layer of CNS material shall be moistened before compaction.

v. In case of distributaries with smaller bed width in cutting reaches it may not be possible to compact the CNS layer by power rollers. In such cases the CNS material filled up in the excavated section shall be hand tamped in suitable layers till adequate width is available for compaction, by power rollers. Further layers shall be compacted by power rollers. In case of wider section of the distributaries, the placing and compaction of the CNS layers shall be done on both the side slopes independently. After compaction is done, the canal section shall be cut to the required neat lines and excavated CNS materials shall be re-used in further reaches. Laying and compaction of CNS layers shall be done as per drawings to achieve specified field densities.

2.6.7 WEATHER CONDITIONS

(a) Embankment material shall be placed only when weather conditions are satisfactory to permit accurate control of the moisture content in the embankment material. Before closing the work on embankment, in any continuous reach prior to monsoon, the top surface shall be graded away from the canal and rolled with a smooth wheeled roller to facilitate runoff. Prior to resuming work, the top surface shall be scarified and moistened or allowed to dry as the case may require.

(b) The contractor shall provide suitable protection works to protect the slopes from erosion due to rain. No payment whatsoever shall be made for providing such protection work and repairing any monsoon damages.

2.6.8 INSPECTION AND TESTS 2.6.8.1 GENERAL

(a) The Engineer-in-charge would exercise thorough check on the quality of fill material delivered to the embankment and on the degree of compaction. He would further arrange to obtain and record the data of in-situ properties of the high banks after compaction, for comparison with design assumptions. To achieve these objectives, a programme of field testing and inspection shall be planned,

(b) The scope of testing and inspection is as under:

- i) The quality of materials used for bank work will be checked periodically. ii) Checks on the effectiveness of placement and compaction procedures shall be made by field density tests at prescribed intervals.
- iii) Record tests of compacted fill shall be made at regular intervals

2.6.8.2 BEFORE COMPACTION

(a) Material delivered to the fill shall be visually examined and their properties estimated by way of inspection.

Borrow Area

- i) Excavation of borrow areas shall be limited in extent and depth as indicated on plans .
- ii) Estimation of moisture content of materials shall be made by visual examination and feel.
- iii) **Sample** shall be taken for laboratory analysis in case of soil is of different characteristics.

(b) These inspection / checks shall be supplemented by sampling the materials at prescribed intervals and by testing the samples in the laboratory for gradation and moisture content etc.

Embankment

- i. Moisture content tests shall be carried out in the laboratory while placing the fill materials.
- ii. Moisture content shall be controlled by adding water or allowing the soil to dry up to the extent required.
- iii. It shall be ensured that the methods of dumping, spreading and moisture conditions are such as will result in reducing segregation and variation of moisture content to a minimum.

2.6.8.3 DURING COMPACTION

Inspection during compaction shall ensure:

- i. That the layer thickness of the material is as specified.
- ii. That the fill is compacted at least upto 90% of Standard Proctor density or as otherwise specified or 70% relative density as the case may be.
- iii. That no excessive rutting, waving or scaling of the fill occurs during compaction.

2.6.8.4 AFTER COMPACTION

The condition of the fill after compaction shall be observed and recorded particularly with respect to rutting or waving. However, the properties of materials after compaction shall be determined primarily by field density tests. Routine tests on samples taken from constructed embankment shall include, density tests, and moisture content tests. The record

tests shall include grain size distribution Atterburg limits, permeability & consolidation

characteristics.

2.6.9 FREQUENCY OF TESTING

(a) Before and after compaction, the sampling and testing of materials shall be done at sufficient frequencies so that effective checks on the full operations are maintained. Testing frequencies shall be as per standards prescribed by the departments. However, the actual frequencies shall be adjusted to suit to the nature and variability of materials placed and the rate of fill placement as per the directions of the Engineer-in-charge.

(b) Testing shall be performed at higher frequencies than those specified above during initial stages of construction in order to establish control and testing techniques. Testing shall be conducted additionally, as and when required in case of special problems such as variation in the construction materials, in equipment performance and weather.

(c) In addition these tests shall be made

- i. In areas where the degree of compaction is doubtful and
- ii. In areas where embankment operations are concentrated.

.. (d) Locations of likely insufficient compaction shall cover the following or any other areas so determined by the Engineer-in-charge.

- i. The junction between areas of mechanical tamping and rolled embankment along structures.
- ii. Areas-where rollers turn.
- iii. Areas where improper water content has been encountered.
- iv. Areas where dirt clogged rollers have been encountered.
- v. Areas containing materials differing substantially from the average.

2.6.10 RECORD AND REPORT

The Contractor shall maintain chronological and location wise record of the source of materials and the embankment placing operations in order to have a continuous check on the works. Thus, it should be possible to have a complete description of materials that has gone into in any portion of the embankment.

2.6.11 PROTECTION

The Contractor shall take all precautions necessary for the protection of all works by diversion of adjacent streams, surface drainage, rain water etc. Any damage to earth work due to any reason whatsoever shall be repaired by the contractor at his cost till the work is certified as completed and taken over by the .

2.6.12 MEASUREMENT AND PAYMENT

1. Levels of the stripped base of the bank/CNS layer shall be taken before forming the compacted embankment /CNS layer at intervals of 30 mtrs or at closer intervals as may be considered by the Engineer-in-charge. The bank/CNS layer quantities shall be calculated with reference to these levels. Levels shall be taken for the compacted embankment / CNS layer to evaluate the quantity of work done.
- ii. The bank /CNS layer quantities shall be calculated on the basis of area and the distances of this cross sections by prismatic formula by deduction of quantity on bank work and payment to the CNS neat line profile shall be made the government order regarding shrinkage shall also be adapted
- iii. In case of curves the quantities will be evaluated along the centroid of sub-zones of cross section and quantities worked out accordingly.
- iv. The unit rate for forming embankment/CNS layer shall include setting out, clearing site, preparation of base for embankment /CNS layer including dewatering and, desilting, if necessary, removal of top 'soil in- the borrow area, sorting out materials, dewatering and desilting if required. Conveying soil with all leads and all lifts including loading and unloading spreading in layers, breaking clods, watering to optimum moisture content wherever prescribed, compacting, hand packing where to optimum Moisture content wherever prescribed, compacting, hand packing where specified, sectioning,

CONTRACTOR

EXECUTIVE ENGINEER

neat finishing of the bank, maintenance of haul roads, r maintenance of embankment /CNS layer during construction, final clearance of work site etc.

v. Incase of the intermediate running payment bills and the final bill deductions shall be made in the quantity of embankment /CNS layer towards settlement and shrinkage In accordance with the proceeding of the Government of Karnataka given in Annexure D.

vi. Further, the running bills will be paid at reduced rates as per the scale given below depending upon on the percentage of the quantity of work turned out.

SI. No.	Percentage of cumulative total quantities, Payable under running bills to the total tender Quantity.	Percentage of quoted Rates
1	0 to 50	95.00
2.	50 to 100	97.5
3.	Final bill on completion of work	100.00

2.7 BACK-FILL IN FOUNDATION TRENCHES AND AROUND STRUCTURES

2.7.1 GENERAL

(a) The type of material used for backfill and manner of depositing the material, shall be subject to approval. As far as practicable, backfill material shall be obtained from the excavation for structures or from adjacent canal excavation or from excavation of other ancillary works.

(b) Back-fill material shall contain no stones larger than 7.5 cms Size, or as prescribed by Engineer-in-charge.

(c) The backfill material shall be placed to the lines and grades as shown on the drawings or as prescribed in this paragraph or as directed by the Engineer-in-charge.

(d) The backfill material shall be placed carefully and spread in uniform layers of specified thickness and each layer will be moistened and compacted to required degree of compaction at specified moisture contents. The backfill shall be brought up as uniformly as practicable on the both sides of walls and all sides of structures to prevent unequal loading. The backfill material shall be placed at about the same elevation on both side of the pipe portions of the structures and culverts and difference in elevation shall not exceed 15 cms. at any time. The contractor shall. be responsible for providing adequate earth cover wherever necessary such as over the pipes or pipe culverts, to prevent damage due to loads of construction equipments.

(e) If a haul road is built over a pipe, all backfill around and over the pipe shall be placed to a uniform surface and no humps or depressions shall be permitted at the pipe crossings.

2.7.2 COMPACTION OF BACKFILL

When compacting soil against abutment of masonry or concrete structures, width to an extent of 0.6 mtr. shall be compacted with pneumatic tampers. Roller shall not be used close to structures to avoid damage. The size and weight of compacting equipment shall depend on nature of material, the height and load assumed in design of a structure. The backfill close to the structure upto the rolled layer shall be compacted in suitable uniform layers, using pneumatic tampers to a dry density of at least 96% of standard proctor. The moisture content of the earth fill placed against the rock or the structures shall be about 2% higher than O.M.C. to allow' for penetration into cavities. Compaction at joints of earthwork and backfill around structures shall be carried out with special care without claiming any extra cost.

The back filling above the structure shall be done initially by spreading layers not exceeding 10 cm in thickness compaction has to be done by pneumatic tamper. This method of back filling is to be continued till the filling reaches a height of not less than 0.6 mts above the highest level on the structure.

CONTRACTOR

EXECUTIVE ENGINEER

It is only after this back filling in regular layers and compaction by power rollers in the case of embankment will be permitted.

2.7.3 MEASUREMENT AND PAYMENT

Measurement for payment, for backfill in foundation trenches and around structures shall be made restricting to the pay lines shown on the drawings. Any over excavation and consequent extra backfill outside pay lines will be at the cost of the contractor. The payment shall be made on a volumetric basis under the relevant items of schedule - B

2.8 ROCKFILL

2.8.1 GENERAL

Rock fragments available from the canal excavation shall be used in all-in-fill embankment if found suitable, as per the directions of the Engineer-in-charge. The thickness of loose layer of rockfill shall not be more than 60 cms using well-graded rock fragments varying from 0.014 cum (1/2 cft) to 0.75 cum. (1 cubic yard). The rockfill shall be placed or dumped in approximately horizontal layers with finer materials in the interior of the embankment and larger materials towards the outer edge. Voids in the rock fill shall be filled and packed with smaller stones of not

less than 7.5 cms in size, in such a manner as to obtain a dense fill with minimum of voids to the satisfaction of the Engineer -in-charge. Compaction shall be done by movement of crawler tractor or loaded tippers. The relative density of the hand packed and compacted rockfill shall not be less than 70%.

2.8.2 MEASUREMENT AND PAYMENT

Payment for construction of rock fill section will be made at the unit price per cubic meter quoted in schedule B. The measurements will be on cross sectional basis of the finished compacted rockfill section taken at an interval of 30 mtrs. or closer interval as directed by the Engineer - in-charge.

In case of curves the quantities will be evaluated along the centroid of each sub-zone of the cross section and the quantities worked out accordingly.

In case of intermediate payments, 5% deduction in the volume of the rockfill actually constructed shall be made towards shrinkage and settlement. In the final bill deductions towards shrinkage will be made as per government order (copy under Annexure D)

Further, the intermediate payments will be made at reduced rates as per the table given below:

SL. No.	Percentage of cumulative total quantities, Payable under running bills to the total tender Quantity.	Percentage of quoted Rates
1	0 to 50	95.00
2.	50 to 100	97.50
3.	Final bill (on completion of work)	100.00

2.9 ROCK TOE

(a) Materials for rock toe shall consist of suitable free draining rock fragments, cobbles and boulders. The stones / rubble available from the excavation shall be used. If the materials is not sufficient, stones/rubbles shall be brought from the approved quarries.

The material shall be got approved by the Engineer -in - charge prior to being brought to site. The material shall be clean and well graded consisting principally of rock fragments. Fragments less than 0.01 cum. shall not be used. Sufficient fine material such as rock spalls, cobbles and coarse gravel to fill the voids among the larger stone shall be used. Use of stones above 0.028 cum is not obligatory. The material shall be selected and placed in such way that the larger stones shall be placed near the outer slope and the

CONTRACTOR

EXECUTIVE ENGINEER

smaller ones adjacent to the inner slope. The stones shall be properly hand packed, so as to produce a dense and well graded fill with no large voids and cavities. The surface of the outer slope shall be fairly even and uniform.

(b) Suitable outfall for draining the seepage water collected in the rock toe shall be provided depending upon the site conditions.

- (b) The dimensions of the rock toe zone shown in the drawings are tentative and if required, modifications may be ordered by the Engineer during execution of the work. The contractor shall work according to such modifications without any increase in unit rates.

2.9.1 MEASUREMENT AND PAYMENT

The item shall be paid on quantity basis for the cubic contents laid at the rate quoted in schedule - B. The quantities for payments shall be worked out from cross sections taken at an interval of 30 mtrs. or closer. The payment will be restricted to the quantities within the lines as shown on the drawing including the authorized modifications thereof.

2.10 LAYING OF FILTERS

Filters media shall be provided to the dimensions shown in the drawing or as directed by the Engineer-in-charge. The number of layers, the thickness of each layer and gradation of filter material shall be as specified in drawing or as directed by the Engineer-in-charge. The placing of the filter materials shall be such that the segregation within the layer is prevented. The Filter materials shall be watered and compacted so as to achieve a relative density of not less than 70%.

Care shall be taken not to mix up the filter materials of a layer with soil with filter materials of adjoining layer.

Suitable transition filter is intended to be provided between earth fill and all-in -fill zone consists of less than 50% of minus 80 mm. material. The contractor shall provide the transition filter as shown in the drawing or as directed by the Engineer-in-charge for which payment will be made at quoted rates. Horizontal filter blanket shall be provided, wherever prescribed, connecting the inclined filters as shown

in the drawings or as directed by the Engineer-in-charge. Before placing the horizontal filter layers, the foundation thereof shall be cleared and brought to level by filling in depressions (if any) with selected impervious materials compacted at OMC. Each layer of filter media shall be adequately watered and compacted by moving the hauling and spreading equipment over it or by other means approved by the Engineer-in-charge. The rock toe, if prescribed, shall then be laid in such a way as not to damage the filter blanket in any way.

Inclined filters abutting the outer, slope of the impervious core shall be provided as per approved drawings or as directed by the Engineer-in-charge. Filter materials shall be so placed that it conforms to the position indicated in the drawing and the continuity of each layer is ensured. The thickness and location of each individual filter layer shall be maintained by placing the material between temporarily placed mild steel sheets or wooden boards which shall be withdrawn before compaction. The inclined filter and the embankment material adjacent to it shall be raised together.

2.10.1 FILTERS DRAINS

Filters drains shall be provided at suitable locations and to the dimensions shown in the drawing to collect seepage from the embankment and to discharge the same away from the embankment by suitable means according to the site conditions as directed by the Engineer-in- charge.

2.10.2 FILTER MATERIALS

(a) The filter materials shall consist of well-graded sand, gravel or crusher broken aggregate. The material shall be free from debris, brushwood, vegetable matter, decomposed rock, and other deleterious matter. Sand in filter media shall conform to the specifications in IS: 383-1970 or its latest version. Silt and clay content in sand shall be less than 5% (IS: 1498- 1970)

(b) Filter materials shall not be placed until the sub-grade has been inspected and finally approved by the Engineer-in-charge. The filter material shall be laid in layers not exceeding 15 cms. in thickness or as prescribed by the Engineer-in-charge. The number of layers, the thickness of each layer

CONTRACTOR

EXECUTIVE ENGINEER

and the size of the ingredients shall be as per the final design which will be furnished to the contractor based on the laboratory test satisfying primarily the following filter criteria:

- i) $\frac{D_{15}(F)}{D_{85}(B)} < 4$
- ii) $\frac{D_{15}(F)}{D_{15}(B)} = \text{between } 4 \text{ and } 40$

Where D 15 and D 85 are particle diameter corresponding to 15% and 85% passing

'F' denotes filter material 'B' denotes base material. The percentage being determined by weight after mechanical analysis.

(c) The gradation curves of the filter material shall be nearly parallel to the gradation curves of the base material

(d) The requirement for grading of the filter shall be established by the field laboratory on the basis of mechanical analysis of adjacent materials

(e) The size and grading of filter material shall generally be as indicated in the drawing. The Engineer-in-charge may at his discretion modify the gradation in the filter layer to satisfy the filter criteria. The contractor shall do the necessary processing of the filter materials at his own cost.

(f) The material brought by the contractor to the site shall be tested by the quality control organization of the in the laboratory at the project site. The result thereof shall be final and binding. All material not conforming to the requirement so determined shall not be permitted for use on the said work.

2.10.3 MEASUREMENT AND PAYMENTS

The quantity of the filter material shall be calculated from initial levels taken at 30 mtrs. or even closer interval if warranted by unevenness of the ground, before and after laying filter material. Payment shall be made on volumetric basis as per the rate quoted in schedule -B. The rate includes costs of procuring, handling, and - placing, watering and compacting the filter material and all incidental operations with all leads and lifts etc., complete.

2.11 TURFING

Turfing the down stream slope shall be done with locally available approved good quality grass according to the directions of the Engineer-In-charge. Turfing shall be laid on 25cms thick soil of approved quality over the finished embankment face. The rate shall include the cost and conveyance and laying of 25cms thick soil and approved grass and watering. The rate shall also include maintaining the turfing till the end of the maintenance period, including watering and replacement of grass wherever necessary.

2.11.1 MEASUREMENT AND PAYMENT

The payment shall be made on the surface area basis. The slope length shall be measured at intervals of 30mtrs. Or at closer intervals as may be directed by the Engineer-In-Charge, Payment shall be made after the bed re-established its growth. Payment for this item shall be made on the basis of the unit rate quoted in the Schedule-B.

SECTION – III
A. CONCRETE LINING

3A MANUAL CONCRETE LINING

3A.1 SCOPE OF WORK

(a) Concrete lining shall be done by laying unreinforced cement concrete of required grade with maximum size of aggregate of 20 mm for the canal reach having side slopes of 0.25:1 and 0.5:1. The concrete used shall be of controlled grade the mix proportion being decided by the preliminary tests. The thickness of lining shall be as shown in the drawing. The thickness of lining generally varies from 7.5 cms to 10 cms depending upon the section of the canal. The canal sections shall be as shown on the drawings. If during construction it is found necessary to alter the canal sections and side slopes or the thickness of lining, the contractor shall be informed

in writing of such changes, and he shall execute the work accordingly at the rates quoted in schedule -B without any extra claim on account of changes in the section of the canal and thickness of lining.

(b) In certain situations such as the reaches where bed filing is more than 3 mtrs, nominal reinforcement is likely to be specified in the side lining. In such cases, the extra payment shall comprise of only a payment for steel reinforcement at the rates quoted in schedule - B. The concrete of the lining shall be paid at the rates quoted therefore in schedule B irrespective of whether the reinforcements are introduced or not.

(c) The scope of work also includes the following :

- i) Preparing the base for lining and laying the concrete lining including dewatering and desilting.
- ii) Providing grooves for joints to required depth and width at specified intervals as per drawings and as directed by the Engineer-in-charge.
- iii) Providing filter materials of approved quality, where specified as per drawings.
- iv) Trimming the canal section for preparing sub-grade for concrete lining, in all sorts of soil, murrum and rock and back filling the over excavated sections with suitable materials including watering and compacting the bed and slopes using suitable compacting equipment and dewatering and desilting where required.

3A.2 APPLICABLE PUBLICATIONS

All concrete, its constituents, methods and procedure of manufacture shall conform to the latest versions of the Indian standard specifications and other publications listed below unless otherwise specified.

3.A.2.1 INDIAN STANDARDS FOR REFERENCE

- | | | |
|----|-----------------------------------|--|
| 1. | IS: 8112-1989
(First revision) | 43 grade ordinary portland cement – specification |
| 2. | IS : 383 - 1970 | Coarse and fine aggregates from natural sources for concrete |
| 3. | IS : 456 - 1978 | Code of practice for plain and reinforced concrete |

CONTRACTOR

EXECUTIVE ENGINEER

4.	IS: 460 - 1978	Test Sieves
5.	IS : 516 - 1959	Method of tests for strength of concrete.
6.	IS : 650 - 1966	Standard sand for testing of cement (Reaffirmed 1980)
7.	IS : 1119 - 1959	Methods of sampling and analysis of concrete
8.	IS: 1489 - 1976	Portland Pozzolona cement
9.	IS : 1791 - 1968	Batch type concrete mixers
10.	IS : 2386 : 1963	Methods of tests for aggregates for concrete. (Part I to VIII)
11.	IS : 2430 - 1969	Methods for sampling of aggregates for concrete.
12.	IS : 2505 - 1980	Concrete Vibrators, immersion type.
13.	IS : 2506 - 1964	Screed board concrete vibrators.
14.	IS : 2580 – 1965	Jute bags for packing cement.
15.	IS : 2722 – 1964	Portable swing weigh – batchers for concrete (Single and double bucket type).
16.	IS : 3085 – 1965	Methods of test for permeability of cement, mortar and concrete.
17.	IS : 3873-1979	Code of practice for laying in- situ cement concrete lining on the canals.
18.	IS : 4031 – 1968	Methods of physical tests for hydraulic cement.
19.	IS : 4032 – 1968	Methods of chemical analysis of hydraulic cement (Reaffirmed 1980)
20.	IS : 4558 - 1983	Code of practice for under drainage of lined canal.
21.	IS : 4634 – 1968	Method of testing performance of batch type concrete mixers.
22.	IS : 4656 – 1968	From vibrators for concrete
23.	IS : 4845 – 1968	Definitions and terminology relating to hydraulic cement.
24.	IS : 4925 – 1968	Concrete batching and mixing plant.
25.	IS : 4926 – 1976	Ready mixed concrete
26.	IS : 5256 – 1968	Code of practice for sealing joints in concrete lining on canal
27.	IS : 5512 – 1983	Flow table for use in tests of hydraulic cement and pozzolonic materials.
28.	IS : 5513 – 1976	Vicat apparatus
29.	IS : 5515 – 1983	Compaction factor apparatus.
30.	IS : 5529	Code of practice for in – situ permeability tests.
31.	IS : 5640 - 1970	Method of test for determining aggregates impact value of coarse aggregates.
32.	IS : 5816 – 1970	Method of test for splitting tensile strength of concrete cylinders.
33.	IS : 5889 – 1970	Vibrator plate compactor
34.	IS : 5892 – 1970	Concrete transit mixers and agitators.
35.	IS : 6461 – 1972	Glossary of terms of relating of cement concrete aggregates, materials etc.
36.	IS : 6923 - 1973	Method of test for performance of screed board concrete vibrator
37.	IS : 6925 – 1973	Method for test for determination of water soluble chlorides in concrete admixtures.
38.	IS : 7245 - 1974	Concrete Pavers
39.	IS : 7320 – 1974	Concrete slump test apparatus.

40.	IS : 7861	Code of practice for extreme weather concreting
41.	IS : 7861 – 1971 (Part = I) (Part II – 1981)	Recommended practice for hot weather concreting Recommended practice for cold weather concreting
42.	IS : 8041 – 1978	Rapaid hardening Portland cement
43.	IS : 8043 – 1970	Hydrophobic Portland cement
44.	IS : 8112 – 1976	High strength ordinary Portland cement
45.	IS : 8142 – 1976	Method of test for determining setting time of concrete by penetration resistance.
46.	IS : 9013 – 1978	Method of making curing and determining compressive strength of accelerated cured concrete test specimen.
47.	IS : 9284 – 1979	Admixtures for concrete
48.	IS : 3860 – 1966	Method of test for abrasion resistance of concrete.
49.	IS : 3860 – 1966	Pre-cast concrete slabs for canal linings.
50.	IS : 4969 – 1968	Method of test for determining flexural strength of pre – cast concrete slabs for canal lining.

3.2.2 OTHER PUBLICATIONS

- | | | |
|----|---|-------------------------------|
| 1. | Concrete Manual (latest edition) | U.S.B.R. |
| 2. | American Society for Testing of Materials | C-491-80 water reducing agent |
| 3. | Manual of Canal lining | C. B. I. & P. |

3.3 CLEARING SITE.

The area proposed for lining the canal as a whole shall be cleared of all objectionable material. Any waste material obtained from such site clearance shall be disposed off in a manner directed by the Engineer-in-charge. The cost of this operation shall be deemed to have been covered under the rates quoted for canal lining.

3.4 PREPARATION OF SUB-GRADE FOR CONCRETE LINING

3.4.1 GENERAL

A sound and firm bed for lining shall be obtained by suitably preparing the sub-grade as follows: -

(a) As specified in Para 1.9.1 the last 200 mm of excavation in soils and soft rock will be carried out immediately before placing the concrete lining. Prior to this excavation, the sub - grade soil will be scarified and wetted if necessary and compacted at optimum moisture content. The compacted sub-grade thereafter shall be trimmed and dressed to required profile.

(b) If there are over excavations, the back filling will be carried out as specified in Para 1.9.4. which gives suitable procedure of back filling the over excavation of soils and of rock. If at any point the sub-grade consisting of earth is disturbed or loosened, it shall be moistened, as required, and thoroughly compacted by tamping, rolling or other approved methods to form firm foundations for placing the concrete lining. In case of excavation in soft or hard rock, all loosened and disturbed sub-grade will be knocked out and removed and the excavation, if any so caused shall be treated as specified in para 1.9.4.

(c) All loose materials shall be removed at the end panels of existing lining against which lining is to be placed under the specifications, and all voids beneath the existing lining shall be refilled and' thoroughly compacted,

(d) Suitable material trimmed from the canal shall be used for canal embankments, for road embankment, for back till around structures or for bedding material. Where material suitable for bedding as determined by the Engineer-in-charge is encountered during trimming operations and cannot be placed in one continuous operation, such material shall be stockpiled along the right of way where designated by the Engineer-in- charge.

3.4.2 TOLERANCE IN PREPARATION OF SUB-GRADE

Excavated profile provides the final base for lining and departure from the lines show on the drawings shall not exceed:

Alignment	-	20 mm on straight section
	-	50 mm on tangents
	-	100 mm on curves
Departure from levels shown on the drawings	-	20 mm

The above tolerance shall be negotiated gradually through smooth transition in a length of 30 mtrs.

3A.5 MATERIALS

3A.5.1 CEMENT

- a) Cement shall be 43 grade ordinary Portland cement
- b) Sampling and testing will be done by and at the expense of the No cement shall be used until notice has been given that the test result are satisfactory. Cement older than 90 days shall not be used unless test results satisfy the minimum strength requirements. The 43 grade ordinary Portland cement shall, for its physical and chemical requirements conform to IS : 8112-1989 ordinary Portland cement (First Revision)

3A.5.2 FINE AGGREGATE GENERAL

i. GENERAL

All aggregates shall conform to IS: 383 - 1970 and its latest edition and shall be proposed as directed by the Engineer-in-charge. Sand shall be natural sand from river bed, and the maximum size, shall be limited to 4.75 mm (3/16"). Fine aggregates will be tested by the Engineer-in-charge for their gradation, specific gravity, water absorption, fineness modules, soundness, petrography's analysis, deleterious constituents and alkali - aggregate reactivity.

ii. QUALITY

(a) Sand shall consist of hard, dense, durable and uncoated silicious gritty materials. It shall be free from injurious amount of dust, lumps, soft and flaky particles, shale, alkali, organic matter loam and other deleterious substances. The maximum percentage of each of the deleterious substances in sand as delivered to the mixer shall not exceed the following values:

Material passing: IS No.8. (BSS No. 200)	: 3.0 percent by weight
Clay lumps	: 1.0 percent by weight
Cinders and clinkers	: 0.5 percent by weight
Mica	: 2.0 percent by weight
Total of all deleterious substances including alkali, mica coated gmins, Soft and flaky particles, loams etc.	: 5.0 percent by weight

(b) **Sand** shall be free from injurious amount of organic impurities and sand producing colour darker than the standard in the calorimetric test for organic impurities shall be rejected.

iii. GRADING

Sand shall be well graded so as to impart good workability and good finishing. Sieve analysis of natural sand shall conform to the following limits of gradation.

IS Sieve Designation	Percentage passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100

4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100
2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100
1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100
600 micron	5 - 34	35 - 59	60 - 79	80 - 100
300 micron	5 - 20	8 - 30	12 - 40	15 - 50
150 micron	0 - 10	0 - 10	0 - 10	0 - 15

The grading of fine aggregates, when determined as described in IS - 2386 (Part-I) 1963 shall be within the limits given in the table 4 of IS: 383 and shall be described as fine aggregates, Grading zones, I, II, III, IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 micron IS sieve by a total amount not exceeding 5% it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS. Sieve or to percentage passing any other sieve size on the coarse limit of Grading Zone I or the finer limit of Grading Zone IV.

iv. STORAGE

All sand shall be stored on the site of work in such a manner as to prevent intrusion of foreign matter.

3A.5.3 COARSE AGGREGATE

i. GENERAL

(a) Coarse aggregate for concrete shall consist of clean, hard dense, free from vegetation and durable, crushed metal or gravel. Predominantly flaky aggregates shall not be used. All coarse aggregates shall be washed and / or screened by the contractor, if required. The percentage of deleterious substance in coarse aggregate shall not exceed the following values:

Sl. No.	Deleterious No. Substance Weight max uncrushed crushed	Method of Test	Fine aggregate % by weight max		Coarse Aggregate % by	
					Uncrushed	Crushed
1	2	3	4	5	6	7
i.	Coal & Lignite	IS : 2386	1.00 (Part II) 1963	1.00	1.00	1.00
ii.	Clay lumps	IS : 2386	1.00 (Part II) 1963	1.00	1.00	1.00
iii.	Material finer than 75-µm IS Sieve (Part I) 1963	IS : 2386	3.00	15.00	3.00	3.00
iv.	Soft fragments	IS : 2386 (Part II) 1963	--	--	3.00	--
v.	Shale	IS : 2386 (Part II) 1963	1.00	--	--	--
vi.	Total percentage of all deleterious materials (except mica) including Sl. I to V for Col. 4, 6 & 7 and Sl. No. i and ii for Col. 5 only.	---	5.00	2.00	5.00	5.00

Coarse aggregate will be tested by the Engineer-in-charge for their gradation, specific gravity, water absorption, impact and abrasion values, soundness, petrographic analysis, deleterious constituents, flakiness, and elongation indices, and alkali aggregate reactivity.

(c) The sum of the percentage of all the deleterious substance shall, however, not exceed 5% by weight. The coarse aggregate shall satisfy abrasion, soundness, crushing and alkali aggregate reactivity test and water absorption results as laid down in IS : 383 - 1970 and other relevant Indian standard specifications.

ii. GRADING

(a) Coarse aggregate shall be well graded and shall have a maximum size of 20 mm.

CONTRACTOR

EXECUTIVE ENGINEER

- (b) The gradation shall give a dense concrete of the specified strength and consistency that will work readily into position without segregation and without the use of excessive water content
- (c) **The** grading of coarse aggregate shall be in the nominal size as mentioned in table - II of IS : 383-1979 reproduced below:

I.S. Sieve Designation	% Passing for graded
80.00 mm	--
63.00 mm	--
40.00 mm	100
20.00 mm	95-100
16.00 mm	--
12.50 mm	--
I.S. Sieve Designation	% Passing for graded
10.00 mm	25-55
4.75 mm	0-10
2.36 mm	--

However, the exact gradation required to produce a dense concrete of specified strength and desired workability shall be decided by the Engineer-in-charge.

(d) The aggregate should be collected in separate stock piles for the gradation 20 to 10 mm and down wise. Testing for gradation and batching will be carried out only when the collection is done in above manner.

iii. STORAGE

(a) Aggregate shall be stacked in such a way as to prevent the admixture of foreign materials such, as soil, vegetable matter etc. Heaps of fine and coarse aggregate shall be kept separate. When different sizes of fine or coarse aggregates are procured separately, they shall be stored in separate stock piles, sufficiently away from each other to prevent the materials at the edge of the piles from getting intermixed.

(b) The aggregate shall be stock-piled adjacent to the mixer site as to require minimum rehandling and labour when conveyed to the mixer.

(c) The aggregate shall be placed on a dry hard patch of ground if available otherwise a platform of planks or plain galvanized iron sheets or alternatively on a floor of dry bricks or thin layer of lean concrete.

(d) The aggregate shall be kept free from getting dirty by people through rubbish like papers, vegetable matter and bidi etc.

(e) To minimize moisture variations, the stock piles shall be as large in area as possible but low and fairly uniform in height preferably 1.25 to 1.50 metre and the lowest layer of about 30 cms shall be allowed to act as drainage layer and not used till the end. Generally not less than 10 days requirement shall be stock piled.

3A.5.4 WATER

(a) Water used for mixing of concrete and mortar should be free from injurious amounts of deleterious materials. Potable water is generally considered satisfactory for mixing and curing.

(b) **Where** water is found to contain any sugar or acid, alkali or salt, the Engineer-in-charge will refuse to permit its use. As a guide the following table represents the maximum permissible values:

Organic	0.02%
Inorganic	0.30%
Sulphate	0.05%
Alkali Chlorides	0.10%
Suspended matter	0.20%
PH value	6 to 8

3A.5.5 AIR ENTRAINING ADMIXTURES

CONTRACTOR

EXECUTIVE ENGINEER

i. GENERAL

Air entraining-admixture when approved for being used as an admixture, shall be added to the concrete. patch-in solution when directed by the Engineer-in-charge. It shall be batched by means of mechanical batcher capable of correct measurement and in such manner .as will ensure uniform distribution of the agent throughout the batch during the specified mixing period. The amount of air entraining agent used shall be such as to effect air entertainment of 6 percent by volume in that portion of the concrete containing aggregate smaller than the 20 mm. square mesh sieve after its placement and vibration in the forms. The actual percentage of air shall be as fixed by the Engineer-in-charge and will be changed whenever such change is deemed necessary to meet the varying conditions encountered during constructions. The admixture shall be supplied by the contractor himself, at his cost for use in the concrete mix. Charges for labour, transport, storage and mixing shall be borne by the contractor. No claim on any account for use of this admixture or any other admixture in the concrete shall be entertained by the .

ii. TESTS FOR DETERMINING MIX PROPORTIONS

Sample required for evolving design mix of concrete have to be furnished by the contractor 3 months in advance of the concrete placement programme. Samples shall be collected from approved quarries relevant to the portion of work. Contractor shall provide satisfactory facilities for easy and quick collection of adequate test samples. All tests for deciding the mix proportions. for the evaluation and approval of admixutres, if any, shall be made by and at the expense of the . The cement content of the mix design would be decided not only from the considerations of strength requirements but also from durability.

3A.6 CAST-IN-SITU CONCRETE LINING

3A.6.1 GENERAL

This work shall generally conform to I.S. 3873- I 978. All concrete for lining work shall be governed by IS : 456-1978. Concrete for lining works shall be of controlled grade with suitable admixtures of approved air entrining agents, using well graded aggregate with maximum size of aggregate of 20 mm.

3A.6.2 BATCHING

- (a) The batching and mixing plant shall be fully automatic and will automatically start the weighing operation of materials and stop automatically when designated weight of each material is reached and interlock in a manner as specified in IS: 4925-1968. The wet mixing of the concrete shall be done in mixer attached with batching plant. In no case mixing shall be allowed outside the batching and mixing plant i.e. mixing will not be allowed in transit mixture. The semi automatic or manually operated batching and mixing plant will not be allowed.
- (b) The prescribed amount of the various materials of concrete including water, cement, admixtures, the groupings of fine aggregates and each individual size of coarse aggregate shall be measured and controlled within the specified limits of accuracy. The amount of water, cement and aggregate shall be determined by weighing. In the case of fine aggregates, the surface moisture shall be determined in accordance with the method prescribed in Appendix-D of IS: 456-1978 and its subsequent amendments or publications. In the case of coarse aggregates, percentage of free water shall be determined by weighing a representative sample, then surface drying each particle individually with a clean piece of cloth and re-weighing.
- (c) The proportions of various materials shall be changed as directed in order to maintain the desired quality of the concrete. The batching equipment shall be constructed and operated so that combined inaccuracies in feeding and measuring the materials shall not exceed $1\frac{1}{2}$

- percent for water and cement and 2 percent for each size of aggregate
- (d) The operating performance of each scale or other measuring device shall be checked by standard test weight to be supplied by the contractor and test weight shall be got calibrated by the contractor and the tests shall cover the ranges of measurements involved in the batching operations. Tests of equipment in operation shall be made at least once every fortnight and adjustments, repairs or replacement, be made as necessary to meet the specified requirement for accuracy of measurement.
 - (e) Aggregate shall not be batched for concrete or mortar when free water is dripping from the aggregate.
 - (f) Before the concreting operation is started the contractor shall provide communication facility in the form of wireless, walki- talki or telephone between the batching and mixing plant and site/sites of various concrete placement and got approved by the Engineer-In-Charge.

3A. 6.3 MIXING

- (a) Concrete shall be mixed in a mechanical ready mix mixer and shall be as dense as possible, plastic enough to consolidate well and stiff enough to stay in place on the slopes.
- (b) Mixing shall be continued until there is a uniform distribution of materials and the concrete is uniform in colour and consistency, The time of mixing shall be as shown in table-I of IS : 457-1957 reproduced below:

Capacity of Mixer	Minimum time of mixing	
	Natural Aggregates	Manufactured Aggregates
3 m ³ or larger	2 Minutes	2 ½ Minutes
2 m ³	1 ½ Minutes	2 Minutes
1 m ³ or smaller	1 ¼	1 ½ Minutes

3A.6.4 CONSISTENCY

The amount of water used in the concrete shall be fixed a required from time to time during the course of concreting work to secure concrete of the proper consistency and to adjust for any variation in the moisture content or grading of the aggregates, as it enters the mixture. Addition of water to compensate the stiffening of the concrete resulting from over mixing or objectionable drying before placing shall not be permitted. Uniformity in concrete consistency from batch shall be required. Where concrete is laid from bottom to the top of the slope. A slump 50-70 mm shall be allowed for lining. Where canal lining machines are used the slump shall be 50 mm. To have a close control of the consistency and workability of concrete, the slumps of concrete shall not vary by more than 20 mm which would otherwise, interfere with the progress and quality of the work.

3A.6.5 CONVEYANCE

- (a) Concrete shall be handled from the place of mixing to the place of final depositing as rapidly as practicable by use of equipment such as transit mixers which will prevent initial setting, segregation or loss of any of the ingredients. It shall be transported and compacted in its final position within 30 minutes of its discharge from the mixer.
- (b) If segregation occurs during transport, the concrete shall be remixed before being placed, after observing the time requirements as above.

3A.6.6 PLACING AND COMPACTION

- (a) Concrete shall be placed only in the presence of a duly authorized representative of the . Concrete shall be placed and compacted before initial setting time and should not be subsequently disturbed.

(b) Placing of concrete shall not be started until all form work is completed and all parts to be embedded are placed and preparation of surface upon which concrete is to be laid, has been completely inspected and then so directed by the Engineer-in-charge. All absorptive surfaces against which concrete is to be laid shall be moistened adequately so that moisture will not be withdrawn from freshly placed concrete. The surfaces however, shall be free from standing water and mud.

(c) Concrete shall be deposited and spread on the bed and sides of the canal as indicated on the drawings, in alternate panels. It shall be well compacted by using tampers vibrators and screeds and finished smooth by wooden floats and travel to get smooth, hard and even surface. For lining of side slope, concrete shall be screeded up the slope, and vibrated ahead of the screed. Concrete required for keys as shown on drawings shall be laid integrally with side-slope lining. Slip forms shall be used for the side slopes of the canal.

(d) As an alternative to hand placing, or the slip forms, the contractor may choose to use longitudinally operating self aligning, slip form machine with built in vibrators attached the side forms as effectively compact and finish concrete.

3A.6.7 SLIP FORM FOR SIDE SLOPES OF THE CANAL

The slip form used for placing concrete to the side slopes of the canal shall comprise of weighted steel faced slip form screed, about 70 cms wide, pulled up the slopes by hoisting equipment placed on the canal berms or on the top of the service road/inspection path. The screed travels up over the screed guides which are firmly laid over the sub grade of the side slopes, at the two ends of the panel being concreted and are correctly positioned to serve, in addition, as form work for those two sides. When the adjacent panels are already concreted, the screed guides are dispensed with and the slip form screed travels supported over the adjacent panels at its two ends.

The screed guides may comprise rolled steel channels the heights of which correspond to the thickness of the lining. The screed guides shall be correctly aligned, transverse to the canal alignment and shall be correctly positioned conforming to the designed side slopes of the canal.

The slip form screeds shall be of rigid construction and shall not deflect during the concreting operation. The weights placed over the slip form screed shall be adequate and uniformly placed so as to exert enough pressure on the concrete and to ensure smooth operation without being lifted or otherwise disturbed during the concreting operations. The screed shall be steel faced and unvibrated. The concrete shall be vibrated ahead of the slip form screed using immersion type vibrators. The construction of the slip form including the pulling ropes, the hoists and the hoisting arrangements shall be such as to ensure that the slip form screed would move up the slope evenly and slowly. Laborers vibrating the concrete would be positioned over the top of the traveling slip form screed and would ensure that the concrete is well vibrated and dense as it is slipped under the screed. Together enough concrete for being vibrated and fed under the slip form screed, a steel plate lip is provided at the rising end of the slip form and the arrangement works like a moving hopper. The workability of the concrete and the concreting operation including the vibrating arrangements shall be such as to ensure that the surface made by the slip form will require no further screeding and very little finishing.

The slip forms of above description shall be employed without fail in all main canals, branch canals and major distributaries. The concreting method in smaller channels like laterals may comprise of manually moving up the screeds over the screed guides laid on the sub grade. The size of the screed, in such cases would be smaller. Consolidation of concrete lining is accomplished mainly in the screeding operation. Three-meter screed panels should be quite practicable for two-man operation of the screed.

3A.6.8 FINISHING

(a) All exposed concrete surfaces shall be cleaned of impurities, lumps of mortar or grout and unsightly stains. Finished surface shall be even, smooth and free from pockets and equivalent to that obtainable by effective use of a long handle steel trowel. Surface irregularities shall not exceed 6 mm for

bottom slab and 12 mm for side slopes, when tested with a straight edge of 1.5 .meter length.

(b) The surface of concrete finished against form shall be smooth and shall be free from projections, honeycombing and other objectionable defects. Immediately on the removal of forms, all unsightly ridges or lips shall be removed and under desirable local bulging on exposed surfaces shall be remedied by tooling and rubbing.

(c) Repairs to concrete surface and additions where required shall be made by cutting regular opening into concrete and placing fresh concrete to the required lines. Chipped opening shall sharp and shall not be less 75 mm in depth. Plastering of concrete surface will not be allowed.

(d) The unformed surface of lining shall conform to U4 finish as described in Para 4.14.2 iv). The form surface of lining shall conform to (F4) finish as described in Para 4.14.1 e) iv).

3A.6.9 CURING

(a) Water Curing

Subsequent to laying of concrete lining and after a period of 24 to 36 hours, the lining should be cured for atleast 21 days. On bed, this may be done by constructing 15cms deep earthen bunds across the bed so that a small depth of water will stand on the bed. The curing of side slopes may be done by constructing masonry drains with weep holes or perforated pipes on the coping at the top of the lining or by sprinklers such that the surface is always kept wet. If the surface is covered with gunny bags or straw, intermittent sprinkling may also be allowed provided that the underneath of the gunny bags and straw are always wet.

(b) Membrane Curing

i. As an alternative to water curing, membrane curing may also be done using curing compounds of approved manufacture conforming to specifications ASTM designation cx 309-38. Curing compounds should not be used on surfaces that are to receive additional concrete, paint or tile that require a positive bond, unless it has been demonstrated that the membrane can be satisfactorily removed before a subsequent application or that the membrane can serve satisfactorily as a base for the application.

ii. The compound shall be applied at a uniform rate sufficient to comply with the requirement of the test for water retention (ASTM-C156=65). The usual values for water retention coverage range from 3.5 to 5.0 sqm per litre.

iii. Curing compound can be applied by hand spray or mechanical distributors at about. 75 to 100 psi (5 to 7 kgs per sqm.) On small areas such as patches curing compounds may be brushed with a wire or bristled brush.

iv. On formed concrete surfaces the curing compound shall be applied immediately upon removal of the form. If there is any drying or appreciable loss of moisture the surface should be sprayed with water and allowed to reach a uniformly damp appearance with no free water on the surface when the compound is applied.

v. The contractor shall demonstrate the effectiveness of the curing compound he intends to utilize. Such compounds shall be Used on the work only after successful demonstration to the satisfaction of the Engineer-in-charge. The contractor shall also produce the test certificate to show that the material conforms to stated specifications.

vi. Application of the curing compound shall be strictly as per the manufacturer's specifications. After application of the curing compound the membrane shall be protected by covering of sand or earth of not less than 25 mm. in thickness or by other means, if concrete is subjected to foot traffic or other construction activity. Protective covering shall not be placed until the sealing membrane is thoroughly dry and shall be removed by the contractor after the final acceptance of the work. The curing compound shall be used only if it has been tested and

approved by the Engineer-in-charge. the cost of furnishing transporting, handling and supplying all materials including labour etc. used for curing of concrete shall be included in the unit rate tendered for the. concrete. The contractor shall maintain adequate and appropriate curing material and means of applications at site of work failing which his work may have to be halted and for which the contractor shall not be entitled for any claim whatsoever.

3A.7 TESTS OF CONCRETE AND ACCEPTANCE CRITERIA

3A.7.1 GENERAL

Testing of concrete shall be carried out at the cost of the department by the quality control Division in representative samples taken at the site of laying the concrete in accordance with relevant Indian Standard specifications.

3A.7.2 SAMPLING PROCEDURE AND FREQUENCY

(a) Sampling procedure

A random sampling procedure shall be adopted to ensure that each concrete batch has a reasonable chance of being tested, i.e. the sampling should be spread over the entire period of concreting and should cover all mixing units.

(b) Frequency

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following :

Quantity of concrete per Shift Cum.	Number of Samples
1 to 5	1
6 to 15	2
16 to 30	3
31 to 50	4
51 and above	4 plus one additional Sample for each additional 50 cum or part thereof.

Note: Atleast one sample shall be taken during each shift at each placement location.

3A.7.3 SAMPLING AND STRENGTH TEST OF CONCRETE

Sample from fresh concrete shall be taken as per IS : 1199-1959 and cubes shall be made' cured and tested at 28 days in accordance with IS : 516-1959

3 7.4 TEST SPECIMEN

(a). Three test specimen shall be made from each sample for testing at 28 days. Additional-cubes may be required for various purposes, such as to determine the strength of concrete at 7 days or at the time of striking form work, or to determine the duration of curing or to check the testing cubes cured by accelerated methods as described in IS : 9013-1978. The specimen shall be tested as described in IS : 516-1959.

(b) Test strength Samples

i) The test strength of the sample shall be average of three specimen. Individual variation should not be more than 15% of the average.

ii) . Contractor shall provide necessary unskilled labour and facilities for transport for collection of samples, cores, etc and shall be present at the time when the-samples, cores etc, are taken. Testing shall be carried out at the testing laboratories set up at the site or a any other laboratory that the 'Engineer-in-charge may decide upon and the results given thereby shall be considered as correct and-authentic and acceptable to the contractor.

The contractor shall be given access to all operations and tests that may be carried out as aforesaid. All testing charges are to be borne by the department .

3A.7.5 STANDARD DEVIATION

Standard Deviation based on test results:

(a) Number of test results - The total number of test results required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 tests, results, as early as possible, when a mix is used' for the first time.

(b) Standard Deviation to be brought up to date - The calculation of the standard deviation shall be brought up to date after every change of mix design and at least once a month.

Determination of Standard Deviation:

(a) Concrete of each grade shall be analyzed separately to determine its standard deviation.

(b) The standard deviation of concrete of a given grade shall be calculated using the following formula from the result of individual tests of concrete of that grade obtained as specified in 14.4 ; or IS : 456-1978.

Estimated Standard Deviation $S = \sqrt{\frac{\sum \Delta^2}{n-1}}$ 1

Where

Δ = Deviation of the individual test strength from the average strength of 'n' samples, and
n = Number of sample test results.

(c) When significant changes are made in the production of concrete batches (for example changes in the materials used, mix design, equipment or technical control) the standard deviation value shall be separately calculated for such batches of concrete ..

Assumed Standard Deviation

Where sufficient test results for a particular grade of concrete are not available the value of standard deviation given in Table 6 of IS : 456-1978 clause 14.5.3 may be assumed.

Table 6
Assumed standard deviation
(clause 14.5.3 of IS : 456-1978)

Grade of Concrete	Assumed Standard Deviation {N/mm ² }
M 10	2.3
M 15	3.5
M 20	4.6
M 25	5.3
M 30	6.0
M 35	6.3
M 40	6.6

However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in Table 6, of IS: 456-1978 it shall be permissible to use that value.

3A.7.6 ACCEPTANCE CRITERIA

The concrete shall be deemed to comply with the strength requirements if:

- (a) Every sample has a test strength not less than the characteristic value
or
- (b) The strength of one or more samples though less than the characteristic value, is in each case not less than the greater of.
 - (1) The characteristic strength minus 1.35 times the standard deviation and
 - (2) 0.80 times the characteristic strength; and the average strength of all the samples not less than the characteristic strength

1.65
plus (1.65 -) times the Standard Deviation
(Number of samples) 1/2

CONTRACTOR

EXECUTIVE ENGINEER

The concrete shall be deemed not to comply with the strength requirements if:

- (a) The strength of any sample is less than the greater of:
 - (1) The characteristic strength minus 1.35 times of the standard deviation and
 - (2) 0.80 times the characteristic strength
- (b) The average strength of all the samples is less than the characteristic strength
3
plus $(1.65 - \dots\dots\dots) \times \text{Standard Deviation}$
(Number of samples) $1/2$

Concrete which does not meet the strength requirements as specified in 15.1 of IS 456-1978 but has a strength greater than that required by @ 5.2 of IS : 456-1978 may at the discretion of the designer, be accepted as being structurally adequate without further testing .

If the concrete is deemed not to comply pursuant to 15.2 of IS : 456-1978 the structural adequacy of the parts affected shall be investigated (sec 16 of IS : 456-1978) and any consequential action as needed shall be taken.

Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance.

Concrete is liable to be rejected if it is porous' or honey combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances. specified or construction tolerance have not been met. However, the hardened concrete may- be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-'-charge.

3A.7.7. CORE TEST

Core / samples may also be taken by drilling the hardened concrete of the lining for testing the compressive strength. Cores shall be of diameter 7.5 cms and tested as per IS : 516-1959. Three test cores taken at any cross section will constitute one sample. Test samples shall be taken for branch canals, distributaries etc. at intervals as indicated below or at closer intervals, if considered necessary.

	Discharging Capacity	Approx. Average intervals
1	Above 14 cumecs.	250 mtrs.
2.	Greater than 3 to 14 cumecs.	500 mtrs.
3.	Above 0.30 cumecs, upto 3 cumecs.	750 mtrs.
4.	0.3 cumecs. & below	1000 mtrs.

The points from which cores are to be taken and the number of cores required shall be at the discretion of the Engineer-in-charge and shall be representative of the whole of concrete concerned. In no case, however, shall fewer than three cores be tested.

Cores shall be prepared and tested as described in IS : 1199-1959 and IS,.... 516 -1959.

Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to atleast 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%. Cored holes shall be refilled with the same grade of concrete without any extra cost. In the event of difference between the test results of cubes specimen taken while laying concrete and core specimen taken later, result of core sample testing will prevail.

3A.8 JOINTS

Joints shall be spaced and located as shown in the drawing or as directed by the Engineerin-charge. The joints shall be formed in the manner as specified below when the concrete is hand placed. In situ sleepers, in case bed and precast in case of sides shall be provided under the joints. The sleeper shall be of sizes shown on the drawing. Concrete used for sleeper shall be of the same grade- as for lining. Before laying cement concrete, the top of the sleeper both in bed and side slopes shall be treated with two layers of

sealing compound as prescribed in clause 9 of IS : 5256-1968 and as shown in the drawing. Slabs shall be laid in alternate compartment with an interval of atleast one day for setting and contraction.

The faces of the previously placed concrete shall be painted with sealing compound as prescribed In IS : 5256-1968 to ensure that no bonding takes place The grooves at the joints shall be of size and shape as shown on the drawing and filled with hot applied sealing compound. Filling of the joint with hot applied sealing compound should be taken up after completion of all other canal work. In the mean time the grooves shall be filled with clean coarse sand.

Expansion Joints

Expansion joint shall not be provided except where structure intersects the canal.

At intersecting structures an expansion joint of 25 mm width filled with sealing compound conforming to IS:-5256-1968 or with P.V.C. water stops shall be provided. -

Construction Joints

A construction joint is placed at any location where it is suited as an exigency to. construction (interruption of work.). It later performs the function of a transverse, longitudinal or expansion joint.

Contraction joints Contraction joint shall be provided at places shown on the drawings or directed by the Engineer-in-charge in accordance with provisions laid down in 6.2.1 and 6.2.2. of IS : 3873-1978. Where lining operations are continuous, transverse grooves or longitudinal and transverse grooves both in cases of concrete lined canal with lined perimeter more than 10 mtrs. shall be formed as shown in Fig: (1) in accordance with "Table 2 of IS : 3873-1978.

Deviations from established lines, grades and dimensions shall be tolerated to the extent set forth herein provided that the reserves the right to diminish the tolerance set forth herein if tolerances impair the structural action or operational function of the lining.

- | | | |
|------|--|---|
| i. | Departure from established alignment | 20 mm on straight reaches
50 mm on tangents. |
| ii. | Departure from established grade | 100 mm on curves, 20mm
on straight reaches |
| iii. | Variation in concrete lining thickness | 10% of lining thickness provided
average thickness is not less than specified thickness. |

Any departure from alignment or grade shall be uniform and no correction in alignment be made in less than 50 mtrs.

3A.9 DEWATERING

Canal reaches where water is encountered above canal bed level shall be dewatered continuously during preparation of sub-grades and placing of concrete for lining till the concrete has attained necessary strength. No separate payment shall be made for dewatering operations, as the same shall be deemed to have been included in rate of related finished item of work in the Schedule –B.

3A.10. DESILTING

Whenever desilting is encountered in canal reaches during preparation of sub-grades and placing of concrete for lining, it shall be done by the contractor. No separate payment shall be made for this operation as the same be deemed to have been included in the rate of the concerned finished item of work in the schedule - B.

3A.11 MEASUREMENT AND PAYMENT

I. PLAIN CEMENT CONCRETE LINING

(a) Measurement will be on the basis of volume of concrete lining for the thickness specified on the drawing and payment will be at the unit rate quoted in schedule B. The correct thickness shall be maintained at the time of concreting by taking necessary care at the time of setting up form works and the placement, compaction and finishing of concrete. The thickness shall be cross checked by :

1. Volume of concrete placed and area covered.
2. Use of probe when concrete is green

3. coring.

No separate payment will be made for filling up any over breakages and preparation of sub-grade for lining of canals.

(b) The unit rate for lining also includes cutting or forming of grooves to specified depth in panels and filling with sealants as directed by the Engineer-in-charge, cost of all material including sleepers for joints, all leads and lifts, all tools, plant and labour for mixing, formwork, conveying, placing, compacting, finishing, curing and also for dewatering and desilting during placing of concrete lining and all incidental charges.

ii. CONCRETE LINING WITH NOMINAL REINFORCEMENT

The quantity of cement concrete lining with nominal reinforcement will be measured on volumetric basis on the same lines as of plain concrete lining. Payment shall be made at the unit rate quoted in schedule - B. The rate excludes reinforcement to be provided in lining, but is inclusive of costs of all materials transport with. all lead and lifts, all tools, plant and labour for mixing; conveying, placing, compacting, finishing, curing etc. and also for dewatering and desilting during the placing of the reinforcement and -the concrete. Reinforcement is payable separately.

3A.12 GUARD STONES/BOUNDARY STONES/CHAINAGE STONES

All stones shall be quarried from the approved quarry only. The stones shall be clean, hard, durable, dense, tough and shall be free from decay, weathered portions, skin, veins, flaws, cracks, cavities, vesicles and other defects. Stone shall be as far as possible uniform in colour and texture. Stones shall be of fine medium grained and shall give ringing sound when struck with a hammer. They shall be of the required size and shall be dressed neatly on the exposed faces. The guard stones shall be hammer dressed.

The stones shall be fixed on both the sides of canal at intervals as directed by the Engineer-in-charge. The size of stones shall be 75 cm x 20 cm x 20 cm and the portion above the ground level shall be dressed to the required size and as directed by the Engineer-in-charge. Arrow marks shall be engraved for boundary stones as directed.

The stones shall be fixed by excavating a -pit and back filled with excavate~ material. The stones shall be white washed as directed. The rate quoted by Contractor for this item shall includes cost and conveyance of all material, with all leads and lifts, dressing to the required size and shape including engraving arrow mark (for boundary stones) and white washing as directed by the Engineer-in-charge fixing in position by excavating a pit of required size and refilling with excavated materials including consolidation, watering etc., complete.

3.12.1 MEASUREMENTS AND PAYMENTS

Measurements shall be taken after fixing the stones in position in terms of numbers and payment will be made on the basis of unit price quoted in the Schedule - B.

3.13 CANAL BED STONE

Providing and fixing canal bed stones

The canal bed stones shall be fixed at intervals 20 metres as directed by the Engineer-in-charge. The size of stones shall be 75cm x 20cm x 20cm and the portion above the "ground level shall be dressed to the required size and shape as directed by the Engineer-in-charge, the stone be fixed by excavating pit of required size and refilling with excavated material. The rate quoted by the contractor for this item include cost and conveyances of all materials with all leads and lift dressing to the required size and shape as directed by the Engineer-in-charge, fixing in position by excavating pit of required size and refilling with excavated material complete.

3.13.1 MEASUREMENTS AND PAYMENTS

Measurements shall be taken after fixing the stones in position in terms of numbers 'and payment

CONTRACTOR EXECUTIVE ENGINEER

will be made on the basis of unit price quoted in the Schedule - B.

3.14KM STONE/1/10(HECTOMETER) STONE OF SIZE 0.65 X 0.15 X 0.10M AND KM STONE SIZE 1.11 M X 0.35M X 0.25M

The stone shall be fixed as directed by the Engineer-in-charge. Size of the stone shall be as per IRC including painting surface with two coats of approved colour and shade and lettering with black paint of approved quality as directed. The stone shall be fixed by excavating a pit to the depth of 0.3m filled with CC M10 Prop block of size 0.7 x 0.45 x 0.40 and hectometres size of 0.5 x 0.45 x 0.40. The rate quoted by the contractor for this item shall include cost and conveyance of all materials dressing this tones painting and lettering as directed etc., complete with all lead and lifts.

3.14.1 MEASUREMENTS AND PAYMENTS

Measurements shall be taken after fixing the stones in position in terms of numbers and payment will be made on the basis of unit price quoted in the Schedule - B.

3B- CONCRETE LINING BY MECHANICAL PAVER

3B-1 SCQPE OF WORK:

- (a) The section covers specification for Item No.8 .
- (b) Concrete lining shall be done only by mechanically operated paver for canal reaches by laying plain/RCC Cement Concrete of M-15 grade with maximum size of aggregate as 20 mm. The thickness of lining shall be as specified. The canal sections shall be as shown on relevant drawings. If during the construction it is found necessary to alter the canal sections and side slopes without altering the thickness of ,lining. The Contractor shall be informed in writing of such changes. The rates quoted being on square metre basis for the specified thickness, the Contractor shall have to execute the work at the same rates as quoted without any extra claim for change in the section of canal.
- (c) Lining shall be provided for the length specified on the drawing on either side of structure with a thickness as specified on slopes and curvature and in bed with reinforcement as specified on the relevant drawings. This lining may be allowed manually but in that case only compaction shall have 'to be done using screed vibrator only.
- (d) During the preparation of subgrade for canal lining the proud earthwork shall be excavated and trimmed by trimmer only. This excavation for trimming for preparing the base for lining shall be carried out immediately prior to laying of the lining but in no case the time interval should exceed 3 days in normal weather and 2 days in adverse weather conditions.
- (e) The scope of work also includes the following:
 - (i) Desilting /Dewatering whenever and wherever in the canal section for preparing the base for lining and laying concrete lining. The ground water table shown in subject to large deviation and may vary for full depth of full canal section.
 - (ii) Providing and fixing in position PVC strips / bitumen- joint in canal joints in lining works.
 - (iii) Providing concrete steps ladders at required intervals or as directed.
 - (iv) Providing strip drains and necessary under drainage arrangements with filter around it as per drawings.
 - (v) Providing earth ramps at regular intervals or as directed.

3B-2 APPLCABLE PUBLICATIONS:-

All items of work concrete, its constituents, methods and procedures of manufacture shall conform to Indian Standard Specifications and other publications listed below

3B.2.1 Indian Standards

1	IS : 269-1976	Specification for 33 grade Ordinary Portland cement (fourth revision)
2	IS : 383,1970	Specification for coarse and fine aggregates from natural sources for concrete (second revision)
3	IS : 456-1978	Code of practice for plain and reinforced, concrete (Second revision) (Amendment No.1)
4	IS : 457-1957	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
5	IS : 460-1985	Specified for test sieves (Part 1 to 3)
6	IS : 516-1959	Method of test for strength of concrete (amendment No.1)
7	IS : 650-1966	Specification for standard sand for testing of cement (first revision) (Amendments No.1,2 and 3)
8	IS :-1199-1959	Method of sampling and analysis of concrete. Specification for Portland Pozzolana cement (second revision) (Amendment No.1 to 7)
9	IS : 1489-1976	
10	IS : 1791-1985	Specification for batch type concrete mixers (second revision)
11	IS : 2386-1977 (Part 1 to VIII)	Methods of test for aggregates for concrete.
12	IS : 2430-1986	Methods for sampling of aggregates for concrete (first revision)
13	IS : 2505-1980	General requirements for concrete vibrators, immersion type (second revision)
14	IS : 2506-1982	General requirements for screed board concrete vibrators.
15	IS : 2580-1982	Jute sacking bags for packing cement (second revision)(with Amendments No.1 to 3)
16	IS : 2722-1964	Specification for portable swing weigh batchers for concrete (single and double bucket type)
17	IS : 3085-1965	Methods of test for permeability of cement, mortar and concrete.
18	IS : 3535-1986	Method of sampling hydraulic cement (First revision)
19	IS : 3873-1978	Code of practice for laying in situ cement concrete lining of canals (first revision)
20	IS : 4031-1988 (part 1 to 13)	Methods for physical test for hydraulic cement (First revision)
21	IS :4032-1985	Method of chemical analysis of hydraulic cement (first revision)
22	IS 4558-1983	Code of practice for under drainage or lined canals (first revision)
23	IS : 4634-1968	Method for testing performance of batch – type concrete mixers.
24	IS: 4656-1968	Specification for form vibrators for concrete
25	Is : 4845-1968	Definitions and terminology relating to hydraulic cement (Reaffirmed 1987)
26	IS : 4925-1968	Specification for concrete batching and mixing plant.
27	IS : 4926-1976	Specification for ready mixed concrete (first revision)
28	IS : 5256-1968	Code or practice for sealing joints in concrete lining on canals.

CONTRACTOR

EXECUTIVE ENGINEER

29	IS : 5512-1983	Specifications for flow table for use in test of hydraulic cement and pozzolanic materials (first revision)
30	IS : 5513-1976	Specifications for Vicat apparatus (first revision)(Amendments I)
31	IS : 5515-1983	Compacting factor apparatus (first revision)
32	IS : 5529-1985 (Part I & II)	Code of practice for in-situ permeability test
33	IS : 5640-1970	Method of test for determining aggregate impact value of soft coarse aggregates.
34	IS : 5816-1970	Method of test for splitting tensile strength of concrete cylinders.
35	IS : 5889-1970	Specification for vibratory plate compactor.
36	IS : 5892-1970	Specification for concrete transit mixer and agitators.
37	IS : 6461 (Part I to XII)	Glossary of terms relating to cement concrete
38	IS : 6923-1973	Method of test for performance of screed board concrete vibrators
39	IS : 6925-1973	Method of test for determination of water soluble chlorides in concrete admixtures.
40	IS : 7245-1974	Specification for concrete pavers
41	IS : 7320-1974	Specification for concrete slump test apparatus (Amendment No. 1) Code of practice for extreme weather concreting.
42	IS : 7861-1975 (Part I & II)	
43	IS : 8041-1978	Specification for Rapid Hardening Portland cement (first revision) (Amendments No.1 to 4)
44	IS : 8043-1978	Specification for Hydrophobic Portland Cement (First revision) (Amendments No. 1 to 3)
45	IS : 8142-1976	Method of test for determining setting time of concrete by penetration resistance.
46	IS : 9013-1978	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
47	IS : 9103-1979	Specification for admixtures for concrete.
48	IS : 9284-1979	Method of test for abrasion resistance of concrete
49	IS : 12200-1987	Code of practice for provision of water stops joints in masonry and concrete dams.

3B.2.2 B. Other Technical Publications

- I USBR Manual
- 2 Relevant ASTM Standards
- 3 Relevant ACI Codes and manual
4. CBIP (Manual on Canal Lining)

Note: Generally the Bureau of Indian Standard code will be followed for all items for works. Whenever this code does not exist the reference will be taken to other technical publications directed by Engineer -In-Charge.

3B.3 CLEARING SITE:

The area proposed for lining the canal, as a whole shall have to be cleared of all objectionable material. Any waste material obtained from such site clearance shall be disposed off in a manner directed by the Engineer -InCharge. The cost of this operation shall be deemed to have been covered under the rates quoted for canal lining.

3B.4 TRIMMING THE CANAL SECTION AND PREPARATION OF SUB GRADE FOR CONCRETE LINING:-

3B.4.1 General

(a) The provisions of this paragraph applies to the preparation of subgrade upon
CONTRACTOR EXECUTIVE ENGINEER

which concrete lining is to be placed .

- (b) Before starting the work of trimming the canal section upto the underside of concrete lining and preparing subgrade for concrete lining.
The work of trimming the canal section upto and underside of concrete lining and preparing sub grade shall be carried out by mechanical trimming machine of adequate capacity to match with the paving machine used for lining immediately prior to laying of the lining but in no case the time interval should exceed 3 days in normal weather conditions and 2 days in adverse weather conditions.
All along the canal alignment the raincuts on the banks shall be filled up with approved excavated material and shall be compacted adequately to required line and level. The material required for filling the over excavation, raincuts, if not available during excavation in soils to be done under this item, shall be hauled from spoil bank and placed in position. The trimmed by mechanical means like road grader, mechanical trimmers etc. and side slopes shall be trimmed to the required section by mechanical trimmers only. The canal bed and slopes shall be dressed, watered to a depth of 15 cm or upto an impervious . layer which ever is less and compacted by suitable rollers and slope compactors. This item also includes dewatering and / or desilting the canal section as and when required.
- (c) If at any point material has been excavated beyond the payline required to receive the concrete lining, the excess excavation shall be refilled in horizontal layers with selected material moistened, if required, and compacted using rollers and slope compactors. Where placing and compacting bedding material is on a sloping foundation, the layers may be placed parallel to the surface of the foundation. If at any point the foundation material is disturbed or loosened during the excavation process or otherwise it shall be moistened, if required, and thoroughly compacted by tamping, rolling or other approved methods to form foundations for placing the concrete lining.
- (d) Immediately prior to placing the first lift of bedding material, the surfaces of the excavation and embankment to receive the material shall be adequately wetted to a depth of 15 cm or to impermeable material whichever is less as approved by the Engineer -In-Charge.
- (e) After the canal prism has been shaped to a reasonably true and even surface as described above, bedding material shall be placed on adequately wet surfaces in layers of 15 cm maximum thickness to bring the bedding material to a height where it can be trimmed to form a true and even surface upon which the concrete for lining is to be placed. Each layer of bedding material shall be moistened and thoroughly compacted.
- (f) At the end panels of existing lining against which lining is to be placed under these specifications, all loose material shall be removed and all voids beneath the existing lining shall be refilled and thoroughly compacted.
- (g) At- the end of panels of, existing lining just before monsoon the contractor shall take all measures to adequately protect the underneath of lining in slope and bed so as to prevent the monsoon water, entering below the lining and damage it.
i. At the end of panel or at the construction joint, PVC strip shall be provided and same shall not be paid separately.
- (h) Suitable useful material trimmed from the canal shall be used to complete canal embankments or to construct road embankments or for backfill around structures or to deposit bedding material. Where material suitable for bedding as determined by the Engineer –In-Charge is encountered during trimming

operations and cannot be placed in one continuous operation, such material shall be stockpiled along the right-of way where designated by the Engineer -In-Charge

3B. 4.2. Tolerances

Excavated profile provides the final base for lining and tolerances i.e. departure from established alignment shall be as indicated here below.

20 mm on straight section.

50 mm on tangents

100 mm on curves

Departure from established grade

20mm

The above tolerance shall negotiated gradually through smooth transition in a length of 50 m.

3B.5 MATERIALS FOR LINING:-

3B.5.1 Cement

- (a) Only Ordinary Portland Cement (OPC grade 43, shall be generally used and shall be procured in bulk by the contractor.
- (b) Sampling and testing shall be done as per IS : 3535 of 1989 by the quality control authority of Department. No cement shall be used until notice has been given that the test results are satisfactory. Cement older than 90 days shall not be used unless the test results satisfy the minimum strength requirements.

Cement shall, for its physical and chemical requirement conform to IS : 269-1976 where ordinary Portland Cement is used. Manufacturer's test results of its laboratory should be furnished so that works can be allowed if the manufacturer's lab results are found OK till tests the cement.

- (c) The Contractor shall create a suitable and adequate infrastructure for procuring, handling, storing and conveying bulk cement to batching plant at site, with advance planning of work to be done in next fifteen days, as approved by the Engineer-in-Charge.

3B.5.2 Fine Aggregate:

I) General:

- (a) All the aggregates shall conform to IS ; 383-1970 or its latest version and as directed by the Engineer-in-Charge. Sand to be used shall be natural as obtained from the river bed and the maximum size shall be limited to 4.75 mm.

Fine aggregates will be tested for their gradation, specific gravity, water absorption, fineness modules; soundness; petrographic analysis, deleterious constituents and alkali aggregate reactivity. Due allowance shall be made if at the time of mixing, the sand is wet. The exact extent of such allowance or bulkage shall depend upon the quantity of moisture in sand and it shall be decided by the Engineer-in-Charge.

- (b) The Contractor shall procure approved quality of sand from any of the sources at his own cost.

(ii) Quality:

- (a) Sand shall_ consist of hard, inert. dense, durable and uncoated silicious gritty materials. It shall be free from injurious amount of dust, lumps soft and flaky particles, shale, alkali, organic matter, loam and other deleterious substances. The maximum percentage of each of the deleterious substance in sand as delivered to the mixer shall not exceed the following values:

Limits of deleterious material:

- (i) Coal and lignite 1.0 Percent by weight
- (ii) Clay lumps 1.0 Percent by weight
- (iii) Material finer than 3.0 Percent by weight

CONTRACTOR

EXECUTIVE ENGINEER

- 75microns I.S. sieve
- (iv) Shale 1.0 Percent by weight
- (v) total of percentage of all deleterious material (except Mica) 5.0 Percent by weight
- (c) Sand shall be free from injurious amount of organic impurities and sand that are producing a colour (Obtained by dissolving 9 grams of chemically pure (c.p.) ferric chloride and 1 gram of c.p. cobalt chloride in 100 ml of water to which one third ml of hydro chloride acid has been added) darker than the standard in the test (organic test) for organic impurities shall be rejected.

(iii) Grading

- a) Sand shall be well graded so as to impart good workability and good finishing. Sieve analysis of natural sand shall conform to the following limits of gradation.

IS Sieve	Cumulative percentage of weight passing through sieve
10mm	100
4.75mm	92 - 100
2.36mm	75 - 92
1.18mm	55 - 82
600 micron	30 - 64
300 micron	10 - 64
150 micron	3 - 10

- (a) Deviations from the prescribed limits of cumulative percentage retained on sieve 10mm, 4.75mm, 150 micron IS sieves shall be permitted provided total of such deviations do not exceed 5 percent. No deviation from the prescribed limit shall be permitted for cumulative percentage retained on 600 micron IS sieve.

(iv) Fineness Modulus:

- (a) Sand shall have a fineness modulus between 2.4 to 3.0 'subject to the gradation specified in the preceding paragraph.
- (b) The modulus shall be computed by adding cumulative percentage of sand retained on the standard screens 4.75mm, 2.36mm, 1.18mm, 600 micron, 300 micron, 150 micron IS sieves and dividing the sum by 100. Gradation of sand shall be so controlled that the fineness modulus of at least 9 out of 10 consecutive test samples of finished sand shall not vary by more than 0.10 from the average of 10 test samples. Sand having any deviation from the specified range of gradation and fineness modulus shall not be permitted to be used in work without the written permission of Engineer-in-Charge.

(v) Testing:

The following testing frequencies shall be maintained for the same source of fine aggregates:

Sl No.	Name of Test	Min. No. of test specified
1	Gradation for fineness modulus	Daily one test. If the variations of daily F.M. values is more than 0.1, then frequencies may be increased Daily one test Daily one test
2	Silt content	Twice in concreting work season.
3	Moisture content	
4	Sp. Gravity and water absorption soundness, alkali aggregate	

CONTRACTOR

EXECUTIVE ENGINEER

	reactivity, petrographic examination.	
--	---------------------------------------	--

(vi) Storage

All sand shall be stored on the site of work in such a manner as to prevent intrusion of foreign matter.

3B.5.3 Coarse Aggregate

(i) General

- (a) Coarse aggregate for concrete shall consist of clean; hard, dense and durable crushed metal free from vegetable matter. Predominantly flaky aggregates shall not be used. All coarse aggregates shall be washed and/or screened by the Contractor, if required. The percentage of deleterious substance in coarse aggregate shall not exceed the following values:

	Material passing 75 micron
IS sieve screen	3 percent by weight
Shale	Nil percent by weight
Coal and lignite	1 percent by weight
Soft fragments	3 percent by weight
Clay lumps	1 percent by weight

- (b) The sum of the percentage of all the deleterious substances shall however, not exceed 5 percent by weight. The coarse aggregate shall satisfy -abrasion, soundness, crushing and alkali aggregate reactivity tests and water absorption results as laid down in IS : 383-1'970 and other relevant Indian Standard Specifications.

(ii) Source

The Contractor shall have to make his own arrangement for arranging good and approved quality of aggregate.

(iii) Grading

- (a) Course aggregate shall be well graded and shall have a maximum size of 20mm.
- (b) The gradation shall give a dense concrete of the specified strength and consistency that will work readily into position without segregation and without the use of excessive water content.
- (c) The grading of coarse aggregate shall be in the nominal sizes as mentioned in Table II of IS : 383-1970 reproduced below in respect of 40 MSA and 20 MSA.

IS Sieve Designation	Percentage Passing for aggregate of nominal size		
	40 mm	20 mm	10 mm
80 mm	--	--	--
63 mm	100	100	--
40 mm	85 – 100	85 – 100	--
20 mm	0 – 20	--	--
16 mm	--	--	--
12.5 mm	--	--	100
10 mm	0 – 5	0 – 20	85 - 100
4.75 mm	--	0-5	0 - 20
2.36 mm	--	--	0 – 5

(In concrete for canal lining, the percentage of 4.75 to 10mm fraction shall be reduced to about 5 to 10 percent of the total coarse aggregate). However, the exact gradation required to produce a dense concrete of specified strength and desired workability shall be decided by the Engineer-in-Charge.

- (d) The material passing through the screen shall be in grade ranging from 20 to 4.75mm. Each grade of material shall be stacked 40mm to 20mm, 20mm to 10mm and 10 mm to 4.75 mm.
- (e) Coarse aggregate shall consist of inert, clean, hard, strong, durable and structurally sound particles of crushed stone and shall be free from thin elongated soft pieces, organic or other deleterious matter capable of developing good Bond with cement paste and weather resistant and unaffected by water. It shall have no adherent coating of clay, silt, mud or any other adherent coating. It shall

CONTRACTOR

EXECUTIVE ENGINEER

be from a source approved by Engineer-in-Charge. Coarse aggregates' shall conform to IS : 383-1970 and IS: 515-1959.

- (f) Coarse aggregates shall be washed and screened at the source approved by the Engineer-in-Charge. If necessary, Contractor shall remove all vegetation and other perishable substances and objectionable amounts of other foreign and deleterious matter. The cost of washing and screening at the source shall be borne by the Contractor. In case the coarse aggregate brought to the site of work is not washed and screened at the source, the Contractor shall make necessary arrangements for washing and screening at the B&M plant and its cost shall be borne by the Contractor.
- (g) Following shall be maximum size of coarse aggregate for the different items of work.
- (h)

Sl No.	Item of Work	Max. Nominal size of Coarse aggregate (MSA)
1	Foundation concrete and gravity retaining walls (mass concrete)	40 mm
2	RCC Rafts, piers, abutments, barrels, cutoff walls, breast walls, transition walls and stanching ring, etc.	20 mm
3	RCC work in main and cross girders, Deck slab, wearing coat, curb, parapet walls, approach slab, pier caps and other thin walled members and in zones of congestion caused by closely spaced reinforcements bars.	20 mm
4	For any other items of construction not covered under 1 to 3	As specified in the drawings or in case it is not specified in drawing as directed by the Engineer –in-charge.

(iv) Testing :

The following testing frequencies shall be maintained for the same source of course aggregate.

Sl No.	Name of Test	Minimum No. of Tests specified
1	Gradation	Daily one test for each nominal size of aggregate.
2	Water	Daily one test for each nominal size of aggregate.
3	Silt Content	Daily one test for each nominal size of aggregate.
4	Sp. Gravity and water absorption, impact or abrasion value, density, soundness, alkali- aggregate reactivity, petrographic examination.	Twice in a concreting working condition.

(v) Storage (Stock Piles)

- (a) Aggregate shall be stacked in such a way as to prevent the admixture of foreign materials such as soil, vegetable matter etc. Heaps of-fine and coarse aggregates shall be kept separate when different sizes of fine or coarse aggregate are procured separately, they shall be stored in separate stockpiles, sufficiently away from each other to prevent the materials at the edge of the piles from getting intermixed.
- (b) The aggregates shall be stockpiled adjacent to the mixer site so as to require minimum rehandling and labour when conveyed to the mixer.
- (c) The aggregates shall be placed on a dry hard patch of ground if available otherwise a platform of planks or plain galvanised iron sheets or alternatively on a floor of dry bricks or a thin layer of lean concrete.
- (d) The aggregates shall be kept free .of dirt, rubbish, papers, vegetable matter and bidi, etc. an the

CONTRACTOR

EXECUTIVE ENGINEER

stack piles by the collection .of people..

- (e) To minimise moisture variations the stockpiles shall be spread over as large in area as possible but kept low and fairly uniform in height preferably 1.25 to 1.50 metre "and the lowest layer of about 30 cm height shall be allowed to act as drainage layer and not used till the end.

3B.5.4 Water

(a) Water used for mixing .of concrete and mortar shall be free from injurious amounts .of deleterious materials. Potable water is generally considered satisfactory for mixing and curing.

(b) Where water is found to contain any sugar .or an excess of acid, alkali .or salt, the Engineer-in-Charge will refuse to permit its use. As-a guide the following table represents the maximum permissible values.

Percent by weight

Organic	0.02
Inorganic	0.30
Sulphate	0.05
Alkali Chlorides	0.10
pH value	5 to 8

3B.6.5 Admixtures

(i) General

Super plasticizer as an admixture shall be added to the concrete batch in solution. It shall be batched by means .of mechanical batcher capable .of correct measurement and in such a manner as will ensure uniform distribution of the agent through out the batch during the specified mixing period. The contractor will be allowed to use any other admixture, .only after prior approval of the Engineer-In-Charge. Cost of such admixture shall be borne by the contractor and shall be deemed to have been included in the unit rates quoted by the contractor for relevant items.

(ii) Tests

If the contractor uses his approved admixtures, the Contractor shall provide satisfactory facilities for easy and quick collection of adequate test samples. All tests for the evaluation and approval of an admixture shall be made by and at the expense of the department.

3B.6 CAST IN-SITU CONCRETE LINING:-

3B.6.1 General

The work shall conform to IS: 3873-1978. All concrete for lining shall be - governed by IS: 456-1978. The concrete shall be of controlled grade with admixtures of super plasticizer using well graded aggregates with maximum size of aggregate of 20 mm.

3B.6.2 Mechanized paver for lining Works:

The Mechanized paver shall be used for lining work. The mechanized paver shall consist of following:

1. Paver itself inclusive the proper design of different compartment of frames in a sufficient length for bed and slope lining work separately.
2. The slope paver shall be attached with trimmer along with jumbo.
3. Automatic Jack movement facilities for design thickness
4. Belt conveyer system for placing of concrete in bed and slope for each paver.

CONTRACTOR

EXECUTIVE ENGINEER

5. Auger for cutting of concrete.
6. Diesel generator having sufficient capacity for running the paver and belt conveyor etc.
7. The inserting facilities of longitudinal and transverse strips as per the drawing.
8. Rail and channels.
9. Roller with tube vibrator for each paver.

The above all parts of the mechanised paver shall be erected and maintained properly. The unserviceable parts of the paver shall be replaced due to wear and tear of paver as and when required. The pinch rail, rail and channels level shall be checked by the Engineer-in-Charge or his representative before of the lining work.

3B.6.3 Batching

(a) The batching and mixing plant shall be fully automatic and will automatically start the weighing operation of materials and stop automatically when designated weight of each material is reached and interlock in a manner as specified in IS:4925-1968. The wet mixing of the concrete shall be done in mixer attached with batching plant. In no case mixing shall be allowed outside the batching and mixing plant i.e. mixing will not be allowed in transit mixture. The semi automatic or manually operated batching and mixing plant will not be allowed.

- (b) The prescribed amount of the various materials of concrete including water, cement, admixtures, the groupings of fine aggregates and each individual size of coarse aggregate shall be measured and controlled within the specified limits of accuracy. The amount of water, cement and aggregate shall be determined by weighing. In the case of fine aggregates, the surface moisture shall be determined in accordance with the method prescribed in Appendix-D of IS: 456-1978 and its subsequent amendments or publications. In the case of coarse aggregates, percentage of free water shall be determined by weighing a representative sample, then surface drying each particle individually with a -clean piece of cloth and re-weighing.
- (c) The proportions of various materials shall be changed as directed in order to maintain the desired quality of the concrete. The batching equipment shall be constructed and operated so that combined inaccuracies in feeding and measuring the materials shall not exceed 1 ½ percent for water cement ratio and 2 percent for each size of aggregate.
- (d) The operating performance of each scale or other measuring device shall be checked by standard test weight to be supplied by the contractor and test weight shall be got calibrated by the contractor and the tests shall cover the ranges of measurements involved in the batching operations. Tests o equipment in operation shall be made at least once every fortnight and, adjustments, repairs or replacement, be made as necessary to meet the specified requirement for accuracy of measurement.
- (e) Aggregate shall not be batched for concrete or mortar when free water is dripping from the aggregate.
- (e) Before the concreting operation is started the contractor shall provide communication facility in the form of wireless, walki-talki or telephone between the batching and mixing plant and site/sites of various concrete placement and got approved by the Engineer-In-Charge.

3B.6.4 Mixing

- (a) concrete shall be mixed in a mechanical ready mix mixer and shall be as dense as possible, plastic enough to consolidate well and stiff enough to stay in place on the slopes.
- (b) Mixing shall be continued until there is uniform distribution of the materials and the concrete is uniform in cool and consistency. The time of mixing shall be as shown in Table -I of IS : 457-

Capacity of Mixer	Minimum time of mixing	
	Natural Aggregates	Manufactured Aggregates
4 m ³ or larger	2 minutes	2 ½ minutes
3 m ³	1 ½ minutes	2 minutes
1 m ³ or smaller	1 ¼ minutes	1 ½ minutes

3B-6.5 Consistency

The quantity of water to be used in the concrete shall be determined from time to time during the course of concreting work in order to secure concrete of proper consistency and also adjust for any variation in the moisture content or grading of the aggregates as they enter the mixer. Addition of water to compensate the stiffening of the concrete resulting from over mixing or objectionable drying before placing shall not be permitted. Uniformity in concrete consistency from batch to batch shall be ensured. By taking slump test concrete shall be laid from the bottom to the top of the slope, for which the consistency shall be such that the concrete will just stay in place on the slope. A slump of 60 to 70 mm shall generally be allowed. For heavier longitudinally operating slip form machines, a slump of 50 mm shall be permitted.

To have a close of consistency and workability of the concrete, the slump of concrete shall not vary more than 20 mm from the one specified above as it would otherwise interfere with the progress and quality of the work.

3B.6.6 Transporting

- (c) Concrete shall be handled from the place of mixing to the place of final depositing as rapidly as practicable by use of equipment such as transit mixers which will prevent initial setting, segregation or loss of any of the ingredients. It shall be transported and compacted in its final position within 30 minutes of its discharge from the mixer.
- (d) If segregation occurs during transport, the concrete shall be remixed before being placed, after observing the time requirements as above.

3B.6.7 Placing-and Compaction

- (a) Concrete shall be placed only in the presence of a duly authorised representative of the . Concrete shall be placed and Compacted before initial setting time and shall not be subsequently disturbed.
- (b) Placing of concrete shall not be started until subgrade is ready and preparation of surface upon which concrete is to be laid, have been completely inspected and approved by Engineer-In-Charge. All absorptive surfaces against which concrete is to be laid shall be moistened adequately so that moisture shall not be withdrawn from freshly placed concrete. The surfaces, however, shall be free from any water and slush.
- (c) Concrete shall be deposited in all cases as neatly as practicable directly in its position and shall not be caused to flow in a manner to permit segregation. Excessive separation of the coarse aggregate caused by allowing the concrete to fall freely from too great a height or at too great an angle from the vertical shall not be permitted and where such separation would otherwise occur the Contractor shall provide suitable means / belt conveyor to convey the concrete without allowing such separation.

3B.6.8 Hand Placing

Manual placing of concrete shall not be permitted except as mentioned as in para 3.1(c).

3B.6.9 Mechanical Placing

- a) The lining is required to be laid by using mechanised paving equipment. Each set of paving machine shall constitute.

- (i) Paving Machine
 - (ii) Trimmer
 - (iii) Belt conveyor for placement of concrete
 - (iv) Work bridge
- (b) For efficient placing and finishing of the concrete lining on slopes and in bed, concrete lining machines such as slip form paver or concrete paver finisher of approved quality and design shall be used. Rated Capacity of each lining equipment shall not be less than 12 cubic metre / hour. Each lining machine and associated support equipment utilized under this contract shall place canal lining at an average sustained rate, of advancement of not less than 10 meters per hour. This minimum rate shall be obtained for paving operations on the side slopes and on the bottom of the canal while also meeting the requirements for lapsed time following trimming, consolidation of concrete, thickness, tolerances, finishes, joints and other requirements specified herein.
- The equipment and operation for foundation trimming subgrade preparation, concrete production, concrete delivery, joint 'production, curing compound placement and other associated activities supporting the placement of the canal lining shall be matched with the lining equipment capability so as not to impede the specified placement rate of each lining operation. The overall equipment deployment shall be such as to ensure the completion of canal lining within the schedule period specified in the contract.
- (c) Concrete when deposited shall unless otherwise specified have a placement temperature of not less than 4.50 C and not more than 32⁰C. Unless otherwise specified. The specifications of Para 3.10 shall also apply.
- (d) Concrete shall be deposited and spread on the bed and sides of the canal as indicated on the drawings for panel joints in between them. Concrete may be laid to facilitate, placing, vibrating, finishing and curing operations. The side lining concrete on the sides of canals shall be screened up the slope, while the concrete is being vibrated ahead of the vibrating roller. Concrete required for keys as shown on the drawings be laid integrally along with', the side slope lining. Simultaneously while placing the concrete longitudinal and transverse PVC strips shall be mechanically inserted at the location as shown in the drawing. The PVC shall be continuous along the longitudinal and transverse joints. It shall be seen that both the strips vertically be, embedded in concrete.
- (e) Under normal circumstances manual lining shall not be allowed except in circumstances of mechanical failure and to the extent of utilizing the concrete already received at site of work. In case if manual concrete lining, is allowed for the reason mentioned as above or as per the request of the contractor a deduction of Rs. 10.00/m² shall be effected. However, the manual lining shall be restricted to about 50 m² at any location.
- (f) Alternatively the contractor can select to use longitudinally operating self aligning, slip form machine with built-in vibrators attached to the side forms so as to effectively compact and finish the. slope and bed concrete.
- (g) The joints are formed by lining equipment in green concrete.

3B.6.10 Finishing

- (a) All exposed concrete surface shall be cleaned of impurities, lumps of mortar or grout and unsightly stains. The finished surface shall be even, smooth and free from pockets and equivalent to that obtainable by effective use of a long handle steel trowel. Surface irregularities, when tested with a straight edge of 1.5 metre length shall not exceed 6 mm in canal bed for bottom slab and 12 mm in that laid on side slopes.
- (b) The surface of concrete finished shall be smooth and free from projections, honeycombing and other objectionable defects.
- (c) Repairs to concrete surface and additions where required shall be made by cutting regular opening

into the concrete and placing fresh concrete to the required lines. Chipped openings shall be sharp and shall not be less than 75mm depth.

3B.6.11 Curing

3B.6.11.1 General

The concrete lining on slopes with key including curvature portions at junction of slope and bed lining shall be cured with liquid membrane forming curing compound in accordance with specifications given in para 3.7.11.2. The concrete lining in canal bed shall be cured with water in accordance with the specifications given in para 3.7.11.30. If water curing of lining in canal bed is not carried out to the satisfaction of the Engineer-In-Charge as per specifications, the contractor shall be directed to switch over to liquid membrane forming curing compound for curing for which no extra payment shall be made to the Contractor.

All equipment, material, etc. needed for curing and protection of concrete shall be at hand and ready for installing before actual concreting begins. Detailed plans, methods and procedures where by the various phases of curing and protection shall be firmly established, shall be settled and got approved in writing from the Engineer-in-Charge sufficiently in advance of the actual concreting.

The equipment and method proposed to be utilized shall provide for adequate control and avoid interruption or damage to the work of other agencies.

3B.6.11.2 Membrane Curing

(a) These specifications cover curing of concrete using membrane forming compound to retard the loss of water during the early hardening period and to reduce the temperature rise in concrete exposed to radiation from the sun. This compound shall be suitable for use as curing media for fresh concrete and after initial moist curing.

(b) Concrete of canal lining on slopes including key at the top and curved portion at the bottom of the slope of the canal shall be cured with liquid membrane forming white pigmented curing compound which shall form water retaining surface to achieve the desired effect of water curing at 28 days. The curing compound shall be white pigmented of approved quality conforming to ASTM-C-309- 81 Type-2.

(c) White pigmented compound [Type-2] shall consist of finely divided white pigments and vehicle/solids, ready mixed for immediate use without alteration. The compound shall present a uniform white appearance when applied uniformly to a fresh concrete surface at a specified rate of application.

It shall be of such consistency that it, can, be readily applied by spraying to provide uniform coating at temperatures above 4⁰C. Two coats shall be applied from the application of the first coat, second coat shall be applied after an interval of approximately one-hour. They shall adhere to freshly placed concrete that has stiffened or sufficient to resist marking during the application and to damp hardened concrete and shall form a continuous film when applied at the specified rate of application. When dry, the covering shall be continuous, flexible and without visible breaks or pin holes and shall remains unbroken film for at least 28 days after application. It shall not react deleteriously with the concrete.

(c) The compound shall meet with the requirement of water retention test as 'per ASTM designation C-156-80. The loss of water in this test shall restricted to not more than 0.55 kg/m² of exposed surface in 72 hours.

(e) The white pigmented compound [Type-2] when tested as specified in accordance with method E-97 of ASTM shall exhibit a daylight reflectance of not less than 60% of that of magnesium oxide.

CONTRACTOR

EXECUTIVE ENGINEER

- (f) It shall fulfill the requirement of drying time when tested in accordance with ASTM-C-309-81. The compound applied shall be dry to touch in not more than 4 hours. After 12 hours it shall neither be tacky nor tack off (peel off) concrete when walked upon nor it shall impart a slippery surface.

(g) Testing

- (i) The liquid membrane forming curing compound shall be brought in the Manufacturer's original clear containers. Each container shall be legibly marked with the name of the manufacturer, the trade name of the compound, the type of compound and class of vehicle/solids, the nominal percentage of non-volatile material and batch or lot number date/week/month/year. The lot numbers will be assigned to the quantity compound mixed, sampled and tested as single product. The manufacturer test results from manufacturer's lab shall be furnished to the Engineer-In-Charge for approval.
- (ii) Curing compound to be used on site shall be got tested at least 14 days in advance so that the result of water retention tests, reflectance test, drying etc. are available before it can be permitted for use. All of the filled containers, represented by the approved sample shall then be sealed to prevent leakage, substitution or dilution.
- (ii) The Engineer-In-Charge or his authorized representative should mark each container represented by the samples with a suitable identification mark for later identification and correlation and shall be kept in store with double lock arrangements, of which one key shall be kept with the Contractor and the other with Engineer-In-Charge. Random samples shall be collected from every batch of the compound. Frequency of sampling shall be one , sample for every 2000 liters of each batch, or as directed by the Engineer-in-charge. The Contractor shall provide samples and labour for Collecting samples as above at free of cost. Testing shall be carried out by the for which Contractor shall not be charged.

(h) Method of Application

The compound shall be sprayed using mechanical sprayer with-agitator only of approved design to ensure uniform and continuous membrane on the concrete surface. The coverage shall be at the rate specified by the manufacturer or at the rate of 4 to 5 m² per liter. Field trials shall be conducted to decide effective coverage rate, which depends upon surface finish. If the effective coverage rate works out to less than that specified by the manufacturer or the rate specified above, no compensation whatsoever shall be paid to the Contractor for less coverage. Before applying the curing compound the concrete surface shall be cleaned by brooms or other means not to disturb, damage or any foot impression on concrete.

With a view to ensure thorough and complete coverage, in each coat approximately one half of the compound for a given area should be applied by moving the spray gun back and forth in one direction and the remaining half at right angles to this direction. The curing compound shall be applied as soon as the bleeding water or shine disappears, leaving dull appearance. Equipment for spraying curing compound shall be of pressure tank type (5 to 7kg/cm²) with provision of continuous agitation. Spraying on concrete lining shall be. done in such a way that the green concrete is not disturbed or damaged or any foot impression left. Necessary schemes or spraying by mechanized means shall be got approved from the Engineer-in-charge. However, in emergency for very small areas (patches) it can be applied with brush as per the direction of the Engineer-In-Charge. Such compound shall be used on the work only after production of test results and approval of the schematic plan of spraying curing compounds. Adequate care shall be taken to prevent tiny movements on cured surface up to 28 days after application of curing compound.

- (i) Under unavoidable circumstances, created by non availability or short supply of specified curing compounds, the Contractor may be allowed - to resort to water curing of concrete lining on slopes obtaining prior approval of the Engineer-In-Charge in writing. Such water curing shall be

restricted to only a short reach and for a very short period and will in no case be construed as a general relaxation. It shall be carried out without any extra cost to department and in accordance with the following specification.

- (ii) The concrete lining on slopes including curvature portion at junction of slope and bed lining shall be moist cured with hessian cloth strong canvas coat of hemp or jute tied and spread over the slope. Soon after that the concrete is initially hardened and shall be kept moist with light water spray. The hessian cloth shall be kept continuously wet for at least 21 days by supplying water through perforated pipe laid along the edge of the canal lining or by any other method approved in writing by Engineer-in-charge. Adequate care shall be taken to ensure that the perforations in the pipe do not get choked.

3B.6.11.3 Water Curing

Unformed top surface of invert of the canal shall be kept continuously moist by covering it completely with wet burlap coarse canvass of just as soon as the concrete has hardened sufficiently say, 4 to 6 hours after concrete placement. The burlap shall be kept continuously wet by spraying water for at, least 12 hours. There after curing by ponding shall be resorted to. Concrete cured with water shall be kept wet ponding for at least 14 days. Water lost evaporation shall be replenished periodically to keep the surfaces continuously (not periodically) submerged under water.

When the curing of concrete in the canal bed is not found satisfactory the Engineer-In-Charge may ask the Contractor to resort to membrane curing without any extra cost to department.

3.B.7 TESTING OF CONCRETE AND ACCEPTANCE OF WORK

3.B.7.1 General

Testing of concrete shall be carried out at the cost of the department on representative samples taken at the site of laying the concrete in accordance with relevant Indian standard specification.

3B.7.2 Sampling Procedure and Frequency

- (a) **Sampling Procedure:** A random sampling procedure shall be adopted to ensure that each concrete batch has a reasonable chance of being tested i.e the sampling should be spread over the entire period of concreting and should cover all mixing units.
- (b) **Frequency:** The minimum frequency of sampling of concrete of each grade shall be in accordance with the following.

Quantity of concrete m ³	Number of set (Six Samples)
Upto 5	1
6 to 15	2
16 to 30	3
31 to 50	4
51 and above	4 plus one additional sample for each additional 50 m ³ or part thereof.

Note At least, one sample shall be taken during each shift

3B.7.3 Test Specimen

Three test specimens shall be made from each set for testing at 28 days. Additional cubes may be required for various purposes, so as to determine the strength of concrete at 7 days or at the time of striking formwork, or to determine the duration of curing or to check the testing cubes cured by accelerated methods as described in IS:9013-1978. The specimen shall be tested as described in IS: 516-1959.

3B.7.4 Test Strength of Samples/specimen

- (a) The test strength of the samples shall be the average of three specimens. Individual

variation shall not be more than 15 percent of the average.

- (b) Contractor shall provide necessary unskilled labour for collection of samples/cores etc. and facilities for immediate transport of collected samples, cores, etc. from site to laboratory and shall remain present at the time when carried out at the testing laboratories set up at the site or at any other laboratory that the Engineer-In-Charge may decide upon and the results given there by shall be the contractor. The Contractor shall be given access to all operations and tests that may be carried out as aforesaid. All testing charges are to be borne by the department .

3B.7.5 Acceptance Criteria

- a) The average strength of the group of cubes cast for each day shall not be less than the specified -cube strength for the work. About 20 percent of the cubes cast for each day may have values less than the specified strength provided the lowest value is not less than 85% of the specified strength.

(b) In case the concrete does not conform to the acceptance criteria for strength as specified above, the Engineer-In-Charge reserves the right to reject the work accept the same at a reduced rate derived from tendered rate and as approved by him. Whenever necessary for the purpose of obtaining economy, workability, density, impermeability, durability or strength on account of variations of the quality and gradation of aggregates or other materials, the Engineer-In-Charge shall after testing make necessary changes in the proportion of mix. Contractor shall have to effect these changes, and shall not be entitled to any compensation on account of such changes.

3B.8 JOINTS

In canal lining contraction joints shall be provided to accommodate contraction of the concrete or to provide continuity between the breaks in construction work. Joints shall be provided as shown on the drawings or as directed by Engineer-in-charge.

Normally, in plain cement concrete lining joints shall be provided at 4 m center to center, where as in case of RCC lining joints shall be provided in longitudinal direction only at 8 m center to center & expansion joint in transverse direction @ 7.5 m center to center. The detailed specification for PVC para 3.14. The reinforcement shall be discontinued at joint.

3B.9 TOLERANCES

- (a) The intent of this paragraph is to establish tolerances that are consistent with modern construction practice and yet be governed by the effect that permissible deviations will have upon the structural action or operational function of the structure. Deviations from the established lines, grades and dimensions shall be department reserves the right to diminish the tolerance set forth if such tolerance impairs the structural action or operational function of the lining.

- (b) Tolerance for lining shall be permitted within the following limits:

(c)	Departure from established alignment	20mm on straight reaches, 50 mm on tangents.
(d)	Departure from established grade	100 mm on curve, 20mm on straight reaches.
(e)	Variation in concrete lining thickness	10% of lining thickness provided average lining thickness of each day's placement is not less than specified thickness.

Any departure from alignment or grade shall be uniform and no corrections in alignment be made in less than 50m. No overrun in concrete quantity shall be paid to the Contractor.

3B.10 DEWATERING & DESILTING:

Dewatering due to water entering into canal for any reason shall be resorted to and continued during preparation of sub grades, providing underdrainage arrangements and placing of concrete for lining in bed & slope till such period the concrete attains necessary strength. No separate payment shall be made for dewatering and desilting for presence of water due to any reason in the

canal operation, as the same is deemed to have been included in rate of related item in Schedule-B.

3B.11 MEASUREMENT AND PAYMENT

(i) Plain Cement Concrete Lining:

- (a) Measurement will be on the basis of square metre of plain concrete lining and payment will be at the unit rate quoted in Schedule-B. Payment for lining will be made for the thickness shown on the drawings and on square metre basis of the surface area in bed and on sides including keys. The thickness of lining shall be maintained in relation to final subgrade on which lining is to be laid. The thickness shall be cross checked by (1) Volume of concrete placed from batching and mixing plant and area covered (2) Use of probe when concrete is green and (3) coring if required. Any over run in quantity of concrete in lining shall not be paid to the Contractor.
- (b) The unit rate for lining also includes costs of all material transport with all leads and lifts, mixing; formwork, conveying, placing, compacting, smooth finishing, curing etc. forming grooves for joints but subject to provisions made in 3.7.9 (e)
- (c) No overrun in concrete quantity shall be paid to the Contractor.
- (d) The unit rate quoted by the bidder for the respective item shall be deemed to have included the requirement of cement for miscellaneous operations like priming of mixer, laying cement slurry for successive lifts, finishing of concrete etc. also.

SECTION – IV

4.0 PLAIN AND REINFORCED CONCRETE

4.1 SCOPE OF WORK

The specification covers the requirements of plain and reinforced concrete for use in various components of structures. The work covered under this section consists of furnishing all materials including formwork, equipment, labour for the manufacture, transport, placing, vibrating, finishing and curing of the concrete for the structures and performing all the operations necessary and ancillary thereto including dewatering and desilting etc., as required; For the reinforced concrete structures, granite quartzite, dolerite. or trap shall only be used as coarse aggregate.

4.2 APPLICABLE PUBLICATIONS

All concrete, its constituents, methods and procedures of manufacture, placement etc. shall conform to Indian Standard Specifications and other publications listed below unless otherwise specified.

4.2.1 INDIAN STANDARDS FOR REFERENCE

- | | | |
|----|------------------------------------|---|
| 1. | IS : 303- 1975 | Plywood general purpose |
| 2. | IS : 432-1966 (part 1) | Mild steel and medium tensile steel bars |
| 3. | IS : 516-1976 | Portland slag cement |
| 1. | IS : 516- 1959 | Methods of test for strength of concrete |
| 5. | IS : 2505-1980 | Concrete vibrators immersion type. |
| 6. | IS : 2506- I 964 | Screed board concrete vibrators. |
| 7. | IS : 3370-1965-1967
(All parts) | Code of practice for concrete structures
for the storage of liquids. |

CONTRACTOR

EXECUTIVE ENGINEER

- | | | |
|-----|----------------|--|
| 8. | IS : 3558-1983 | Code of practice for the use of immersion vibrators for consolidating concrete. |
| 9. | IS : 4656-1968 | Form vibrators concrete |
| 10. | IS : 4990-1981 | Plywood for concrete shuttering works. |
| 11. | IS : 5242-1979 | Method of test for determining shear strength of mild steel. |
| 12. | IS: 8989-1978 | safety code for erection of concrete framed structure. |
| 13. | IS : 9077-1979 | Code of practice for corrosion protection of steel reinforcement in R.B. and R.C.C construction. |

In addition to the above, relevant Indian Standards referred in Section-III shall also apply.

4.2.2 OTHER PUBLICATIONS

- | | | |
|----|--|--------------------|
| 1. | Indian road congress standard specifications and code of practice for road bridges | section I, II, III |
| 2. | Concrete Manual (Latest Edition) | U.S.B.R. |
| 3. | American Society for testing of materials | C. 494.80 |
| 4. | Design aids to IS : 456-1978 for reinforced concrete. | SP 16(S & T) 1980 |

4.3 COMPOSITION

(a). Concrete shall be composed of cement, fine aggregate (natural sand of manufactured sand or both), coarse aggregates (manufactured or natural gravel) admixtures and water, well mixed in Proportion and brought to the proper consistency. The design mix proportions shall be adjusted to produce a durable and workable concrete, suitable for specified conditions of placements and design strength.

(b) For all items of concrete in any portion of the structure or its associated works, controlled concrete shall be used where specified.

4.4 MATERIALS

4.4.1 CEMENT

(a) Only 43 grade ordinary Portland cement shall be used for R.C.C. constructions while Pozzolona Portland cement (P.P.C.) shall be allowed to be used for plain concrete.

(b) Immediately, upon receipt at the site of the work, cement shall be stored separately in dry, water tight and properly ventilated structures. All storage facilities shall be subject to approval and shall be such as to permit easy access for inspection and identification. Sufficient cement shall be kept in stock for completion of concreting undertaken. Cement shall be used in order of receipt and cement older than 90 days shall not be used unless the test results satisfy the minimum strength requirements. The provision made in Para 3.5.1 shall also apply.

4.4.2 FINE AGGREGATES

The provisions made under Para 3.5.2 shall apply.

4.4.3 COARSE AGGREGATES.

(a) Coarse aggregates shall consist of hard, strong, durable particles of crushed stone or gravel and shall be free from thin elongated soft pieces, organic or other deleterious matter. It shall have no adherent coating. It shall be from a source, approved by the Engineer-in-charge. Coarse aggregates shall conform to IS : 383-1970 and IS : 515- 1959.

(b) Coarse aggregates shall be washed if necessary to remove all vegetations and other perishable substances and objectionable amounts of other foreign matter. The cost of washing and screening shall be borne by the contractor.

(c) Following table gives an indication of the maximum size of coarse aggregate for the different items of work. However maximum size of coarse aggregate shall be adopted as indicated on the

drawings:

SI No.	Item of work	Maximum Nominal size of coarse Aggregate (MSA)
(i)	Foundation floor and gravity retaining walls (mass concrete)	40 mm / 80 mm
(ii)	R.C.C. Rafts, piers, Abutments Barrels, cutoff walls, Breast walls Staunching rings etc.	40 mm
(iii)	R.C.C. work in main and cross girders, Deck slab, wearing coat, curb, parapet walls, approach slab, pier caps, diaphragm wall and other thin walled members and in zones of congestion.	20 mm

(d) For heavily reinforced concrete members, as in the case of ribs of main beams, maximum size of aggregate shall usually be restricted to 5 mm. less than the minimum lateral clear distance between the main bars or 5 mm less than the minimum cover to the reinforcement, whichever is smaller. However, if required under special Circumstance, the Engineer may permit an aggregate of maximum size 25% more than this/critical spacing / cover, provided that proper vibration is ensured. The other provision of section 3.5.3 shall apply.

4.4.4 REINFORCEMENT STEEL

The provisions of SECTION - V shall apply.

4.4.5 WATER

The provision of Para 3.5.4 shall apply.

4.4.6 ADMIXTURES

Admixtures like water reducing agents, air entraining agents, water proofing agents etc. shall be used only if permitted by the Engineer. The kind of admixture its make and quality, the proportion and the manner of mixing shall be subject to Engineer's approval.

4.4.7 EPOXY

Use of epoxy for bonding fresh concrete for repairs shall be permitted on written approval of the Engineer. Epoxy shall be applied in accordance with the instructions of the manufacturers. The cost of such repair shall be borne by the contractor.

4.5 CONCRETE FOR STRUCTURES

Controlled ready mix concrete shall be used for the structures in three grades designated as M-10, M-15 and M-20. The mix shall be designed using representative samples of available coarse and fine aggregate as well as cement and. water to achieve the required workability strength and durability standards. Mix design studies and test will be made by the department.

4.6 STRENGTH REQUIREMENT OF CONCRETE

The compressive strength requirement for the various grades of controlled concrete shall be as per **TABLE NO.1** given below:

TABLE NO. 1

Grade of concrete	Compressive test strength in N/Sq mm of 150 mm cube conducted in accordance with IS: 516-1959	
	Min. at 7 days	Min: at 28 days
M-10	7	10
M-15	10	15

CONTRACTOR

EXECUTIVE ENGINEER

M-20	13.5	20
------	------	----

Note: in all cases, the 28 days compressive strength specified in table shall alone be the criteria for acceptance or rejection of the concrete on the basis of its strength. Where the strength of a concrete mix as indicated by tests lies in between the strength for the two grades specified in table, such concrete shall be classified for all purpose as concrete belonging to the lower of the two grades between which its strength lies.

4.7 PROPORTIONING CONCRETE

- Concrete mix shall be designed on the basis of preliminary test. The proportion of ingredients shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available. Samples of construction material required for evolving design mix shall be supplied 3 months in advance.
- Unless it can be shown to the satisfaction of the Engineer-in-charge that supply of properly graded aggregates of uniform quality can be maintained till the completion of the work, grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions as required. Different sizes shall be stacked in separate stockpiles. Required quantity of materials shall be stock piled atleast 3 days in advance before use. Grading of coarse and fine aggregates shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the supplies are maintaining the uniform grading as approved for samples used in the preliminary tests. In proportioning concrete the quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tank or weighed. All measuring equipment shall be maintained in a dean serviceable condition. Their accuracy shall be periodically checked.
- It is** most important to maintain the specified Water cement ratio. To this end, moisture content in both fine and coarse aggregates shall be periodically determined and the amount of mixing water shall be adjusted to compensate for any variations in. the moisture content. For the determination of moisture content in the aggregates IS : 2386-1963 (Part III) shall be referred to. Suitable adjustment shall also be made in the batched weight of the aggregate depending upon the variations in their moisture content.

(d) The amount of cement for various grades of concrete as mentioned in the specification of the respective items(including lining with Mechanical paver) in schedule –B may be considered for quoting the rate in the schedule -B

TABLE

Sl.No	Description	Grade of concrete	Approx quantity of cement per cum/Sqm of concrete
1	M-15 CC,(20mm CA) for lining	M-15	270.00/Cum
2	M-15 CC,(20mm CA) for lining with paver 100mm 80mm	M-15	28.90 Kg/sqm 23.30 Kg/sqm
3	M-10 CC,(40mm CA) for foundation	M-10	220.00 Kg/Cum
4	M-15 CC,(20mm CA)	M-15	270.00 Kg/Cum
5	M-20 CC,(20mm CA) for sub structure and super structure	M-20	330.00 Kg/Cum
6	M-15 CC,(40mm CA) for foundation filling	M-15	240.00 Kg/Cum
7	M-20 CC,(20mm CA) for RCC trough	M-20	330.00 Kg/Cum
8	M-20 CC,(20mm CA) for Deck slab	M-20	330.00 Kg/Cum
9	M-20 CC,(20mm CA) for columns and	M-20	330.00 Kg/Cum

CONTRACTOR

EXECUTIVE ENGINEER

	beams		
10	M-20 CC,(20mm CA) for wearing coat	M-20	330.00 Kg/Cum

Note: Table to be separately enclosed, with respect to different items of concrete referred in Schedule-B of the tender as per SR adopted.

(e) Actual cement level required for the aggregates to be used shall be determined by Laboratory tests. The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the formwork. When concrete is hardened, it shall have the required strength, durability and surface finish. A mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than that stipulated in table under para 4.6 above. Due to the change in design mix, if it becomes necessary to use less or more cement per cubic metre / square metre of concrete than shown in the above table, no extra payment will be made to the contractor for variation in cement content during execution.

f) The quantity of water shall be just sufficient to produce a dense concrete of required workability-and strength for the job. An accurate and strict control shall be kept on the quantity of water.

(g) **Incase** of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips all reinforcement. The degree of consistency, which shall depend upon the nature of work and methods of vibration of concrete, shall be controlled by regular slump tests. Following slumps shall be adopted for different types of works:

Type of work	Slump Allowed
I. Mass concrete for RCC foundations, footing and retaining walls	40 mm to 50 mm
II. Beams, slabs and columns	40 mm. to 50mm.
III. Thin RCC section with congested steel	50mm. to 60 mm.

4.8 PRODUCTION OF CONCRETE

4.8.1 PRODUCTION OF AGGREGATES

Production of aggregates may include quarrying of the raw material and processing viz. transporting, crushing, screening and washing. Water used for washing aggregates shall be clean and free from alkali, salts and other impurities. After washing, fine aggregates must be stored in stock piles with a free draining base for atleast 3 days to ensure that sand, delivered to the batching plant will have a reasonably uniform moisture content. The storage and handling shall be in such a manner as to prevent inter mingling of various sizes of aggregates required separately for grading purposes. No foreign matter shall be allowed to mix with aggregate.

4.8.2 BATCHING

(a) The prescribed amount of the various materials of concrete, including water, cement, admixtures the groupings of fine aggregates and each individual size of coarse aggregates shall be measured and controlled within the specified limits of accuracy. The amount of water, cement and aggregates shall be determined by weighing. In the case of fine aggregates, the surface moisture shall be determined in accordance with the method prescribed in Appendix D of IS : 456-1978 and its subsequent amendment or publications. In the case of coarse aggregates; percentage of free water shall be determined by weighting representative sample, then surface drying each particle individually with a clean piece of cloth and reweighing.

(b) The batching equipment shall be constructed and operated so that the combined inaccuracies in feeding and measuring the materials shall not exceed 1 % for water and cement and 2% for each size

of aggregate.

(c) The operating performance of each scale or other measuring device shall be checked by test weight and the test shall cover the ranges of measurements involved in the batching operations. Tests of equipments in operation shall be made atleast once every fortnight and adjustment, repairs or replacement, be made as necessary to meet the specified requirements for accuracy of measurement.

(d) Aggregate shall not be batched for concrete or- mortar when free water is dripping from the aggregate.

(e) **Incase** uniformity in the materials used for concrete has been established over a period of time, proportioning may be done by volume batching, provided periodical checks are made on mass / volume relationship of the material. When weighing is not practicable, quantities of fine and coarse aggregate (not cement) may be determined by volume. If fine aggregate is moist and volume batching is adopted, allowance would be made for bulking in accordance with IS : 2386-Part III - 1963.

4.8.3 MIXING

(a) The concrete ingredients shall be mixed thoroughly in ready mix batch mixers of satisfactory type and size, which are so designed as to ensure uniform distribution of all the constituent materials throughout the mass at the end of mixing period. The plant shall be so designed and operated that all materials entering the mixer can be accurately proportioned and readily controlled, The entire batch within the mixer shall be discharged-before re-charging. The volume of mixed materials per batch shall not exceed the rated capacity. A mixer will be considered unsatisfactory, if from three tests of any one batch, a range in slump exceeding 25 mm or a range in air content exceeding one percent is noticed between representative samples taken at different portions of the mixer discharge.

(b) For any one batch, uniformity of fresh concrete weight of air free mortar of two samples one taken at the front and one at the end of the mixer discharges, when determined in accordance with the provisions of the mixer performance test, designation 26 in the appendix of the seventh edition of the United States Bureau of Reclamation concrete manual, shall not exceed 1.6 percent of the mean value. The adequacy of mixing shall also be determined- in accordance with "Method of sampling and analysis of concrete" as per IS :1199- 1959 and its subsequent amendments. Excessive variation on the unit weight of air free mortar indicates that mixing time should be increased. Mixer efficiency test shall be made at the start of a job and at such intervals as may be necessary to ensure compliance with the requirements for effective mixing. The minimum mixing time specified herein may be reduced if mixer efficiency test conform that the reduced time permits satisfactory mixing.

(c) The first concrete batch at the start of continuous mixing operation or after a lapse of 30 minutes in continuous mixing operation shall be made richer by the addition of extra cement as directed.

(d) For any one batch, the difference between the unit weight of coarse aggregate from concrete samples from the front and end of the mixer or mixer discharge, when determined in accordance with the above mentioned mixer performance test shall not exceed 10% of the mean value.

(e) The mixing of each batch shall continue, for not less than the period stated in table I of IS: 457- 1957 reproduced at Para 3.6.3 unless tests of mixer performance show that variation in the prescribed time is necessary or acceptable. Each mixer shall have a timing device for indicating the completions of the required mixing period.

(f) The actual time of mixing shall be checked atleast twice during each shift and in the case of central batching plant where the timing device is provided, the same shall be adjusted if there is error. The timing device shall be so interlocked with the discharge gate of the batch hopper that timing does not start until the discharge gate is fully closed and all ingredients are in the drum. A suitable record shall be kept of the average time consumed in charging, mixing and discharging a batch during each run.

(g) The full contents of the drum shall be discharged quickly to avoid segregation.

(h) The minimum periods specified are conditional on the materials being fed into the mixer in a manner which will facilitate efficient mixing and an operation of the mixer at its designed speed. The following sequence of charging the mixer may be adopted.

i. **Five** to ten percent of the total quantity of water required for mixing-adequate to wet the

- drum thoroughly shall be introduced before the other ingredients in order to prevent any caulking of the cement on the blades or sides of the mixer.
- ii AH dry ingredients (cement and the fine and coarse aggregate) shall be simultaneously fed into the mixer in such a manner that the period of flow for each ingredient is about the same. Eighty to ninety percent of the total quantity of water required for mixing shall be added uniformly along with the dry ingredients.
 - iii. The remaining quantity of water shall be added after all the other ingredients are in the mixer.
 - iv. Portion of the coarse aggregate, however, may be added last. This will facilitate clearance of the chutes and removes any fine aggregates or cement adhering to the sides.
 - (i) Excessive mixing requiring additions of water to preserve the required concrete consistency will not be permitted.
 - (j) When the mixer is stopped, before placing again any ingredients in the mixer, all hardened concrete or mortar shall be removed from the inner surface of the mixer.
 - (k) The re tampering of partially hardened concrete or mortar requiring renewed mixing with or without the addition of cement aggregate or water shall not be permitted:

4.9 TEMPERATURE OF CONCRETE AND WEATHER CONDITIONS

The temperature of concrete at the time of placement shall not exceed 35 degree C. concreting operations shall be temporarily suspended during excessively hot weather when their temperature inside the form exceeds 45 degree C. or when conditions are such that the concrete cannot be placed at the required temperature. Wherever necessary, exposed surfaces of fresh green concrete shall be adequately shaded from the direct rays of the sun and protected against premature setting or drying by curing under continuous fine spray of water.

4.10 TRANSPORTING OF CONCRETE

(a) concrete shall be handled from the place of mixing to the place of final depositing as rapidly as practicable by use of equipment such as transit mixers which will prevent initial setting, segregation or loss of any of the ingredients. It shall be transported and compacted in its final position within 30 minutes of its discharge from the mixer.

(b) **Where** the time of haul exceeds 20 minutes, mixed concrete shall be transported in suitable agitators or transit mixers as stated herein above.

(c) If buckets are used for conveying low-slump concrete, they shall be capable of promoting discharge in controlled quantities without splashing or segregation and shall be of such capacity that there is no splitting of batches in loading buckets. Buckets shall be of the bottom dump type permitting an even, controlled flow into the forms or hopper without undue splashing or segregation. Conveying vehicles shall be designed to facilitate uniform delivery rather than quick dumping.

(d) Chutes used - for conveying concrete shall be of such size and shape as to ensure a steady uniform flow of concrete in a compact mass without separation or loss of ingredients and shall be protected from wind and sun where necessary to prevent loss of slump by evaporation and shall be furnished with a discharge hopper. Free fall or drop of concrete shall be limited to 150 cms. Chute sections shall be made of or lined with metal and all runs shall have approximately the same slopes not flatter than 1 vertical to 2.5 horizontal. The required consistency of concrete shall not be changed in order to facilitate chuting. Where it becomes necessary to change the consistency, the concrete mix shall be completely redesigned. Wherever there is free fall within the conveying system, suitable baffle plates, splash board, or down spouts shall be provided to prevent segregation, splashing or loss of ingredients. Whenever it is necessary to hold the discharge end of a chute more than 3 meters above the level of the fresh concrete, a flexible down spout shall be used to break the fall and confine the flow. The lower end of the spout shall be held close to the place of deposit. Whenever depositing is intermittent, a discharge hopper shall be provided.

All chutes shall be thoroughly cleaned before and after each run. All washed water and debris shall be disposed off outside the forms.

(e) Equipment used for transporting concrete from the mixer to the forms shall be maintained free from deposits of stiff concrete and leakage of mortars. Batch containers, transit mixers, agitators, chutes, concrete pumps. Pipe lines and discharge hoppers shall be thoroughly cleaned after each run. All wash water and debris shall be disposed of outside the forms.

4.11 PREPARATION FOR PLACING CONCRETE

4.11.1 GENERAL

(a) Concrete shall not be placed until all form work required is completed, embedded parts if any installed and checked and surface prepared for placing. No concrete shall be deposited until the foundation has been inspected and approved

(b) All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleared of all such mortar or grout before fresh concrete is placed and shall be oiled with a commercial form oil or alternatively covered with LDPE film as specified in para 4.13.4

4.11.2 FOUNDATION SURFACES

(a) Immediately before placing concrete, all surfaces of foundations upon or against which the concrete is to be placed shall be free from standing water, mud and debris. All surfaces of rocks upon or against which concrete is to be placed shall in addition to the foregoing requirements be cleaned and free from all lubricants, objectionable coating and loose semidetached or unsound fragments. The surface of absorptive foundations upon or against which concrete is to be placed shall be moistened thoroughly and kept sufficiently wet for atleast 24 hours prior to placing concrete so that the moisture will not- be drawn from the freshly placed concrete. The cleaning and roughening of the surfaces of rock shall be performed by the use of high velocity air water jets, wet sand blasting; stiff brooms, picks or by other-effective means.

The washing and scrubbing process shall be continued until the wash water collected in puddles is clear and free from dirt. In the final cleaning process the wash water may have to be removed by sponges. If any drilled holes are left in the foundation surface, which are not longer needed, the same shall be cleared with air water jetting and filled up completely with cement slurry.

(b) In the case of earth or shale foundations, all soft or loose mud and surface debris shall be scraped and removed. The surface shall be moistened to a depth about 15 cms (6 inches) to prevent the sub grade from absorbing water' from the fresh concrete. Just before placing the concrete, the surface of the earth shall be tamped or otherwise consolidated sufficiently to prevent contamination of concrete during placing. If subsoil water is met within the foundation, it shall be dewatered as directed till the placing and setting of concrete. All concrete shall be placed upon clean damp surface free from standing water and never upon soft mud, dried porous earth or upon fills that have not been subjected to approved rolling and desired compaction.

(c) Foundation of porous or free draining material shall be thoroughly compacted by flushing and by subsequent tamping or rolling, if necessary. The finished foundation surface shall then be blanketed with a layer of tar paper or closely woven burlap carefully lapped and fastened down along the seams so as to prevent the loss of mortar from the concrete.

4.11.3 SURFACE OF CONSTRUCTION AND CONTRACTION JOINTS

(a) The surface of construction / contraction joints shall be clean, rough and damp but free from standing-pools of water when receiving the next lift. Clean up shall comprise removal of all laitance, loose or defective concrete coating, sand, curing compounds if used and other foreign materials, if necessary by scrapping, chipping or other suitable means.

(b) The surface of construction / contraction joints shall be cleaned by use of high-pressure

water jet or by wet sand blasting and swashed thoroughly. Water jetting and blasting and washing shall be performed just prior to the placing of concrete .

(c) The method used in disposing of water employed in cutting, washing and rinsing of concrete surface shall be such that the. Waste water does not stain, discolour or effect exposed surfaces of the structures. Methods of disposal of waste water shall be subject to approval.

4.12 PLACING AND COMPACTING CONCRETE

(a) After the surfaces have been cleaned and dampened, as specified, surfaces or rock and construction joints shall be covered, wherever practicable, with a layer of mortar approximately 10 mm to 15 mm thick. The mortar shall have the same proportions of water, air entraining agent if any, -cement and fine aggregate as the concrete mixture which is to be placed upon it. The water cement ratio of the mortar, which is placed, shall not exceed that of the concrete to be placed upon it and the consistency of the mortar shall be suitable for being spread uniformly and worked thoroughly into all irregularities of the surfaces.

(b) In so far as it is practicable, concrete shall be placed directly in its- final position and shall not be caused to flow in a manner to permit or cause segregation. Methods and equipments employed in placing concrete will ensure that aggregate is not separated from the concrete mass.

(c) In placing mass concrete in a lift successive batching of concrete shall be placed in a systematic arrangement in order to avoid exposure of parts of the live surface of a concrete layer.

(d) In mass concrete placement, delay may occur resulting in cold joints within a lift. When placement is resumed while concrete is so green (and therefore capable of ready bonding) that it can be dug out with a hand pick, the usual contraction joint treatment will not be required if the surfaces are kept moist and the concrete placed against the surface is thoroughly and systematically vibrated over the entire area adjacent to the older concrete. If the delay is short enough to permit penetration of the vibrator into the lower layer during routine vibration of successive layers, the vibration will assure necessary bonding.

(e) If for any cause, the working surface is left exposed until it has hardened to a considerable extent, it shall be left to set and cured for not less than 56 hours or longer. If for any reason a strength greater than 15.2 kg/sqm (500 PSI) has been attained before completing the lift, the surface thus interrupted shall be given a thorough clean up as for normal lift joint surface and the work shall be commenced with a mortar layer as specified.

(f) In placing mass concrete, the exposed area of fresh concrete shall be maintained at the practical minimum by first building up the concrete in successive approximately horizontal layers to the full width of the block and full height of the lift over a restricted area at the downstream end of the block and then continuing upstream in similar progressive stages to the full area. The slope formed by the unconfined upstream edge of the successive layers of concrete shall be kept steep as practicable in order to keep its area minimum. Concrete along these edges shall not be vibrated until adjacent concrete in the layer is placed, except that it shall be vibrated immediately when weather conditions are such that the concrete will be harden to an extent the later vibration may not fully consolidate and integrate in with more recently placed adjacent concrete.

(g) Re tampering of concrete shall not be permitted. Any concrete, which has become so stiff that proper placing without re tampering cannot be ensured shall be wasted

(h) In formed work, structural concrete placement shall generally be started with an over sanded mix containing 20 mm maximum size aggregate and 'an extra sack of cement for one cubic metre and having a 125 mm slump placed several centimeters deep on the joints at the bottom of the form. Concrete placement shall commence immediately thereafter.

(i) Concrete shall be compacted to the maximum practicable density, in such a manner that it

is free from pockets of coarse aggregate and is in intimate contact with surface of forms and embedded materials. Unless otherwise permitted, all concrete shall be compacted by mechanical vibrator.

(j) Compaction of concrete shall whenever practicable be carried out by use of immersion type vibrators having vibrating heads of 100 mm or more in diameter shall be operated at speed of atleast 6,000 revolutions per minute when immersed in the concrete. ,

(k) Vibrators having vibrating heads less than 100 mm. in diameter shall be operated at speed of atleast 7,000 revolutions per minute in the concrete.' Normally formwork shall be designed to provide for the insertion and operation of mechanical vibrators in the placed- concrete. Form vibrator shall be used wherever internal vibration is not possible or would be inadequate.

(l) In compacting each layer of concrete, the vibrator shall be operated in almost vertical position and the vibrating head shall be allowed to penetrate and revibrate, the concrete in the upper portion of the underlying layer. In the area where freshly placed concrete in each layer joins previously placed concrete, more vibration than usual shall be performed the vibrators penetrating deeply at close intervals along these contacts, Layers of concrete shall not be placed until layers previously placed have been vibrated thoroughly as specified. Contacts of the vibrating head with surface of the forms shall be avoided thoroughly.

(m) During placing and until curing is completed, the concrete shall be protected against the harmful effect of exposure to sunlight, wind and rain as directed.

(n) For all concrete items, the concrete used must be invariably ready mixed and placed mechanically. Wherever mechanical means cannot be used their only manual placing of ready mix concrete (RMC) may be allowed.

4.13 FORM WORK

4.13.1 GENERAL

(a) Form work shall be used wherever necessary to confine the concrete and shape it to the required lines, or to ensure against contamination of the concrete by material caving or sloughing from adjacent surface left by excavation or other features of the work All exposed concrete surfaces having slope steeper than of one horizontal to one vertical shall be formed.

(b) Form work may be of timber, steel or precast concrete panels or such other suitable - materials or combination of such materials as may be directed by the Engineer. Form work shall be substantially and rigidly constructed to the shapes, lines and dimensions required, efficiently propped and braced to prevent deformation due to placing, vibrating and compacting concrete, other incidental loads or the effect of weather.

(c) The surfaces of form work shall be made 'such as to produce surface finishes as specified and formwork joint space be tight enough to prevent Joss of liquid from concrete.

Joints between the formwork and existing concrete structures shall also be "grout tight". The formwork shall be arranged to facilitate easing and removing of the various parts in correct sequence without jarring or damaging the concrete. Fixing blocks, bolts or similar devices may be embedded in the concrete, provided they do not reduce the strength or effective cover of any part of the structure below the required standard but the use of through bolts shall be avoided as far as possible. Temporary - opening shall be provided at all points necessary in the forms to facilitate cleaning and inspection immediately before placing of the concrete.

(d) Forms shall overlap the hardened concrete in the life previously placed by not less than 75 mm. and shall be tightened strongly against the hardened concrete so that when concrete placement is resumed, the forms will not spread and allow off-set or loss of mortar at construction joints. Additional bolts or form ties shall be used as necessary to hold forms tight against hardened concrete. Particular attention shall be paid in setting and tightening the forms for construction joints so as to get a smooth joint free from sharp deviations or projections.

(e) Moulding strips shall be placed in the comers of forms so as to produce chamfered edges as required on permanently exposed concrete surface.

4.13.2 MATERIALS TO BE USED

(a) Materials used for form sheathing and lining shall conform to the following requirements:

Required finish	Timber Sheathing or lining	Steel Sheathing or lining
F1	Any type and grade meeting the dimensional requirement of surface finish except that metal form shall be used on surfaces of internal transverse and longitudinal joints in mass concrete gravity walls	Steel sheathing permitted steel lining permitted except on surfaces of internal transverse and longitudinal joint in the structure component where steel sheathing is required
F2	Common grade timer or plywood sheathing or lining	Steel sheathing permitted steel lining permitted if strongly supported.
F3	For plain surface common grade timber or plywood	Steel sheathing permitted
F4	For warped surfaces timber which is free from knots and other imperfections and which can be cut and bent accurately to the required curvatures without splintering or splitting.	Steel sheathing permitted, steel lining not permitted.

Steel sheathing denotes steel sheets not supported by a backing of timber boards, steel lining denotes steel sheet, supported by back of timber boards.

(b) **Timber** sheathing or lining shall be of such kind and quality or shall be so treated or coated that there will be no chemical deterioration or discoloration of the formed concrete surfaces. - The type and condition of form sheathing and lining and the ability of forms to withstand distortion caused by placement and vibration of the concrete and the workmanship used in the form construction shall be such that the formed surfaces will conform to applicable requirements -of this specification pertaining to finish or formed surfaces .

(c) Forms for concrete surfaces required to receive F2 and F3 finish shall be constructed so as to produce uniform and consistent texture and pattern on the concrete faces Metal patches on forms for these faces will not be permitted. The form sheathing or lining shall be so placed that all horizontal form marks are continuous across the entire surface. Where finish F2 is specified the sheathing or lining shall be placed so that the joint marks on the concrete surfaces will be in general alignment both horizontally vertically and the form sheathing material used for such surfaces shall be restricted to one type in anyone major features of the work.

(d) Forms for surfaces required to receive F4 finish shall be constructed so as to conform accurately to the required curvature of the section. Where necessary to meet requirements for curvature the form sheathing shall be built up of laminated splices cut to make right, smooth form surface. The forms shall be constructed that the joint marks on the concrete surface shall in general, follow the line of water flow.

(e) After the forms have been constructed all surface imperfections shall be corrected. All the nails shall be hidden and any roughness and all angles on the surface of the forms caused by matching the forms materials shall be dressed to curvature.

(f) Embedded ties for holding forms shall remain embedded and except where F1 finish is permitted, they shall terminate not less than two diameters or twice the minimum dimension of the tie or ten millimeters, whichever is greater from the formed faces of the concrete. The use of metal rods or other similar devices embedded in he concrete for holding forms shall be permitted if the ends of the rods are omitted or subsequently removed to a depth as specified above from the surface of the concrete without injury to the concrete, provided that for walls subjected to water pressure on one side and required to be watertight the rods shall not be taken through the wall. Complete removal of embedded rod shall not be permissible. Removal of embedded fasteners on the ends of the rods shall be done so as to

CONTRACTOR

EXECUTIVE ENGINEER

leave holes of regular shape for reaming. All holes left by the removal of fasteners from the ends of the rods shall be immediately reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough and completely filled with dry patching mortar and the surfaces shall be finished to match the adjacent concrete. Wire ties shall be permitted only where specifically approved and shall be cut off flush with the surface of the concrete after the forms are removed. Wire ties shall not be used when permanently exposed finished surfaces are required. Where F I finish is permitted, ties may be cut off flush with formed surface.

(g) The ties shall be constructed so that removal of the end or end of fasteners can be accomplished without causing appreciable spalling at the faces of the concrete. Recesses resulting from removal of the ends of the form ties shall be filled in accordance with the provision for repair of concrete as per Para 4.15.

4.13.3 FORM, CENTERING AND TEMPORARY WORKS

(a) All centering, form work and temporary works shall be constructed according to the approved drawings and specifications. The IS: 883: 1970 code of practice for design of structure timber in building shall be applicable for this work.

(b) As soon as practicable, after the acceptance of his tender, the contractor shall submit a scheme showing the order or procedure and method by which he proposes to carry out the work, together with such details as are necessary to demonstrate the adequacy, stability and safety of the methods.

(c) Necessary data for the general scheme of centering shall be obtained well in time.

(d) After approval of the general scheme, the contractor shall prepare detailed design and a drawing for execution of the form work, centering and temporary works. These shall be forwarded to the Engineer-in-charge for approval. No work shall be carried out without prior approval of the Engineer-in-charge.

(e) Notwithstanding the approval given to the design criteria and loading and the general scheme for the centering, the entire responsibility for the satisfactory execution of the centering and all temporary works shall rest with the contractor and he shall be liable to pay all claims and compensation arising from any loss or damage to life and property due to any deficiency, failure or malfunctioning of the centering or the temporary work.

(f) All centering and supports shall be properly braced and cross braced in 2 directions. The supports shall be strong enough to withstand the weight or pressure when considerable quantity of wet concrete is poured. When the centering posts rest on soft ground; their load shall be distributed by means of scantlings / planks of not less than 5 cms thickness / short piles. Wherever the stage of centering is more than 3 mtrs. Invariably steel centering shall be resorted to.

(g) Reuse of forms etc.

Forms required to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned and repaired before reuse. Where metal sheets are used for lifting forms, the sheets shall be placed and maintained in the forms without humps and other imperfections. All forms shall be checked for shape and strength before reuse.

4.13.4 CLEANING AND TREATMENT OF FORMS

At the time the concrete is placed in the forms, the surfaces of the forms shall be free from encrustations of mortar, grout or other foreign material. Before concrete is placed, the surfaces of the forms designated to produce F-1, F-2, F-3 and F-4 finishes shall be oiled with a commercial form oil, that will effectively prevent sticking and will not stain the concrete surface. For timber forms, form oil shall consist of pure, refined, pale paraffin mineral oil or other approved form oil. For steel, forms shall consist of refined mineral oil suitably compounded with one or more ingredients, which are appropriate for the purpose. Care shall be taken to keep form oil out of contact with reinforcement. In the alternative the surfaces of the forms designated to produce formed surfaces shall be overlaid with LDPE film of 200 microns.

4.13.5 REMOVAL OF FORMS

(a) Except as otherwise provided in this Sub-Clause forms shall be removed as soon as the concrete has hardened sufficiently, thus facilitating satisfactory curing and earliest practicable repair of surface imperfections.

(b) Forms on upper sloping surfaces of concrete, such forms on the water sides of wrapped transition, shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any

needed repair or treatment required on such sloping surface shall be performed at once and be followed immediately by the specified curing.

- (c) In order to avoid excessive stresses in the concrete that might result from swelling of the forms, timber forms shall be loosened as soon as this can be accomplished without damage to the concrete.
- (d) Subject to approval, forms on concrete surface close to excavated rock surface may be left in place provided that the distance between the concrete surface and the rock is less than 400 mm and that the forms are not exposed to view after completion of the works.
- (e) Forms shall be removed with care so as to avoid damage to the concrete. Concrete damaged if any in form removal shall be repaired in accordance with the provisions for repair of concrete as per Para 4.15.
- (f) The following minimum intervals of time will generally be allowed when using ordinary Portland cement between placing concrete and striking form work, but the period shall be modified in case of wet weather and also as per direction of Engineer-in charge.
 - i) Walls, columns and vertical faces 24 to 48 hours or as may be decided by the Engineer-in charge
 - ii) Slabs 14 days
 - iii) Beam Soffits 14 days
 - iv) Slab spanning upto 6.0 mtrs. 14 days
 - v) Slab spanning over 6 mtrs. 21 days

NOTE: In normal circumstances, and where ordinary Portland cement is used forms may generally be removed after expiry of the above period. For other cements, the stripping time recommended for ordinary Portland cement may be suitably modified.

Where the shape of the element is such that the form work has re-entrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking, occurring due to the restraint imposed ..

4.14 FINISHES AND FINISHING OF CONCRETE SURFACES

4.14.1 FORMED SURFACES

(a) Allowable deviation from plumb or level and from the alignment profile, grades and dimensions shown on the drawings is defined as 'tolerance' and is to be distinguished from the irregularities in finishes as described herein. The tolerance in concrete construction is specified in Para 4.21.

(b) The classes of finish and requirements for finishing of concrete-surface shall be as shown on the drawing or as hereinafter specified. In the event of finishing not being definitely specified herein or on the drawings the finishes to be used shall be as directed by the Engineering-charge. Finishing of concrete surface shall be performed only by skilled workmen.

(c) **Completed** concrete surfaces will be tested where necessary to determine whether surface irregularities are within the limits hereinafter specified.

(d) Surface irregularities are classified as 'Abrupt' or 'gradual' offsets caused by displaced or misplaced form sheathing, or lining or form sections or by loose knots or otherwise defective timber form will be considered as abrupt irregularities and shall be tested by direct measurements. All other irregularities shall be considered as gradual irregularities and will be tested by use of template, consisting of a straightedge or the equivalent thereof for curved surfaces. The length of the template shall be 150 cms for testing of formed surfaces and 300 cms for testing unformed surfaces.

(e) The classes of finish for formed concrete surface are designated by one of the symbols F1, F2, F3 and F4. The jute bags rubbing or sand blasting will not be required on formed surfaces and grinding will not be required on formed surfaces other than that necessary for the repair of surface imperfections. Unless otherwise specified or indicated on the drawings, the classes of finish, which will apply, are as follows.

i) Finish F1

This finish applies to surfaces where roughness is not objectionable, such as those upon or against which fill material, masonry or concrete will be placed, the upstream face of the structure that will permanently be under water or surface that will otherwise be permanently concealed. The surface treatment shall be the repair of defective concrete, correction of surface depression deeper than 25 mm and tilling of the tie rod holes. Forms sheathing will not leak mortar when concrete is vibrated.

Forms may be built with a minimum of refinement.

ii) Finish F2

This finish is required on all permanently exposed surface for which other finishes are not specified, such as in Head Regulators, Cross Regulators, Drainage syphons, Bridges and Retaining Walls not prominently exposed to public view except wherein F1 finishes are permitted. Forms shall be built in a workmanlike manner to the required dimensions and alignment, without conspicuous offsets or bulge. Surface irregularities shall not exceed 5 mm for abrupt irregularities and 10 mm for gradual irregularities measured with 1.5 mtrs. template.

iii) Finish F3

This finish is designated for surface of structures prominently exposed to public view where appearance is also of special importance. This shall include inside of drainage barrels, piers of bridges and beams and slabs of cross regulators, syphons, aqueducts, drops, parapets, railings and decorative features on the structures and on the bridges. To meet with the requirements for the F3 finish forms shall be built in a skillful, workmanlike manner, accurately to dimensions. There should be no visible offsets, bulges, or misalignment of the concrete. At construction joints the forms shall be tightly set and securely anchored close to the joint. Abrupt irregularities shall not exceed 5 mm for irregularities parallel to the directions of flow and 2.5 mm for irregularities in other directions. Gradual irregularities shall not exceed 5 mm. Irregularities exceeding this limit shall be reduced by grinding on a level of 1 to 20 ratio of height to length.

iv) Finish F4

This finish is required for formed concrete surface at the cut and ease waters of the piers portions of outlets, draft tubs, high velocity flow surface of outlet work downstream from gates and spillway tunnels of dams and where evenness of surface is essential. The Forms must be strong and held rigidly and accurately to the prescribed alignment. For wrapped surface the forms shall be built up in section cut to make tight smooth form surfaces after which the form surfaces are dressed and sanded to the required curvature. Gradual irregularities shall not exceed 5 mm. Abrupt irregularities shall not be permitted. Formations of air holes on the surface of the concrete designated to receive finish shall be minimized and where such air holes are found, they shall be repaired in accordance with the provisions of relevant paragraph.

4.14.2 UNFORMED SURFACES

(a) The classes of finish for unformed concrete surfaces are designated by the symbols, VI, U2, V3 and U4. Unless otherwise specified or indicated on the drawings, these classes of finish shall apply as follows:

i) Finish U1

This finish applies to unformed surfaces that will be covered by fill material, masonry or concrete, or where a screeded surface meets the functional requirements. - Finish VI is also used as the first stage of finishes for U2 and V3. Finishing operations shall consist of sufficient leveling and screeding to produce an even uniform surface. Surface irregularities measured as described in this section, shall not exceed 10 mm.

ii) Finish U2

a. This is a floated finish, and used on all outdoor unformed surfaces - not specified to receive

finishes VI and U3. It may be used for such surfaces as apron and floors of cross regulators and heart regulators, drainage barrels, aqueducts and escapes and inside of slopping aqueduct troughs.

b. Finish V2 is also used as the second stage of finish for V3. Floating may be performed by hand or power driven equipment. Floating shall be started as soon as the screeded surface has stiffened sufficiently to prevent the formation of laitence and shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. If finish V3 is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling. Surface irregularities measured as described in this section shall be removed as directed.

iii) Finish U3

This is a travelled finish and may be specified for tops of parapets prominently exposed to view and conduit invert immediately downstream of regulating gates and valves. When the floated surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be started. Steel troweling shall be performed with firm pressure, that will flatten the sandy texture of the floated surface and produce a dense uniform surface free from blemishes and trowel marks. Surface irregularities, measured as described in relevant parts of this section, shall not exceed 5 mm where hard steel travelled finish is specified, the regular U3 finish shall be trowelled again after the surface has nearly hardened using firm pressure and trowelling until the surface is hard and has a slightly glossy appearance.

iv) Finish U4

a. This is a steel trowelled finish similar to finish U3 except that light surface-pitting and light trowel marks such as obtained from the use of machine trowelling or lining machine will be acceptable, provided the surface irregularities do not exceed the limits specified for finish U3.

b. Unformed surfaces which are nominally level shall be sloped for drainage as shown on the drawings or as directed, unless the use of other slopes or level surface is indicated on the drawing, narrow surface such as tops of parapets, tops of walls and kerbs shall be sloped approximately half centimeter per 30 cms of width.

For canal lining the finish U4 shall be adopted.

4.15 REPAIR OF CONCRETE

4.15.1 GENERAL

(a) Repairs of concrete shall be performed by skilled workers and in the presence of an experienced Engineer. The Contractor shall correct imperfections on the concrete surfaces as necessary to produce surface that conform with requirements of the paragraph "finishes and finishing of concrete surfaces", Repairs on formed concrete shall be completed as soon as practicable after removal of forms and within 24. hrs after removal of forms. Concrete that is damaged from any cause and concrete that is honeycombed, fractured or otherwise defective and concrete which because of excessive surface depressions has to be excavated and built up to bring the surface to the prescribed lines shall be removed and replaced by dry pack mortar or concrete as hereinafter specified. Where bulges and abrupt irregularities protrude outside the limits specified in the paragraph 'finishes and finishing of concrete surfaces', the protrusions shall be reduced by bush hammering and grinding so that the surfaces are within the specified limits.

(b) Before repair is to commence, the methods proposed for the repair shall be approved by the Engineer -in charge. Routine curing should be interrupted only in the area of repair operations.

4.15.2 METHODS OF REPAIRS

For new works four methods are used as under:

i) DRY PACK METHOD

This method should be used for holes having a depth nearly equal to, or greater than the least surface dimensions, for cone bolt, she bolt and grout insert holes, and narrow bolts cut for the repair of cracks. Dry pack should not be used for relatively shallow depressions where lateral restraint cannot be obtained, for filling in back of considerable lengths of exposed reinforcement ; nor for filling holes which extend entirely through the wall, beam, etc.

ii) CONCRETE REPLACEMENT METHOD

Concrete replacement should be used when holes extend entirely through the concrete section,

when holes in un reinforced forced concrete are more than 1,000 sqcms in area and - 100' cms or more in depths and when holes in reinforced concrete are more than 500 sqcms in area and deeper than the reinforcement steel.

iii) MORTAR REPLACEMENT METHOD

This should be used for holes too wide to dry pack and too shallow for concrete replacement and for all comparatively shallow depressions, large or small, which extend no deeper than for side of the reinforcement bars nearest to surface.

iv) EPOXY METHOD

A thermosetting plastic known as epoxy can be used as a bonding medium whenever long time curing of conventional concrete cannot be assured. Also epoxy mortars of fine sand as well as plain epoxy are suitable for concrete repair work and should be used whenever very thin patches are to be placed or immediate reuse of the area is required or where moist curing cannot be effectively accomplished.

Preparation for epoxy-bonded repairs should in general be identical to that for other concrete repairs except that every efforts should be made to provide surfaces thoroughly dry. Drying of the immediate surface for -atleast 24 hrs. and warming to temperature between 18 degree C to 27 degree C. are essential for proper application epoxy bonded repairs. Preparation for the use of epoxy- mortars should include through cleaning and drying of the areas to be repaired. A wash of dilute 1:4 muriatic acid rinsing with clean water "and subsequent drying is desirable, where feasible. If acid wash is not feasible, preparation may be accomplished as for other concrete repairs with final cleanup being by means of sandblast method, followed by air water jet washing and thorough drying, epoxy repairs shall be carried out only by a trained personnel. The type of epoxy to be used shall be got approved by the Engineer-in charge.

4.15.3 PREPARATION OF CONCRETE FOR REPAIRS

All concrete of questionable quality should be removed. It is better to remove too much concrete than too little because affected concrete generally continues to disintegrate and while the work is being done it costs but little more to excavate to ample depth. Moistening, cleaning, surface drying and complete curing are of utmost importance when making repairs, which must be thoroughly bonded, watertight and permanent. Surfaces within trimmed holes should be kept continuously wet for several hours, preferably overnight prior to placing new concrete. Immediately before placement of the filling, the holes should be cleaned so as to leave a surface completely free from chipping dust, dried grout and all other foreign materials. Preliminary washing as soon as the chipping and trimming are completed is desirable to remove loose material. Final cleaning of the surfaces to which the new concrete is to be bonded should be done by wet sandblasting followed by washing with air water jet for through cleaning and drying with an air jet. Care should be taken to remove any loose materials embedded in the -surface by chisels during the trimming and to eliminate all shiny spots indicating free surface moisture. Cleaning of the steel if necessary should be accomplished by sand blasting. The prepared surface shall be approved by the Engineer-in charge.

I. DRY PACKING OF CONCRETE

For this method of repair, the holes should be sharp and square at the surface edges, but the comers within the holes should be rounded, especially when water tightness is required. The interior surfaces of holes left by cone bolts, she bolts etc. should be roughened to develop an effective bond. Other holes should be under-cut slightly in several places. Holes for dry pack should have minimum depth of 25 mm.

ii) CONCRETE REPLACEMENT

Preparation for this method should be as follows:

- a. Holes should have minimum depth of 100 mm. in new concrete and the minimum area of repair should be 500 sqcms for reinforced and 1,000 sqcms for unreinforced concretes.

CONTRACTOR

EXECUTIVE ENGINEER

b. Reinforcement bars should not be left partially embedded. There should be a clearance of at least 25 mm around each exposed bar.

c. The top edge of the holes at the face of the structure should be cut to a fairly horizontal line. If the shape of the defect makes it advisable, the top of the cut may be stepped down and continued on a horizontal line. The top of the hole should be cut to 1 to 3 upward slope from the back towards the face of the wall or beam. It may be necessary to fill the hole from both sides, in which case the slope of the top of the cut should be modified accordingly.

d. The bottom and sides of the holes should be cut sharp and approximately square with the face of the wall when the hole goes entirely through concrete section, spalling or feather edges shall be avoided by having chippers worked from both faces. All interior corners should be rounded to a minimum radius of 25 mm.

iii. MORTAR REPLACEMENT

When mortar gun is used with this method, comparatively shallow holes should be flattered outwardly at about 1 to 1 slope to avoid inclusion of rebound. Corner within the holes should be rounded. Shallow imperfections in concrete may be repaired by mortar replacement if the work is done promptly after removal of the forms and while the concrete is still green, for instance when it is considered necessary to repair the peeled areas resulting from surface material sticking to steel forms the surfaces may be filled using mortar gun without further trimming or cutting. Whenever hand placed mortar replacement is used, edges of chipped out areas should be squared with the surface leaving no feather - edges.

iv. USE OF DRY PACK MORTAR

The surface after preparing should be thoroughly brushed with a stiff mortar or grout barely wet enough to thoroughly wet the surface after which the dry pack material should be immediately packed into place before the bonding grout has dried. The mix of bonding grout shall be 1 to 1 cement and fine sand mixed to a consistency like thick cream. Under no circumstance should bonding coat be wet enough or applied heavily enough to make the dry material more than very slightly rubbery. Dry pack is usually a mix (by dry volume or weight) of one part of cement to 1.50 parts of sand that will pass No. 16 ASTM Screen.

4.15.4 PROCEDURE OF REPLACEMENT OF CONCRETE, CURING OR REPAIRS ETC.

All procedures for replacement of concrete, mortar replacement, use of epoxies and curing of repairs shall according to the provisions laid down in chapter VII "Repairs and Maintenance of Concrete" Concrete Manual of the United States Bureau of Reclamation, seventh Edition 1963.

4.16 CURING OF CONCRETE

4.16.1 GENERAL

(a) All equipment, material etc, needed for curing and protection of concrete shall be at hand and ready for installing before actual, concreting begins. Detailed plans, methods and procedures whereby the various phases of curing and protection shall firmly established, shall be settled and got approved in writing from the Engineer - in charge sufficiently in advance of the actual concreting. The equipment and method proposed to be utilised shall provide for adequate control and avoid interruption or damage to the work of other agencies.

(b) All Concrete shall be cured by water in accordance with the requirement of sub-clause (3)

CONTRACTOR

EXECUTIVE ENGINEER

of this Clause or membrane curing in accordance with the requirement of sub-clause (4) of this Clause. Concrete surfaces to be painted shall not be cured by membrane curing.

4.16.2 WATER CURING

(a) Uniform top surfaces of walls and piers shall be moistened by covering with water saturated material or by- other effective means as soon as the concrete has hardened sufficiently to prevent damage by water i.e. normally after 24 to 36 hrs of placement of concrete.

Exposed finished surfaces of concrete shall be protected against heating and drying from the Sun for atleast 72 hrs after placement in location. When finishing or repairs are involved, concrete shall not be disturbed by workmen walking on it or by storing materials on the surface or otherwise for at least 10 hours after placing. These surfaces and steeply sloping and vertical fanned surfaces shall be kept completely and continuously moist, prior to and during from removal, by Water applied on the unformed top surfaces and allowed to pass down between the forms and formed forms and formed concrete faces. This procedure shall be followed by the specified water curing and membrane curing.

(b) Concrete cured with water shall be kept wet for at least 21 days immediately following placement of the concrete or until covered with fresh concrete by covering with water saturated material or by a system of perforated pipes, or mechanical sprinklers or porous hoses or by any other suitable method, which will keep all surfaces continuously (not periodically) wet. For uncovered portions curing should continue for specified period.

(c) The contractor shall make arrangements at work site for storing the water required for atleast 3 days curing. The concrete work shall not be started until the water required for 3 days curing is stored in advance.

4.16.3 MEMBRANE CURING

(a) Membrane curing shall be by application of a suitable type of white / pigmented curing compound which forms a water retaining membrane on the surface of concrete, provided that on concrete surfaces which will be permanently exposed to view clear curing compound may be required excepting canal lining as per Para 3.5.9(b) Curing compound shall be applied to the concrete surfaces after demonstrating its effectiveness as per Para 3.5.10 by spraying one coat to provide a continuous uniform membrane over all area, with a maximum coverage per gallon as prescribed by the manufacturer's instructions according to the roughness of the surface to be covered. If necessary to cover the surface adequately, a second coat of curing compound shall be applied by spraying at right angle to the direction at which the first coat was applied. Mortar encrustations and fines on surfaces for which finish F4 is specified shall be removed prior to application -of curing compound. Curing compound shall be applied to all areas of concrete surface except that those areas with surface imperfections, which shall be omitted until repaired.

(b) **When** curing compound is to be used for unformed concrete surfaces, application of the compound shall commence immediately after the finishing operations are completed.

(c) - When curing compound is to be used on formed concrete surfaces, the surface shall be moistened with light spray of water immediately after the forms are removed and shall be kept wet until the surfaces do not absorb more moisture.

As soon as the surface film of moisture disappears but while the surface still has a damp appearance, the curing compound shall be applied. There must be ample coverage with compound at edge, comers and rough spots of formed surface.

After application of curing has been completed and the coating is dry to the touch any required repairs of concrete surfaces shall be performed. Each repair, after being finished, shall be moistened and coated with curing compound in accordance with the foregoing requirements.

(d) Traffic and other construction operation shall be such as to avoid damage to coating of curing compound for a period of not less than 28 days after application of the curing compound. Where it is impossible because Of construction operations to avoid traffic over surfaces coated with curing 'compound, the membrane shall be protected by a covering of sand or earth not less than-15 mm in thickness or by other effective means. The protective covering shall not be placed until the sealing

membrane is completely dry. Any sealing membrane, that is damaged or that peels from concrete surface within 28 days after application, shall be repaired without delay.

(e) Curing compound shall be of approved quality.

4.17 REQUIREMENT OF CONCRETE CONSTRUCTION

4.17.1 GENERAL

All concrete construction shall conform to the permissible tolerance and technical provisions as described in this section and to the detailed requirement of the following paragraphs. All structures shall be built in a workman like manner or to the lines, grades and dimensions shown in the drawing or as prescribed by the Engineer-in-charge. The location of all the construction joint shall be subject to the approval of the Engineer-in-charge. The dimensions of each structure shown- on the drawings are tentative and shall be subject to such change as may be found necessary by the Engineer-in-charge due to design considerations.

4.17.2 CONCRETE IN VARIOUS COMPONENTS OF BRIDGES, DRAINAGE SYPHON AQUEDUCTS, ETC.,

(a) The items of the schedule B for concrete in aforesaid structures include all concrete in the various components of the structure and blockouts.

(b) Expansion joints shall be constructed as shown on the drawing or as directed. Premoulded bituminous fibre type expansion joint material shall be placed in the expansion joints. Lighting recesses shall be constructed in the parapets as directed by the Engineer-in-charge. Open joints or false joints shall be constructed as shown on the drawings or as directed by the Engineer-in-charge. Performed expansion joint filler shall be placed- in the road way and side walls where shown on the drawing or as directed by the Engineer-in-charge.

4.17.3 CONCRETE IN BLOCKOUTS

(a) All concrete required to be placed in blockouts to permit the installation and adjustment of mechanical and other equipments shall be included in the respective concrete as described above. The concrete surface of the blockouts shall be chipped and roughened as described hereinafter before the concrete is placed in blockouts.

(b) Exceptional care shall be taken in placing the concrete in blockouts in order to ensure satisfactory bond with the concrete previously placed and to secure complete contact with all metal work in the blockouts.

(c) The roughening of the concrete surface of the 'blockouts shall be performed by chipping or sand blasting as approved by the Engineer-in-charge and in such a manner as not to loosen, crack or shatter any part of the concrete' beyond the roughened surface. After being roughened the surface of the concrete shall be cleaned thoroughly of loose fragment, dirt and other objectionable substances and shall be sound and hard to ensure good mechanical bond between the existing and new concrete. All concrete, which is not hard, dense and durable, shall be removed to the depth required to the satisfaction of the Engineer-in-charge.

4.17.4 EMBEDMENT IN CONCRETE

In some of the locations of structures as shown on the relevant drawings a few conduits or openings shall have to be provided through R.C.C./ P.C.C./ masonry work. Construction of the surface for either placement of concrete or for laying of masonry shall have to be suitably carried out as to meet with the placement of such conduits or openings. No extra claim for such construction shall be entertained.

4.18 CONSTRUCTION JOINTS IN UNREINFORCED CONCRETE WALLS

(a) Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown on approved Drawing or as directed by the Engineer-in-charge.

(b) For vertical construction joints stopping boards shall be fixed previously at a predetermined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concreting is completed against it. Concreting shall be continued right upto the board.

CONTRACTOR

EXECUTIVE ENGINEER

shall not be removed before expiry of the specified period for removal of vertical forms.

(c) Before resuming work at any construction joints when concrete has not yet fully hardened, all laitance shall be removed thoroughly, care being taken to avoid dislodgement of coarse aggregates. The surface shall be thoroughly wetted and all free water removed from the surface shall then be coated with cement slurry. On this surface, layer of concrete not exceeding) 50 mm in thickness shall first be placed and shall be well rammed against old work particular attention being paid to comers and closed spots, work thereafter shall proceed in a normal way.

(d) When work has to be resumed on a surface, which has hardened, it shall be thoroughly raked, swept clean, wetted and covered with a layer of neat cement grout. The neat cement grout shall be followed by a 15 mm thick layer of mortar mixed on the same proportion as in concrete and concreting resumed immediately thereafter. The batch of concrete shall be rammed against the old work to avoid formation of any stone pockets particular attention being paid to comers and close spots .

In all cases, the position and detailed arrangements of all construction joints shall be predetermined and got approved by the Engineer-in-charge.

4.19 TEST AND ACCEPTANCE CRITERIA

GENERAL

Samples from fresh concrete shall be taken as per IS : 1199-1959 and Cubes shall be made, cured and tested at 28 days in accordance with IS : 516-1959

NOTE: For relatively small and isolated works in which quantity of concrete is less than 15 cum the strength tests may be waived by the Engineer-in-charge at his discretion.

In order to get a relatively quicker ideas of the quality of concrete optional tests on beams for modulus of rupture at 72 + hrs. or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose the values given in Table 5 may be taken for general guidance in the case of concrete made with ordinary Portland cement in all cases. The 28 days compressive strength specified in Table 1-shall alone be the criteria for acceptance or rejection of the concrete.

If however, from -test carried out in a particular job over a reasonably long period, it has been established to the satisfaction of the Engineer-in-charge that a suitable ratio between 28 days compressive strength at 7 days may be accepted, the Engineer-in-charge may suitably relax the frequency of 28 days compressive strength specified in 14.2 of IS : 456- 1978 provided the expected strength values at the specified early age are consistently met.

TABLE-5
Optional requirement of concrete
(clause 14.1.1 of IS : 456-1978)

Grade of Concrete	Compressive strength on 15 cms Cubes Min. At 7 days N/sqmm	Modules of Rupture by Min. at 72+hrs. N/sqmm.	Beam Test Min at 7 days N/ Sqmm
1	2	3	4
M 10	7.0	1.2	1.7
M 15	10.0	1.5	2.1
M 20	13.5	1.7	2.4
M 25	17.0	1.9	2.7

CONTRACTOR

EXECUTIVE ENGINEER

M 30	20.0	2.1	3.0
M 35	23.5	2.3	3.2
M 40	27.0	2.5	3.4

FREQUENCY OF SAMPLING

Sampling Procedure:

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested; that is, the sampling should spread over the entire period of concreting and cover all mixing units.

Frequency:

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

Quantity of Concrete in the work, Cum.	Number of Samples
Up to 1 to 5	1
6 to 15	2
16 to 30	3
31. to 50	4
51 and above	4 plus one additional sample for each additional 50 cum or part thereof.

NOTE: At least one sample shall be taken from each shift.

TEST SPECIMEN

Three test specimens shall be made from each sample for testing at 2,8 days. Additional cubes may be required for various purposes, such as to determine the strength of concrete at 7 days or at the time of striking the form work, to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS: 9013- 1978*. The specimen shall be tested as described in IS: 5161959.

TEST STRENGTH OF SAMPLE:

The test strength of the sample shall be the average of the strength of three specimen. The individual variation should not be more than plus or minus 15 percent of the average.

STANDARD DEVIATION:

Provision made under para 3.7.5 shall apply.

ACCEPTANCE CRITERIA:

The provision made under para 3.7.6 shall apply.

CORE TEST

The locations at which cores are to be taken and the number of cores required shall be at the discretion of the Engineer-in-charge and shall be representative of the whole of concrete concerned. In no case, however, fewer than three cores shall be tested.

Cores shall be prepared and tested as described in IS: 516-1959*.

Concrete in the member represented by a core test shall be considered acceptable if the average equivalent cube strength of the cores is equal to atleast 85 percent of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75 percent.

In case the core test results do not satisfy- the requirements of IS: 456-1978 or where such tests have not been done, load test (as per IS: 456-1978) may be resorted to.

HYDRAULIC TEST

After curing period of the water retaining structure is over, a hydraulic test shall be carried out. Water should be filled in the structure to the designed depth and maintained for a period of 7 days. Starting from the end of 7 days, observations of water level will be made for a period of 7 days. The drop in the water level observed should correspond to evaporation applicable to circumstances. There should also be no visible dampness or sweating on the exposed surfaces. In case of leakage, rectification work

CONTRACTOR

EXECUTIVE ENGINEER

shall be carried out to achieve the desired water tightness. After rectification done hydraulic tests shall be repeated.

4.20 STEEL REINFORCEMENT

The provision made under SECTION - V shall apply.

4.21 TOLERANCE IN CONCRETE CONSTRUCTION

4.21.1 GENERAL

(a) Permissible surface irregularities for the various classes of concrete surface finishes specified in the relevant portion of the paragraph of "Finishes and Finishing of Concrete Surfaces", are defined as "finishes" and are to be distinguished from "Tolerance" as described in this section. Deviation from the established lines, grades and dimensions shall be permitted to the extent set forth in this clause, provided that lesser tolerance than that set forth in this clause may be prescribed at site if such tolerances are considered to impair the structural action or operational action or operational function of the structure.

(b) Where tolerances are not stated in the specifications or drawings for any individual structure of feature- thereof permissible deviations shall be interpreted in conformity with the provisions of this Clause.

(c) Concrete work that exceeds the tolerance limits specified in this section shall be either remedied satisfactorily or removed.

4.21.2 TOLERANCE FOR CANAL STRUCTURE

Variation in alignment, grade and dimensions of the Structures from the established alignment, grade and dimensions shown on the drawings shall be within the tolerances specified in Table below. Variation shall not be cumulative. Where the provisions of paragraph 4.14, "finishes and finishing of concrete surfaces", as specified herein before, would permit greater variations than those allowed in the table, provisions of the table given on the following page shall apply.

TABLE

a. Pipe Culverts, float wells and similar structures			
i.	Departure from established alignment		25mm
ii.	Departure from established grade		25mm
iii.	Variation from plumb or specified batter for lines and surfaces of columns, piers and walls and for arises.		
	When overall length of line or surface is:		
	3 mtrs or less	Exposed	10mm
		Buried	20 mm
	More than 3 mtrs.	Exposed	12 mm
		Buried	25mm
IV. For any two successive intermediate points on the line or surface separated by :			
	3-mtrs or less	Exposed	10mm
		Buried	20mm
	More than 3 mtrs.	Exposed	12mm
		Buried	25mm
b. Variation from level or specified grades for slabs.			
i.	When overall length of line or surface is :		
	3 mtrs. or less	Exposed	10mm
		Buried	20mm
	More than 3 mtrs.	Exposed	12mm
		Buried	25mm
i.	For any two successive intermediate points on the line or surface separated by :		

3 mtrs or less	Exposed	10mm
	Buried	20mm
More than 3 mtrs	Exposed	12mm
	Buried	25mm

- c. Variation in cross-sectional dimension of columns, beams, slabs, walls and similar members of
..... minus 6mm
..... plus 12mm
- d. Variation in sizes and locations from those specified for slab and wall openings12mm
- e. Variation 10m plumb or pipe erected vertically in any length of 3 mtrs. 12mm
- f. **Tolerances** for bridges:
Departure from established alignment.. . 6mm
- g. footings
i. Variation of dimensions
in plain..... minus 12mm
..... plus 50mm
ii Misplacement of eccentricity 2 percent of the footing width in the direction of misplacement but not more than 50mm
iii. Reduction in thickness..... 5 percent of specified thickness.
- h. Variation from plumb or specified batter for lines and surfaces of piers and walls.
i. Exposed construction:
When overall height of line or surface is:
3 mtrs or less 10mm
more than 3 mtrs 12mm
for any two successive intermediate points on the line or surface separated by :
3 mtrs or less..... 10mm
more than 3 mtrs 12mm
ii. Buried construction Twice the amounts listed in h(i) above
- i. Variation from level of specified grades for beams Horizontal grooves, railing off sets and diaphragms

i. Exposed Constructions:

When overall length of line or surface is :

3 mtrs or less.....	10mm
more than 3 mtrs	12mm

For any two successive intermediate points on the line or surface separated by :

	3 mtrs or less.....	10mm
	more than 3 mtrs.....	12mm
ii.	For buried construction: Twice the amounts listed in i (i) above	
j.	Departure of bridge deck and rails from specified grades.....	6mm
k.	Variation in cross-sectional dimensions from those specified for piers, walls, beams and similar parts of bridge structures. minus	6mm
 plus	12mm
L.	Variation from that specified in the thickness of bridge slabs..... minus	3mm
 plus	6mm

4.21.3 (a) **GENERAL**

Bulges, Depressions and offsets are defined as concrete Surface irregularities. Concrete surface irregularities' are classified as "abrupt" or "gradual" & are measured relative to the actual concrete surface.

(b) **ABRUPT SURFACE IRREGULARITIES**

Abrupt surface irregularities are defined herein as offsets such as those caused by misplaced or loose forms, loose knots in form member, or other similar forming faults. Abrupt surface irregularities are measured using a short straight edge, atleast 15 cms. long held firmly against the concrete surface over the irregularity, and the magnitude of the offset is determined by direct measurement.

(c) **GRADUAL SURFACE IRREGULARITIES**

Gradual surface' irregularities are defined herein as bulges and depressions resulting in gradual changes on the concrete surface. Gradual surface irregularities are measured using a template conforming to toe design profile of the concrete surface being examined. Templates for " measuring gradual surface irregularities shall be provided by the contractor, templates shall be atleast 2.5 mtrs. in length. The magnitude of gradual surface irregularities is defined herein as a measure of the rate of change in slope of the concrete surface.

(d) The magnitude of gradual surface irregularities on concrete surfaces shall be checked by the contractor to ensure that the surface are within specified tolerances. The will also make such checks of hardened concrete surfaces as determined necessary to ensure compliance with these specifications. Templates for these surface shall be furnished by the concrete free of charge and shall be available for use by the at all times.

4.22 **UNACCEPTABLE WORK**

All defective concreting work, including those due to honeycombing, under sizing, under-strength etc. shall be demolished and rebuilt by the contractor at his cost. In exceptional cases where such work is accepted by the Engineer-in-charge after the contractor has made specified repairs, all cost of repairs shall be borne by the contractor. Acceptance of such works will be in accordance with the provisions of IS: 456-1978. In the event of the work being accepted, allowing under sizing commensurate with higher material, strength and accepting materials not fully meeting the specifications etc. the contractor shall be paid for the work actually carried out by him at a reduced rate derived from-the tendered rate as approved by the Engineer-in-charge.

4.23 **MEASUREMENTS AND PAYMENTS**

(a) Except otherwise specially provided for in the specifications, measurements of concrete for payment shall be made on the basis of the volume of concrete measured and calculated as being contained within the prescribed concrete outlines shown on the relevant drawings.

(b) **Measurement**, for payment, for the concrete laid in pockets in the foundation shall be made on the basis of the volume of the pockets filled.

CONTRACTOR

EXECUTIVE ENGINEER

(c) No measurements shall be made for the concrete backfill beyond the minimum lines of excavation shown on the drawings except where such payment is specifically authorized. Measurement of concrete shall be made after deducting the volume of all recesses, passageways, chambers, openings, cavities and depression but without deductions for round or beveled edges or space occupied by electrical conduits and reinforcement.

(d) Concrete in bridge side walls, kerbs and parapets in full length of the structure and block outs etc. shall be measured on the basis of volume of concrete calculated as being contained within the concrete outlines shown on the relevant drawings

(e) The unit rate for concrete shall include the cost of all materials labour, tools and plant required for mixing placing in position, vibrating and compacting finishing as per directions of the Engineer-in-charge, curing and all other incidental expenses for producing, concrete of specified strength to complete the structure of its components as shown on the drawings and according to these specifications. The rate shall also include the cost of providing, fixing and removing of all centering and form work required for the work. unless otherwise specified in the contract.

(f) The unit rate also includes the cost of dewatering, desilting, diversion and protection work as may be necessary during and after concreting work.

(g) All expenses likely to be incurred by the Contractor In transporting materials supplied to him, if any, to the site of work, the expenses incurred in improving the quality of materials to acceptable levels (such as screening, washing, etc.) and the expenses incurred in proper storage of materials as directed by the Engineer-in-charge etc. are deemed to be included in the unit rate.

(h) Payment for the various classes of concrete shall be made on the basis of unit rate per cubic metre entered in respect of items in Schedule B.

(i) No extra payment shall be made towards authorized variations in cement content per cubic metre of concrete as prescribed in para 4.7(d) and (e) above.

SECTION-V

5.0 REINFORCEMENT

5.1 SCOPE OF WORK .

The work includes supplying, cutting, bending, binding, welding and erecting in position high yield strength deformed (H.Y.S.D.) steel bars and mild steel (M.S.) bars as reinforcement for concrete of various components of drainage syphons, syphon aqueducts, road bridges, cross regulators, head regulators, escapes, lining and other structures.

5.2 INDIAN STANDARDS FOR REFERENCE

1	IS : 226-1975	Structural steel (Standard Quality)
2	IS : 280-1978	Mild steel wire for general ,Engineering. purposes
3	IS : 432-1966	Mild steel and medium tensile bars and drawn steel wire for concrete reinforcement.
4	IS : 432-196.6(part-I)	Mild Steel and medium tensile steel bars
5	IS : 432-1996 (part-V)	Hard drawn steel wire
6	IS : 814-1974	Covered electrodes for metal or welding of structural steel
7	IS : 814-1974(part- I)	For welding products other than sheets
8	IS: 814-1974(part-II)	For welding sheets
9	IS: 1139-1966	Hot rolled mild steel medium tensile steel and high yield strength steel deformed bars for concrete
10	IS : 1278-1972	Filler rods and wires for gas welding.
11	IS : 1481-1970	Metric steel scales for Engineers
12	IS: 1521-1972	Method 'for tensile testing of steel wires
13	IS : 1566-J967	Hard drawn steel wire fabrics for concrete reinforcement
14	IS : 1608-1972	Method for tensile testing of steel products
15	US : 1786-1979	Cold twisted steel bars for concrete reinforcement
16	IS: 2502-1963	Code of practice for bending and fixing of bars for

CONTRACTOR

EXECUTIVE ENGINEER

		concrete reinforcement
17	IS : 2751 – 1979	Code of practice for welding of mild steel bars used for reinforced concrete construction.
18	IS : 5525 – 1969	Recommendations for detailing of reinforcement in reinforced concrete works.
19	IS : 941 – 1979	Recommendations for welding cold worked steel bars for reinforced concrete construction

In addition to the above the relevant Indian Standard codes referred to in SECTION – 7.4 shall also apply.

5.3 STEEL REINFORCING BARS

5.3.1 GENERAL

(a) Steel reinforcing bars shall be placed in concrete where shown on the drawings or as directed by the Engineer-in-charge. The drawings issued with these specifications show only in part the requirement of reinforcement and further drawings shall be issued by the Engineer-in-charge during the course of the contract.

(b) As far as possible, high yield strength deformed bars conforming to IS: 1786-1979 shall be used as reinforcement. However, in case of Non-availability of such bars other steel bars conforming to IS: 432-1966 and / or IS: 1139-1966 shall be used as per the directions of the Engineer-in-charge.

5.3.2 CUTTING, BENDING AND, BINDING

(a) The contractor shall be responsible for the accuracy of the -Cutting, bending and placing of the reinforcement. Reinforcement shall be inspected for compliance with the requirement of grade, size, shape, length splicing and locations after it has been placed. No concreting shall be started unless the reinforcement as placed in the work is finally checked, recorded and certified by the Engineer-in-charge.

(b) Before the reinforcement is placed, the surface of the bars and the surfaces of any metal bar supports shall be cleaned of the rust, loose mill scale, dirt, grease and other objectionable foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.

(c) Reinforcing bars shall be accurately placed and secured in positions as shown in the drawing so that the bars and fabric shall not be displaced during the 'placing of concrete. The contractor shall also ensure that there is no disturbance of reinforcing bars already placed.

(d) Wire for binding reinforcement shall be of soft and annealed mild steel and shall conform to IS: 280-1978. The binding wire shall have tensile strength of not less than 56kg/sqmm. The wire shall have minimum diameter of 1 mm. Chairs, hangers, spacers and other supports for reinforcement, may be of concrete, metal or other approved material. Where portions of such supports will be exposed on concrete surfaces designated to receive F2 or F3 finish, the exposed portion of support shall be galvanized or coated with other corrosion resistant material without which the concreting will not be permitted. Such supports shall not be exposed on surfaces of F4 finish unless otherwise shown on the drawings.

The minimum allowable clearance between parallel round bars shall not be less than 1.50 times the diameter of the larger bars and for square bars shall not be less than twice the side dimensions of the larger bars. In no case the minimum clearance between the bars shall be less than 1.50 times the maximum size of aggregate irrespective of the shape of the reinforcing bar. Bars crossing each other where required shall be secured by binding wire in such a manner that they do not slip over each other at the time of fixing and concreting. Wire used for binding reinforcement shall not be measured for payment.

5.3.3 SPLICING

(a) Where it is necessary to splice reinforcement the splices shall be made by lapping, by

CONTRACTOR

EXECUTIVE ENGINEER

welding or by mechanical means.

(b) Joints or splices in reinforcing bar shall generally be made at the locations where neither shear nor bending moment is maximum, but the contractor would be permitted to take joints or splices at other position provided that such positions are approved by the Engineer-in-charge and -joints and splices in adjacent bars are staggered as directed by the Engineer-in-charge. Approval of such additional splices will generally be restricted to splices not closer than 9 mtrs. in horizontal bars and 4 mtrs. in vertical bars measured between midpoint of laps.

(c) If the contractor proposes to use welded splices in reinforcing bars the equipment, the material and all welding testing procedures shall be subject to the approval or-the Engineer-in-charge. The contractor shall also carry out test welds as required by the Engineer-in-charge.

(d) : For welded-splices for reinforcing bars conforming to IS : 1786-1979, welding shall be done in accordance with IS : 9419-1979 .. For reinforcing bars conforming to IS: 432 (part-I) 1966 and IS : 1139-1966 welding shall be done in accordance with IS : 2751-1966. Electrodes for manual metal are welding shall confirm to IS : 814 (part-I) 1974 and IS : 814.(part-II) 1974, mild steel filler rods for oxyacetylene welding. shall conform to IS : 1278-1972 provided they are capable of giving a minimum butt weld tensile strength of 41 kg/ sq mm.

(e) Reinforcing bars 28mm'in diameter and larger may be connected by butt welding, provided that lapped splices will be permitted if found to be more practicable than butt welding and if lapping does not encroach on cover limitation or hinder concrete or reinforcement placing.

(f) Reinforcing bars 25mm diameter and less' may be either lapped or butt welded, whichever is most practicable.

(g) Butt welding of reinforcing bars shall be performed under cover from weather and may be performed either by the gas pressure or flash pressure welding process, or by the electric arc methods. The following requirements shall apply to all welding of reinforcing bars including butt welding and the preparation of welded reinforcement mats.

(h) Welded pieces of reinforcement shall be tested at the rate of 5% of total number of joints welded. Specimen shall be taken from the actual site of work. Strength of the weld provided shall be at least 25% higher than the strength of bar.

(i) If the contractor proposes to use mechanical couplings for reinforcing bars he shall submit samples of the proposed coupling to the Engineer-in-charge for approval not less than 60 days prior to their proposed use.

5.3.4 CARE OF PLACED REINFORCEMENT AND CONCRETE

Where reinforcement bars are bent aside at construction joints and afterwards bent back into there original position, care shall be taken to ensure that at no time the radius of the bend is less than 6 times the diameters for deformed bars and 4 times diameters for plain mild steel bars. Care shall also be taken, when bending such bars, to ensure that the concrete around the bars is not damaged.

5.4 MEASUREMENTS AND PAYMENT

Measurement for payment for furnishing and placing reinforcing bars will be made only on the calculated -weight of the bars placed in concrete, in accordance with the drawings or as directed by the Engineer-in-charge. The calculated weight for reinforcing bars shall be determined as follows:

i) The calculated weight per meter of reinforcing bars used shall, be based on the standard weight and the corresponding lengths of bars placed in concrete by the contractor.

ii) All other joints or splices shown on the drawings or as directed by Engineer-in-charge shall be measured as laps. Mechanical coupling and welded joints approved by the Engineer-in-charge shall be measured for payment in terms of length of equivalent lap joint. Except as provided in paragraph 5.3.3 additional joints or splices shall not be' measured for payment.

Payment for furnishing and placing reinforcement bars shall be - made at the rate tendered thereof in Schedule B. The rate shall include the cost of supply of steel, preparing reinforcement as per detailed drawings; including furnishing and attaching

wire ties and cutting, bending, lapping, painting etc., cleaning, securing and maintaining in position all reinforcing bars as shown on he drawings or as directed by the Engineer-in-charge. The unit

rate shall also include cost of all incidental operations necessary to complete the work as per specifications. Lapping will be measured but not paid for separately and wastage of steel shall neither be measured nor paid for as unit rates quoted covers the same.

iii) The position and dimension of lapped splices will normally be shown on the reinforcement drawings. Where splices are required for the work the following minimum overlap of spliced bars shall be used for the various sizes and grades shown. Hooks will not normally be prescribed for splices in structural grade deformed bars.

LAPPED SPLICES

Diameter of bar	Grade of Bar	Minimum length of overlap in straights splice
6mm	Structural Plain	30cm
10mm	Structural Plain	46 cm
12 mm	Structural deformed	38cm
16mm	Structural deformed	48 cm
20mm	Structural deformed	58 cm
22mm	Structural deformed	66 cm
25mm	Structural deformed	86 cm
30 mm	Structural deformed	97 cm
35 mm	Structural deformed	107cm

SECTION – VI

6 GATES

6.1 RADIAL GATES FOR REGULATORS AND ESCAPES

6.1.1 APPROVAL OF DESIGNS AND DRAWINGS

The item is for supplying and erection of radial gates for the vents of the cross regulators on main canal or BranchCanal or escapes and head works of branch canal. The dimensions and the outline arrangements of gates shown in the tender drawings are tentative. The al shall however supply, working drawings of the structures showing therein the precise dimensions of the gates, the hoisting arrangements etc. On receipt of these drawings, the contractor shall submit within 60 days design and drawings of the gates including those of embedded parts, anchorages, hoisting arrangements etc, for the approval of the . The designs and drawings shall be transmitted to the contractor with the approval or the suggestions for modification within a period of 60 days. If the drawings are returned with suggestions for modification the contractor shall effect necessary modifications and submit the final drawings within a-Period of 45 days and the final approval shall be' communicated in not more than 30 days, provided all suggestions made are complied with in full.

6.1.2 DESIGN PROCEDURE FOR GATE AND HOISTS

The design of the radial gates shall be in conformity with IS: 4623-1967. "Recommendations for structural design of radial gates". The design of hoists shall be In conformity with IS: 6836-1978 "design of rope drum and chain hoists for hydraulic gates".

6.1.3 MATERIAL

The materials for the various parts of the radial gates shall be as specified below :

Sl No	Ref.To IS specification	Recommended Material	Component part
1.	IS : 226-1962 IS : 2063-1962	Structural Steel	Skin Plate

CONTRACTOR

EXECUTIVE ENGINEER

2.	IS : 2062-1962	Structural Steel	Stiffeners Horizontal girders
3.	IS : 2062-1962 IS : 808-1964	Structural Steel	Arms bracings, tie members, anchorage girder, yoke-girder, embedded girder, rest girder, load carrying anchors.
4.	IS: 1030-]962	Cast Steel	Guide rollers
5.	IS : 1030-1962	Cast Steel	Trunnion hub & bracket
6.	IS : 1030-] 962	Corrosion resisting steel	Pin
7.	IS : 8] 8-1962	Bronze	Bushing
8.		6mm thick stainless steel Plates	Seal seut, sill beum
9.	IS : 226 – 1962	Structural Steel	Seal Base
10.	IS : 4623 – 1976 and Appendix-A	Structural Steel and rubber	Rubber seal

6.1.4 ANCHORAGES AND HOISTING ARRANGEMENT

The rate shall be preferably designed with independent anchorages and rear suspension with galvanized wire rope, cast steel rope drum and electrically operated hoist. The contractor shall supply suitable electrical motor with switch and switch panel also, including necessary wiring as directed. Provisions shall also be made for manual operation in case of power failure. The gear arrangements shall be such as to facilitate easy operation by two operators.

6.1.5 PROCUREMENT OF MATERIALS

The contractor shall make his own arrangements for procurement of the necessary material. The will however supply structural steel if available at divisional issue rates. All materials shall be of approved quality and for all materials procured from sources, other than the al stores, the contractor shall produce necessary LS.I test certificates.

1. Fabrication

Fabrication may be done either at work spot or in contractors work or elsewhere under intimation to the . The contractor shall afford all facilities for-tile inspection of the fabrication by the al officer. All fabrication shall be done in a workmanlike manner, in accordance with relevant I.S. specifications and as directed.

2. Transportation

The fabricated parts shall be transported to the work spot carefully at contractors cost without causing any damage.

3. Schedule of Supplies

The construction programme of the civil works of the regulators and escapes and the schedule of delivery at work spot of the fabricated parts of the gates shall be well coordinated. The contractor shall furnish and follow a schedule of delivery acceptable to the department.

4. Erection

Erection of any component of gate shall be commenced only after approval of the component by the

CONTRACTOR

EXECUTIVE ENGINEER

Executive Engineer. Such approval shall be given after due inspection at work spot and without absolving the Contractor his responsibility to rectify any defects which may be noted subsequently till the gate is finally handed over after satisfactory erection, commissioning and test operations.

5. The gate shall be provided with two coats of anti corrosive paint of approved quality over one coat of primer.

6.1.6 TEST OPERATION

Before the work is finally accepted the test operation of gate shall be done in the presence of the Engineer-in-charge, after due intimation and any defects noticed shall be set right. Test operation shall be done when the canal is functioning with full depth of flow. However, if for no omission on the part of the Contractor, the Canal does not commence functioning within 6 months after the stipulated date of completion of his work the test operation shall be done with such depth of water as may be available in the canal.

6.1.7 MEASUREMENTS AND PAYMENTS

Payment shall be made per tone of the finished weight of the structural steel and cast steel components' of the gate proper and its embedded parts including the gate, the sill beam, sill plate, girder, trunion, hub and brackets, trunnion pin anchor girder, yoke girder, rest girder the rods and the members. The weight of the rolled sections of structural steel and of tie rods shall be computed by multiplying the measured length of these sections by the standard weight per running meter as given in relevant LS specifications. The weight of structural steel plates shall be computed multiplying the standard measured surface area of the plate by the weight per square metre of such plates as given by LS specification. No deductions shall be made towards the holes made for rivets and bolts. No addition shall be made for the weight of bolts, rivets and welds. The weight of bronze and cast steel parts of the gate shall be determined by actual weighing.

The hoists including hoist drums, wire rope, Electrical motors, switches, switchboard panel shall not' be separately measured and paid. The rate quoted for the gates deemed to include the Cost of the hoists also'

The schedule for part payment of intermediate bills shall be as under:

Sl	Stage	Cumulative rate of payment
1	After procurement of materials, on production of supplier's vouchers and hypothecation of materials procured.	A payment of 40% of the accepted unit rate of the gate for the gross weight of the required materials procured or actual cost whichever is less.
2	After fabrication at workshop	A payment of 65% of the accepted unit rate of the gate for the weight of the fabricated parts.
3	After transportation of fabricated parts to work site.	A payment of 70% of the accepted unit rate of the gate for the weight of fabricated parts.
4.	After erection inclusive of hoisting arrangements complete.	A payment of 90% of the accepted unit rate for the weight of the completed gates.
5.	After commissioning test operation and final acceptance.	At 100% of the accepted unit rate for the weight of the gates accepted.

6.2 VERTICAL LIFT SLIDE GATE

The vertical lift slide gates are for the gates of the Distributory head works. The dimensions and the out-line arrangements shown in the tender drawings are tentative. The will supply working drawing

CONTRACTOR

EXECUTIVE ENGINEER

of each Distributory head works to the Contractor showing there in the precise dimensions of the gates and the location, elevation etc., of the hoisting arrangements. The contractor shall then furnish within 60 days the design and drawings of the gates and the hoisting arrangements including hoist platform, anchorages etc. for approval of the . The design and drawings shall be approved or returned with comments for modification within a period of 60 days from the date of receipt by the department. If the drawings are returned with comments, the contractor shall furnish the final drawings incorporating all suggested modifications within a period of 45 days and final approval shall be communicated within 30 days.

The gate shall be manufactured using plates and rolled sections of structural steel. The design shall be in conformity with IS: 5620-1970 "Design criteria for low head slide gates". The gate shall be with screw gear hoists, the force being 'transmitted through a screw attached to the, centre of the gate. On the upper end .of this shaft, a square screw thread is cut for the length necessary to secure required travel of the gate and the screw nut to fit the thread is housed in a box in which it can freely revolve, the box being fixed to the hoist platform. The nut is revolved by means of a spanner of captained. Guide collars are provided to support the screw shaft at suitable intervals.

The contractor shall make his own arrangements for procurement of materials. They will supply structural steel plates and rolled sections if available in the all stores at the issue rate. Contractor shall produce necessary I.S.I. test certificate for all materials procured from sources other than all stores.

The gate shall be fabricated in workman like manner and in accordance with relevant I.S. specification and transported to work site carefully. Erection shall commence only after inspection and approval by the Engineer-in-charge.

The gate shall be painted with 2 coats of anti corrosive paint of approved,quality over a coat of red oxide primer.

Trial operations of the gate shall be made in the presence of Engineer-in-charge and any defects noticed shall be set right promptly. If the commissioning of Canal is delayed by more than 6 months after the agreed date of completion of the gated structure, due to no fault on the part of the contractor, the test operation will be done with such depth of water as may be available in the canal.

6.2.1 MEASUREMENTS AND PAYMENTS

The weight of gate shall be computed from the measured lengths of rolled sections and rods and measured surface area of the plates by multiplying with standard weight per RMTR and standard weights per Sq.mtr. respectively, given in relevant I.S. specifications.

Intermediate payments shall be made at 90% of the accepted unit rates for the weight of gates erected. Full payments shall be made after successful trial operations.

SECTION – VII

7 RUBBLE MASONRY:

7.1 SCOPE OF WORK

The work covered under this section consists of furnishing all material, equipment and labour for providing and laying uncoarsed rabble masonry in substructure and superstructure and performing all functions necessary and ancillary thereto and including pointing of exposed surfaces and curing. This also includes dewatering if required.

7.2 INDIAN STANDARDS FOR REFERENCE

1. IS:1121-1974 Method of test for determination of strength properties
(All parts) Of natural building stones
2. IS: 1122 - 1974 Method of test for determination of true specific gravity of natural

CONTRACTOR

EXECUTIVE ENGINEER

building stones.

3. IS:1123-1975 Method of identification of natural building stones.
4. IS : 1124 - 1974 Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
5. IS : 1125 - 1974 Method of test for determination of weathering of natural building stones.
6. IS : 1126 - 1974 Method of test for determination of durability of natural building stones.
7. ES : 1127 - 1970 Recommendations for dimensions and workman ship of natural building stone for masonry work.
8. IS : 1129 - 1972 Recommendations for dressing of natural building stone
9. IS: 1542-1977 Sand for plaster
10. IS: 1597-1967 Code of practice for construction of stone masonry.
- II. IS : I 597 - 1967 Rubble stone masonry
Part 1
12. IS : 1706 - 1972 Method of determination of resistance to wear by abrasion of natural building stones.
13. IS : 2116 - 1980 Sand for masonry mortars.
14. IS : 2250 - 1981 Code of practice for preparation and use of masonry mortars
15. IS : 140 I - 1967 Stone facing.
Part I
16. IS : 4121 - 1967 Method of test for determination of water transmission
17. IS : 4122 - 1967 Method for the surface softening of natural building stones by exposure to acidic atmosphere.
18. IS : 4348 - 1973 Method of test for determination of permeability of natural building stones.
19. IS: 5218 - 1969 Method of test for toughness of natural building stones.
20. IS : 7779 Engineering properties of building stones.
21. IS:8381-1977 Recommended practice for quarrying stones for construction purpose.

7.3 MATERIAL

7.3.1 CEMENT

The provisions of sub para 3.5.1 shall apply.

7.3.2 WATER

The provisions of sub -para 3.5.4 shall apply.

7.3.3 SAND

(a) Sand to be used in mortar shall conform to IS: 2116 - 1980 and the gradation limits given below:

I.S. sieve designation	Percentage of weight passing I.S sieve
4.75 mm	100
2.36 mm	90-100

CONTRACTOR

EXECUTIVE ENGINEER

1.18 mm	70-100
600 Micron	40-100
300 Micron	5 – 70
150 Micron	0 – 15

(b) The provisions of sub-para 3.5.2 shall also apply

(c) Before collecting the sand required for mortar for the masonry work, the contractor shall ensure that the sample of sand proposed to be used are supplied to the project laboratory for casting the mortar cubes, and material shall be collected only after ascertaining the results of the test on the mortar cubes. During the execution of the work sand collected at site shall also be tested for all specification requirements.

7.3.4 RUBBLE (STONES)

Stone shall be hard, sound free from cracks, decay and weathering_ Stone shall be used from surplus usable excavated rubble or from the approved quarries, if required. Stone with round surface shall not be used. Stones when immersed in water for 24 hours shall not absorb water by more than one percent of their dry weight when tested in accordance with IS: 1125 -1974.

The length of stone shall not exceed three times its height and the breadth on the base shall not be greater than three fourth of the thickness of wall and in any case not-less than 15 cm. Minimum crushing strength of stones shall not be less than 600 Kg/Sqcm.

7.4 U.C.R. Masonry

7.4.1 MORTAR

The mortar shall consist of cement, sand and water thoroughly mixed in the proportion as specified. Proportion of cement and sand shall be on weight basis as specified in schedule -8. Due allowance shall be made for the moisture content in sand. Mixing water shall be added to achieve required workability .

7.4.2 MIXING

(a) The mortar shall be mixed in mechanical mixers of tilting type having calibrated water tank for storing water. The first batch of the mortar at the commencement of work with any mixer shall be made richer by adding 10 percent more cement over and above that required for the particular mix. In case of mechanical mixing, the mortar shall be mixed for at least 3 minutes after addition of water. Hand mixing shall not be allowed. However, in exceptional circumstances such as mechanical break down of mixer, work in remote areas or when the quantity of work is very small, mixing in hand operated mixers shall be permitted.

(b) All ingredients shall be fed to the mixer simultaneously. The quantity of water to achieve the required consistency shall be predetermined by trial mixes, and proportion of water from 5 to 10 percent shall precede and the like quantity shall follow the introduction of other materials. The remainder of water quantity shall be added during mixing operation.

(c) The wet mortar shall be used within 30 minutes of mixing, mortar remaining unused, after above time shall be rejected and shall not be allowed to be used

7.4.3 MODE OF LAYING

(a) The dressing of stone shall conform to the general requirements covered in IS: 11291972.

Stone' shall be sufficiently wetted before laying to prevent absorption of water from mortar. All stones shall be laid full in mortar both in bed and in vertical joints and settled carefully in place with a wooden mallet immediately on placement so that it is firmly bedded in before the same has set. Clean chips and spalls shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. Whenever foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. Vertical joints shall be staggered. Transverse bond shall be provided by the use of bond stones extending from the front to the back of the masonry. In case of thick walls beyond 60 cm, bond stones shall overlap each other in their arrangement. Overlap shall not be less than 15 cms. Bell shaped bond stones or headers shall not be used.

Bond stone shall be stacked separately and marked to distinguish it from other stones. Masonry work shall be started after sufficient numbers of bond stones are collected on site as directed by the Engineer-in-charge. Bond stones shall be inserted at the rate of one per square meter and shall be staggered.

(b) At all angular junctions, stones at each alternate course shall be well bonded into the respective course of the adjacent wall. All connected masonry in structures shall be carried up at one uniform level throughout as far as possible, but when breaks are unavoidable the masonry shall be in sufficient long steps to facilitate jointing of new work with old. Stepping shall not be more than 45 degrees with the horizontal. Masonry work shall be carried out to truly plumb or to the specified batter. Face work and hearting shall be brought up evenly. The top of each course, however, shall not be leveled lip by use of flat chips. Chips and spalls of stones may be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that not hollow spaces are left anywhere in the masonry. Chips shall not be used below hearting stones to bring these up to level of face stones. Use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 percent of the quantity of stone masonry.

(c) **Hearting** or interior filling of water face shall consist of rubble stones, not less than 15 cm in any direction carefully laid, hammered down with - a wooden mallet into position and firmly bedded in mortar. Hearting should be laid nearly level with facing and backing.

(d) The joint shall not be more than 25 mm thick but shall be sufficiently thick to prevent stone to stone contact and shall be completely filled with mortar. The total content of mortar in masonry shall not be less than 40% and not more than 48% of the volume of masonry.

(e) When fresh masonry is to be placed against existing surface of structure, the old surface shall be cleaned of all loose material, roughened and wetted as directed by the Engineer-in-charge so as to achieve a good bond with the new work.

(f) The scaffolding shall be sound and strong to withstand all loads likely to come upon it. The holes, which provide resting space for horizontal members, shall not be left in masonry. The holes left in the masonry work for supporting the scaffolding shall be filled

(g) Green work shall be protected from- rain by suitable cover. Masonry work in cement mortar shall be kept consistently moist on all faces for a minimum period of twenty one days after 24 hours of construction and continuous for 21 days. Watering should be done carefully so as not to washout the mortar joints or disturb the masonry in any manner. During hot weather all finished or partly completed work shall be covered or wetten in such a manner as to prevent drying. The raking of joints where necessary shall be done at the end of day's work when mortar is green.

7.4.4 MEASUREMENT AND PAYMENT

(a) Cross-section at 3 mtrs or closer intervals shall be taken to determine the quantity of masonry. Payment shall be made on the basis of the volume of the masonry work calculated as being contained within the pay lines shown on the drawing.

(b) No allowance shall be made for the masonry backfill beyond the pay lines of excavation shown on the drawings except where such payment is specifically authorised. Payment for masonry shall be made on the basis of the unit rate for the respective items in Schedule - B. The unit rate for stone masonry shall include the cost of all labour, materials, tools, plant, and scaffolding, curing etc. and other expenses incidental to the work. The unit rate also includes dewatering and desilting required, if any.

7.5 POINTING

7.5.1 GENERAL

(a) For a surface, which is to be subsequently pointed, the joints shall be squarely raked out to a depth of 20 mm. While the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed and cleaned.

(b) Mortar required for pointing shall be prepared in accordance with the provisions of para No. 7.4.1 and 7.4.2. The cement and sand shall be used in proportion as specified in the 'respective items or as directed by the Engineer-in-charge.

(c) For pointing, mortar shall be filled and pressed into the raked out joints before giving the required finish. Superfluous mortar shall be cut off from the edges of the lines and the surface of the masonry shall also cleared of all mortar.

(d) **Curing** shall be started as soon as the mortar used for finishing has hardened sufficiently not to be damaged when watered. It shall be kept wet for a period of atleast 21 days. During this period it shall be suitably protected from all damages.

7.5.2 MEASUREMENT AND PAYMENT

Measurement for payment of the pointing work shall be on square metro basis. Payment will be made at the unit rate for pointing as per schedule - B which shall include the cost of all labour, materials, tools, scaffolding curing and other expenses incidental to the work.

7.6 TEST FOR MORTAR FOR CONSTRUCTION OF MASONRY:

(a) At least one set of test cubes of cement mortar used shall be taken for each day's work and it shall be tested for 28 days strength.

(b) . From the design mortar mix, cubes using the material shall be cast in the laboratory at suitable intervals and their strength is determined. This strength shall deemed as the standard strength for that mortar. The strength of the test cubes shall be found out and shall not be less than 80% of the standard strength mentioned above. For acceptance, the 28. days strength of test cubes shall be the criteria, 80 percent of the test cubes should satisfy the above criteria. All laboratory testing work shall be carried out by the as per relevant Indian standards and the contractor shall be permitted to watch the test if he so desires. The Cost of testing be borne by the department..

7.7 CONTROLLING PAYMENT

The unit rate in Schedule - B for masonry work shall represent the rate for the work to be done under the item to its full height. Part payment shall, however, be made on intermediate bills as shown below:

Percentage of Work done	Percentage of Ten de red rate to be paid for the work
Until 50% of masonry is done	95%
more than 50% but less than 100% of masonry is done	98%
When 100% of masonry is done	100%

The above percentages shall be applied to each component of individual structure separately.

SECTION-VIII

8.0: REVETMENT AND PITCHING:

8.1 The bed or slope to receive the pitching or revetment shall be prepared 'true to line and grade and shall be moistened and well rammed so as to present a clear uniform compact surface.

8.2 The stones shall be hard, sound and durable and as regular in shape as possible and with length not less than specified. Each stone shall not be less in size than 0.015 cum unless otherwise specified or ordered by the Engineer-in-charge, having regard to nature of the stone obtainable in-the approved source. For revetment only the size stones shall be 'used.

8.3 The stones shall be laid closely in position on the prepared bed and firmly set with their narrowest end downwards, and level with the finished surface of the pitching. The stones shall be laid breaking joint as far as possible, in the direction of flow of water. The stones are to be placed perpendicular to the finished surface. i.e. perpendicular to the slope for revetments and to the specified thickness.

8.4 The interstices between adjacent stones shall be filled in with stone spalls of the, proper size; well driven in with crowbars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. The final wedging shall be done only after obtaining the orders of the Engineer-in-charge. The final wedging shall be done with the largest sized chips practicable, each chip being well driven with a hammer so that no chip is possible at being picked up or removed by hand.

8.5 Profiles of string and pegs are to be put up to ensure that the pitching is done true, straight, and to the proper slope throughout and revetments in all cases are to be built up from the foot of the bank to be reverted.

8.6 On completion the surface presented by the apron or revetment shall be even throughout, free from irregularities, to the required length, breadth and slope specified as shown in the drawings.

8.7 When use of rubble of canal spoils is specified, rubble required for the work shall be issued at the nearest available stacks of the excavated materials of the canal in the reach concerned or in any of the adjoining reaches if available. The contractor shall sort out useful rubble, hammer dress to the required size shape and convey the same to the work spot at his cost.

8.8 MEASUREMENTS AND PAYMENT

Payment shall be made on volumetric basis in cum of the pitching and revetment' as in Schedule - B. The unit rate quoted shall include the cost and conveyance of rubble, preparation of bed, laying and packing of rubble in accordance with the above specification to specified thickness, and all other incidental charges.

SECTION – IX

9.0 SUPPLYING, LAYING AND JOINTING HUME (PRE - CAST) PIPES:

9.1 Pipes and collars of specified classes shall be procured by the contractor at the site of work. No pipe shall be placed in position until the foundations have been approved by the Engineer-in-charge. Where two or more rows of pipes are to be laid adjacent to each other they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

9.2 The laying of pipes on the prepared foundation shall start from the outlet proceed towards the inlet and shall be completed to the specified lines and grades. The pipes shall be fitted and matched so that when laid in work, they form a culvert with a smooth uniform invert.

9.3 Any pipe found defective or damaged during laying shall be removed, replaced by the contractor at his cost.

9.4 JOINTING

9.4.1 One collar shall be provided at each joint. The collar shall be of R.C. C. having the same strength as the pipes to be joined. Caulking space shall be between 13 and 20 mm according to the diameter of the pipes. Caulking material shall be slightly wet mix of cement and sand in the ratio of 1:3 rammed with caulking irons. Before caulking the collar shall be so placed that its centre coincides with the centre of the joint and an even annular space is left between the collar and the pipe .

9.4.2 All joints shall be made with care so that their interior surface is smooth and consistent with the interior surface of the pipes. After finishing, the joints shall be kept covered and damp for at least 14 days.

9.5 BEDDING FOR PIPE

The bedding shall provide a firm foundation of uniform density throughout the length of the culvert and shall conform to the specified levels and grade. Concrete cradle bedding or first class bedding shall be provided, as specified in the drawing. The specifications of concrete cradle bedding and first class bedding shall conform to IS : 783 - 1959 or its latest version

9.6 BACKFILLING

Specification for backfilling shall be as per Para 2.10.

Backfilling will be separately paid as mentioned in Para 2.10.3.

9.7 OPENING TO TRAFFIC

No traffic shall be Permitted to cross the pipe lines unless the earth tilling above the latter IS at least 0.6 metre.

9.8 MEASUREMENTS AND PAYMENTS

R.C.C. pipes as laid shall be measured along their centre between the inlet and outlet ends in running meters.

9.9 RATE

The rate shall include the cost of pipes and collars, transportation, handling, storing, laying in position and jointing pipes and also the cost of preparing specified bedding.

9.10 ELASTOMERIC BEARING

9.10.1 GENERAL

Elastomeric bearing conforming to IRC - 83 (part II) section-I and as per the MOST specification 2095 is to be used.

9.10.2 PLACING

Elastomeric bearing pads of required size shall be fixed in position true to Line and level as directed by Engineer - in charge,. It includes cost and conveyance of all materials, labour and fabrication machine ring inputs, gas cutting, straightening, mixing neoprene with respect with respect to nodules with chemicals, vulcanising of Elastomeric compound with reinforcement plates etc. as per drawing and as directed by Engineer-in charge.

9.10.3 TESTING

The cost per cubic centimeters shall be inclusive of one extra bearing for Testing, for which no separate payment will be made and also for testing.

9.10.4 MEASUREMENT AND PAYMENT

The Electrometric bearings will be measured on volumetric Basis in cubic centimeter .is provided and fixed and payment will be made as per the rates quoted in Schedule - B, it is inclusive of testing charges.

SECTION – X

10.0 WATER STOPPER

10.1 Water bars are performed strips of impermeable material, which are to be embedded in the concrete during construction so as to span across the joint and provide a permanent watertight seal during the whole range of joint movement. The most useful forms of water bars are strip with a central longitudinal corrugation and a central longitudinal hollow to be with thin walls with stiff wings. The material used for the water bar are synthetic rubbers and plastics have very considerable advantage in handling, splicing and in making intersections.

With all water bars, it is important to ensure proper compaction of the concrete. The bar should have such shape and width that the water path through the concrete round the bar should not be unduly short. The water bar should either be placed centrally in the thickness of the wall or its distances from either side of the wall should not be less than half the width of the bar. The full concrete cover to all reinforcement should be maintained.

10.2 Joint sealing compound: Joint sealing compounds are impermeable ductile materials, which are required to provide a watertight seal by adhesion to the concrete throughout the range of joint movement. The commonly used materials are based on asphalt, bitumen, or coal tar pitch with or without filters, such as lime stone or slate dust, asbestos fibre, chopped hemp, rubber or other suitable material. These are usually supplied after construction or just before the reservoir/delivery chamber is put into service by pouring in the hot or cold state. These may also be applied during construction such as by packing round the corrugation of water bar. For detailed specification refer IS 3370 (Part-I) - 1965.

10.3 MEASUREMENT AND PAYMENT

Payment shall be made on running meter of the water stopper. The unit rate quoted shall include the cost and conveyance of all materials such as water stopper, joint sealing compound and placing and providing joint sealing compound in accordance with the above specification and all other incidental charges.

G.I. PIPE HAND RAILS

10.4 G.I. Pipes of approved quality, conforming to the relevant IS code of 40mm dia. in three rows shall be fixed to RCC posts of CC M-15 grade of size 100mm x 100mm at top and 150mm x 150mm at bottom placed at a distance of 2 mtr intervals at a height of 750mm. including curing, finishing etc. as directed by Engineer-in-charge.

Handrails shall be properly jointed and installed and painted with two coats of paint as approved by Engineer-in-charge

10.5 MEASUREMENT AND PAYMENT

The measurement of handrails including posts shall be made on running meter basis, The rates quoted for the item shall include supplying, transporting, casting, installing and painting and other incidental charges.

LIST OF DRAWINGS : Separately enclosed

Note : Tenderers are not required to complete this form at the time of tendering.