

PART - II

TECHNICAL SPECIFICATIONS

For technical specifications, refer Indian Railways Unified Standard Specifications (Works and Materials), 2010 amended up to date/ Gujarat State SOR/Codes/Manual / NH SOR /Codes/Manual as shall be relevant and the specification for fabrication and erection of steel girder bridges and Locomotive Turn Table (Fabrication Specification), Serial No B1 - 2001 amended up to date. The decision of V.P. (GUDC) is final and binding to the contractor.

Indian Railways Unified Standard Specifications (Works and materials), Volume I & II are available for sale at the offices of General Managers and DRMs at all Zonal Railways & Production Units.

2.1 GENERAL GUIDELINES REGARDING SPECIFICATIONS AND SPECIAL CONDITIONS FOR SUPPLY OF CEMENT FOR CONSTRUCTION WORKS

2.1.1 SUPPLY OF CEMENT:

2.1.1.1 Supply of cement to various specifications as required for various items under different schedules will be paid under the items in Schedule.

2.1.1.2 The cement required for various items of work under Schedule shall be supplied by the Contractor at the site of work in accordance with the requirements and specifications.

2.1.1.3 For supply and use of cement in various works, relevant Indian Railways Unified Standard Specifications (Works and Materials), Volume I & II - 2010, IRS codes/ Guj. State SOR/Codes/Manual/MORTH Code IS Specifications & design requirement as relevant will be applicable. Wherever, relevant specifications are not available, decision of the Engineer shall be final and binding on the contractor.

2.1.2 SPECIFICATIONS FOR CEMENT:

2.1.2.1 The cement used shall conform to any of the following standards.

- (i) 33 Grade Ordinary Portland Cement conforming to IS: 269
- (ii) 43 Grade Ordinary Portland Cement conforming to IS: 8112
- (iii) 53 Grade Ordinary Portland Cement conforming to IS: 12269
- (iv) Rapid Hardening Ordinary Cement conforming to IS: 8041
- (v) High Strength Portland Cement conforming to IRS: T: 40
- (vi) Hydrophobic Portland cement conforming to IS: 8043
- (vii) Low heat Portland cement conforming to IS: 12600
- (viii) Sulphate Resistance Cement conforming to IS: 12330

2.1.3 SOURCE AND PACKAGING:

2.1.3.1 Cement to be used on the works shall be procured from the main / reputed cement plants or from their authorized dealers. Decision of V.P. (GUDC) regarding reputed firms shall be final and binding on the contractor.

2.1.3.2 Cement shall be packed in jute sacking bags conforming to IS: 2580-1982, double hessian bituminised (CRI type) or woven HDPE conforming to IS: 11652-1986, woven polypropylene conforming to IS: 11653:1986, Jute synthetic union conforming to IS: 12174:1987, or any other approved composite bags, bearing the following information in legible markings:

- (i) Manufacturer's name or Registered Trade Mark of manufacturer, if any.
- (ii) Grade of cement
- (iii) Type of cement
- (iv) Weight of each bag in Kg.
- (v) Date of manufacture,
- (vi) IS Code No. to which the cement conforms.

2.1.3.3 All cement bags shall have com.y stitches intact and if any sign of tampering with com.y stitches is noticed, the same will be rejected without any test and no compensation shall be payable in this regard.

2.1.4 TEST CERTIFICATE REGARDING QUALITY OF CEMENT:

2.1.4.1 Necessary test certificates will have to be produced by the contractor regarding the quality of the cement conforming to the specification in addition to the manufacturer's certificates.

2.1.4.2 V.P. (GUDC) reserves the right to take samples during the course of the work and get the cement tested in reputed laboratories to ascertain the conformity to the specification. Cost of such testing shall be borne by the contractor without any extra payment.

2.1.4.3 Tests on cement shall be done as per relevant IS Codes. These tests are as follows:

- (i) Compressive strength
- (ii) Initial and final setting time
- (iii) Consistency
- (iv) Soundness.
- (v) Fineness

2.1.4.4 The Contractor shall arrange to carryout above tests for every 50 Tonnes of cement, and for every change in lot/batch, contractor will submitted test report from manufacturing comfy and shall submit to the V.P. (GUDC) and take approval of the V.P. (GUDC) before using in work. No extra payment will be made for conducting such tests.

2.1.4.5 Any temporary structure required for storage of cement, has to be provided by the tenderer at his cost and shall be removed after completion of work. The V.P. (GUDC) will only provide suitable land wherever land is available and is free for

use. On completion of the work or as directed by the Engineer, the shed if put up by the Contractor, should be removed by the contractor and site cleared at his cost.

2.1.5 CONSUMPTION OF CEMENT:

2.1.5.1 The cement consumption for other than design mix concrete, shall be as per Annexure -7 of Special condition, as applicable and relevant. The quantity of cement will be decided based on the approved design mix keeping in mind Minimum and Maximum cement content specified for various grades. Excess cement used will not be paid for and the decision of the Engineer in this connection shall be final and binding on the Contractor.

2.1.6 PAYMENT FOR CEMENT:-Deleted

2.1.7 GENERAL:-

2.1.7.1 No wastage of any of the materials supplied and used in the work by the contractor including cement is payable by V.P. (GUDC), contractor shall make his own arrangements for storing cement for use in work.

2.1.7.2 Contractor should take proper precautionary measures to store the cement in good condition against rains, etc. Storage of cement at the work site shall be at the contractor's expense and risk. Any damage occurring to cement due to faulty storage in contractor's shed or on account of negligence on his part shall be the liability of the contractor.

2.1.7.3 53 Grade/43 Grade/33 Grade of cement should be stacked separately in countable manner.

2.1.7.4 Admixture as per IS: 9103 of approved manufacturer by the Engineer shall be permitted to be used in concrete wherever required. However, no extra payment for the admixtures used shall be payable unless otherwise specified in the Schedule.

2.1.7.5 Cement for temporary and enabling works shall be arranged by the contractor at his own cost and no extra payment will be paid on this account.

2.1.7.6 Deleted

2.2 GENERAL GUIDELINES REGARDING SPECIFICATIONS AND SPECIAL CONDITIONS FOR CONCRETE WORKS

2.2.1 Specifications:-

2.2.1.1 Concrete for PCC/ RCC/PSC (Including piling , piers, abutments and RCC deck slab/girders etc.) shall be as per relevant IS Specifications. Some important guide lines are listed below. Along with these, all other relevant IRS, IRC and IS specifications with their up to date versions shall also govern. These govern all concrete works in bridges, etc., as applicable.

(i) IRS Concrete Bridge Code.

- (ii) IS 456: Code of Practice for Plain and Reinforced Concrete.
- (iii) Relevant Indian Railway Unified Standard Specifications (Works & Materials) Volume I & II, Engineering Department, 2010
- (iv) Relevant IRS/IRC/MORTH/IS Specifications/Codes
- (v) Relevant PSC Codes & specification.

2.2.1.2 Specifications for cement, steel, binding wire, used in concrete construction shall be as per IRS/IRC/MORTH/IS specifications with latest corrections slips/revisions. Any other specifications/rules/guidelines issued from time to time by Railway Board/RDSO shall also govern the works.

2.2.1.3 In all matters of execution, including testing of various components, where the above codes/specifications/guidelines are not clear or explicit or at variance, the directions given by the Engineer shall be final and binding on the contractor.

2.2.2 Cement:-

2.2.2.1 The cement used in concrete construction shall be 43/53 Grade Ordinary Portland cement as per the design and as specified in the relevant schedules. Specifications for cement are covered under the supply schedule.

2.2.3 Reinforcement:-

2.2.3.1 All Reinforcement Steel (TMT Bars of Grade Fe 550D with CRS) shall be procured as per specification mentioned in IS: 1786. Independent tests shall be conducted, wherever required, to ensure that the materials procured conform to the Specifications.

These steel shall be procured only from those firms, which are Established, Reliable, Indigenous & Primary Producers of Steel, having Integrated Steel Plants (ISP), using iron ore as the basic raw material and having in house iron rolling facilities, followed by production of liquid steel and crude steel, as per Ministry of Steel's guidelines.

2.2.3.2 Bars shall be cut, bent and placed correctly and accurately to the size and shape as shown in the detailed drawing. Preferably bars of full length shall be used. The reinforcement shall be tied with annealed/ mild steel binding wire. Overlapping of bars, where necessary, shall be done as directed by Engineer. Rates quoted include the cost of annealed steel binding wire of appropriate specifications. Rate also include necessary cutting and straightening is also included.

2.2.3.3 Welding of reinforcement will not be generally permitted except in special circumstances under the written approval of the Engineer.

2.2.3.4 A register shall be maintained by the Contractor with full details of reinforcement provided for accountal and payment of steel reinforcement. The contractor should sign such register approved by V.P. (GUDC) before undertaking concreting works, as a token of acceptance of the details of reinforcement steel provided in works, failing which the details as recorded by V.P. (GUDC) shall be binding on the contractor for the purpose of payment and no dispute will be entertained by V.P. (GUDC) on this account.

2.2.3.5 Contractor shall remove from site any steel materials rejected by the Engineer within a reasonable time as specified by him.

2.2.3.6 Protective Coatings:- In order to offer adequate resistance against corrosion, reinforcement bars may be provided with suitable protective coatings depending upon the environmental conditions In aggressive environments (severe, and extreme) application of cement slurry coating after removal of rust and other loose material from the surface of the reinforcement bar will generally be sufficient.

2.2.3.7 The steel consumption shall be as per the drawings issued by the V.P. (GUDC). Quantity of steel reinforcement consumption shall be as per reinforcement actually utilized in the work based on approved bar bending schedule. Nothing extra will be paid for wastage or for cut rods, if any, which will be property of the contractor. The weight of the steel will be calculated from the nominal weight given in the producer's hand / IRUSS (W & M),2010-Volume-I books.

2.2.4 Coarse & Fine Aggregates:-

2.2.4.1 Aggregates shall comply with the requirements of IS: 383 and shall be subjected to the tests in accordance with IS: 2386. Coarse aggregates shall be from crushed stone from approved quarries. Sand shall be from good river sources of approved quarries only.

2.2.4.2 The size of the coarse aggregates shall be as per relevant IRS / IS specifications.

2.2.4.3 The size of the fine aggregates shall be as per relevant IRS / IS specifications.

2.2.4.4 Coarse aggregate shall be crushed and roughly cubical in shape. Fine aggregate shall be naturally produced. Creek/ Marine sand shall not be used in permanent works.

2.2.4.5 The grading of the sand shall conform to relevant IS specification. The sand shall be screened on a 4.75 mm size screen to eliminate over size particles. The sand, if required, shall be washed in screw type mechanical washers in potable water to remove excess silt, clay and chlorides wherever required. The screening and washing of sand shall be completed at least one day before using it in concrete. The washed sand shall be stored on a sloping platform and in such a manner as to avoid contamination.

2.2.5 Water:-

2.2.5.1 Water used for washing of aggregates and for mixing and curing concrete shall be clean, potable and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel and shall conform to clause 5.4 of IS : 456.

2.2.5.2 In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength as per IS : 4031 (Part VI) and initial setting time tests IS : 4031 (Part V).

2.2.5.3 Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

2.2.6 Admixtures:-

2.2.6.1 In bridges, use of admixtures is governed by clause 4.4 of IRS Concrete Bridge Code.

2.2.6.2 The admixtures, when permitted, shall conform to IS: 9103. Calcium chloride or admixtures containing calcium chloride shall not be used in structural concrete containing reinforcement, prestressing tendon or other embedded metal. The admixture containing Cl & SO₃ ions shall not be used. Admixtures containing nitrates shall also not be used. Admixtures based on thiocyanate may promote corrosion and therefore shall be prohibited.

2.2.6.3 Concrete admixtures shall be obtained only from established manufactures with proven track record or as per approved list wherever available.

2.2.6.4 The contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer before the same is put to use:

- (a) The chemical names of the main ingredients in the admixtures.
- (b) The chloride iron content, if any, expressed as a percentage by mass of the total admixture.
- (c) Values of dry material content, ash content and relative density of the liquid admixture which can be used for Uniformity Tests.
- (d) Whether or not the admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so to what extent.
- (e) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.
- (f) There would be no increase in risk of corrosion of the reinforcement or other embodiments as a result of using the admixture.
- (g) Retardation achieved in initial setting time.
- (h) Normal dosage and detrimental effects, if any, of under dosage and over dosage.
- (i) Recommended dosages and expected results, including proof for the same wherever required. Independent test results shall be produced by the contractor on demand/as specified.

2.2.7 Storage of materials: -

2.2.7.1 Storage of materials shall be as per IS: 4082. All materials may be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space must also permit easy inspection, removal and restoring of the materials. All such materials even though stored in approved godowns / places, must be subjected to acceptance test prior to their immediate use.

2.2.7.2 Aggregate shall be stored at site on a hard and dry level patch of ground. If such a surface is not available, a platform of planks or of corrugated iron sheets, or a floor of dry bricks, or a thin layer of lean concrete shall be made so as to prevent the admixture of clay, dust, vegetable and other foreign matter.

Stacks of fine and coarse aggregate shall be kept in separate stack piles, sufficiently removed from each other to prevent the materials at the edge of the piles getting intermixed. On a large job it is desirable to construct dividing walls to give each type of aggregate its own compartment. Fine aggregate shall be stacked in place where loss due to the effect of wind is minimum.

Unless specified otherwise or necessitated by site conditions, stacking of aggregate should be carried out in regular sizes.

2.2.7.3 Cement shall be transported, handled and stored at the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water-tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months. Cement older than 3 months from the date of manufacture shall not be used. Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the Contractor without charge to V.P. (GUDC). For more details regarding stacking and storage of cement etc of Indian Railway Unified Standard Specifications (Works & Materials), Volume II, - 2010 as shall be applicable or relevant. The decision of V.P. (GUDC) is final and binding to the contractor.

2.2.7.4 The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground level by at least by 150mm and shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Every bar shall be inspected before assembling on the works and any defective, brittle, excessively rusted or burnt bars shall be removed. Cracked ends of bars shall be cut out.

2.2.8 Testing of cement & others:-

Cement and other items shall be tested as per specifications. However, the contractor shall also arrange for additional tests at his own cost as required by the

Engineer as and when required. The decision of the Engineer shall be final in this regard.

2.2.9 Concreting:

2.2.9.1 The contractor shall make his own arrangements for supply of water and electricity for all his works at his own cost. He shall arrange potable quality water for use in all concrete works and samples of water shall be got tested from approved laboratory/approved by the Engineer before being used in concreting. Apart from water, fine & coarse aggregates and all other materials shall be tested from time to time by the contractor at his cost to ensure proper quality works.

2.2.9.2 Maximum / minimum size of aggregates, standards of quality of materials, minimum cover for concrete, use of admixtures / chemicals, treatment to reinforcement / finished surfaces, etc., shall be as per relevant Codes, IS / IRS specifications and conditions of contract as specified.

2.2.9.3 All exposed concrete surfaces shall be finished smooth by the contractor at his own cost. Shuttering materials for RCC in superstructure shall be strictly of steel only to permit vigorous vibration and to ensure no deviation of finished dimensions by more than +5/-0 mm and wooden shutters are not permitted. For other works also, proper quality of shuttering materials which will permit vibrating and will not require additional finishing shall only be used. If there is any variation in the surface, alignment or lines in the products beyond permissible rejection limits indicated in these conditions, the V.P. (GUDC) reserves the right to reject the same and the contractor shall not have any claim in this regard and cost of V.P. (GUDC) materials involved will be recovered from the contractor including penalties, if any imposed.

2.2.10 Weigh batching, vibrating, curing & testing:

2.2.10.1. All concrete shall be machine batched, machine mixed and machine vibrated, by using appropriate vibrators. Weigh batching plant, mixers, vibrators, etc., of appropriate capacity, as specified/directed by the Engineer, shall be arranged by the contractor at his cost. In this case, Weigh batching plants shall have computerized control for weighing, loading, mixing and delivery.

2.2.10.2. Batching plants, transit mixers, concrete pumps, etc., shall be installed by the contractor necessarily at site. In case of failure of any of the above, standby arrangements for ensuing continuous concreting has to be provided by the contractor at his cost. For piling works concreting shall be done continuously as per the volumes designed without break and accordingly standby arrangements shall be ensured by the contractor.

2.2.10.3. Curing & vibrating shall be arranged by the contractor at all locations/heights at his own cost and no extra payment on this account will be admissible. Curing of concrete shall be done as per relevant IS Codes / Specifications. If curing is not done by the contractor properly, V.P. (GUDC) may get it done through any other means at the Contractor's cost without any notice to him and recover from his bills the same including penalty if any at the discretion of the Engineer. The concrete shall be kept wet constantly by ponding or covered with a layer of sacking canvas etc.

- 2.2.10.4.** Test cubes shall be cast at regular intervals and tested to ascertain the strength of concrete. The contractor shall establish a cube testing facility along with operator at the site or nearby area to facilitate prompt testing of concrete. Test cube moulds as required as per IS Codes shall be made available by the contractor at his cost.

2.2.11 Design Mix Concrete:

(a) **General:** Design Mix is mandatory for all grades. For concrete of compressive strength greater than M55, specialized literature should be consulted. Admixtures may be used while designing. Only design mix shall be used for all items of concrete. Prior to the start of construction, the contractor shall submit details of each trial mix of each grade of concrete to the Engineer for approval. When the proportions of the mix are approved, the contractor shall not vary any of the design parameters or the source of the materials without the approval of the Engineer. Wherever there is a significant change in materials used, fresh trial mix shall be arranged by the contractor as required by the Engineer. The concrete shall be designed keeping in view the minimum cement content and maximum cement content. Minimum cement content depends upon the environmental exposure conditions but maximum Cement Content shall be limited to 450kg/m.³

(b) **Mix Design and Proportioning:** Recommended guidelines for Concrete Mix Design are given in IS: 10262 which may be referred to for details. As mentioned therein in order that not more than the specified proportion of test results is likely to fall below the characteristic strength, the concrete mix has to be designed for a somewhat higher target average compressive strength. In terms of clause 9.2.2 of IS: 456, the Target Mean Strength of Concrete mix should be equal to the characteristic strength plus 1.65 times the Standard Deviation. Mix proportion shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and completely fill the form work. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

Determination of the proportions of by weight of cement, aggregate and water shall be based on design mix.

As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23-1982. (Special Publications 23-1982 of Bureau of Indian Standards) Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer. All concrete proportions for various grades of concrete shall be designed separately and mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.

(c) **Standard deviation:** Standard deviation calculations of test results based on tests conducted on the same mix design for particular grade designation shall be done in accordance with Clause 9.2.4 of IS 456. Table 8 of IS 456 gives the standard deviation that can be assumed for design of mix in the first instance. The final standard deviation figures

may be determined based on test results for the particular grade of concrete when available.

Max size of Aggregate, Target Mean Strength			
Grade of Concrete	Max size of Aggregate (mm)	Characteristic Strength (f_{ck}) at 28 days (N/mm^2)	Target Mean Strength (f_{ck}) 28 days (N/mm^2)
M20	20	20	26.60
M25	20	25	31.60
M30	20	30	38.25
M35	20	35	43.25
M40	20	40	48.25
M45	20	45	53.25

- (d) **Approval of Design Mix:** The contractor shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer for his comments and approval. Concrete of any particular design mix and grade shall be produced / manufactured for works only on obtaining written approval of the Engineer.

2.2.12 Requirements of Consistency:- The mix shall have the consistency which will allow proper placement and consolidation in the required position. Every attempt shall be made to obtain uniform consistency. The optimum consistency for various types of structures shall be as indicated in table below or as directed by the Engineer.

Slump Required for workability		
	Type	Slump (mm)
1	(a) Structures with exposed inclined surface requiring low slump concrete to allow proper compaction	25
	(b) Plain Cement Concrete	25
2	RCC structures with widely spaced reinforcements; e.g. solid columns, piers, abutments, footings, well steining	40-50
3	RCC structures with fair degree of congestion of reinforcement; e.g. pier and abutment caps, box culverts well curb, well cap, walls with thickness greater than 300mm	50-75
4	RCC and PSC structures with highly congested reinforcements e.g. deck slab girders, box girders, walls with thickness less than 300mm	75-125
5	Underwater concreting through tremie e.g. bottom plug, cast-in-situ piling	100-200

The minimum slump of concrete in case of bored cast in situ pile shall be 150 to 200 mm.

2.2.13 Durability:- The durability of concrete depends on its resistance to deterioration & environment in which it is placed. The resistance of concrete to weathering, chemical attack, abrasion, frost and fire depends largely upon its quality and constituent materials. Susceptibility to corrosion of the steel is governed by the cover provided and the permeability of concrete. The cube crushing strength alone is not a reliable guide to the quality and durability of concrete; it must also have adequate cement content and a low water-cement ratio. The general environment to which the concrete will be exposed during its working life is classified into three levels of severity that is moderate, severe, and extreme as described below:

Environment	Exposure condition
MODERATE	Concrete surface protected against weather or aggressive conditions. Concrete surface sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation. Concrete structure continuously under water. Concrete in contact with non aggressive soil /ground water.
SEVERE	Concrete surface exposed to severe rain, alternate wetting & drying or occasional freezing or severe condensation. Concrete exposed to aggressive subsoil / ground water or coastal environment.
EXTREME	Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. Concrete structure surfaces exposed to abrasive action, surfaces of members in tidal zone. All other exposure conditions which are adverse to exposure conditions covered above.

Maximum water-cement ratio, grade of concrete and cementitious material content for various environment conditions for achieving durability are indicated below for guidance:

2.2.13.1 Maximum Water Cement Ratio:-

The limits for maximum water cement ratio for design mix shall be based on environmental conditions as defined in durability clause. The limits for maximum water cement ratio for different environmental conditions shall be as given in Table below:

Environment	Maximum Water-Cement Ratio		
	Plain Concrete (PCC)	Reinforced Concrete (RCC)	Pre stressed Concrete (PSC)
Moderate	0.50	0.45	0.40
Severe	0.45	0.40	0.40
Extreme	0.40	0.35	0.35

2.2.13.2 Grade of Concrete:- From durability consideration, depending upon the environment to which the structure is likely to be exposed during its service life, minimum grade of concrete shall be as given in table below.

Minimum Grade of Concrete

(A) For Bridges in Pre stressed Concrete and important Bridges.

Structural member	Moderate exposure	Severe Exposure	Extreme exposure
PCC member	M-25	M-30	M-35
RCC member	M-30	M-35	M-40
PSC member	M-35	M-40	M-45

(B) For Bridges other than mentioned above and sub-structure

Structural member	Moderate exposure	Severe Exposure	Extreme exposure
PCC Member	M-15	M-20	M-25
RCC member	M-20	M-25	M-30

2.2.13.3 Cementitious Material Content:- Maximum Cementitious Material Content shall be limited to 450kg/m³. Depending upon the environment to which the structure is likely to be exposed during its service life, minimum Cementitious Material Content in concrete shall be as given in table below:

Minimum Cementitious Material Content				
Environment	Minimum Cementitious Material Content in Kg/cum			
	Plain Concrete		Reinforced Concrete	
	(PCC)		(RCC)	
	Grade	Content	Grade	Content
Moderate	M25	240	M30	300
Severe	M30	250	M35	350
Extreme	M35	300	M40	400

2.2.13.4 Clear cover is the least distance from outer most surface of steel or binding wire or its end to the face of concrete. It is also an dimension used in design and indicated on the drawings. From durability consideration, minimum clear cover shall be as under.

Minimum Covers			
Type of structure	Extreme Environment	Severe Environment	Moderate Environment
Slab	50	35	25
Beam/Girder	60	50	35
Column	75	75	50
Piles	75	75	50

2.2.14 Permeability of concrete: Permeability requirements are as specified in IRS Concrete Bridge Code. Permeability test shall be mandatory for all RCC bridges

under severe and extreme environment. Under moderate environment, permeability test shall be mandatory for all major bridges and for other bridges and structures.

2.2.15 Mixing of concrete:

- 2.2.15.1 Concrete shall be mixed either in a mini mobile batching plant or in a batching and mixing plant as per the specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer.
- 2.2.15.2 Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement.
- 2.2.15.3 Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. The first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of mix to another.

2.2.16 Transporting, Placing and Compaction of Concrete:

- 2.2.16.1 The method of transporting and placing concrete shall be approved by the Engineer. Concrete shall be transported and placed as near as practicable to its final position, so that no contamination, segregation or loss of its constituent materials takes place. Concrete shall not be freely dropped into place from a height exceeding 1.5 metres.
- 2.2.16.2 When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without the use of excessive quantity of water and without any segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.
- 2.2.16.3 All formwork and reinforcement contained in it shall be cleaned and made free from standing water, dust, immediately before placing of concrete.
- 2.2.16.4 No concrete shall be placed in any part of the structure until approval of the Engineer has been obtained.
- 2.2.16.5 If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper construction joint is formed.
- 2.2.16.6 Except where otherwise agreed to by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 450 mm when internal vibrators are used and not exceeding 300 mm in all other cases.

- 2.2.17 Concrete when deposited shall have a temperature of not less than 5° C and not more than 40°C. It shall be compacted in its final position within 30 minutes of its discharge from the mixer, unless carried in properly designed agitators, operating continuously. It may be necessary to add retarding admixtures to concrete if trials shows that the period indicated above are unacceptable. In all such matters, engineer's decision shall be final.
- 2.2.18 Concrete shall be thoroughly compacted by vibration or other means approved by Engineer, during placing and worked around the reinforcement, embedded fixtures and into corners of the formwork to produce a dense homogenous void-free mass having the required surface finish. When vibrators are used, vibration shall be done continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation. Over vibration shall be avoided to minimize the risk of forming a weak surface layer. When external vibrators are used, the design of formwork and disposition of vibrator shall be such as to ensure efficient compaction and to avoid surface blemishes. Vibrators shall not be applied through reinforcement and where vibrators of immersion type are used, contact with reinforcement and all inserts like ducts etc., shall be avoided. The internal vibrators shall be inserted in an orderly manner and the distance between insertions should be about one and half times the radius of the area visibly affected by vibration. Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns.
- 2.2.19 Mechanical vibrators used shall be of appropriate specifications, type and capacity and as directed by the Engineer.

2.2.20 Equipment and machinery for concreting: as per Tender Provision

- 2.2.20.1 All the machinery are required to be arranged by the contractor at his own cost and the agreement rates for concreting include the same. No extra payment is admissible for any machinery arranged by the contractor.

2.2.21 TRANSPORTATION OF CONCRETE & PUMPING OF CONCRETE

2.2.21.1 General

Fresh concrete can be transported to the placement area by a variety of methods. Common among them are:

- Mixer trucks
- Stationary truck bodies with or without agitators.
- Buckets hauled by trucks.
- Conveyor belts.
- Hose or pipe line by pumping.

Each type of transportation has specific advantages and limitations depending on the condition of use, mix, accessibility and location of placing.

2.2.21.2 Transportation by Mixer Trucks

2.2.21.2.1 These are essentially revolving drums mounted on truck chassis. Truck mixers used in the job shall be labelled permanently to indicate the manufacturer's specifications for mixing like:-

- Capacity of drum.
- Total number of drum revolutions for complete mixing.
- Mixing speed
- Maximum time limit before completion of discharge and after cement has entered the drum.
- Reduction in time period of discharge due to warm weather or other variables.

All above information shall only form guidelines for the manufacturer/producer of concrete.

2.2.21.2.2 Fulfilment of the stipulated number of revolutions or elapsed time shall not be the acceptable criterion. As long as the mixing water limit is not exceeded and the concrete has satisfactory plastic physical properties and is of satisfactory consistency and homogeneity for satisfactory placement and consolidation and is without initial set, the concrete shall be acceptable.

2.2.21.2.3 When the concrete is totally mixed in transporting trucks volume of concrete being transported shall not exceed 63% of the rated capacity of the drum. In case the concrete is totally mixed in the central batching plant, the transporting truck may be loaded up to 80% of the rated capacity of the drum. In this case the drum shall be rotated at charging speed during loading and reduced to agitating speed after loading is complete.

2.2.21.2.4 When transporting concrete by truck mixers, delivery time shall be restricted to 90 minutes or initial setting time whichever is less from the time cement has entered the mixer to completion of discharge.

2.2.21.3 Transporting by Agitating / Non-agitating Trucks.

2.2.21.3.1 Transporting ready mix concrete by this method shall consist of truck chassis mounted with open top bodies. The metal body shall be smooth and streamlined for easy discharge. Discharge may be from the rear when the body is mechanically tilted. Body of the truck shall have a provision of discharge gate. Mechanical vibrators shall be installed at the discharge gate for control of discharge flow.

2.2.21.3.2 Agitators, if mounted, also aid in the discharging of concrete from the truck in addition to keeping the concrete alive.

2.2.21.3.3 Water shall not be added to concrete in transport through this system.

2.2.21.3.4 Bodies of trucks shall be provided with protective covers during period of inclement weather.

2.2.21.3.5 Delivery period, when adopting this system of transporting concrete shall be restricted to 30 minutes from the moment all ingredients including cement and water enter in mixer to completion of discharge.

2.2.21.4 Transporting by Buckets

This method of transportation is very common for transportation of centrally mixed concrete. Buckets of suitable capacities may be filled with concrete which is totally mixed in central plant and hauled to the job site. Buckets then may be conveyed to the actual point of placement either with the help of crane/hoist or they may be carted

As in the case of open truck transportation, extra water shall not be added to concrete transported in buckets. Concrete shall be protected from inclement weather by necessary covering arrangements. Also, maximum delivery period for this system of transportation from the time cement is introduced into the mixer to completion of discharge shall not exceed 30 minutes.

2.2.21.5 Cleaning

Before loading concrete in either truck mixer, open bodied trucks or buckets, the containers shall be thoroughly cleaned, washed and dried, so that there is no water or moisture in the container which may affect the designed water content of the concrete.

2.2.21.6 Other Methods of Transportation

Transportation of concrete either by belt conveyors or by pumping is envisaged in some works.

If, the producer/manufacturer/purchaser/contractor of ready mix concrete desires to use such methods of transportation, they may do so provided their scheme and complete specifications are submitted to the Engineer for his record and approval.

2.2.21.7 Objective

Method of transportation used shall ensure:-

Efficient delivery of concrete

No significant alteration of properties with regard to water cement ratio, slump, air content and homogeneity.

All variables in transportation, considering type and accessibility of placement locations, distance, time interval etc., shall be carefully studied before arriving at the method used.

2.2.21.8 Pumpable Concrete (Extracted from Para 8.9 of Concrete Bridge Code, 1997)

General- Pumpable concrete is the concrete which is conveyed by pressure through either rigid pipe or flexible hose and discharged directly into the desired area. It is especially used where space for construction equipment is very limited.

Pumping Rate and Range – Depending on the equipment, pumping rate should be 10 to 70 cum. per hour. Effective pumping range is up to 300m horizontally and 90m vertically.

(i) Proportioning Pumpable Concrete

- a) Basic Consideration - More emphasis on quality control is essential to the proportioning and use of a dependable pump mix. Concrete mixes for pumping must be plastic. Particular attention must be given to the mortar and to the amounts and sizes of coarse aggregates.
- b) The maximum size of angular coarse aggregate is limited to one-third of smallest inside diameter of the hose or pipe. Provisions should be made for elimination of oversized particles in the concrete by finish screening or by careful selection of aggregates.

(ii) Pumping Concrete

- a) Proper planning of concrete supply, pump locations, line layout, placing sequences and the entire pumping operation will result in saving of cost and time. The pump should be placed as near the placing area as practicable and the entire surrounding area must have adequate bearing strength. Lines from the pump to the placing area should be laid out with a minimum of bends. The pipe line shall be rigidly supported.
- c) While pumping downward 15m or more, it is desirable to provide an air release valve at the middle of the top bend to prevent vacuum or air build up. When pumping upward, it is desirable to have a valve near the pump to prevent reverse flow.

2.2.22 Construction Joints:-

- 2.2.22.1 Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown on the drawings, except with express approval of the Engineer. The joints shall be provided in a direction perpendicular to the member axis. Sequencing of concrete placement should be organized in such a way that cold joints are totally eliminated. The sequence of concreting shall be submitted for approval of Engineer prior to concreting of the structural element. Concreting shall be carried out continuously up to the construction joints, the position and arrangement of which shall be predetermined by the designer.
- 2.2.22.2 Construction joints should be positioned to minimize the effect of the discontinuity on the durability, structural integrity and appearance of the structure. Joints should be located away from regions of maximum stress caused by loading particularly where shear and bond stresses are high.
- 2.2.22.3 Laitance, both on the horizontal and vertical surfaces of the concrete, should be removed before fresh concrete is cast. The surface should be roughened to promote

good adhesion. Various methods for removal can be used but they should not dislodge the coarse aggregate particles. Concrete may be brushed with a stiff brush soon after casting while the concrete is still fresh and while it has only slightly stiffened. If the concrete has partially hardened, it may be treated by wire brushing or with a high pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed. Fully hardened concrete should be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles.

- 2.2.22.4 Where there is likely to be a delay before placing the next concrete lift, protruding reinforcement should be protected. Before the next lift is placed, rust loose mortar, or other contamination should be removed from the bars and where conditions are particularly aggressive and there has been a substantial delay between lifts, the concrete should be cut back to expose the bars for a length of about 50 mm to ensure that contaminated concrete is removed.
- 2.2.22.5 In all cases, when construction joints are made, it should be ensured that the joint surface is not contaminated with release agents, dust, or curing membrane and that the reinforcement is fixed firmly in position at the correct cover.
- 2.2.22.6 When the formwork is fixed for the next lift, it should be inspected to ensure that no leakage can occur from the fresh concrete. It is a good practice to fix a 6 mm thick sponge which seals the gap completely. The practice of first placing a layer of mortar or grout is not recommended. The old surface should be soaked with water without leaving puddles, immediately before starting concreting; then the new concrete should be thoroughly compacted against it. When fresh concrete is cast against existing mature concrete or masonry the older surfaces should be thoroughly cleaned and soaked to prevent the absorption of water from the new concrete. Standing water should be removed shortly before the new concrete is placed and the new concrete should be thoroughly vibrated in the region of the joint.
- 2.2.23 **Finishing of concrete:** The finished surface of concrete after removal of formwork shall be such that no touching up is required. All fins/holes caused by form joints, supports, rods etc., shall be ground/filled up effectively using appropriate machinery shutters, formwork etc., used in construction shall be as specified in the conditions and the labour used shall be skilled to suit the quality requirements of the work. Any surface, finished poorly in the opinion of the Engineer shall require repair/remedial measures at the cost of the contractor and the Engineer's decision in this regard shall be final. Any structure, which has deficiencies in finishing including product parameters beyond the rejection limits, as specified in these conditions, are liable to be rejected and the decision of the Engineer shall be final in this regard.
- 2.2.24 **Coatings for concrete:** Normally finished concrete structures do not require any surface protective coatings in non aggressive environment (moderate) for all structures. For aggressive environment (severe and extreme conditions), Epoxy phenolic IPN coating or CECRI Integrated four coat system can be used in superstructure of bridges and coal tar epoxy coating for sub structure of bridges (in affected part only).

2.2.25 Shuttering, Formwork & False work:-

- 2.2.25.1 Shuttering, Formwork & False work shall be designed to meet the requirements of the permanent structure, taking into account the actual conditions of materials, environment and site conditions. Careful attention shall be paid to the detailing of connections and functions. All the materials used for shuttering, formwork & false work shall conform to the specified quality consistent with the intended purpose and actual site condition as applicable. All shuttering, form work, false work, etc., shall be got approved by the Engineer before it is put into use.
- 2.2.25.2 Forms shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subjected at the time of removal of formwork or as approved by the Engineer. In normal circumstances and where Ordinary Portland Cement is used, forms may generally be removed after the expiry of the following periods:-

Stripping Time	
a) Walls, columns and vertical faces of all structural members	24 to 48 hours as may be decided by the Engineer
b) Slabs (props left under)	3 days
c) Beam soffits (props left under)	7 days
d) Removal of props under slabs 1) Spanning up to 4.5 m 2) Spanning over 4.5 m	7 days 14 days
e) Removal of props under beams 1) Spanning up to 6 m 2) Spanning over 6 m	14 days 21 days

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

2.2.26 Defective Concrete and Measurement of concrete:

- 2.2.26.1 Should any concrete be found honeycombed or in any way defective which may be, at the discretion of the Engineer suspected to affect the performance of the structure, shall be rejected outright. Contractor shall have no claim in this regard and the decision of the Engineer shall be final. The member, structurally independent, in which the concrete is found to be defective, shall be replaced by the contractor at his cost fully. The damages arising on account of such defective concreting shall also be recoverable from the dues of the contractor, including penalties if any. V.P. (GUDC) reserves the right to get the member replaced by any means at the cost of the contractor at any cost if the contractor delays reproduction.
- 2.2.26.2 However, some surface defects, not affecting the structural properties shall, on the instruction of the Engineer, be repaired as per the approved procedures. The complete cost of such repairs shall be borne by the contractor and no compensation shall be payable. Records of such repairs done shall be maintained by the contractor.

Tolerances for Finished Concrete Bridge Structure		
S No	Description of defects in any part or full member or the structure at the decision of the Engineer.	Permissible limits (unless otherwise specified in designs/drawings)
1	Shift from alignment	1) ± 25 mm in member.
2	Deviation from plumb in piers or variation from specified batter.	1 in 250 subjected to a maximum value of 0.5 times the least lateral dimension of pier.
3	Deviation from plumb in abutments or variation from specified batter.	1 in 125
4	Cross sectional dimensions of piers, abutments and girders	+20mm/-5mm
5	Thickness of deck slab of bridges	+ 6 mm / - 3 mm
6	Size and location of openings	± 12 mm
7	Plan dimensions of footings (formed excavation)	+ 50 mm / - 25 mm
8	Plan dimensions of footings (unformed excavation)	+ 75 mm / - 00 mm
9	Thickness of footings	= 5%, + No limit
10	Footing eccentricity	0.02 times the width of the footing in the direction of deviation, but not more than 50 mm
11	Reduced level of top of footing / pier / bed block	± 5 mm
12	Centre to centre distance of pier and abutments at pier top	± 30 mm
13	Centre to centre distance of bearings along s.	± 5 mm
14	Centre to centre distance of pier bearings across s.	± 5 mm

2.2.26.3 The tolerances for finished concrete bridge structures shall be governed by IRS Concrete Bridge Code and shall be followed; deviations beyond the permissible limits shown are liable to be rejected. These tolerances apply to other structures also appropriately.

2.2.27 Sampling and Strength Testing of Concrete:

2.2.27.1 General: Samples from fresh concrete shall be taken as per IS: 1199 (method of sampling and analysis of concrete). Concrete for making 3 test cubes shall be taken from a batch of concrete at point of delivery into construction according to procedure laid down in IS: 1199 and 150 mm cubes shall be made, cured and tested at the age of 28 days for compressive strength in accordance with IS:516. The 28 days test strength result for each cube shall form an item of sample.

Concrete shall conform to the surface finish and tolerance as prescribed in Unified specifications. Random sampling and lot by lot of acceptance / inspection shall be made for the 28 days cube strength of concrete.

Concrete under acceptance shall be notionally divided into lots for the purpose of sampling, before commencement of work. The delimitation of lots shall be determined by the following:

- (i) No individual lot shall be more than 30 cum in volume.

(ii) At least one cube forming an item of the sample representing the lot shall be taken from concrete of the same grade and mix proportions cast on any day.

(iii) Different grades of mixes of concrete shall be divided into separate lots.

(iv) Concrete of a lot shall be used in the same identifiable component of the bridge.

2.2.27.2 Sampling.

2.2.27.2.1 Frequency of Sampling

Sampling procedure: A random sampling procedure shall be adopted to ensure that each concrete batches forming the lot under acceptance / inspection shall have a reasonable chance of being tested that is, sampling should be 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 table below. At least one sample shall be taken from each shift of work.

Minimum Frequency of Sample	
Quantity of concrete in work, (M ³)	No. of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50 M ³ or part thereof

2.2.27.2.2 Test Specimen: Three test specimens shall be made from each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS: 9013. The specimen shall be tested as described in IS: 516.

2.2.28 Test Results of Sample: The test results of the sample shall be the average of the strength of 3 specimens. The individual variation should not be more than ± 15 percent of average. If more, test results of the sample are invalid.

2.2.29 Acceptance Criteria of Concrete: Acceptance criteria shall be acceptance of concrete as per Clause No 16 of Annexure 4.2 of Indian Railway Unified Standard Specifications (Works & Materials), Volume I, 2010. The decision of V.P. (GUDC) is final and binding to the contractor. Also refer criteria of concrete vide clause no 20.3.11.5 of Indian Railway Unified specifications. The 28 days compressive strength shall be the criterion for acceptance or rejection of the concrete.

The followings shall also be strictly followed.

- (i) Whenever a mix is redesigned due to a change in the quality of aggregate or cement or for any other reason, it shall be considered a new mix and initially subject to the acceptability criteria above.
- (ii) If the concrete produced at site does not satisfy the above strength requirements, the Engineer shall reserve the right to require the contractor to improve the methods of batching, the quality of the ingredients and redesign the mix with increased cement content, if necessary. The Contractor shall not be entitled to claim any extra cost for the extra cement used for the modifications stipulated by the Engineer for fulfilling the strength requirement specified.
- (iii) It is the complete responsibility of the contractor to redesign the concrete mixes by approved standard methods and to produce the reinforced concrete conforming to the specification and the strength requirements approved by the Engineer. It is expected that the Contractor will have competent staff to carry out this work.

2.2.30 Setting of field laboratory by the Contractor:

2.2.30.1 For all works, the Contractor shall set up a field laboratory of his own for testing of cement/water/concrete at work site, which should be open for use and inspection by the V.P. (GUDC) officials at any time and carryout the tests with his own equipments, gauges, machinery, consumables and operators, at his own cost. The laboratory shall be equipped with necessary equipment to carry out various tests such as property tests, sieve analysis, setting time of cement, compression tests on cubes, slump test, workability test etc., on aggregate, cement, water and concrete required for ensuring the required quality. For steel however, test reports of reputed institutes/laboratories are acceptable.

2.2.30.2 The cost of setting up the laboratory, equipping the same, maintaining conducting all tests on materials and cubes shall be borne by the contractor, within his quoted rates for works and no extra payment is eligible for the same.

2.2.30.3 All gauges, machines, equipments and other measuring and testing equipments of the laboratory shall be got checked / calibrated regularly and the necessary certificates furnished to the Engineer by the Contractor.

2.2.30.4 All the equipments, machinery etc., shall be kept in good working condition. Contractor shall also maintain the required qualified / experienced staff at the laboratory.

2.2.30.5 The following is the minimum laboratory facilities at the site which are to be provided and operated by the contractor at his cost.

- (i) Testing of fine and coarse aggregates as per IS:383 and IS:2386.
- (ii) Testing of cement concrete as per IS: 8142 and IS:516.

(iii) Testing of water as per IS: 456 and IS: 3025.

(iv) Certain non-routine testing such as (a) Testing of admixtures, (b) Chemical testing of fine and coarse aggregates (c) Permeability of concrete (permeability test on concrete shall be got done when the mix design is approved / changed of the reputed laboratories as approved by Engineer). The frequency and need for these tests shall be decided by the Engineer, based on stipulations contained in conditions of contract or on the basis of accepted Engineering practice (e.g. whenever source of admixture is changed, tests stipulated in the codes will have to be carried out afresh, etc).

2.2.30.6 As frequently as the Engineer may require, testing shall be carried out in the field for:

- (a) Moisture content and absorption and density of sand and aggregate.
- (b) Silt content of sand.
- (c) Grading of sand and aggregates.
- (d) Slump test of concrete.
- (e) Concrete cube test.
- (f) Permeability test for concrete
- (g) Density of Plasticizer.
- (h) PH Value of water

2.2.31 Ladders for inspections: Steel ladders are to be provided at the abutments and all pier locations on both sides of girder bridges to enable inspecting officials to get down from the ROB Road level to the top of the piers / abutments.

2.2.32 Expansion joints: Expansion joints – strip seal elastomeric type expansion joint shall be for 80mm expansion gap in RCC deck slab as per drawings.

2.2.33 Seating of foundations:

As far as possible, open foundations should be located on the firm ground having stable strata. The strata shall be well compacted before levelling course and foundations are laid on the levelling.

In case foundations resting on rock, no foundation shall be laid on sloping rock. The rock shall be made level for the width of the foundation before levelling course is laid. Before seating on the rock, capacity of the rock shall be assessed properly and safe bearing capacity assessed in the designs is to be confirmed.

The seating of the rock shall be achieved by cutting into the rock at least by 0.50m depth to ensure removal of all weak layers and for obtaining adequate anchorage in case of open foundations. After level surface is made on the rock, a rich mix layer of 150mm thick shall be laid to even the bedding surface.

If the rock is encountered while piling, pile shall be anchored into rock to the depth as per codal provision.

- 2.2.34 Drainage outlets:** 100mm GI/PVC pipes in case of deck slab in bridges will serve as drainage spouts.

2.3 GENERAL GUIDELINES AND SPECIFICATIONS FOR BORED CAST-IN-SITU RCC PILE FOUNDATIONS:

- 2.3.1 The piles shall be bored cast-in-situ. The scope of the work included in relevant schedules is for the provision and testing of bored cast-in-situ RCC pile foundations with the pile cap. Items for piling in soil has been provided in schedule. If any boulder in the form of obstruction comes in the boring, no extra payment for piling in boulders shall be made. Bore log provided by the V.P. (GUDC) for construction are only indicative in this regard and it is the contractors' responsibility to make correct assessment of ground conditions before starting the piling operation. Rate of piling is divided into four items (a) item of empty boring (b) payment of concrete in M: 35 from pile item (c) Payment of reinforcement in MT from pile item.(d) Payment of liner in MT. Rate of Item of piling includes cost of all materials, Cement and labour involved in all operations. The Payment of empty boring, concrete M35, reinforcement and liner paid separately in respective items.

2.3.2 CONCRETING IN BORED CAST-IN-SITU PILES

- (i) Bored Cast-in-situ concrete piles shall be installed by making a bore into the ground by removal of material. Cast-in-situ concrete piles may be cast in metal liners which may remain permanently in place. The metal casing shall be of sufficient thickness and strength to hold its original form and show no harmful distortion after it and adjacent casings have been driven and the driving core, if any, has been withdrawn.
- (ii) Concreting and reinforcement work will be done in accordance with relevant clauses in Chapters 3 and 4 of Indian Railway Unified Standard Specifications (Works & Materials) Volume - I, 2010 supplemented by these specifications. The decision of V.P. (GUDC) is final and binding to the contractor.
- (iii) Any liner or bore-hole which is improperly located or shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer at the cost of the Contractor.
- (v) Bored cast-in-situ piles in soils which are stable may often be installed with only a small casing length at the top. A minimum of 2.0m length of top of bore shall invariably be provided with casing to prevent any loose soil falling into the bore. In cases in which the side soil lower down can fall into the hole, it is necessary to stabilise the side of the bore hole with drilling mud, or a suitable steel casing. The casing may be left in position permanently specially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.
- (vi) For bored cast-in-situ piles, casing / liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length as approved by the Engineer. Materials inside the casing shall be removed progressively by air lift, grab or percussion equipment or other approved means. Unless otherwise approved by the Engineer, the diameter of the bore-holes shall be not more than the inside diameter of the liner.

- (vii) Where bored cast-in-situ piles are used in soils liable to flow, the bottom of the casing shall be kept enough in advance of the boring tool to prevent the entry of soil into the casing, thus preventing the formation of cavities and settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimise inflow of water or leakage of slurry during concreting. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn. Prior to the lowering of the reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials. Cover to reinforcing steel shall be maintained by suitable spacers, tied in advance to the reinforcement.
- (viii) Wherever practicable, concrete should be placed in a clean dry hole. Where concrete is placed in dry condition and there is casing present, the top 3m of the pile shall be compacted using internal vibrators.
- (ix) Before concreting under water, the bottom of the hole shall be cleaned of drilling mud and all soft or loose material very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2. The drilling mud should be maintained at 1.5m above the ground water level.
- (x) Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimise the softening of the soil by excess water. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.
- (xi) The concrete shall be properly graded, shall be self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty, clays and other soils with the tendency to squeeze into the newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.
- (xii) The placing of concrete shall be a continuous process from the toe level to the top of the pile. To prevent segregation, a tube or tremie pipe as appropriate shall be used to place concrete in all piles.
- (xiii) To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6m (length of pile) per hour. Under water concreting should be done with tremie.
- (xiv) The maximum water cement ratio shall be 0.50 for cast in situ piles.
- (xv) The cement content shall not be less than 400 kg/cum of concrete.
- (xvi) The minimum slump of concrete for bored cast-in-situ piles shall 150mm to 200mm, but the slump should not exceed 200mm in any case.
- (xvii) **Concreting under water:-**General requirements and precautions for concreting under water shall be as given in concreting chapter 3 of IR Unified Standard

Specifications (Work & Materials), Volume - I, 2010. This would be further supplemented by given following instructions. The decision of V.P. (GUDC) is final and binding to the contractor.

- (a) The concreting of a pile must be completed in one continuous operation. Also, for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and concreting of pile for full height must be accomplished in one continuous operation without any stoppage.
 - (b) The concrete should be coherent, rich in cement with high slump and restricted water cement ratio.
 - (c) The tremie pipe will have to be large enough with due regard to the size of aggregate. For 20mm aggregate the tremie pipe should be of diameter not less than 150mm and for larger aggregate, larger diameter tremie pipes may be necessary.
 - (d) The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.
 - (e) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
 - (f) The pile should be concreted wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pile.
 - (g) All tremie tubes should be scrupulously cleaned after use.
 - (h) In special circumstances, the Engineer may permit use of any other proved method of concrete placement designed for under water concrete. In such cases, a detailed method statement should be prepared and got approved by the Engineer.
 - (xviii) The diameter of the finished pile shall not be less than that specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the pile length cast.
- 2.3.3 The schedule of quantities in this contract is based on bored cast-in-situ pile of required capacity and for approximate anticipated depth as indicated in the drawings. Depth of piles is likely to vary and contractor shall have no claim whatsoever irrespective of the depth of piles provided at any and all locations. Installation of piles shall be carried out as per layout drawings, installation criteria and the instructions of the Engineer. The method of installing the piles, including details of the equipment shall be submitted by the contractor and got approved by the Engineer before start of work.
- 2.3.4 Piling work shall conform to specifications IS: 2911 Parts 1 & 4 unless otherwise specified.
- 2.3.5 Workmanship of bored cast-in-situ piles includes the provisions for control of piling installation, use of drilling mud, cleaning of borehole, tremie concreting, defective pile, recording of data shall be as per Clause 8 of IS: 2911(Part 1/Section 2).

- 2.3.6 The specifications for safe load, test load, total displacement, net displacement etc., shall also conform to provisions as per IS: 2911 (Part 4).
- 2.3.7 The contractor shall set out piles with precision survey duly erecting permanent bench marks and other references. He shall be responsible for correct maintenance of position and plumb thereafter and these shall be checked periodically. The control of alignment and inclination of piles shall be as per IS: 2911(Part 1/Section 2). Tolerances as specified in the above code or as specified shall govern.
- 2.3.8 Level marks shall be put accurately on each pile immediately after it is installed. If any pile shows subsequently a tendency to heave up due to installation of other piles later or due to any other reason, corrective course of action shall be suggested and taken by the contractor after approval by the Engineer at the cost of contractor.
- 2.3.9 Durability provisions such as clear cover to reinforcements, minimum and maximum cement content, maximum water-cement ratio and permeability of concrete shall be adhered to as mentioned earlier and below. The exposed area of pile above the ground level. In case of harmful chemical constituents found in subsoil and in water such as chlorides and sulphides, special provisions as per relevant codes of practice shall be followed for protection against reinforcement corrosion and disintegration of concrete and for such protection against corrosion and bio-fouling, the pile concrete/liner below cut-off level shall be painted with appropriate material, if ordered by Engineer for which payment will be made separately as specified in relevant schedules.
- 2.3.10 Sulphate resistant cement may be used on need based consideration after conducting the soil investigation and water investigation. It shall not be used under such conditions where concrete is exposed to risk of excessive chlorides and sulphate attack both. Requirements of concrete exposed to sulphate attack shall be as per Table 4 of IS: 456. Where chloride is encountered along with sulphate in soil or ground water, Ordinary Portland Cement with C3A contents from 5 to 8 % shall be desirable to be used in concrete instead of sulphate resisting cement. For pH around 4, steel and concrete both have to be specially quoted. If sulphate resistant cement is used which has faster setting properties, curing shall start within five hours of concreting.
- 2.3.11 Method of boring, namely, Bailer and Chisel, Rotary, Direct Mud Circulation (DMC), Reverse Mud Circulation (RMC), Percussion, etc., shall be chosen as appropriate to strata and site conditions. The agreement rates for piling are inclusive of any type of boring/any type of supporting arrangements adopted by the contractor and no extra payments are admissible for any type of scheme adopted by the contractor.
- 2.3.12 Borehole stability shall be maintained with casing and/or mud circulation..
- 2.3.13 Use of drilling mud (Bentonite) in stabilizing the sides of bore holes is mandatory in soils of inadequate capacity. The decision on the need of use of Bentonite will be taken by the Engineer which is final. The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. The bentonite slurry shall be under constant circulation till start of

concreting and shall meet the requirements stipulated in the subsequent clauses. Agreemental rates for piling includes the cost of Bentonite and related operations and the contractor cannot claim any extra cost on this account.

- 2.3.14 Providing MS Liners: This item is for supply and fixing contractor's permanent MS liners for the pile from the top of working platform upto the required depth as may be decided by the Engineer. The contractor shall fabricate the MS liners from his own MS sheets to suit the diameter of the pile as directed. Required length of MS liners will be made up by welding each unit outside by the contractor with his own equipments and plants. It shall be clearly noted that the MS sheets required for manufacture of the liners shall not be supplied by the V.P. (GUDC). The welding shall be of proper quality so as to withstand the hammering forces. The payable depth shall however, be measured only from the cut off level though the liner might have been provided right from the level of working platform on practical considerations, since the length above the cut off level has to be necessarily removed by gas cutting for facilitating peeling of the top portion of the pile and for interlacing its reinforcement bars into the capping slab. Therefore, the rate quoted shall cater for the element of cutting and removing the surplus length of MS liners. There is, however, no objection for the surplus pieces, if usable, are united and are re-welded to the required length for reuse on some of the other piles. No claim shall be entertained if the cut pieces cannot be reused by the contractor.
- 2.3.15 The contractor shall take all necessary precautions while piling close to existing structures/other foundations/track so as to minimize vibrations and ground movement. Bores shall be encased as directed by the Engineer and boring shall commence only after precautionary measures are taken. While working near the existing track, infringements and other safety aspects shall be specially considered and taken care of.
- 2.3.16 The contractor shall indemnify the V.P. (GUDC) Administration against any claim or obligations arising out of any damage to structure or out of any injury to any person/persons due to piling working done by him.
- 2.3.17 The contractor shall mobilize and maintain requisite resources for piling including concreting. Additional resources, as a standby shall also be available in advance of work, to take care of any eventualities. Admixtures as approved by Engineer shall be kept in readiness before concreting to meet any exigencies. After boring and/or cage lowering to avoid borehole instability and settlement of bentonite, boreholes shall not be left un-concreted for long.
- 2.3.18 The spoils arising out of boring shall be disposed off as directed by Engineer within the agreemental rates. In case of piling close to Railway track or near the existing road, contractor shall make adequate arrangements for disposing the muck away properly. Contractor shall also make adequate drainage arrangement for mud slurry so that the same does not affect the tracks or roads or adjoining properties.
- 2.3.19 The bored spoils may be dumped in a low lying area as directed by Engineer so that work site is restored back to normal condition after completion of work.
- 2.3.20 When the bore has reached its final depth, it shall be free from any foreign matter before placing the reinforcement cage and concreting for the pile is started.

Reinforcement for the pile shall be carefully placed in position and concreting then started. The cover block used also shall satisfy strength and permeability criteria.

- 2.3.21 If hard rock is encountered, socketing in hard rock shall also be provided as per codal provision.
- 2.3.22 In case of sloping bedrock profile, the requisite depth of socketing shall be ensured as minimum all round piling and the payment will be made for the least depth of socketing only and no claims of differential depth of socketing are admissible.
- 2.3.23 The bottom level of pile cap will be decided by Engineer, depending upon capacity and ground level.
- 2.3.24 Care shall be taken for free flow of concrete through splices and congested reinforcement zones with proper detailing and monitoring.
- 2.3.25 The quantity of concrete required for a particular pile shall be calculated as per depth of the pile and nominal diameter of the pile. This quantity shall be checked with the actual quantity of concrete used, which is to be recorded and signed jointly by the contractor and representative of the V.P. (GUDC). Theoretical quantity of concrete, calculated as per depth and nominal diameter of the pile shall form the basis of calculating the cement quantity as per approved design mix, for payment to the contractor,
- 2.3.26 For the finishing of pile heads, the clearances of reinforcements in the pile cap and the keying of the pile head into the pile cap shall be as given in IS: 2911.
- 2.3.27 The contractor shall maintain bore log register and bored samples for each pile boring and concreting. The details shall contain various operations in pile boring with time, type of soil met with depth of penetration with levels, liner welding and lowering details, obstruction to boring, if any, machine down time, rock touch level and final socketed level. The flushing out details before cage lowering and before concreting shall also be recorded. The concreting details such as mix proportions, sounding at various depths vis-à-vis cement / concrete consumption, unusual observations while concreting, interruption to concreting, if any and overflow concrete shall be recorded. The swelling and/or squeezing of borehole in uncased portion shall be specially monitored with recording of sounding depth, quantity concreted actually and quantity theoretically estimated corresponding to that sounding depth.
- 2.3.28 The payable depth of piles shall be taken up to the clear distance from the cut-off level (bottom of pile cap) to the average bottom of the bore. The depth so measured shall be rounded off to the nearest first decimal of a metre (0.05 metre or more to be reckoned as 0.10 metre whereas below 0.05 metre to be reckoned as 0.00 metre) for the purpose of making payment.
- 2.3.29 In group of two or more piles, piles of same diameter and same load carrying capacity shall be installed. The distance between centre to centre of such piles shall be governed by IS: 2911. In case the contractor offers to install the piles closer than this spacing, he shall state the reduction in the working load of the pile which will be subject to the approval of Engineer. The additional piles required on this account

shall be provided by the contractor without any extra cost to the V.P. (GUDC). Also cost of cement and steel reinforcement used on this score will have to be borne by the contractor. New MS liners shall also be to contractors account.

- 2.3.30 If any pile during boring has deviated from the design position or from the verticality or if the safe allowable load of the pile is not obtainable as per the design, all these facts shall be reported promptly to the Engineer during the execution of the work with suggestion from the contractor regarding adequate corrective measures. The Engineer shall consider the suggestions of the contractor and shall give necessary directions for the corrective measure which shall be done by the contractor at his own cost and risk. However, if certain piles are rejected by the Engineer on account of improper location / verticality / alignment / capacity, the Engineer may allow the rejected piles to be left in their places and additional piles may be installed to take up the safe working load of the rejected piles with satisfaction of Engineer without any extra cost to the V.P. (GUDC). If any such changes involve additional expenditure due to increase in size of pile cap, etc., the same shall also be borne by the contractor including the extra cost involved in the usage of the extra quantity of cement and steel used in such changes.
- 2.3.31 No payment will be made for rejected piles and also for the cement, steel and the MS liners provided for the rejected piles.
- 2.3.32 **Pile load Test:** IS: 2911 (Part 4) prescribes various guidelines and procedures for load tests on piles. Pile load test shall be conducted as per IS: 2911 (Part 4) and as directed by the Engineer. Vertical load tests (compression) and lateral load tests shall be adopted for testing of piles. There shall be two categories of tests on piles for each type of loading (vertical and lateral), namely, initial tests and routine tests. Initial tests should be carried out on test piles which are not to be incorporated in the work. Routine tests shall be carried out as a check on working piles.

Initial load test is carried out to determine the ultimate load capacity and arrival at the safe load by application of factor of safety whereas routine test is conducted to determine the safe load of pile, checking the safety load and extent of safety. In other words, routine test is conducted to check whether the pile is capable of taking the working load assigned to it.

Non-destructive testing i.e. Integrity testing of pile using Low Strain / Sonic Integrity Test / Sonic Echo test method in accordance with IS: 14893 shall be carried out for integrity testing of concrete in the installed pile.

The vertical load test and lateral load test shall be carried out as per clause 6 and 7 of IS: 2911 (Part 4).

Safe load on a pile is derived by applying a factor of safety on ultimate load capacity of pile as determined by a load test whereas working load is the load assigned to pile according to design. The safe loads on single pile and on group of piles for the initial test and routine test shall be in accordance clause 6.1.5 and 6.1.6 of IS: 2911(Part 4). Test load shall be 2.5 times the safe capacity load for Initial Load. For routine test, test load shall be at least 1.5 times the working load for maximum settlement not exceeding 12mm in case of single pile whereas test load

shall be equal to the working load for maximum settlement not exceeding 25mm in case of group piles.

The test shall be carried out at cut off level wherever practicable, otherwise suitable allowance shall be made in the interpretation of the test results / test load if the test is not carried out at cut-off level.

The contractor shall submit all data along with load vs settlement, time vs settlement, interpretation of the pile load test, etc., in a report along with characteristics of the pile as per IS 2911 and as directed by the Engineer.

For any other type of test such as pullout tests, etc. if considered necessary, the contractor shall make arrangements in consultation with the Engineer and payments for the same will be eligible as decided mutually in advance.

Payment for initial vertical load test, routine vertical load test and lateral load test will be made against a separate item provided in the schedule.

- 2.3.33 The contractor is required to carry out load test in pile or group of piles as per provisions contained in IS : 2911 (Part 4) of and shall provide all the designing, testing, loading, supporting, instrumenting, recording & reporting arrangements at the agreement rates. The design, instrumentation etc., shall be approved by the V.P. (GUDC).
- 2.3.34 The payment for the test of the pile or group of piles shall be made to the contractor only when the test is found to be satisfactory. For tests which are found to be unsatisfactory or which are not completed due to any reasons whatsoever, no payment shall be made to the contractor.
- 2.3.35 The agreemental rates for tests include instrumentation, reporting, arranging of necessary kentledge, R.S. Joists, sand bags, etc, required for loading the platform for successful testing of the pile or group of piles and removing the same from the site of work after the test is completed and clearing the site to the satisfaction of the Engineer and no extra payment shall be made on this account.
- 2.3.36 In case of defective piles, V.P. (GUDC) reserves the right to order, at the cost of contractor, non-destructive test for integrity and / or capacity assessment or additional static load tests as confirmatory tests at the cost of the contractor. The test shall be considered satisfactory only if the criteria laid in specifications are satisfied and the behaviour of the pile or pile group during the period of test does not disclose any defects as specified in relevant codes and as directed by the Engineer.
- 2.3.37 Each pile shall be identified with a reference member. Level marks shall be accurately painted on each pile immediately after its installation. The contractor shall record all the information during installation of piles as directed by the Engineer. Pile records in triplicate shall be submitted by the contractor.
- 2.3.38 Approval of the termination depth of the pile by the Engineer shall, in no way, absolve the contractor on the integrity of the pile.

- 2.3.39 **Control of Position and Alignment:** Piles shall be installed as accurately vertical (for vertical piles) as possible. The permissible limits for deviation with respect to position and alignment shall confirm to IS: 2911 (Part 1/Section 2).
- 2.3.40 Working level shall be above the cut-off-level. After the initial boring of about 1m, temporary guide casing of suitable length shall be lowered in the pile bore for vertical pile. The diameter of guide casing shall be such as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc. The temporary guide casing (if provided) shall be withdrawn cautiously, after concreting is done up to the required level. While withdrawing the casing, concrete shall not be disturbed.
- 2.3.41 Permanent MS Liners shall be provided for piles up to point of refusal or as directed by the Engineer. The bottom end of the MS Liner shall be stiffened by welding additional plates to withstand the impact during driving.
- 2.3.42 In case hard rock is encountered, chiselling is essentially required for softening of the rock, the same may be adopted only on approval of the Engineer, at no extra cost to the V.P. (GUDC). Advancement of pile bore shall be done by drilling only, in case of use of rotary hydraulic drilling rig.
- 2.3.43 Specifications for Bentonite shall be as follows: Liquid limit of bentonite when tested in accordance with IS: 2720 (Part V) shall be 400 percent or more. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.03 and 1.10 gm / ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pile bore may be up to 1.25 gm / ml. The marsh viscosity when tested by a marsh cone shall be between 30 to 60 Seconds/stroke. The pH value of the bentonite suspension shall be between 9 and 11.5.
- 2.3.44 Cleaning of borehole: - After completion of borehole up to the required depth, the borehole shall be cleaned as per clause 8.3 of IS: 2911 (Part 1/Section 2).
- 2.3.45 A protocol shall be maintained regarding the strata at the founding level, SPT value, percent core recovery, Unconfined Compressive Strength (UCS) from the nearest borehole, socketing horizon, flushing of pile bore, time interval between end of boring and start of concreting, bentonite density before start of concreting.
- 2.3.46 Top of Concrete in Pile and Cut off-level (COL):- Cut-off-Level of piles shall be as indicated in drawings released for construction. The top of concrete in pile as cast shall be above the cut-off-level by 1.0 metre (maximum) to remove all laitance and weak concrete and to ensure good concrete at cut-off-level, for proper embedment into the pile cap. The area surrounding the piles shall be excavated up to the bottom of the pile caps. After seven days of concreting of pile, the exposed part of concrete above the COL shall be removed / chipped off and made rough at COL. The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap. The pile top shall be embedded into the pile cap by 150 mm or clear cover to reinforcement, whichever is

higher. All loose material on the top of pile head after chipping to the desired level shall be removed and disposed off as directed by the Engineer.

- 2.3.47 Reinforcement: The longitudinal reinforcement shall project 50 times its diameter above cut-off-level unless otherwise indicated. Proper cover to reinforcement and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose. Placement of reinforcement cage to its full length shall be ensured before concreting. Minimum clear cover to the reinforcement shall be 75 mm, unless otherwise mentioned.
- 2.3.48 Building Up of Piles: If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut-off-level, then the pile shall be built up by using at least one grade higher concrete than specified for piles, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement, as per design requirement and suitable shuttering shall be provided, before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction, to ensure lateral capacity of the pile.
- 2.3.49 Breaking Off: If any pile already cast requires breaking, due to subsequent change of Pile's cut-off-level, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile, such as loosening, cracking etc., and to the satisfaction of the Engineer. If any pile is cracked, the same shall be replaced by the contractor at his own cost.
- 2.3.50 Bore Hole testing: Bore hole shall be made as per IS:1892.

2.3.51 IMPORTANT CONSIDERATIONS, INSPECTION / PRECAUTIONS

- (i) While concreting uncased piles, voids in concrete shall be avoided and sufficient head of concrete shall be maintained to prevent inflow of soil or water into the concrete. It is also necessary to take precautions during concreting to minimise the softening of the soil by excess water. Uncased cast-in-situ piles shall not be permitted where mudflow conditions exist.
- (i) The drilling mud such as bentonite suspension shall be maintained at a level sufficiently above the surrounding ground water level to ensure the stability of the strata which is being penetrated all through the boring operation and until the pile has been concreted.
- (ii) Where bentonite suspension is used to maintain the stability of the bore-hole, it is essential that the properties of the material be carefully controlled at stages of mixing, circulating through the bore-hole and immediately before concrete is placed. It is advisable to limit:
- (a) The density of bentonite suspension to 1.05 g/cc and maintain it.
 - (b) The marsh cone viscosity between 30 and 40 seconds.
 - (c) The pH value between 9.5 and 11.50
 - (d) The silt content less than 1 per cent
 - (e) The liquid limit of bentonite not less than 400 per cent

These aspects shall act as controlling factors for preventing contamination of bentonite slurry by clay and silt.

- (iii) The bores shall be washed by bentonite flushing to ensure clean bottom at two stages viz. (a) after completion of boring and (b) prior to concreting after placing of reinforcement cage. Flushing of bentonite shall be done continuously with fresh bentonite slurry till the consistency of inflowing and out flowing slurry is similar.
- (iv) Tremie of 150mm to 200mm diameter shall be used for concreting. The tremie should have uniform and smooth cross-section inside, and shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal. Other precautions to be taken while tremie concreting are:
 - (a) The sides of the bore-hole have to be stable throughout
 - (b) The tremie shall be water tight throughout its length and have a hopper attached at its head by a water tight connection.
 - (c) The tremie pipe shall be large enough in relation to the size of aggregates. For 20mm aggregate the tremie pipe shall be of diameter not less than 150mm and for larger size aggregate tremie pipe of larger diameter is required.
 - (d) The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the bore-hole with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
 - (e) For very long or large diameter piles, use of retarding plasticiser in concrete is desirable.

2.3.52 Pile Data:

The contractor shall submit data in the following proforma for each pile indicating all technical details along with date and time of various operations in adequate permanent forms/copies for record.

Proforma

- (i) Reference No. Location (Co-ordinates) __ area.
- (ii) Sequence of installation of piles in group
- (iii) Pile diameter & type
- (iv) Working level (Platform level)
- (v) Cut off level (COL)
- (vi) Actual length below COL
- (vii) Pile termination level
 - (a) Start of socket (Level)

- (b) Termination of pile (Level):
- (viii) Top of finished concrete level
- (ix) Date and time of start and completion of boring.
- (x) Depth of ground water table in the vicinity.
- (xi) Type of soil/ rock at pile tip
- (xii) Method of boring operation
- (xiii) Details of drilling mud (Bentonite) as used:
 - (a) Freshly supplied mud:
 - Liquid limit
 - Sand content
 - Density
 - Marsh viscosity
 - Swelling index,
 - PH value
 - (b) Contaminated mud:
 - Density
 - Sand content
- (xiv) (a) Standard Penetration Test (SPT) Penetration for 100 blows at Socketing Level for reference pile:
 - (b) Unconfined Compression Strength (UCS) Value in rock (from the nearest bore hole): Core recovery (from the nearest bore hole):
 - (c) Rate of drilling in mm / hr:
 - (1) At start of socketing horizon
 - (2) At termination level
- (xv) Date and time of start and completion of concreting.
- (xvi) Method of placing concrete
- (xvii) Concrete quantity
 - Actual:
 - Theoretical:
- (xviii) Ref. number of test cubes
- (xix) Grade and slump of concrete
- (xx) Results of test cubes
- (xxi) Reinforcement details:

Main reinforcement Stirrups: Type
 No. _____ No. _____
 Dia _____ Dia _____
 Depth _____ Spacing _____

(xxii) Any other information regarding obstructions, delay and other interruption to the Sequence of work.

(xxiii) Pile bore log details (in brief).

2.3.52 Such structure or parts of the structure which fail or pass the specified tests, shall be removed from the site by the tenderer/contractor at his cost and the contractors shall redo the work. Payments made on account of the rejected structure/part structure work shall be recovered from the contractor and the work will be redone by him at the same rates.

2.4 GENERAL GUIDLINES AND SPECIFICATIONS FOR SUPPLY OF REINFORCEMENT AND STRUCTURAL STEEL

2.4.1 SUPPLY OF STEEL FOR VARIOUS WORKS:

Supply of steel to various specifications as required under various schedules in the contract are governed by the Technical specifications and Special Conditions specified hereunder.

All steel shall be supplied by the Contractor at the site of work and stacked, stored, protected and maintained by him at his cost till they are put into use. Any temporary structure required for storage of steel etc., has to be provided by the Contractor at his cost and should be removed after completion of the work. The V.P. (GUDC) will only provide suitable land for construction of the above temporary shed free of cost wherever available.

For supply and use of steel in various works, relevant IRS Codes Specifications, IS Specifications and Railways/MORTH specification will be applicable or relevant. The decision of V.P. (GUDC) shall be final and binding to the contractor.

2.4.2 SPECIFICATIONS FOR STEEL:

2.4.2.1 The steel supplied by the contractor must satisfy any of the following material specifications as required for the work along with other concerned specifications.

(i) The reinforcement steel shall be Thermo mechanical Treated bars of grade Fe 500D conforming / satisfying to IS 1786 (Up to date).

(ii) The structural steel shall be conforming to IS 2062 (Up to date) as specified. It shall have Sub quality 'BR' & Grade E250 (Fe 410 W) as mentioned in the tender schedule and the requirements of IRS B1-2001 shall be fulfilled for all components for all s.s. 12 mm thick & above plates are fully killed and fully normalized / controlled cooled as mentioned in the tender schedule. 'BR' sub quality indicate the requirement of impact test at room

temperature and should conform to Charpy Impact Test at room temperature in accordance with relevant I.S. Code.

- (iii) Relevant other IS and IRS Specifications with regard to properties, testing and use of the above steel items also shall govern.

2.4.2.2 The contractor shall produce the manufacturers test certificate for each lot of supply satisfying the requirements of relevant IS specifications and at the specific frequency as laid down.

2.4.2.3 The Contractor shall arrange to carryout additional tests on physical properties of steel for every 40 metric tonne (t) of steel, and for every change in lot / batch for reinforcement steel and structural steel, Contractor shall submitted test report from manufacturer at his cost. V.P. (GUDC)reserve to right for carry out additional test if need arise. No extra payment will be made for conducting such tests and the agreemental rate is inclusive of above testing charges.

2.4.3 PROCUREMENT OF STEEL:

2.4.3.1 All Reinforcement steel (TMT bars) and Structural Steel shall be procured as per specification mentioned in BIS's documents – IS: 1786 and IS: 2062. Independent tests shall be conducted, wherever required, to ensure that the materials procured conform to the Specifications.

These steel shall be procured only from those firms, which are Established, Reliable, Indigenous & Primary Producers of Steel, having Integrated Steel Plants (ISP), using iron ore as the basic raw material and having in-house iron rolling facilities, followed by production of liquid steel and crude steel, as per Ministry of Steel's (Government of India) guidelines.

However, only certain isolated sections of structural steel, not being rolled by ISPs, can be procured from the authorized re-rollers of ISPs or authorized licensee of BIS having traceability system and who use billets produced by ISPs with the approval of Engineer.

2.4.3.2 The contractor shall have to submit the cash memo and challans along with the lot / batch of steel purchased in token of proof of purchase of steel from reputed dealers. Steel shall be approved by Engineer only after production of necessary certificates before use in works.

2.4.4 REINFORCEMENT AND STRUCTURAL STEEL:

2.4.4.1 Payment for supply of all types of steel shall be made for the quantity required / used as per the drawings issued from time to time. No payment will be admissible for quantity supplied in excess of the required quantity as per drawings. However, contractor will be permitted to take the excess quantity back by his own means, but no claim for payment for transportation so involved will be admissible. No payment will be made for more supply of steel at the site / excess used in Construction. No payment will be made for steel used in temporary or enabling works unless explicitly provided for in the Schedules. Steel for enabling/temporary works shall be arranged by the Contractor at his own cost.

2.4.5 STAGE PAYMENTS FOR STRUCTURAL STEEL:

2.4.5.1 No Advance Payment shall be made. However, stage payment for manufacturer of steel girders shall be made as per Bills of Quantities by the V.P. (GUDC) for steel physically brought to site by the contractor.

2.4.5.2 Stage payment for steel Girder will be released subject to the following conditions:

- (i) The steel shall be delivered at site and properly stored under covered sheds in measurable stacks and separately maintained for various sizes, sections and dates of supply.
- (ii) The quantities of steel shall be brought to the site only in such instalments that would facilitate smooth progress of work and consumed in reasonable time. The payment will be restricted to a maximum of 30% of the schedule quantity at any point of time.
- (iii) Proper accountable in the Steel Register is to be maintained in the prescribed format at the site for the receipt and use of the steel.
- (iv) Ownership of such steel shall be deemed to vest with the V.P. (GUDC).
- (v) Before releasing the stage payment, the contractor shall insure the steel at his own cost in favour of V.P. (GUDC) against theft, misuse, damages, fire etc.
- (vi) The price variation claim for steel will continue to be governed as per extant PV clause and with reference to delivery at site.
- (vii) The Stage payment will be made, only when the Engineer or his authorized representative certifies that the said quantity of steel is received at site and entered in the register and that in his opinion the steel is actually required in accordance with the contract.
- (viii) No Stage payment is permitted for steel required for temporary and enabling works.

2.4.5.3 (i) 60% payment shall be released after fabrication and receiving fabricated component at ROB site.

(ii) 20% payment shall be released after assembling the fabricated components as per drawing at ROB site.

(iii) 15% payment shall be released after erection and completion of item.

(iv) 05% payment shall be released after date of successful completion of the defect liability period or free maintenance guarantee period whichever is later.

2.4.5.4 Any Stage payment found to be made against the materials brought to the site in excess over the actual materials consumed in work shall be recovered from the contractor dues.

2.4.6 OTHERS:

- 2.4.6.1 Reinforcement steel and structural steel, shall be stored in such a way so as to avoid distortion and to prevent deterioration by corrosion. All steel used should be free from loose Mill scale, loose rust, paints and oil covering / coating etc.
- 2.4.6.2 Steel material, for which stage payment has been availed by the Contractor, shall be property of V.P. (GUDC) and will be issued to contractor by Engineer whenever required for the work. Contractor will be solely responsible for guarding against theft / misuse of the consignment due to any cause what so ever. The stage payment will be made, only when the Engineer certifies that in his opinion that the materials are actually required in accordance with the contract. It is the responsibility of the agency to ensure that steel as per the requirement is brought to site as per approved drawings / requirements.
- 2.4.6.3 The contractor shall be bound to store the materials at site of work earmarked for the purpose by the Engineer and shall not remove from the site nor use for any other purposes than exclusively for execution of the work for which the materials are intended for. Safe guarding of the materials is the responsibility of the contractor even if the material is deemed to be owned by the V.P. (GUDC) and insurance etc., have been arranged by the contractor.
- 2.4.6.4 Contractor shall remove from site any steel materials rejected by the Engineer within reasonable time as specified by him.
- 2.4.6.5 Before the test pieces are selected, the Contractor shall furnish copies of the mill records of the reinforcement steel giving number of coils in each cast with sizes and identity marks to enable identification of the material with the bill produced.

2.5 GENERAL GUIDELINES AND SPECIFICATIONS FOR FABRICATION & ERECTION OF COMPOSITE GIRDER AND SPECIAL CONDITIONS

2.5.1 GENERAL:

This chapter covers the supply of material, fabrication, assembly and erection of Composite/BOW string/Open Web Girders and bearings.

The composite girder shall be fabricated / erected as per approved GAD/ Design and launching scheme provided.

The following are the brief specifications and general guidelines for fabricating and erecting the girders but not limited to.

For detailed technical specifications for fabrication and erection of girders, refer special condition and specification for "Schedule-E", added to superseded by Additional Specifications if any, appended to or as modified from time to time and Indian Railway Specification for Fabrication and Erection of Steel Girder Bridges and Locomotive Turn-Tables (Serial No B1-2001) shall be followed.

The superstructure of these ROBs in Railway portion is composite girder.

Composite girder is a combination of plate girders/ Bow string/ Open Web Girders

and deck slab. These girders involve the use of shear connector also. The Width of bridge is as per approved GAD and approved design. The superstructure includes two RCC crash barriers and two RCC railings as per MORTH design. The wearing coat is made of plain concrete. The wearing coat is 75 mm thick or as per GAD and design. The cross drainage slope of 1 : 40 is in the deck slab to drain the water. 100 mm dia GI/PVC pipe shall be used as drainage spouts.

The RCC deck slab has been designed with design Mix Concrete with grade of Concrete M35. The environmental exposure condition of this area where these ROB's are being constructed is moderate. As per moderate condition, minimum grade of concrete required as per Addendum and Corrigendum slip no 12 of Concrete Bridge Code - 1997 is M30. Minimum grade of concrete requirement is for durability of the structure. Hence, M35 satisfies the codal provisions of Concrete Bridge Code.

The bearings used in these girders are Elastomeric / POT cum PTFE Bearing as per approved GADs & design. The contractor has to purchase the bearings from the approved manufacturers of Railways/RDSO/State Government as may be applicable or relevant, as per approved drawing. The decision of V.P. (GUDC) shall be final and binding to the contractor.

Bearing design shall be done by bearing manufacture as per load/forces on bearing given in the drawing and design/ drawing of bearing shall be got approved from Consultant. The cost of design of bearing shall be borne by the contractor. The decision of the V.P. (GUDC) shall be final and binding to the contractor.

Pin and Metallic Guide bearing have also been shown in the drawings of superstructure of RDSO composite girders. But these are used in Seismic Zone IV and V. For this work, these bearings are not applicable.

The 18m, 22m, 24m, 30m, 36m, 48m and 62m etc as per GADs. Composite plate girder/ Bow string girder/ Open Web Girders are to be fabricated as per Indian Railway Specification for Fabrication and Erection of Steel Girder.

Bridges and Locomotive Turn-Tables (Serial No B1-2001).

High Strength Friction Grip Bolts (HSFGB) shall be used as per drawings of RDSO. Notes for use of HSFGB are given in drawing no. RDSO/B-11760/R.

For skew ROB's, please refer drawing no. RDSO/B-11759/R.

Protection screen is to be provided as per RDSO Drawing No RDSO/ETI/0068 in each ROB.

The protective coating is to be given to the composite girder by metalizing with sprayed aluminium as recommended in RDSO drawings.

The Contractor will be required to develop jigs & Masters for each components of composite Girder and same will be approved by V.P. (GUDC) authorized inspecting

officials. Masters templates should be stored & handled carefully and should be used only for checking the correctness of the jigs from time to time.

After successful inspection of the fabricated components, appropriate surface treatment i.e. metalizing shall be rendered & components transported to bridge sites.

Contractor will be responsible for making material dumping and girder erection yard as per the requirement for which no extra payment will be made by the V.P. (GUDC) to the Contractor.

2.5.2 Site Inspection

Tenderers are requested to inspect the site and carry out careful examination to satisfy them as to the nature of work involved and facilities available at the site. They should note carefully all the existing structures and those under construction through other agencies. They should also study the suitability of utilizing the different equipments and the machinery that they intend to use for the execution of the work. The tenderers should also select suitable sites for the purpose of locating their store yard, laboratory, staff quarters etc., and satisfy themselves with regard to the feasibility of transporting the plate girders from the yard to the final site of placement etc.

2.5.3 Brief Design Data

The composite girders has been designed as per relevant IRS / IRC / RDSO codes and other guidelines.

2.5.4 Codes and Specifications:

The materials as well as execution of works shall be confirming to the following specifications and codes of practice (Latest Revision of the Specification /Codes & upto date correction slips to be referred).

2.5.4.1 Indian Railway Standard Codes and Specifications:

- (i) IR Specification for Fabrication of steel girder bridge & Locomotives turn tables (fabrication specification) – SERIAL NO. B1-2001 issued by RDSO, Reprint - 2008 incorporating A & C slip upto 4 (upto date).
- (ii) IRS : Welded Bridge Code (1989)
- (iii) IRS : Steel Bridge Code (2003)
- (iv) IRS: M-28 Specifications for electrodes.
- (v) IRS: M-39 Specification for wire flux for SAW.

2.5.4.2 Indian Standard Specification:

- (i) IS: 2062-2011 Specification for structural steel.
- (ii) IS: 813-1986 Scheme of symbols for welding.
- (iii) IS: 800-2007.
- (iv) IS: 9595-1996 Manual for metal arc welding.

- (v) IS: 818-1968 Code of Practice for safety and Health requirements in electric and gas welding operations.
- (vi) IS: 5666-1970 Etch (Pre-treatment) Primer
- (vii) IS: 104-1979 Specification for Ready mixed paint, brushing, zinc chrome, Priming
- (viii) IS : 2339-1963 : Aluminium paint
- (ix) IS: 2004-1991 Carbon steel forgings for general engineering purposes.
- (x) IS: 1852-1985 Rolling and cutting tolerances for hot-rolled steel products.
- (xi) IS: 1148-2009 Rivet bars for structural purposes.
- (xii) IS: 4353-1995 Recommendations of Sub-merged Arc welding of mild steel and low alloy steel.
- (xiii) IS: 3935-1966 (shear connector)

2.5.5 Materials

- 2.5.5.1** Steel (Plates and Rolled sections) should conform to IS: 2062-2011. It shall have Sub quality 'BR' & Grade E250 (Fe 410 W) as mentioned in the tender schedule and the requirements of IRS B1-2001 shall be fulfilled for all components for all s.s. 12 mm thick & above plates are fully killed and fully normalized / controlled cooled as mentioned in the tender schedule. BR sub quality indicate the requirement of impact test at room temperature and should conform to Charpy Impact Test at room temperature in accordance with relevant I.S. Code.

Material supplied by the manufacturers shall be ultrasonically tested as per codal provisions at the manufacturer's premises before dispatch. The contractor on receipt of supply in his factory premises/fabrication workshop may have to carry out random USFD testing as per standards laid down in various codes and verify them with the list received from manufacturers, if instructed by the inspection agency/ Site Engineer. Only tested steel shall be used for fabrication. The steel shall comply in all respects with the requirements of approved drawings and relevant codes and specifications and it may be noted that quality of steel used for fabrication shall be the essence of the contract & shall be rigidly followed.

- 2.5.5.2** Structural Steel shall be procured as per specification mentioned in BIS's documents – IS : 2062-2011. Independent tests shall be conducted, wherever required, to ensure that the materials procured conform to the Specifications.

These steel shall be procured only from those firms, which are Established, Reliable, Indigenous & Primary Producers of Steel, having Integrated Steel Plants (ISP), using iron ore as the basic raw material and having in – house iron rolling facilities, followed by production of liquid steel and crude steel, as per Ministry of Steel's (Government of India) guidelines.

However, only certain isolated sections of structural steel, not being rolled by ISPs, can be procured from the authorized re-rollers of ISPs or authorized licensee of BIS having traceability system and who use billets produced by ISPs with the approval of Engineer.

2.5.6 Test Certificates & Testing

All materials for the work shall pass Mechanical test, Charpy test, Chemical Analysis, etc. prescribed by the relevant IS specifications or such other equivalent specifications.

For all materials including HSFG bolts, the contractor shall furnish copies of test certificates from the manufacturers including proof sheets, mill test certificates, etc. showing that the materials have been tested in accordance with the requirements of various specifications and codal provisions.

If any further testing of materials is required by Engineer in respect of these and other items, it shall be arranged for by the contractor at a reputed laboratory/National test house as approved by Engineer. For this, nothing extra shall be payable and accepted rates in the schedule of items shall be deemed to include this.

Even satisfactory outcome of such tests or analysis shall in no way limit, dilute or interfere with the absolute right of the Engineer to reject the whole or part of such materials supplied, which in the judgement of the inspecting authority does not comply with the conditions of the contract. The decision of the Engineer in this regard shall be final, binding and conclusive for all purposes.

The Engineer shall be empowered, at his/her discretion to make or have made under the supervision, any of the tests specified in the specifications mentioned herein in addition to such other tests as he/she may consider necessary, at any time up to the completion of the contract and to such an extent as he/she may think necessary to determine the quality of all materials used therein. In doing so, he/she shall be at liberty under any reasonable procedure, he/she may think fit to select, identify, have cut-off and take possession of test pieces from the material either before, during or after its being worked up into the finished product.

The Engineer shall also be empowered to call for a duly authenticated series of mechanical tests to be obtained from the maker for this materials used in the work and to accept the same in lieu of other tests to the extent he/she deems fit. The Contractor shall supply the material required for the test pieces and shall also prepare the test pieces necessary.

The test shall be carried out by the Contractor, for which Contractor shall provide all facilities including supply of labour and plant. Engineer may at his/her discretion direct the Contractor to despatch such tests pieces as he/she may require to the National Test House or elsewhere as he/she may think fit for such testing purposes.

The Engineer may at his/her discretion, check test results obtained at Contractor's work by independent tests at National Test House.

The Engineer shall at all times be empowered to examine and check the working of the Contractor's plant before and after using it. Should the Contractor's plant be found, in the Engineer's opinion, unreliable, he/she is empowered to cancel any tests already carried out in this contract and have these tests carried out at any National Test House or elsewhere, as he/she may think fit.

2.5.7 Packing

All projecting plates or bars shall be kept in shape by timber or angle bars spiked or bolted to them and the ends of chord lengths, end posts etc at their shipping joints shall be protected and stiffened so as to prevent damage or distortion in transit as the Engineer may direct.

All threaded ends and machined surfaces are to be efficiently protected against damage in transit. The parts shall be transported in convenient lengths.

All straight bars and plates except small pieces are to be transported in convenient bundles temporarily riveted or bolted together or bound with wrought iron or suitable wire as the Engineer may direct. All bolts, nuts, washers, plates under 300mm square and small articles generally are to be packed separately for each s. in cases each weighing when full not more than 350 kg or in strong petroleum casks, or barrels as approved by Engineer. If not entirely filled by the contents the space left shall be closely packed with wood shaving or other suitable material. HSFG & other temporary Bolts of different sizes shall be separately packed in bags, each bag having a label indicating its contents. A list of contents shall be placed on top of each case or cask.

2.5.8 Stacking Materials:

- (a) The materials, on receipt at site, shall be carefully unloaded, examined for defects, checked, sorted and stacked securely on a level bed out of danger from flood and out of contact with water or ground moisture. All materials shall be available for inspection by the Engineer.
- (b) The materials shall be verified with the marking shown on the marking plan of part list, which shall be supplied by the manufacturers or the Engineer.
- (c) Any materials found damaged during transit or while unloading should be stacked separately and damaged portions shall be indicated by paint with distinctive colour. All such materials shall be dealt with under the orders of the Engineer without delay. If any component after receipt at site, has in the opinion of the Engineer or Purchaser, been damaged in transit, such component shall be replaced or repaired to the satisfaction of the Engineer or Purchaser free of cost.
- (d) All such damaged material shall be dealt with as per the orders of the Engineer. Badly damaged portions may require replacement. Slightly distorted parts may be straightened by gradual pressure without heat or annealing. Badly distorted or broken parts must be dealt with as the case demands and as directed by the Engineer.
- (e) Where the work has been passed in the manufacturer's works as strictly interchangeable, all members bearing the same marks can be stacked together without reference to any particular s..
- (f) The tenderer shall unload the material promptly on delivery; otherwise the tenderer shall be responsible for demurrage charges.

- (g) On receipt of rolled steel at workshop or fabrication yard, they shall be carefully unloaded and stacked properly to avoid bending, twisting, corrosion etc.

2.5.9 Manufacturing – The whole work shall be representative of the highest class of workmanship. The greatest accuracy shall be observed in the design, manufacture and erection of every part of the work to ensure that all parts will fit accurately together on erection and similar parts shall be strictly interchangeable as explained interchange ability paragraph. The contractor shall state which of the following alternative methods of manufacture, he intends to adopt.

- (i) The whole of work to be erected complete and pieces marked to place.

- (ii) All s.s to be made strictly interchangeable as specified below

2.5.10 Interchange ability :

- (i) Every s. is to be temporarily erected complete in Contractor's works. and all parts as marked to their place, unless the whole of the work is made completely interchangeable by the use of steel jigs and hard steel bushes controlled by master gauges, in which case the first s. must be completely erected to test the accuracy of the templates. Further s.s or part s. assemblies built from parts selected at random by the Engineer shall be erected from time to time to check the accuracy of the work as the Engineer may require.

- (ii) If the work is considered interchangeable by the Engineer a simplified scheme of marking will be permitted, i.e. all pieces which are identical shall bear one distinguishing mark irrespective of the s. to which they belong. Should the interchange ability not to the satisfaction of the Engineer, the whole of the s.s must be erected complete and all parts marked to their place without additional charge. The tenderers must state in their tenders whether they intend to adopt complete interchange ability or not.

- (iii) Under special arrangement with the Engineer, it shall be permissible for approved portions of the work to be despatched before complete erection of the first s., provided the Contractor satisfies the Engineer that such portions of the work are strictly interchangeable and will assemble correctly and accurately in the complete structure.

2.5.11 The tenderer may fabricate the steel work at his workshop or at the site of the work as is convenient to him. If the fabrication is done in his own workshop, the transportation of the fabricated materials may be done by Road or Rail transport at his own cost. The tenderer must inspect the approach roads right from the workshop and should ensure that it would be possible for him to transport the materials by Road.

2.5.12 If the tenderer propose to fabricate the steel at site, land / site would be given to the tenderer to make temporary workshop free of cost, if available, but on completion of work, the site would be restored to normal condition.

2.5.13 HSFG bolts shall be provided as per RDSO drawing.

2.5.14 The responsibility of custody of the materials, in Tenderer's workshop or site will remain with tenderer till the completion of work and then handed over to the V.P. (GUDC).

2.5.15 All welding consumables (electrodes, wire, flux etc.) shall be procured only from the manufacturers approved by RDSO subject to final approval by Engineer.

2.5.16 Removal of Unused Materials etc:

- (a) The contractor shall take steps as desired by the Engineer to ensure that rejected work is not resubmitted for inspection.
- (b) On the completion of the work, the tenderer shall remove all his unused and surplus materials, plant, stagings and refuse, or other materials produced by his operations and shall leave the site in a clean and tidy condition.

2.5.17 Fabrication

2.5.17.1 General

The fabrication of the girders and its accessories shall be carried out by the contractor in his factory premises or in a well-established fabrication workshop to be set up by the contractor at bridge site or any other location as approved by the Engineer. The workshop staff shall have requisite experience, proven skill and experience in the technique of fabricating large components. Accuracy of fabrication shall be realized through controlled high precision jigs, fixtures and templates, which shall be inspected and passed by Engineer specifically approved in prior by GM/ROB/ CPM, V.P. (GUDC). The fabrication shall be preceded by Quality Assurance plans to be submitted by the contractor and every activity shall be documented in detail. The Quality Assurance Plans shall clearly indicate how individual processes such as cutting of raw steel, making, drilling, assembly bolting, welding, painting, handling etc. shall be monitored for quality. The quality parameters for monitoring shall be identified. These identified quality parameters shall also be specified in these quality plans. The contractor shall get these quality plans approved from Engineer before start of fabrication work. The Engineer shall be empowered to check the manufacturing process from time to time to ensure that the work is executed as per approved quality plans. The quality records shall be submitted to Engineer for record, after completion of fabrication work.

The works of fabrication in contractor's fabrication shop will at all times be open for inspection by Engineer / agency as nominated by Engineer. Before dispatch of fabricated steel work from the shops, the same will be inspected in the contractor's fabrication workshop by Engineer who will thereafter issue inspection certificate.

Any defect noticed during inspection in the execution of work shall be rectified or replaced by the contractor at his own cost. The decision of Engineer or any other agency nominated for inspection as to be rectified or replaced, shall be final and conclusive.

2.5.17.2 Fabrication Drawings

The contractor shall prepare detailed shop drawings including drawing office dispatch lists (DODL's) on the basis of design drawings supplied by Engineer in such size and in such details as may be specified by Engineer. The shop drawings shall be submitted to Engineer in triplicate. No work of fabrication will be started without such approval being obtained. Contractor has to arrange the proof checking of the working fabrication drawings from the nominated Institution / Consultant. The cost will be borne by the contractor. Nomination of the Institution/Consultant for proof checking works will be decided by concerned V.P. (GUDC). Engineer will make all efforts to approve the drawings submitted by the contractor within reasonable time but no claim from contractor for any delay on this account shall be entertained by Engineer.

For Engineer's use and record, the contractor shall supply free of charge, four sets of prints on string paper and one set of neatly executed tracings of all approved detailed drawings and fabrication drawings, soon after communication of approval for use at site.

2.5.17.3 Maintenance of records by Fabricators

The records of fabrication shall be maintained in the registers such as Jigs register, HSFG bolt checking register, Material offering and inspection register, RDSO inspection notes and compliance register, Welding procedure data register, Radiographic inspection register and Statement of material test certificates, etc. The formats are given in Appendix I of IRS B1 – 2001.

2.5.17.4 Tolerance in Fabrication

Basically, composite girders are plate girders. Fabrication tolerance for plate girders shall be as stipulated in Appendix II of IRS-B1– 2001.

All members of the girder and joints are to be either welded or bolted as shown in the approved structural drawings. No welding except where approved by the Engineer is to be carried out at site. All welding and bolting are to be carried out as per relevant IRS Specifications.

2.5.18 Steel Tape

The Contractor shall maintain a master steel tape of approved make for which he/she has obtained a certificate of accuracy from any National Test House or Government recognised institutions competent to do so.

2.5.19 Flattening and Straightening

2.5.19.1 All steel materials, plates, bars and structural shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled unless they are required to be of curvilinear form. Pressure applied for straightening or flattening shall be such as it would not injure the material and adjacent surfaces or edges shall be in close contact or at uniform distance throughout.

2.5.19.2 Flattening and straightening under hot condition shall not be carried out unless authorized and approved by the Engineer.

2.5.20 Planing and Shearing

2.5.20.1 Except where otherwise indicated, cutting of all plates and sections shall be affected by shearing or sawing. All edges shall be clean, reasonably square and true. Wherever possible the edges shall be cut in a shearing machine, which will take the whole length of the plate in one cut.

2.5.20.2 Should the inspection find it necessary, the cut edges shall be ground afterwards.

2.5.20.3 Planning or machining of the edges or surface shall be carried out when so specified in the contract drawings or where specifically ordered by the Engineer. Where machining is specified, the plates or all sections shall be cut in the first instance to such a size so as to permit not less than 3mm of metal being removed from each sheared edge or end, in the case of plates or sections of 12mm or less in thickness and not less than 6mm of metal being removed in the case of plates and sections exceeding 12mm in thickness.

2.5.20.4 The butting ends of all booms and struts where spliced shall be faced in an end milling machine after members have been completely fabricated. In the case of compression members the face shall be machined so that the faces are at right angle to the axis of the members and the joint when made, will be in close contact throughout. At the discretion of the Engineer, a tolerance of 0.4mm may be permitted at isolated places on the butting line.

2.5.21 Flame Cutting

2.5.21.1 Flame cutting by mechanically controlled torch/torches shall be accepted both in the case of mild steel and high tensile steelwork. Provided the edge as given by the torch is reasonably clean and straight, plates may be cut to shape and beams and other sections cut to length with a gas cutting torch, preferably oxyacetylene gas should be used.

2.5.21.2 All flame cut edges shall be ground to obtain reasonably clean square and true edges. Draglines produced by flame cut should be removed.

2.5.21.3 Unless machining has been specifically provided for, special care is to be taken to ensure that ends of all plates and members are reasonably in close contact and the faces are at right angles to the axis of the members and joints, when made, are also reasonably in close contact.

2.5.21.4 Use of multi-head flame cutting machine having multiple oxy acetylene torches is desirable for higher productivity and reducing the distortion due to cutting operation. Plasma-arc cutting method can also be employed. This process offers less heat input causing less distortion.

2.5.22 Method of fabrication

Considering the length and height of s., jigs and fixtures shall be used to guide and support drilling of holes and fixtures during entire fabrication work.

Jigs after manufacture shall be checked and approved by Engineer or any other Inspecting agency as nominated by V.P. (GUDC). Only approved and stamped jigs shall be used for fabrication.

2.5.22.1 Tack Assembly

Tack assembly is the next step in fabrication which assembles the components to get the form of component or girder. This activity is to be done carefully so that the final components/ girders are fabricated to correct geometric shape and the size is within the tolerance specified.

For tack assembly, the components shall be kept on a firm hard bed and shall be held in position using suitable fixtures so that once the measurements are taken to set a component at proper location, these shall not move till the final tack assembly is done. The entire work shall be done in area where arrangements for manipulating the member such turning over, shifting etc can be conveniently done using EOT or other type of cranes and suitable covered shelter for sufficient protection against the weather is available.

Quality of tack Welds: as per clause 24 of Welded Bridge Code,

- (i) Tack welds shall be not less than the throat thickness or leg length of the root run to be used in the joint.
- (ii) Length of the tack weld shall not be less than four times the thickness of the thicker part or 50mm whichever is the smaller.
- (iii) Where tack weld is incorporated in a welded joint, the shape, size and quality shall be suitable for incorporation in the finished weld and it shall be free from all cracks and other welding defects. Tack welds, which have poor quality and can crack, shall be cut out, ground and re-welded.
- (iv) Tack welds shall not be made at extreme ends of joints.
- (v) Tack welds are equally important in the overall quality and performance of the girder and these shall also be made by qualified welders.
- (vi) After the tack assembly is complete, the girder./ component shall be checked for dimensional accuracy as per clause 13 of IRS B1. Drilling Jig and tacked members shall be clamped to a fixture to avoid shifting of jig during handling and drilling.

Tack welding may be permitted only at ends or locations, which will eventually be cut and removed. No active part of the component shall be tack welded as this would initiate crack formation in service.

2.5.23 Template

The contractor shall supply and provide templates at his own cost. **No separate payment shall be made for this and accepted rates shall be deemed to include this aspect.** The templates throughout the work shall be of steel of similar category. The templates shall be used for marking of cutting materials and as well as for profile machining for girders. Templates shall be used for marking of drilling holes in steel structure. In case where actual materials from a bridge have been used as templates for drilling similar pieces the Engineer will decide whether these are fit to be used as part of finished structure.

2.5.24 Template Shop

Fully covered template shop consisting of uninterrupted steel or concrete floor as approved having true and correct level covering adequate area shall be provided by the contractor.

2.5.25 Drilling and Sub punching

All holes shall be drilled but the Contractor may, if he/she so prefers sub-punch them to a diameter 6mm less than that of finished holes, e.g. a punched hole which is to be drilled out to 25mm in diameter shall not exceed 19mm in diameter at the die end. When the bolt holes are to be sub-punched, they shall be marked with a centre punch and made with a nipple punch or preferably, shall be punched in a machine in which the position of the hole is automatically regulated. The punching shall be so accurate that when the work has been put together before drilling, a gauge 1.5mm less in diameter than the size of the punched holes can be passed easily through all the holes.

Holes for turned bolts, should be 1mm under drilled in shop and should be reamed at site to suit the diameter of turned bolt.

The steel bushes shall be case hardened by an approved process and checked for diameter after the heat-treatment. The bores of bushes shall initially have a tolerance of -0mm, 0.1mm. The tolerance shall be checked from time to time and when the bores exceed a tolerance of, -0mm, +0.4mm, the bushes shall be rejected. For this purpose, go and no-go gauges are to be used. Tolerances for checking jigs from master plates shall be +0mm-0.13mm.

The work shall be taken apart after drilling and all burrs left by the drill and the sharp edges of all the bolt holes completely removed.

Drifting to enlarge unfaired holes is prohibited. The holes required to be enlarged shall be reamed provided the Engineer permits such reaming after satisfying himself about the extent of inaccuracy and the effect of reaming on the soundness of the structure. The Engineer reserves the right to reject all steel work if the holes are not properly matched.

On completion of drilling of holes in each component and before shifting the jig, it shall be ensured that all holes are drilled to their correct diameter to reconfirm quality of work.

2.5.26 Temporary Bolts, Nuts & Washers:

Refer Cl.28.1 to Cl.28.8 of IR Fabrication specification Serial No. IRS-B1-2001 issued by RDSO.

2.5.27 Alterations in the Work:

The Contractor shall not in any case or in any circumstances have authority to make any alterations in, modifications of, substitution for, addition to, or omission of work or any method or system of construction, unless an alteration order in writing directing such alteration, modification, substitution, addition, omission or change shall have been given by the V.P. (GUDC) prior to the commencement of the work or part of work nor shall the Contractor be entitled to any payment for or in respect of any such alteration, modification, substitution, addition, omission or change may have been actually made and executed and no course of conduct shall be taken to be a waiver of the obligation and conditions hereby imposed.

All altered, modified, substituted, additional and changed work, labour and materials and all omitted work shall be valued by the Purchaser on the basis of the rates specified in the schedule.

2.5.28 Welding

Welded construction work shall be carried out generally in accordance with the provisions of Indian Railway Standard Welded Bridge Code and subject to further specifications given in the following paragraphs.

All welds should be done by submerged-arc welding process either fully automatic or semi-automatic. Carbon di oxide welding or manual metal-arc welding may be done only for welds of very short runs or of minor importance or where access of the locations of weld do not permit automatic or semi-automatic welding.

Except for special types of edge preparation, such as single and double 'U' single and double 'J' the fusion edges of all the plates which are to be joined by welding may be prepared by using mechanically controlled automatic flame cutting equipment and then ground to a smooth finish. Special edge preparation should be made by machining or gouging.

Site welding should not be undertaken except in special circumstances with the approval of the V.P. (GUDC)/Agency/Officers nominated by V.P. (GUDC). Site welding should be confined to connections having low stresses, secondary members, bracings etc.

Manual metal arc welding may be done taking adequate precautions as per IS: 9595 and under strict supervision.

2.5.29 Welding Procedure

The welding procedure shall be such as to avoid distortion and minimize residual shrinkage stresses. Properly designed jigs should be used for assembly. The welding

techniques and sequences, quality, size of electrodes, voltage and current required shall be as prescribed by manufacturers of the material and welding equipment. The contractor should submit full details of welding procedure in proforma given at Appendix-V of IRS B1-2001.

2.5.30 Sequence of welding and welding pass

For fabrication of welded composite girders, channel shear connectors shall be welded on top flange plate prior to assembly of I-section. This facilitates correction of any distortion of flange plate developed during the welding of channel shear connectors.

In making a typical I-section four fillet welds are to be made. The welding sequence to be followed is indicated by number 1 to 4 as shown in the Fig. 3 of IR Fabrication specification Serial No. IRS-B1-2001 issued by RDSO.

Whenever a square butt weld in a 10 or 12mm thick plate is required to be made, the sequence to be adopted is shown in Fig. 3 of IR Fabrication specification Serial No. IRS-B1-2001 issued by RDSO.

2.5.31 Procedure Trials for welding and cutting

Where required by the Engineer, welding and flame cutting trials as per following shall be carried out and completed before fabrication on representative samples of materials to be used in the work, as follows.

- (i) The samples of material shall be selected and marked by the ENGINEER when the materials for the work are inspected at the mills.
- (ii) The trials of flame cutting shall be carried out in material representative of all thicknesses to be used in the work.
- (i) The welding & flame cutting trials shall be commensurate to the satisfaction of Engineer and the procedures to be adopted in the fabrication of work which shall include:
 - (a) Welding procedure in accordance with IRS Welded Bridge Code supplemented by IS 813 and IS 1980.
 - (b) Heat control techniques required to ensure that the flame cut surface of steel are suitable for inclusion in welds.
- (ii) The trials shall include specimen weld details from the actual construction which shall be welded in a manner simulating the most unfavourable instances of fit-up and preparation. After welding the specimens shall be held as long as possible at room temperature but in any case not less than 72 hours, and then shall be sectioned and examined for cracking. Six representative samples of each weld joint similar to joint used in fabrication of all components shall be prepared by qualified and certified welding operators.

- (v) Procedure trials: Testing shall be to relevant IS code or if approved to BS 709. The following groups of tests shall be carried out with the type of welds.

(a) Butt welds: Transverse tensile test, transverse & longitudinal bend test with the root of weld in tension and compression respectively, charpy V-notch impact test.

(b) Fillet welds: Fillet weld fracture test.

(c) Track welds: Inspection for cracking.

(d) All welds: Macro examination.

Additional tests may also be carried out as per requirement and instruction of Engineer, the cost of which shall be borne by the contractor.

Shop welded joints will be radio graphically examined for 100 %.

Following tests are normally performed on welds.

(a) Non Destructive Tests (NDT):

- Visual inspection/profile gauge for dimensional check of size and throat thickness of weld.
- Etching test for penetration of joint.
- Magnetic particle or Ultra Sonic Pulse Velocity (USPV)
- Gamma Radiography & x-ray (only for butt welds)
- Dye penetration of all welds joints.

(b) Destructive Test :

- Tensile test
- Bend test
- Impact test
- Load test.

Once samples representing the weld joint used in fabrication of all components are tested and test results are found satisfactory, then approval shall be taken from the Engineer for the welding of built up components by approved welding operators. Welding Procedure Qualification Records (WPQR'S) shall include joint details, welding consumables (i.e. electrode/wire & flux combination), weld parameters (i.e. welding current, wire feed speed), welding position, welding equipment carriage speed (for SAW process), arc Length, arc voltage etc.

2.5.32 Preparation of Faces

Preparation of joint face: Except for special types of edge preparation such as single or double 'U' & 'J' joints, the fusion edges of all plates which are to be joined by welding shall be prepared by using mechanically controlled automatic flame cutting equipment with the cutting allowance.

It shall be ensured by Non-destructive tests that the fusion face and adjacent surface are free from cracks, notches or other irregularities that are likely to cause defects during service or interfere with deposition of the weld.

Fusion faces and the surrounding surface up to 50 mm shall be free from mill scale, moisture, oil, paint dirt or any other substance which may affect the quality of the weld, and same shall be removed by grinding or flame cleaning/grit blasting.

Details of joint, fusion faces, root face and gap shall be as per details given in fabrication drawing or as stipulated in IS:9595.

2.5.33 Welding Operation

Parts to be welded shall be assembled such that the joints to be welded are accessible and visible to the operator. Assembly jig and fixture shall be used for accuracy.

Manipulators should preferably be used to execute the sequence of welding without disturbance, in the most suitable position. Fixture shall maintain the alignment with minimum restraint in order to reduce the possibility of locked up stresses.

Run in and run out plate shall be provided for fabrication of built up members or truss to ensure that weld will start on run in plate and weld will stop on run out plate and thus avoid crater defects on the components.

The size and length of weld shall not be less than those specified in the drawing nor shall they be in excess of the requirement without prior approval of the Inspecting Officer. The location of weld shall not be changed without prior approval of the Engineer.

During design and detailing of component lengths, care is to be taken to avoid butt weld in built up members of truss. Therefore it is essential to use only nearest size and length or rolled sections that have been procured to scheduled sizes and lengths by proper planning. No butt weld shall be carried out without approval of Engineer.

Fabrication of components subject to dynamic loading in the structure need careful inspection during fabrication by qualified, experienced and certified Engineer from contractor's side and final approval by Inspecting Officer. This inspection shall be carried out as stipulated in Indian Railway Welded Bridge Code before, during and after welding.

2.5.34 Precautions during welding

The Contractor shall submit list of weld joints of different combined thickness for approval of welding procedure for all members.

The welding of built up component shall be carried out only by approved welding operators and in accordance with Welding Procedure Qualification Records. WPQR's shall be prepared in advance and approved by the Engineer. Proper welding sequence shall be followed to avoid distortion and minimize residual shrinkage stress, and surface defects, within acceptable tolerance limits.

To ensure sound and defect free welding of built up members, record of welding adopted as per approved qualifying procedure shall be maintained in Performa prescribed in guidelines for welded fabrication issued by TPIA (Third Party Inspecting Agency) specifically approved in prior by V.P. (GUDC)OR authorised representative of V.P. (GUDC).

Any change during welding for fabrication of built up member, such as welding sequence, welding process, positioning, wire and flux combination joint details, increase or decrease in combined thickness of joint by 5 mm etc. shall be carried out only after representative samples test and procedure qualification, is accepted. **In no case deviation from WPQR's without approval of Engineer shall be adopted.**

2.5.35 Additional Precautions during Welding

Following precautions shall further be observed during fabrication.

- (i) All equipment's shall be provided with calibrated gauges to observe limits of variation for parameters prescribed in WPQR'S for welding current, arc voltage, speed of travel of equipment etc.
- (ii) Covered shed for environmental control (particularly against dust, moisture and water) shall be provided to avoid entrapment of hydrogen which is likely to cause crack initiation in weld or under bed of weld (i.e. Heat Affected Zone HAZ). Also baking of flux use for submerged arc welding in oven for an hour at 200 degree C shall be carried out o ensure that no moisture is contained in flux during welding.
- (iii) All tack welds shall be carried out by qualified and approved welder only. As tack weld will become part of the final weld, it shall be free from all cracks and other welding defects.
- (iv) If multiple runs are used for fabrication of built up member, inter run cleaning shall be carried out and subsequent weld bed made only after approval of inspecting officer or his authorized representative. This is to check free defects in the weld. Also visible defects such as cracks, cavities, if any, shall be removed by grinding. It shall be ensure during welding that craters are avoided.
- (v) Stray arcing of components, which cause local hard spots or cracking of parent metal, shall be avoided.
- (vi) Flux of approved quality will be permitted for use.
- (vii)The Auto melt grade wire spools of wires for Submerged Arc Welding and Carbon Dioxide (CO₂) consumables of only the approved quality will be permitted.
- (viii) Pre Heat Treatment will be given to the consumables to remove the moisture if any.
- (ix) No violation of welding procedure will be permitted on any account.

2.5.36 Technical Organisation/tools, equipments and plants

- (A) Contractor should have qualified and trained manpower suitable to do the work in terms of technical specifications and contract conditions.
- (B) Contractor should have suitable and adequate plants, machinery and equipment's required to execute the work like:
 - (i) Cutting machine
 - (ii) Radial drilling machine.
 - (iii) Edge milling machine, end milling machines.
 - (iv) Plate/structural steel straightening machine.
 - (v) Pneumatic grinding machine, drilling machines, chipping machines and wrenches etc.
 - (vi) Sand blasting equipment and metalizing equipment's.
 - (vii) Welding machines.
 - (a). SAW
 - (b). MIG/MAG
 - (viii) Welding transformers³⁺
 - (ix) Cranes of adequate capacity.
 - (x) Suitable Jigs and fixtures.
 - (xi) To test the raw material and girders to conform to relevant specification, testing facilities, for the following should be available either in house or through outsourcing.
 - (a). Elcometer for measurement of thickness of paints.
 - (b). Steel measuring taps duly calibrated.
 - (c). Ultrasonic flow detection testing facilities for checking internal flaws.
 - (xii) Suitable Welding manipulator.
 - (xiii) Macro etching/DP or MP testing facilities.
 - (xiv) Tongue tester for measuring current and voltage.
 - (xv) Gauges for checking weld size throat thickness and edge preparation etc..
 - (xvi) All equipment's must meet the requirements of corresponding IS, IRS or other international specifications.

(C) **Manpower:** Adequate No. of trained qualified welders shall be available with the contractor. The welder must be trained in accordance with the provision of IS: 817. They must be trained either from recognized welding institutes or by in house training, where proper training facilities exist. The welder must be tested as per requirements of IS: 7310 and proper records maintained.

List of equipment's mentioned above is only indicated and not exhaustive. The firm shall be required to deploy all other machineries, tools & plants etc. required for successful completion of the work of fabrication, assembly and launching of the girders.

2.5.37 General: Bolting & Welding

Qualified trained, and experienced supervision is essential at all times during fabrication, and for maintenance of records.

After welding of welded components, they shall be finished finally by grinding or matching with the help of a profile template. All the butting ends of components shall be faced in milling machine after members have been completely fabricated. In the case of compression members, the face shall be machined so that the faces are of proper angle as shown in drawing and the joint when made will be in close contact throughout within a gap tolerance of less than 0.15 mm. The Engineer may permit a tolerance of (-) 0.4 mm at isolated points in butting line.

2.5.38 PAINTING

Specification for metalizing and painting will be done as per Clause no 39.2.1 of Indian Railway Specification for Fabrication and Erection of Steel Girder Bridges and Locomotive Turn-Tables (Serial No B1-2001).

2.5.38.1 Surface Preparation

This is the most important factor in ensuring good performance of the steel girder. The surface should be clean, dry and free from contaminants and it should be rough enough to ensure adhesion of the paint film. However it should not be so rough that the film cannot cover the surface peaks.

The cleaning of the surface shall be done initially with the use of emery paper, wire brushes, scrapers etc. for spot cleaning to remove rust, scale etc. Subsequently, sand blasting of the surface shall be done to remove rust, mill scale along with some of the base metal. This will be achieved by high velocity impact of abrasive material against the surface in accordance with the provisions of IS: 6586, which will also create a base for good adhesion. The abrasive material once used for cleaning heavily contaminated surface should not be reused even though re-screened. Washed salt free angular silica sand of mesh size 12 to 30 with a minimum of 40% retained on a 20 mesh screen shall be used for blasting. The material specifications and other requirements shall be as provided in Indian Railways Bridge Manual, 1998.

All site bolts, nuts and washers shall be thoroughly cleaned and dipped in boiled linseed oil. All machined surfaces are to be well coated with a mixture of white lead conforming to IS: 34 and Mutton tallow conforming to IS: 887 as per specifications before despatch to site. Nothing extra shall be payable to contractor on this account.

All the components in the floor and deck system in open web girders and all members in plate & composite girders shall be metalized as IRS specifications.

2.5.38.2 Metal Spraying

The metal spraying shall be carried out as soon as possible after surface preparation but in any case within such period that the surface is still completely clean, dry and without visible oxidation. If deterioration in the surface to be coated is observed by comparison with a freshly prepared metal surface of similar quality which has undergone the same preparation, the preparation treatment should be repeated on the surface to be coated

The wire method shall be used for the purpose of metallising the diameter of the wire being 3mm or 5mm. Specified thickness of coating shall be applied in multiple layers and in no case less than 2 passes of the metal spraying unit shall be made over every part of the surface. At least one layer of the coating must be applied within 4 hours of blasting and the surface must be completely coated to the specified thickness within 8 hours of blasting.

2.5.38.2.1 Purity of Aluminium

The chemical composition of aluminium to be sprayed shall be 99.5% aluminium conforming to IS: 2590.

2.5.38.2.2 Appearance of the Coating

The surface of the sprayed coating shall be of uniform texture and free from lumps, coarse areas and loosely adherent particles.

2.5.38.2.3 Thickness of the Coating

The nominal thickness of the coating shall be 150 μ (microns). The minimum local thickness, determined in accordance with procedure given in clause 2.5.38.3 below, shall be not less than 110 μ (microns).

2.5.38.3 Shop Painting

Any oil, grease or other contamination should be removed by thorough washing with a suitable thinner until no visible traces exist and the surfaces should be allowed to dry thoroughly before application of paint. The coatings may be applied by brush or spray. If sprayed, pressure type spray guns must be used. One coat of wash primer to IS:5666 shall be applied first. After 4 to 6 hours of the application of the wash primer, one coat of Zinc chrome primer to IS:104 with the additional proviso that zinc chrome to be used in the manufacture of primer shall conform to type 2 of IS:51 shall be applied. After hard drying of zinc chrome primer, one coat of Aluminium paint to IS:2339 (brushing or spraying as required) shall be applied.

2.5.38.4 Site Painting

After the steel work is erected at site a second cover coat of Aluminium paint to IS: 2339 (brushing or spraying as required) shall be applied after touching up the primer and the cover coat given in the shop if damaged in transit

2.5.38.5 Method for the Determination of Local Thickness

2.5.38.5.1 Equipment

Any magnetic or electro-magnetic thickness meter that will measure local thickness of a known standard with an accuracy of ± 10 percent.

2.5.38.5.2 Calibration of Instrument

Calibrate and check the meter on one of the following standards (as appropriate):

- (i) (Applicable to magnetic and electro-magnetic meters other than the pull-off type) A soft brass shim, free from burrs, in contact with the grit-blasted surface of the base metal prior to its being sprayed. The thickness of the shim shall be measured by micro meter and shall be approximately the same as the thickness of the coating.
- (ii) A sprayed metal coating of uniform known thickness approximately the same as the thickness of the sprayed coating to be tested, applied to a base of similar composition and thickness to the article being sprayed, grit-blasted in accordance with Clause 2.5.38.1.

2.5.38.5.3 Procedure

For each measurement of local thickness, make an appropriate number of determinations, according to the type of instrument used.

With instrument measuring the average thickness over an area of not less than 0.645 sq cm, the local thickness shall be the result of the one reading.

With instruments having one or more pointed or rounded probes, the local thickness shall be the mean of three readings within a circle of 0.645 cm² area.

With meters having two such probes, each reading shall be the average of two determinations with the probes reversed position.

2.5.38.6 Method of Test For Adhesion

Using a straight edge and hardened steel scribe which has been ground to a sharp 30 degree point, scribe two parallel lines at a distance apart equal to approximately 10 times the average coating thickness. In scribing the two lines, apply enough pressure on each occasion to cut through the coating to the base metal in a single stroke.

2.5.38.7 Inspection

2.5.38.7.1 Determination of Local Thickness

The minimum local thickness shall be determined by the method described above.

2.5.38.7.2 Adhesion

The sprayed metal coating shall be subjected to an adhesion test using the method described above. If any part of the coating between the lines breaks away from the base metal, it shall be deemed to have failed the test. Articles, which have been rejected shall have the defective sections blasted clean of all sprayed metal prior to re-spraying. Where the rejection has been solely due to too thin a coating, sprayed metal of the same quality may be added provided that the surface has been kept dry and is free from visible contamination.

2.5.39 Paints: Source & Quality

Paint and other accessories including those for metallizing work will be supplied by the contractor. Paints manufactured by the following firms (or more) may be used subject to their being in the approved list of RDSO and final approval by the Engineer.

M/s. Jenson Nicholson. Paints

M/s. British / Barger paints.

M/s. Shalimar Paints

M/s. I.C.I. paints

M/s. Nerolac. Paints

The contractor shall furnish to the Engineer, the date of manufacture of paint as certified by the manufacturers with the necessary container marking and test certificate for paint conforming to relevant IS code. In addition to this, he shall also submit the necessary vouchers in respect of paint purchased by him.

The Engineer reserves the right to get the paint tested at contractor's expenses as considered necessary by the Engineer. If the test results do not conform to relevant IS specifications fully, then the lot of paint shall be rejected and got removed from the contractor(s) storage. If the paint has already been applied it shall be removed.

In addition to above, the following tests are required to be carried out in the field.

- Weight per litre
- Consistency test
- Scratch test.
- Flexibility and adhesive test.

The Engineer reserves the right to reject the lot of paint even on the basis of field results.

2.5.40 Painting - General Instructions

Painting shall not be commenced till the surface preparation has been approved by the Engineer or his representative.

Sealed containers of paint of approved brand shall be used. The paint drums must be rolled, turned upside down and shaken before opening. The paint must be stirred well before use. Over stirring which results in invisible air bubbles etc, shall be avoided.

Where brush painting is accepted, the paint must be applied by means of flat brushes not more than 75 mm in width having soft flexible bristles conforming to IS: 384.

Round and oval brushes of approved quality conforming IS: 487 may also be used as per the instructions of the Engineer or his representative or inspecting officer.

All new brushes should be soaked in raw linseed oil conforming to IS: 77 for at least 24 hours before use.

The date of painting shall be marked with paint on the member.

2.5.41 Care during Painting

Paint should be mixed in small quantities sufficient to be consumed within one hour in the case of red lead paint.

The applied coat of paint shall be uniform, and free from brush marks, sack marks, blemishes, scratching, non-uniform thickness, holes, log marks, fuel staining, cracking, scaling, and other defects.

Paint shall be applied only on dry and clean surface free from moisture or dust (including scrapping dust).

Paint should be used within the prescribed life from the date of manufacture.

- 2.5.41.1** Each coat of paint shall be left dry till it sufficiently hardens before the subsequent coat is applied. Each coat of paint shall be inspected by the Engineer and certified as satisfactory before applying subsequent coat.

2.5.42 ASSEMBLY & ERECTION

2.5.42.1 General

The contractor shall provide at his own cost all tools, machinery, equipment and erection material, including all temporary works and shall assemble all components in every respect as stipulated in the contract and in accordance with approved drawings and specifications.

Before starting the work the contractor shall seek the Engineer's approval as to the method he proposes to follow and the type and suitability of equipment he proposes to use for assembly of girder components and launching of girder. The approval of the Engineer shall however not in any way relieve the contractor of the responsibility for the adequacy and safety of methods and/or equipments he proposes to use for carrying out work in full accordance with drawings and specifications.

All temporary work shall be properly designed and substantially constructed for the loads, which it will be called upon to support. Adequate allowance and provision of a lateral forces and wind loads shall be made according to local conditions and ensure that support shall not settle during erection.

When chains are used for lashing care must be taken to protect the edges of members from twisting and distortion, damage to paint and similar effects.

Temporary bracing shall be provided to take care of stresses caused by erection equipment or other incidental loads during erection.

The method use for lifting and slinging flexible members shall be brought to the notice of the Engineer and shall be subject to his approval.

The contractor shall observe sufficient accuracy in the assembly of every part of the work to ensure that all parts fit accurately together.

2.5.42.2 Procedure for Assembly in Workshop & Site

The contractor is required to undertake test assembly of the girders in his fabrication workshop to prove accuracy of templates and Jigs. This assembly can be done in horizontal position. In case the fabrication workshop is set up by the contractor at bridge site itself the test assembly may be done at assembly platform and after testing of accuracy of jigs, fixtures & templates and the same assembly can be launched after bolting.

The test assembly shall be certified by Inspecting agency of the Engineer.

Launching of girders: once sufficient number of girders are assembled and the sub structure has been certified to be ready, launching of girders shall be taken up. The scheme for launching shall be submitted by contractor and approved beforehand by / Railway / or Agency approved by V.P. (GUDC) and any statutory clearances such as CRS sanction must be obtained. The decision of V.P. (GUDC) shall be final and binding to the contractor. Launching can be done by any of the various methods such as using single crane, using multiple cranes, end launching or using derricks. The payment of same shall be borne by Contractor.

2.5.43 Care during Assembly at Workshop

2.5.43.1 Drilling & Drifting of Holes

Drilling of joints shall be avoided as far as possible and when necessary should be done with great care and under expert supervision. Hammers not exceeding 1kg (2 lb) in weight may be used with turned barrel drifts and a number of holes drifted simultaneously, the effect of drifting shall be checked by observation of adjacent unfilled hole.

Any apparent error in shop work which prevents the assembling and fitting of the mating parts by the proper use of drifts shall be investigated immediately.

As all work is rigidly inspected at the fabrication shop before dispatch, these difficulties should not arise and the cause could possibly be due to the use of incorrect components. It is usually important that parts be correctly handed. Should errors still persist, the matter shall be immediately reported to the Engineer who will decide what action is to be taken.

2.5.43.2 Inspection, Testing & Marking

All components shall be offered for inspection prior to painting. All approved components shall be stamped defect free, painted as per specifications prior to dispatch to bridge site.

On final finishing of each component, it shall be marked distinctly with paint with shipping mark for guidance, during assembly of component.

2.5.43.3 Stud shear connectors shall be subjected to the following tests:

The appearance test and test to check the fixing of shear studs shall be as per approved/RDSO drawings.

2.5.44 Transports from Workshop & Stacking at Site

All items fabricated in the workshop shall be marked and packaged with accompanying package list. The items after fabrication shall be transported by contractor to site by Rail/Road in a manner as to cause no damage to the components. Contractor shall be liable for all losses and damages in transit for the materials consigned by him till materials are erected and work completed and taken over by the Engineer. Insurance against loss or damage in transit, if any, shall be the responsibility of the contractor.

After identification & correct marking, all components of each girder shall be dismantled & similar components shall be grouped together & labelled; bolts and plates of each size shall be packed separately, after approval by the Engineer.

The packages shall be of such size by length & weight that they are safely transportable by Rail/Road. The components shall be provided with necessary packing to avoid damage to painting & members in transit.

Dimensions for transport shall be as per standard schedules.

2.5.45 Assembly at site

2.5.45.1 Holes

After drilling holes in temporary tack assembled components, the components shall be taken apart after match marking and all burrs left by drill and sharp edges of all holes shall be removed by spot grinding to ensure full contact when assembled.

Assembly fixture shall be used to build components for turned bolt connection. These connections will help realize correct position of member and matching of coaxial holes in opposite members besides true alignment and level.

After assembly, all blank holes shall be checked with plug gauge of diameter 0.8mm less than hole diameter, to check fair matching of holes before riveting / bolting.

2.5.45.2 Drifts

Drifts as per IRS specifications may be used for drawing light members into position, but their use on heavy members should be restricted to securing them in their correct position. In no case shall drifting be allowed to such an extent that holes are distorted. Drifting to enlarge unfaired holes is prohibited.

2.5.45.3 Making of joints

Cleaning of permanent contact surfaces:- Surfaces which will have permanent contact shall be removed of paints and mill scale down to bare metal, clean and dried and immediately a coating of zinc chrome red oxide priming to IS:2074 shall be applied. Care shall be taken to see that all burrs are removed and no surface defects exist before the parts are assembled.

2.5.45.3.1 Reaming

No reaming shall be undertaken without the written authority of Engineer or his authorized representative except for under drilled holes meant for turned bolts. The contractor shall supply special bolts to fill reamed hole, where reaming is approved. Record of all such variations shall be kept. However, these provisions should not apply for under drilled holes meant for turned bolts. Copies of all correspondence pertaining to the recourse of reaming and the use of oversize bolts shall be sent by the contractor for information to Engineer.

2.5.45.3.2 Service Bolts & Drifts

Joints shall normally be made by filling not less than 50% of the holes with service bolts and barrel drifts in the ratio of four to one. The service bolts are to be fully tightened up as soon as the joint is assembled.

2.5.45.3.3 In cases where the joints have to withstand stresses arising from special methods of erection, provision is to be made to take the whole stress that will or may occur. Cylindrical drifts and turned bolts shall be used to withstand such stresses and no reliance is to be placed on service bolts for this purpose. Up to a maximum of 40 percent of the holes of each member of the joint are to be filled with drifts and balance of strength required is to be attained with turned bolts. The position and number of the drifts and bolts will be decided by Engineer.

2.5.45.4 Painting of Joints

All surfaces, which are in permanent contact, shall be thoroughly cleaned down to the bare metal, to remove mill scale, grease etc. They shall be painted immediately before assembly with one coat of suitable primer and raw linseed oil freshly ground and the surface prepared for painting as per painting specification at Clause 2.5.38.

2.5.46 Assembly and Launching

The launching of girders shall be done as per approved drawings. For this purpose, the contractor shall submit in triplicate, detailed launching schemes of all the girders including design calculations, safety procedures and method statement with such plans, sketches and other details as may be necessary to determine the suitability and adequacy of the schemes proposed. The scheme will be checked by V.P. (GUDC)/Railway/or Agency nominated by the V.P. (GUDC). The Payment for the launching scheme of girders shall be born by contractor. The agency shall provide/arrange all works and full support to obtain CRS sanction. Contractor will be responsible to co-ordinate with Divisional Railway/WR HQ officials to gate CRS sanction. The methods adopted shall not, under any circumstances, cause the stresses in various members of girder s.s to exceed permissible and safe limits at any

stage of launching. One copy duly approved by the Engineer shall be returned to the contractor.

For the Engineer's use and record, the contractor shall supply free of charge, four sets of prints of approved detailed drawings of assembly and launching schemes on strong paper with back of linen for use at site and one set of neatly executed tracings.

The launching system & procedure shown on enclosed drawings are purely indicative of the method proposed for launching for which the permanent members of the girders are designed. The contractor shall provide full structural details of the temporary members and their connections to the girder, along with necessary design calculations not only justifying member's sizes but also for the entire launching system adopted. Contractor will be responsible for getting approval of launching scheme submitted by him from the Engineer.

In order to ensure perfect fit of the temporary components, holes may be carefully drilled for the connecting members in between the girders in situ and T & F High tension grip bolts used.

The launching system shall be test tried if directed by the Engineer and no separate payment for this shall be made.

Nothing extra will be paid to the contractor for adopting any scheme for launching. All temporary members shall be removed after launching and may be taken back by the contractor. Erection gussets provided for connecting the members may be cut and edges ground as required by the Engineer.

2.5.47 Field Bolts, Nuts and Service Accessories

2.5.47.1 The work is to include supply of all units, bolts, nuts, washers etc. required to complete erection at site with an allowance for wastage etc. 12.5% of the net number of field bolts and washers required subject to a minimum number of five in each item.

2.5.47.2 The Contractor shall be responsible for supplying site rivets/bolts of approved length. The length of such bolts shall be verified by snapping a few bolts of each length in the presence of the Engineer.

2.5.47.3 Black hexagonal bolts (Service bolts) with nuts and ordinary platter's washers and drifts for use in the erection of the work shall also be supplied at 60% (45% bolts and 15% drifts) of the number of field bolts per s. in each size (this includes wastage).

2.5.48 Temporary Strengthening

The launching arrangement may include fabrication of launching nose or restraining girders, sway restraining devices such as sway ropes, restraining cables etc. the supply and fixing of members for temporary strengthening of girder members to take care of erection stresses and strains and other relevant components for

satisfactory and successful completion of the defined scope of work. Erection stresses must be kept within safe and permissible limits at every stage of erection.

The contractor has to make arrangements at his own cost for the steel for temporary arrangements including sway restraining devices for launching and temporary strengthening of girder, as may be required for the launching operations. The rate quoted should take into account these factors as nothing extra shall be paid.

2.5.49 Inspection and Rectification

During erection of girders, the contractor shall provide all facilities and permit the Engineer to inspect the field assembly, site bolting and erection of s.s.

After inspection by the Engineer, the contractor shall identify cause of any defect, imperfection and/or fault noticed during such inspection and initiate corrective action as per the direction of the Engineer. All defects, imperfections or faults for which the contractor is liable under the contract, shall be made good by the contractor to Engineer's satisfaction and the cost of identifying and rectifying such defects, imperfection or faults shall be borne by the contractor.

A neat casting bearing the name of the contractor, the place and date of manufacture, the contact number and the standard of loading to be specified by the Engineer shall be bolted conspicuously on all girders. The drawing of the name plate shall be approved by the Engineer.

2.5.50 Erection & Equipment:

- 2.5.50.1 The Contractor shall provide at his/her own cost all tools, machinery, equipment and erection material necessary for the expeditious execution of the work and shall erect the structural steel and iron work, in every respect as covered by the contract and in accordance with the drawings and specifications.
- 2.5.50.2 If any labour, material, plant staging haulage and storage facilities are to be provided by the Engineer, details of such items and the conditions under which these are to be supplied shall be clearly specified in the contract agreements. In the absence of any such provisions in the agreement, the Contractor shall make his/her own arrangement for such items.
- 2.5.50.3 Before starting the work, the Contractor shall advise the Engineer fully as to the method he/she proposes to follow and the amount and character of equipment he/she proposes to use, which shall be subjected to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his/her method or equipment or from carrying the work in full accordance with the drawings and specifications.
- 2.5.50.4 All temporary work shall be properly designed and substantially constructed for the loads, which it will be called upon to support. Adequate allowance and provision of a lateral forces and wind loads shall be made according to local conditions and ensure that support shall not settle during erection.

- 2.5.50.5 Careful and periodical inspection of plants shall be made by the Contractor to ensure that all tackle, ropes, chains and other important lifting gear and machinery are in good order and fit for service and well up to the capacity for which they are required.
- 2.5.50.6 When chains are used for lashing, care must be taken to protect the edges of members to avoid the marking and distortion otherwise caused.
- 2.5.50.7 S. erected upon staging shall be supported upon suitable blocks, which shall ensure that the girders shall be at the correct elevation and alignment when completed. If other methods of erection be adopted where staging in situ is not employed, special means shall be used to ensure this.
- 2.5.50.8 The method used for lifting and slinging flexible members shall be brought to the notice of the Engineer and shall be subject to his/her approval.
- 2.5.50.9 Temporary bracing shall be provided to take care of stresses from erection equipment or other loads carried during erection.

2.5.51 ADDITIONAL SPECIAL CONDITIONS:

2.5.51.1 Land:

V.P. (GUDC) will at its discretion, and, if available, arrange land free for use for contractor's office at sites, field workshop, stores, assembly and erection yard. Land required by the contractor for labour or staff colony or other purpose will have to be arranged by him at his own cost.

2.5.52.2 Further Drawing and Instructions:

- (i) V.P. (GUDC) shall have full power to make and issue further drawings or instructions or direction from time to time as may appear necessary and proper to the contractor for efficient construction, completion and maintenance of the works . The contractor shall be bound by the same as fully as be if they had been mentioned or referred to in the contract, and the contractor shall not be entitled to any extra payment in respect of any work or materials shown or directed to be done supplied by such further drawings or instructions required for completion of unless the V.P. (GUDC) have given an extra order for the same in writing.
- (ii) The tenderer's rate should provide for cutting M. S. Plates for making out M. S. Flats from plates, in case M. S. Flats are not available, No extra payment for such cutting and grinding that may be necessary for converting M. S. Plates to Flats will be admissible.
- (iii) If the works are required to be done in Railway Yards and Tracks are to be crossed, the tenderer shall inspect the site and make himself thoroughly acquainted with site condition and quote rate considering these aspects.
- (iv) The work shall have to be done in such a manner that the normal working of the Railway within the railway yard does not get disturbed. No material/temporary structures should be kept adjacent to the running track which may infringe rail

traffic. The contractor shall take necessary precaution to prevent/cause damage to the Railway property & staff during the execution of the work.

2.5.52.3 Commencement of the Erection Work at site:

The contractor shall commence the erection work when and as soon as, but not until, he receives instructions from Engineer to do so. On such order being given, possession of site/authority shall be given to the contractor of such portion or portions of the site as the Engineer may determine.

2.5.52.4 Contractor to Study Drawing & Specification etc. and His Liability:

The contractor shall be responsible for close scrutiny of the approved drawings supplied by the V.P. (GUDC), For any discrepancies, error or omission in the drawings or other particulars indicated therein, the contractor shall approach the V.P. (GUDC) immediately for rectification of indicated therein, the contractor shall approach the V.P. (GUDC) immediately for rectification of such discrepancies, errors and omission. If any dimension/figure/features etc. on approved drawings or plans differ from those drawings or plans issued to the contractors at the time of calling the tender, the dimensions as figured upon the approved drawings or plans shall be taken as correct.

2.5.52.5 Contractor to Submit His Time Table:

The contractor shall submit a monthly progress of work done during the month by the 4th day of the following month. He will also give the programme of coming month by 25th of each month. The programme will be subject to alteration at the discretion of the V.P. (GUDC) officials.

2.5.52.6 Any Doubtful Points to be referred to the V.P. (GUDC):

Should there be any doubt or obscurity as to anything to be done or not to be done by the contractor or as to these instructions or as to any matter or thing, the contractor must set forth such doubt or obscurity in writing and submit the same to , V.P. (GUDC). Only such reply as the said V.P. (GUDC) may be in writing given shall be taken as the authoritative interpretation of the point in doubt or obscurity.

2.5.52.7 Contractor's Liability:

Any fitting, accessory or apparatus which may not have been mentioned in this specification or the drawings, but which are usual or necessary in the execution of such work, are to be provided by the Contractor without extra payment. The whole work must be completed in all details, whether mentioned in this specification or not, with the exception of such work as has been specified in the schedule of items to be separately provided for in the Contract.

Notwithstanding the specifications and conditions stated in the contract, the contractor shall keep the Engineer/ Employer authority fully indemnified and free from all liabilities and risks consequential to any lapse on his part in respect of material quality, standard of workmanship, accuracy of fabrication and the like. He

shall provide all labour and material required for execution of the work as per all standards and specifications.

2.5.52.8 V.P. (GUDC) desires that successful contractor should establish (at his own cost) the fabrication workshop near the site only for close monitoring of all the quality aspects of this contract work. Contractor's request for establishing workshop/using workshop proposed/located away from the bridge site shall require prior approval.

2.5.52.9 Contractor shall establish fully equipped laboratory for all the tests required on materials/processes/products as per provisions of the contract, Specifications and the direction/approval of the Engineer. Costs of these are deemed to be included in the quoted rates. Prior approval of the engineer shall be obtained for non installation of such testing equipment which can not be installed in normal course due to any reason. However, engineer's decision (for installation and non-installation) in this regard shall be final binding and conclusive.

2.5.52.10 Site Facilities by the Contractor:

Contractor shall provide office / site facilities at the bridge site / other locations for ensuring smooth and efficient communication and work execution. Cost of these facilities deemed to be included in the quoted rates and nothing extra shall be paid for this item.

- (i) Contractor shall supply round the clock electricity in site offices of V.P. (GUDC) located at the bridge during the entire contract work. Contractor shall also maintain the electric fittings/wirings/plants of both the offices in the good condition.
- (ii) To provide proper communication the contractor shall (at his own cost) establish inter office communication system between V.P. (GUDC) office, fabrication workshops and contractor's offices at site. Adequate number of intercom / telephone/ mobile sets or are similar suitable equipments as decided/approved by Engineer fully communicable shall be established in each of the above fabrication shops & at site of bridge work. The entire expenditure incidental to running and maintenance of above shall be borne by the contractor within quoted rates.
- (iii) Contractor shall (at his own cost) depute / nominate safety officers(s) for supervising safety aspects of all works/process including enabling arrangements for execution and inspection of the work. Safety systems/arrangements should be made for each activity of fabrication/erection and its inspection and same should be certified by nominated safety officer. Special care/arrangements are required to be made for supervising the erection/launching process of such high girders and concreting in road deck; arrangements should facilitate satisfactory and fearless inspection of each activity of launching / erection.

2.5.52.11 Declaration of designed fabrication/assembly yard as a part of site:

V.P. (GUDC) may issue necessary declaration on specific request of the contractor subject in the condition that the workshop area are earmarked exclusively for fabrication of girder components for this bridge with separate entry/exit arrangements. This is with further stipulation that such an arrangement should be acceptable to excise department by way of a no objection certificate. Necessary

follow up with Excise Department will be solely the contractor's responsibility. In the event of excise department not agreeing to such an arrangement, the contractor shall not have any claims whatsoever, and shall pay excise tax and other extant taxes as per extant rules within quoted rates and nothing extra would be payable to them on this account.

2.5.53 METHOD OF MEASUREMENT FOR PAYMENT

2.5.53.1 Measurement

For the purpose of payment, quoted rates apply to the weights of structural steel work calculated from final working drawings based on theoretical weights given in the producer's hand books / IRUSS (W &M),2010-Volume-I and using minimum square overall dimensions, no deductions being made for skew cuts, holes or notches. Each gusset shall be measured as equivalent to the dimension of the smallest enclosing rectangle. The rates items quoted by the tenderer shall include all wastage. **The wastage of steel in the form of skew cuts etc. shall be the property of the contractor.**

Payment shall be made on the weight to be calculated in the accordance with the nominal weight of the sections as specified on the drawings. No deduction for holes and no addition for rivets/bolts/welds etc. shall be made.

The drawing office dispatch lists (D.O.D.Ls) when prepared according to procedure shall be submitted by the contractor to the Engineer for approval.

The payment for steel work as per item in the schedule of items shall be released in stages of accepted item rates for quantities executed, as mentioned in the tender schedule. The payment after receipt of material in fabrication shop shall be made on the basis of measurements contained in the supplier's vouchers, if required, these measurements shall be further verified by the representative of Engineer in charge by measuring dimensions/sizes of the sections and multiplying the same by standard weight. Sampling for actual weight of the sections shall also be done by him as per procedure and frequency prescribed by Engineer.

The payment for complete metallizing / painting of all components of girders including all accessories, painting of contact surface etc including all labour and material, tools and plants, machinery required for all operations of work is included in the accepted rates of item in the schedule. Nothing extra shall be paid.

In the event of a dispute arising as to a portion of steel work, weightment shall be made in the presence of the engineer.

No separate payment shall be made for the field bolts, nuts and service accessories for temporary works.

The cost of temporary erection and testing at the Contractor's workshop, marking, packing and delivery at the site of work is to be included in the price quoted on the tender.

Rate include fabrication of all the types of battens, bracings, ties, stiffeners, packing, diaphragms, shop bolts / welding, T&F bolts, drifts, shop welds, templates, jigs,

fixtures, back up supports, accessories, transporting various components from fabrication shop to site including loading, unloading, lift and taxes complete including assembly of girders .

Rate of girder item includes assembling of temporary support for side slewing, raising of girders to the bed block level, providing sliding arrangements and slewing the girder in position and lowering of girder on bearings.

Grouting of holes with epoxy based compounds in the bed block for fixing of HD bolts/anchor pins of bed plates as directed by Engineer are included in the bearing rates.

Rate of girder item includes the Assembling, bolting with contractor's own material, erection, launching, lowering, aligning and placing at exact position as per approved scheme of steel plate girder for required s. in proper level and alignment, grip bolts and with all necessary works like making holes.

The rate of girder item will inclusive of supplying /erection and dismantling of staging, scaffolding and other temporary arrangement required for assembling, erection, launching and lowering of the girder.

The rate shall be also inclusive of cold straightening of deformed bent girder parts before the assembling including contractor's all labour, materials T & P, testing etc. complete.

2.5.54 BEARING

POT cum PTFE bearings/Elastomeric bearings as per approved drawing shall be utilized under the girder as per approve GAD/ Design and its special conditions and specification.

2.5.55 DEFLECTION TEST:

The deflection test shall be carried out as per additional specifications. Load testing will be paid separately as per relevant item.