



**MANUAL OF
SPECIFICATIONS
AND
STANDARDS FOR
EPC CONTRACT 2014**

**MINISTRY OF RAILWAYS
(RAILWAY BOARD)
GOVERNMENT OF INDIA**

RAIL BHAVAN, RAISINA ROAD, NEW DELHI – 110001 (INDIA)

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1. General

- 1.1 This Manual is applicable for Planning, Design & Construction of Rail System (“the Project”) through EPC mode. The scope of the work shall be as defined in the Agreement. This Manual shall be read harmoniously with the intent of the Agreement.
- 1.2 The Project and the project facilities shall conform to the requirements of design and specifications set out in this Manual, which are the minimum prescribed. The project report and other information provided by the Authority shall be used by the Contractor only for its own reference and for carrying out further investigations. The Contractor shall be solely responsible for undertaking all the necessary surveys, investigations and detailed designs in accordance with good industry practice and due diligence, and shall have no claim against the Authority for any loss, damage, risk, costs, liabilities or obligations arising out of or in relation to the project report and other information provided by the Authority.
- 1.3 At least 2 weeks prior to commencement of the work, the Contractor shall draw up a Quality Assurance Manual (QAM) covering the Quality System (QS), Quality Assurance Plan (QAP) and documentation for all aspects of the Project works and send three copies each to the Authority’s Engineer for review. The QAM shall conform to Applicable Laws, Good Industry Practice in vogue and the provisions of the Agreement.
- 1.4 The codes, standards and specifications applicable for design of the components of the Rail System are listed in Clause 2.
- 1.5 The latest version of the codes, standards and specifications, which have been published before the last date of bid submission shall be considered applicable.
- 1.6 The terms ‘**Inspector**’ and ‘**Engineer**’ used in codes, standards or specifications shall be deemed to be substituted by the term “**Authority’s Engineer**”, to the extent it is consistent with the provisions of the Agreement and this Manual. The role of the Independent Engineer (IE) shall be defined in the Agreement.
- 1.7 In the absence of any specific provision on any particular issue in the aforesaid codes, standards or specifications read in conjunction with the Specifications and Standards contained in this Manual, the Contractor shall be at liberty to rely on any International Standard in consultation with Authority’s Engineer.

1.8 All items of building works shall conform to the standards specified in the National Building Code (NBC) and the relevant codes issued by BIS. For this purpose, building works shall be deemed to include station buildings, Depot and workshop, OCC, buildings comprising Project Facilities, traffic integration works, landscape elements and/or any other works incidental to the building works.

The Contractor shall develop fire-fighting system in consultation with Authority's Engineer complying with the local fire safety regulations and Good Industry Practice in vogue. Fire detection and suppression shall generally be as per NBC-2005.

1.10 The design of a rail system shall be fully integrated and compatible with all other sub-systems that constitute the Rail System so that the overall requirements of the Rail System are met. As far as possible, uniformity of design standards shall be maintained throughout the rail system.

1.11 Alternative Standards and Specifications

The requirements stated in the Manual are the minimum. The Contractor will, however, be free to adopt international practices, alternative specifications, materials and standards to bring in innovation in the design and construction provided they are better or comparable with the standards prescribed in the Manual. The specifications and techniques which are not included in the codes, standards or specifications shall be supported with authentic standards and specifications reflected in other internationally recognized codes, standards and specifications. Such a proposal shall be submitted by the Contractor to the Authority's Engineer. In case, the Authority's Engineer is of the opinion that the proposal submitted by the Contractor is not in conformity with any of the international codes, standards and specifications, then he will record his reasons and convey the same to the Contractor for compliance. A record shall be kept by the Authority's Engineer, of the non-compliance by the Contractor of the minimum Specifications and Standards specified in the Manual. Adverse consequences, if any arising from any such non-compliance, shall be treated as "**Contractor Default**" and shall be dealt in accordance with the provisions of the Agreement.

1.12 General considerations for planning, design and construction

The Contractor shall take measures to overcome the physical and operational constraints and plan, design and construct the Project

using appropriate methods, management techniques and technologies. General consideration shall, without being limited to, be as follows:

(a) The constraints

The physical constraints in the Project could be in the form of limitation of right of way, existing train services in the vicinity, inadequate approach roads and underpasses, at-grade yards & stations etc. The operation constraints arise out of the necessity or possibility of closing a portion of the road for construction and/or diverting the traffic to temporary diversions, thereby reducing the capacity and safety of the existing network. The solutions evolved by the Contractor shall be such that these constraints are overcome through appropriate planning, design and construction method, techniques and technologies and by adopting suitable traffic management measures.

(b) Safety of design

All designs shall be safe to ensure that the Project or any part thereof (for example embankment, pavement, retaining structures, bridges, tunnels, culverts, etc.) does not collapse (global stability) nor its serviceability/performance (for example settlement, roughness, undulations, deflections, etc) deteriorates below acceptable level as prescribed in relevant schedule of Agreement and as recognized by Good Industry Practice.

(c) Durability

The Project shall not only be safe but also durable. This would mean that the deteriorating effects of climate and environment (for example wetting and drying, freezing and thawing, if applicable, temperature differences, aggressive environment leading to corrosion, etc) in addition to the traffic shall be duly considered in design and construction to make the Project durable.

(d) Mitigating disruptive effects of construction

The planning, design and construction of the Project shall be such that the construction does not have adverse impact on the environment and does not disrupt the lives and business activities of the people living close to the Project.

1.13 General considerations for rail systems design

The rail systems including all the subsystems designed to be utilized by the Contractor shall be of proven technology and should have been in service in other similar systems for at least 03 years.

1.14 Safety during Construction

1.14.1 The Contractor shall develop, implement and administer a surveillance and safety program for providing a safe environment on or about the Project, and shall comply with the safety requirements set forth in the Agreement.

1.14.2 Before taking up any construction work, the Contractor shall prepare a Traffic Management Plan for each work zone and furnish it to the Authority's Engineer for comments duly incorporating the following:

- (i) Designate a Site Safety Team headed by a qualified Safety Officer.
- (ii) Traffic safety devices as per IRC:SP:55 with the following specifications:
 - a) Signages of retro-reflective sheet of high intensity grade.
 - b) Delineators in the form of cones/drums (300 to 500 mm dia and 1000 mm high) made of plastic/rubber having retro reflective red and white band, at a spacing of maximum 5 m along with a reflective tape (red and white band) to be tied in between the gaps of cones/drums. A bulb/flasher using solar energy is to be placed on the top of the cone/drum for night delineation.
 - c) Barricades using iron sheet (plain) with adequate iron railing/frame painted with retro-reflective paint in alternate black and white (or yellow and black) strips. Warning lights at 5.0 m spacing shall be mounted on the barricades and kept lit in the dark hours and night.
- (iii) Sprinkling of water for dust control at work zones, haul roads and plant/camp sites.
- (iv) Noise/Pollution suppression measures at work zones haul roads and plant/camp sites.
- (v) Mechanical, electrical and fire safety practices.
- (vi) Safety measures like PPE (Personal Protection Equipment) for workers engaged.
- (vii) First Aid and Emergency Response Arrangements i.e. First aid Box, Ambulance, paramedical staff, alarms, etc.
- (viii) Safety training/awareness programmes.

- (ix) Formats to maintain the accident records/emergency response provided during accidents.
- (x) A penalty scheme for violations in provision of adequate traffic control devices and proper traffic management should be proposed by the Contractor. In case of default, the amount of penalty shall be paid by the Contractor to the Authority.
- (xi) A compensation scheme including insurance cover for third party for works/road users and road side residents in case of death/injury/damage to the vehicle/property resulting from accidents on the Project, irrespective of the person at a fault should be proposed by the Contractor.

1.14.3 The Contractor shall also be responsible for ensuring compliance of all labour laws and regulations including those relating the welfare of workers engaged both directly and indirectly on the Project, besides their occupational safety and health.

1.15 The Contractor shall set up field laboratory for testing of materials and finished products as stipulated in QAM. It shall make necessary arrangements for additional/ conformity testing of any materials/products at the government accredited laboratory, for which facilities at site laboratory is not available.

1.16 Environment Mitigation Measures

The Contractor shall carry out tests/monitor various parameters impacting the environment of the Project keeping in view the guidelines of the Ministry of Environment and Forests and submit proposals for mitigation of adverse environment impact including provision of noise barriers, etc. for review and comments of the Authority's Engineer, if any and undertake implementation of the proposals in consultation with the Authority's Engineer.

The Contractor shall take measures as may be necessary in accordance with the Applicable Laws and Good Industry Practice in vogue to control and mitigate the noise and vibration arising from the Rail System and their impact on the users and the neighbourhood. Noise mitigation measures shall be employed to ensure that the prescribed noise limits within the neighbourhood buildings and rail vehicles are not exceeded.

1.17 Utilities

The details of the new utilities which are to be constructed or provided for along or across the Project shall be as specified in relevant schedule of the Agreement.

1.18 Review and comments by the Authority's Engineer

In cases where the Contractor is required to send any drawings or documents to the Authority's Engineer for review and comments, and in the event such comments are received by the Contractor, it shall duly consider such comments in accordance with the Agreement and Good Industry Practice in vogue for taking appropriate action thereon. The correspondence between the Contractor and the Authority's Engineer shall be deemed valid only if a copy thereof endorsed to and received by the Authority.

1.19 Definitions and Interpretation

Unless specified otherwise in this Manual, the definitions contained in the Model EPC Agreement for Railways as published by Ministry of Railways (Railway Board), Government of India shall apply.

2 Standards

2.1 Introduction

The Materials and workmanship specification given herein under is based on Indian Railway Rules, Standard Codes, Manuals and Specifications, Indian Standards and International Standards as scheduled below. Apart from the basic data, specifications etc. all items of works shall be governed by the Codes & Specifications as detailed hereunder and as revised / corrected / amended up to the due date of submission of the Bid Proposal.

The Contractor will be responsible for detailing in his specification of the standards on which his materials and workmanship will be based, and these will be of similar or higher standard than those listed below.

The Contractor is required to review in the first instance the relevant Standards and Codes as mentioned. The specifications will be primarily based on the said standards to the extent that they are applicable.

2.2 Relevant Standards

Subject to the provisions of the Agreement, all items of works shall be governed by the following Rules, Codes, Specifications as on the bid date. In case of any contradiction in various documents mentioned above, the order of precedence shall be as follows:

- a) Indian Railway Rules;
 - (i) Indian Railway General and Subsidiary Rules.

- (ii) Indian Railway Rules for Opening New Railway Lines.
- (iii) Indian Railway Standard Schedule of Dimensions for Broad Gauge.
- (iv) Other Railway Rules specified in 2.2.1.
- b) IRS Codal provisions.
- c) IRC Codal Provisions.
- d) IS Codal Provisions.
- e) Provisions in other International Codes.
- f) Indian Explosive Act.
- g) Indian Explosive Rules.

Note:- In case of road related structures, IRC Codal provisions will prevail over IRS Codal provisions.

2.2.1 Indian Railway Rules, Codes and Specifications

- (1) Indian Railway Rules.
- (2) Indian Railway – Engineering Code.
- (3) Indian Railway Code for Practice of Plain/Reinforced and Prestressed concrete for general / bridge construction (Concrete Bridge Code).
- (4) IRS : Welded Bridge Code for steel bridge girders.
- (5) IRS Standard Code of Practice for design of Sub-structure & Foundation.
- (6) IRS: T-12 2009 Rail Specifications.
- (7) IRS Specifications for Steel Bridges Code.
- (8) RDSO Specification No. GE: IRS-2 (Final): Specification for mechanically produced blanketing material for railway formation including guidelines for laying.
- (9) IR Standard Specification for Fusion of Welding of Rails by Alumino Thermit Welding Process 2006.
- (10) IRS T 29-2000 Cast Manganese Steel Crossings
- (11) IRS T 39-1985 Prestressed Concrete Sleepers
- (12) IRS GE: 1 June 2004 Ballast specification
- (13) IRS T 1966 Fish Plates and Fish Bolts
- (14) IRS Fabrication and Erection of Steel Girder Bridges & Locomotive Turn Tables (BI-1979)
- (15) RDSO/M&C/RP-194/94 – Wiper seal & dust seal.

2.2.2 Indian Road Congress (IRC) Codes and Specifications

- (1) IRC: 5 Standard Specifications and Codes of Practice for Road Bridges Section – I –General features of design.
- (2) IRC: 6 Standard Specifications and Codes of Practice for Road Bridges – Section – II – Loads and Stresses – Seismic provisions of

- this standard are to be adopted for the bridge design.
- (3) IRC:18 Design Criteria for Pre-stress Concrete Road Bridges (Post-tensioned concrete).
 - (4) IRC: 21 Standard Specifications and Codes of Practice for Road Bridges – Section – III –Cement concrete (Plain & reinforced).
 - (5) IRC: 22 Standard Specifications and Codes of Practice for Road Bridges – Section – VI –Composite Construction.
 - (6) IRC:24 Standard Specifications and Codes of Practice for Road Bridges – Section V, Steel Road Bridges.
 - (7) IRC: 54 – 1974 – Lateral and Vertical Clearances for Vehicular Traffic.
 - (8) IRC: 83 (Part – III) - Standard Specifications and Codes of Practice for Road Bridges –Section – IX – Bearings Part –III, Pot, POT cum PTFE Pin and Metallic Guide Bearings.
 - (9) IRC-78:Sub-structure for Road Bridges.
 - (10) IRC-87:Design and erection of false work for road bridges.
 - (11) Specifications for Road and Bridge Works issued by Ministry of Road Transport & Highways. (MORTH).
 - (12) The Manual for Construction and Supervision of Bituminous Works.
 - (13) The Asphalt Institute Manual MS-2.
 - (14) SP 6, 7, 16, 21, 22, 23, 24, 34, 36, 52, 60, 70.

2.2.3 Indian Standard Specifications:

1. IS: 34 White lead for paints.
2. IS: 57 Red lead for paints and other purposes.
3. IS: 75 Linseed oil, raw and refined.
4. IS: 77 Linseed oil, boiled for paints.
5. IS: 102 Ready mixed paints, brushing, red lead, non-settling priming.
6. IS: 104 Ready mixed paint, brushing, zinc chrome, priming.
7. IS: 123 Ready mixed paints, brushing, finishing, semi-gloss, for general purposes to Indian Colours etc.
8. IS: 280 Mild steel wire for general purposes.
9. IS: 383 Coarse and fine aggregate from natural sources for concrete.
10. IS: 432 (Part-I & Part-I) – 1982 – Mild Steel, Medium Tensile Steel Bars and Hard Drawn.
11. IS: 487 Brush, paint and varnish.
12. IS: 456 Plain and reinforced concrete.
13. IS: 516 Method of test for strength of concrete.
14. IS: 786 Conversion factors and conversion tables.
15. IS: 819 - Resistance spot welding for light assemblies in mild steel.
16. IS: 875 (Part 3) – 1987 – Code of Practice for Design Loads (Other than Earthquakes) for Buildings and Structures – Wind Loads

- (Second Revision).
17. IS: 887 Animal tallow.
 18. IS: 975 (all 5 parts) – Design loads (other than earthquakes) for buildings and structures.
 19. IS: 1024-1999 Use of Welding in Bridges and Structures subject to Dynamic Loading – code of Practice – Second Revision (Reaffirmed 1998).
 20. IS: 1024 Welding in bridges and structures subject to dynamic loading.
 21. IS: 1030 Grade 280-520W- Cast Steel.
 22. IS: 1080-1985 Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell).
 23. IS: 1199 Indian Standard Specifications for Method of Sampling and analysis of concrete.
 24. IS: 1200 (all relevant parts) – Method of measurement of building and civil Engineering works.
 25. IS: 1261 – 1959 – Seam Welding in Mild Steel (Reaffirmed 1998)
 26. IS: 1270 Metric steel tape measure.
 27. IS: 1323 – 1982-Oxy-acetylene Welding for Structural Work in Mild Steel (Second Revision).
 28. IS: 1343 Prestressed concrete.
 29. IS: 1493 Design of Bored and Cast in Situ Piles Founded in Rock.- Guide lines.
 30. IS: 1725-1982 Specification for soil based blocks used in general building construction
 31. IS: 1786-1985-High Strength Deformed Steel Bars & Wires for Concrete Reinforcement (Third Revision).
 32. IS: 1791 Batch type concrete mixers.
 33. IS: 1893-2002 Criteria for Earthquake Resistance Design of Structures.
 34. IS: 1904-1986 Code of practice for design and construction of foundations in soils: General Requirements.
 35. IS: 1915 Steel bridge code.
 36. IS: 2074 Ready mixed paint, air drying, red oxide-zinc chrome.
 37. IS: 2339 Aluminum paints for general purposes, in dual container.
 38. IS: 2386 (all 8 parts) – Tests for aggregates for concrete
 39. IS: 2502 Code of practice for bending and fixing of Bars for concrete reinforcement.
 40. IS: 2722 Indian Standard Specifications for Portable Swing Weight batches for concrete (Single and Double Bucket type).
 41. IS: 2751 Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction.
 42. IS: 2809-1972 Glossary of Terms and Symbols Relating to Soil Engineering.
 43. IS: 2911 (Part I to IV) - Code of practice for design and

- construction of pile Foundations.
44. IS: 2974-1982 Part-I: Code of Practice for Design and Construction of Machine Foundations - Part I: Foundation for Reciprocating Type Machines.
 45. IS: 3016:1965 Code of practice for Fire precaution in welding and cutting operations.
 46. IS: 3025 (all 49 parts) – Methods of sampling and test for water and waste water.
 47. IS: 3085 Method of test for permeability of cement mortar and concrete.
 48. IS: 3400 (all 22 parts) – Methods of tests for vulcanized rubbers.
 49. IS: 3502:1994-Steel Chequered Plates – Specifications (Second Revision).
 50. IS: 3696:1987 (Part – I & Part-II)) Safety code for scaffolds and Ladders.
 51. IS: 3764 Safety code for excavation work.
 52. IS: 3955 Design and construction of well foundations.
 53. IS: 4031 (all 15 parts) – Physical tests for hydraulic cement.
 54. IS: 4081 Safety code for blasting and related drilling operations.
 55. IS: 4082 Recommendations of stacking and storage of construction materials at site.
 56. IS: 4091-1979 Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.
 57. IS: 4138 – Safety Code for Working on Compressed Air.
 58. IS: 4326 Earthquake Resistance Design and Construction of Building – Code of Practice.
 59. IS: 4634 Methods of testing performance of batch type concrete mixers.
 60. IS: 4756 – Safety Code for Tunneling Work.
 61. IS: 4880 (Pt.-IV) – Code of Practice for Design of Tunnel – Structural Design of Concrete Lining in Rock.
 62. IS: 4880 (Pt.-V) – Code of Practice for Design of Tunnel – Structural Design of Concrete Lining in Soft Strata and Soils.
 63. IS: 4880 (Pt.-VI) – Code of Practice for Design of Tunnel – Tunnel Support.
 64. IS: 4926 Indian Standard Specifications for Ready Mixed Concrete.
 65. IS: 5513 Vicat apparatus.
 66. IS: 5515 Compaction factor apparatus.
 67. IS: 5666 Etch primer.
 68. IS: 5878 (Pt.-I) – Code of Practice for Construction of Tunnels – Precision Survey and Setting Out.
 69. IS: 5878 (Pt.-II, Section-I) – Code of Practice for Construction of Tunnels – Underground Excavation in Rock – Drilling and Blasting.
 70. IS: 5878 (Pt.-II, Section-II) – Code of Practice for Construction of Tunnels – Underground Excavation in Rock – Ventilation, Lighting,

- Mucking & Dewatering.
71. IS: 5878 (Pt.-III) – Code of Practice for Construction of Tunnels – Underground Excavation in Soft Strata.
 72. IS: 5878 (Pt.-IV) – Code of Practice for Construction of Tunnels – Tunnel Support.
 73. IS: 5878 (Pt.-V) – Code of Practice for Construction of Tunnels – Concrete Lining.
 74. IS: 5878 (Pt.-VII) – Code of Practice for Construction of Tunnels – Grouting.
 75. IS: 6586 Metal spraying for protection of iron steel.
 76. IS: 6911 – Stainless Steel.
 77. IS: 6925 Methods of test for determination of water soluble chlorides in concrete admixtures.
 78. IS: 7205-1974-Safety Code for erection of Structural Steel Work (Fifth Reprint July, 2001).
 79. IS: 7293 Safety code for working with construction machinery.
 80. IS: 7320 Concrete slump test apparatus.
 81. IS: 8629 (Parts I to III) – 1977 – Protection of Iron and Steel Structures from Atmospheric Corrosion (Reaffirmed 2002).
 82. IS: 9103 Admixtures for concrete.
 83. IS: 10080 Vibration machine for casting standard cement mortar cubes.
 84. IS: 10262 Concrete mix design.
 85. IS: 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces.
 86. IS: 14268 Prestressing Strands.
 87. IS: 14881:2001 Method for Blast Vibration Monitoring – Guidelines.
 88. IS: 15594 – Mechanical Vibration – Measurement of Vibration Generated Intermittently in Railway Tunnels by Passage of the Trains.
 89. SP 22 (S&T): 1992 Explanatory Hand Book on codes for Earth Quake Engineering.
 90. SP 70: 2001 Handbook on construction safety practices.
 91. IS codes for soil testing:

S.No.	IS Code No.	Description
1.	IS: 2720 (all parts)	Methods of test for soils.
2.	IS: 2810	Glossary of terms relating to soils dynamics.
3.	IS: 4434	Code of practice for in-situ vane shear test for soils.
4.	IS: 4968	Method of subsurface sounding for soils. Part 1 Dynamic method using 50mm cone without bentonite slurry.

S.No.	IS Code No.	Description
5.	IS: 4968	Method of subsurface sounding for soils. Part II Dynamic method using cone without bentonite slurry.
6.	IS:4968	Method of subsurface sounding for soils. Part III Static cone penetration test.
7.	IS: 5249	Method of test for determination of in-situ dynamic properties of soils.
8.	IS: 460	Specification of test sieves. Wire cloth test sieves.
9.	IS:460-1985 Part 2 Revision 3	Specification of test sieves. Perforated plate test sieves.
10.	IS: 460-1983 Part3 Revision 3	Specification of test sieves Part III Methods of examination of apertures of test sieves.
11.	IS: 1498-1970 Revision 1	Classification and identification of soils for general engineering purposes.
12.	IS: 1607-1977	Methods for test sieving.
13.	IS:5421-1981 Revision 1	Glossary of terms relating to test sieves and tests sieving.
14.	IS:1888-1982 Revision 2	Method of load test on soils.
15.	IS: 1892-1979	Code of practice for site investigations for foundations (With amendment no.1).
16.	IS:2131-1981 Revision 1	Method for standard penetration test fir soils. (Reaffirmed 1987).
17.	IS: 2132-1972 Revision 1	Code of practice for thin walled tube sampling of soils.
18.	IS: 10074-1982	Specification for compaction mould assembly for light and heavy compaction test of soils.
19.	IS: 10077-1982	Specification for equipment for determination of shrinkage factors.
20.	IS: 10379-1982	Code of practice for field control of moisture and compaction of soils for embankment and sub- grade.
21.	IS: 10837-1984	Specification for moulds and accessories for determination of density index (relative density) of

S.No.	IS Code No.	Description
		cohesion less soils.
22.	IS: 11196-1985	Specification for equipment for determination of liquid limit of soils-cone penetration method.
23.	IS: 11229-1985	Specification of mould assembly for determination of permeability of soils
24.	IS: 11209-1985	Specification for shear box for testing of soils.
25.	IS 9179-1979	Method for preparation of rock specimen for laboratory testing.
26.	IS 9143 : 1979	Method for the determination of unconfined compressive strength of rock materials.
27.	IS 9221 : 1979	Method for the determination of modulus of elasticity and Poison's ratio of rock materials in uniaxial compression.
28.	IS 10782: 1983	Method for laboratory determination of dynamic modulus of rock core specimens.
29.	IS 11315: Part 12 : 1992	Method for the quantitative description of discontinuities in rock mass: Part 12 Drill core study.
30.	IS 11315: Part 11 : 1985	Method for the quantitative description of discontinuities in rock mass: Part 11 Core recovery and rock quality.

92. IS codes for cement:

- (1) Ordinary Portland Cement, 33 Grade, conforming to IS:269.
- (2) Rapid Hardening Portland Cement, conforming to IS:8041.
- (3) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.
- (4) Ordinary Portland Cement, 53 Grade, conforming to IS:12269.
- (5) Sulphate Resistant Portland Cement, conforming to IS:12330.

93. IS codes for pre-stressing steel:

- (1) Uncoated Stress relieved low relaxation strands conforming to IS; 1426.
- (2) Plain hard drawn steel wire conforming to IS: 1785 (Part I).
- (3) High tensile steel bar conforming to IS: 2090.

(4) Uncoated stress relieved strands conforming to IS: 6006.

94. IS Codes for structural steel:

- (i) IS: 226 : Structural Steel (Standard Quality)
- (ii) IS: 808 : Specifications for Rolled Steel Beam, Channel and Angle Sections
- (iii) IS: 961 : Structural Steel (High Tensile)
- (iv) IS: 1148 : Hot rolled rivet bars (upto 40mm dia) for structural purposes
- (v) IS: 1149 : High tensile rivet bars for structural purposes
- (vi) IS: 1161 : Steel tubes for structural purposes
- (vii) IS: 1239 : Mild Steel Tubes
- (viii) IS: 1730 : Dimension for Steel Plate, sheet and strip for structural and general engineering purposes
- (ix) IS: 1731 : Dimension for Steel flats for structural and general engineering purposes
- (x) IS: 1732 : Dimension for round and square steel bars for structural and general engineering purposes
- (xi) IS: 1852 : Rolling and cutting tolerances for hot rolled steel products
- (xii) IS: 2062 : Weldable Structural Steel
- (xiii) IS: 4923 : Hollow Steel sections for structural use
- (xiv) IS: 8500 : Weldable Structural Steel (medium & high strength qualities)
- (xv) IS: 11587 : Structural weather resistant steel

95. IS codes for fasteners :

- (i) IS: 1363 Hexagon head bolts, screw and nuts product grade C
- (ii) IS: 1364 Hexagon head bolts, screw & nuts product grade A & B
- (iii) IS: 1367 Technical supply conditions for threaded steel fastener (Parts 1 to 18)
- (iv) IS: 1929 Hot forged steel rivets for hot closing (12-36mm dia)
- (v) IS: 2155 Cold forged steel rivets for hot closing (6-16mm dia)
- (vi) IS: 3640 Hexagon fit bolts
- (vii) IS: 3757 High tensile friction grip bolts

- (viii) IS: 6623 High strength structural nuts
- (ix) IS: 6639 Hexagon bolts for steel structure
- (x) IS: 5624 Foundation bolts
- (xi) IS: 7002 Prevailing torque type steel hexagon lock nuts
- (xii) IS: 5369 Plain washers and lock washers - general requirements
- (xiii) IS: 5370 Plain washers with outside dia = 3 X inside dia
- (xiv) IS: 5372 Taper washers for channels (ISMC)
- (xv) IS: 5374 Taper Washers for I beams (ISMB)
- (xvi) IS: 6610 Heavy washers for steel structures
- (xvii) IS: 6649 Hardened and tempered washers For high strength structural bolts and nuts

96. IS codes for welding consumables:

- (i) IS:814 (Part 1) Covered Electrodes for Metal Arc Welding of structural steel for welding other than sheets
- (ii) IS: 814 (Part 2) For welding sheets
- (iii) IS: 1278 Filler rods and wires for gas welding
- (iv) IS: 1395 Low and medium alloy Steel covered electrodes for manual Metal Arc Welding
- (v) IS: 3613 Acceptance Tests for wire flux combinations for submerged arc welding of structural steel
- (vi) IS: 7280 Bare wire electrodes for gas shielded arc welding of structural steel
- (vii) IS: 6419 Welding rods and bare electrodes for gas shielded arc welding of structural steel
- (viii) IS: 6560 Molybdenum and chromium-molybdenum low alloy steel welding rods and bare electrodes for gas shielded arc welding

97. Codes for structural steel work for railway bridges:

- 1) IRS: Steel Bridge Code
- 2) IRS: Welded Bridge Code.
- 3) IRS: Code of Practice For Electric Welding Of Mild Steel Structures
- 4) IRS: Fabrication & Erection of Steel Girder Bridges &

Locomotive Turn Tables (B1-2001).

- 5) IRS: Standard Specification for Classification, Testing and Approval of Metal-Arc Welding Electrodes, Serial No M.28-76.
- 6) IRS: Standard Specification for Classification, Testing and Approval of Submerged Arc Welding Wire-Flux Combinations for Use On Indian Railways Serial No M.39-68.
- 7) IRC: 22 (2008) Standard specifications and code of practice for road bridges – Section VI (Composite Construction).
- 8) BS: 5400-6 (1999) Steel, concrete and composite bridges- Specifications of material and workmanship, Steel.
- 9) IS: 800 (1984) Code of Practice for General Construction in Steel.
- 10) IS: 808 (1989) Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.
- 11) IS: 814 (1991) Covered Electrodes for Manual Metal Arc Welding of Carbon & Carbon - Manganese Steel.
- 12) IS: 816 (1969) Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel.
- 13) IS: 817 (1969) Code of Practice for Training and Testing of Metal Arc Welder
- 14) IS: 919 (1993) ISO System of Limits & Fits (Part 1 & Part 2).
- 15) IS: 1148 (1982) Hot Rolled Rivet Bars (up to 40mm) for Structural Purposes.
- 16) IS: 1182 (1983) Recommended Practice for Radio Graphic Examination of Fusion Welded Butt Joints in Steel Plates.
- 17) IS: 1363 (1992) Hexagon Head Bolts, Screws and Nuts of Product grade C (Part 1 to Part3).
- 18) IS: 1364 (1992) Hexagon Head Bolts, Screws and Nuts of Product Grades A &B (Part 1 to 5).
- 19) IS: 1367 (1991) Technical Supply Conditions for Threaded Steel Fasteners.
- 20) IS: 1852 (1985) Rolling & Cutting Tolerances for Hot-Rolled Steel Product.
- 21) IS: 2016 (1967) Plain Washers.
- 22) IS: 2062 (2006) Hot Roiled Low, Medium and High Tensile Structural Steel.
- 23) IS: 2595 (1978) Code of Practice for Radio Graphic Testing.

- 24) IS: 3600 (1985) Methods of Testing Fusion Welding Joints (Part 1 to Part 9).
- 25) IS: 3613 (1974) Acceptance Tests for Wire Flux Combinations for Submerged Arc Welding.
- 26) IS: 3658 (1981) Code of Practice for Liquid Penetrant Flow Detection.
- 27) IS: 3757 (1985) High Strength Structural Bolts.
- 28) IS: 4000 (1992) High Strength Bolts In Steel Structures-Code of Practice.
- 29) IS: 4353 (1967) Recommendations for Submerged Arc Welding of Mild Steel and Low Alloy Steel.
- 30) IS: 4943 (1968) Assessment of Butt and Fillet Fusion Welds in Steel Sheet, Plate and Pipe.
- 31) IS: 5334 (1981) Code of Practice for Magnetic Particle Flow Detection of Welds.
- 32) IS: 5369 (1975) General Requirements for Plain Washers and Lock Washers.
- 33) IS: 5372 (1975) Taper Washers for Channels.
- 34) IS: 5374 (1975) Taper Washers for I Beams.
- 35) IS: 6623 (1985) Specification for High Strength Structural Nuts
- 36) IS: 6649 (1985) Specifications for hardening and tempering washers for high strength structural nuts.
- 37) IS: 6755 (1980) Double Coil Helical Spring Washers.
- 38) IS: 7215 (1974) Tolerances for Fabrication of Steel Structure.
- 39) IS: 7318 (1974) (Part I) Approval Tests for Welders When Welding Procedure Approval is not required -fusion Welding of Steel.
- 40) IS: 8910 (1978) General requirements of Supply of Weldable Structural Steel.
- 41) IS: 9595 (1996) Recommendations for Metal Arc Welding of Carbon & Carbon-Manganese Steels.

2.2.4 Indian Standard Specifications for Electrical Works

- (1) IS: 694 PVC insulated Electric cable working voltage up to and including 11000 volts
- (2) IS: 732 Codes of Practice for Electrical Wiring Installations
- (3) IS: 1255 Code of Practice for Installation and Maintenance of

- Power Cables up to and including 33kV rating
- (4) IS: 1293 Three Pin Plugs and Socket Outlets Rated Voltage up to and including 250 Volts and rated Current up to and including 160 Amps.
 - (5) IS: 1554 PVC Insulated (Heavy Duty) Electric Cables for Working up to and Including 1100 Volts
 - (6) IS: 1913 General and safety Requirements for Fluorescent Lamp Luminaries Tubular
 - (7) IS: 2026 Power Transformers
 - (8) IS: 10561: 1983 / IEC 606 (1978) Application Guide for Power Transformers
 - (9) IS: 2309 Protection of Buildings and Allied Structures Against Lightning – Code of Practice
 - (10) IS: 2705 Current Transformers
 - (11) IS: 3043 Code of Practice for Earthing
 - (12) IS: 3156 Voltage Transformers
 - (13) IS: 3480 Flexible Steel Conduits for Electrical Wiring
 - (14) IS: 3636 Code of Practice for Interior Illumination
 - (15) IS: 3837 Accessories for Rigid Steel Conduit for Electric Wiring
 - (16) IS: 3842 Application Guide for Electric Relays for AC Systems
 - (17) IS: 3961 Recommended Current Ratings for Cables
 - (18) IS: 4615 Switch Socket Outlets
 - (19) IS: 5133 Boxes for the Enclosure of Electrical Accessories
 - (20) IS: 5831 PVC Insulation and Sheath of Electrical Cables
 - (21) IS: 6665 Code of Practice for Industrial Lighting
 - (22) IS: 7098 XLPE Cables
 - (23) IS: 8623 (Part-I) Factory Built Assemblies of Switchgear and Control Gear for Voltage up to and Including 1000V AC and 1200V DC
 - (24) IS: 8623 (Part-II) Bus Bar Trunking
 - (25) IS: 8828 Miniature Circuit Breakers
 - (26) IS: 9224 HRC Cartridge Fuse
 - (27) IS: 9537 Rigid Steel Conduits for Electrical Wiring (Second Revision)
 - (28) IS: 9676 Reference Ambient Temperature for Electrical Equipment
 - (29) IS: 10028 Selection, Installation and Maintenance of Transformers
 - (30) IS: 0118 Code of Practice for Selection, Installation and

- Maintenance for Switchgear and Control Gear
- (31) IS: 11171 Dry Type Power Transformers
 - (32) IS: 12640 Earth Leakage Circuit Breakers
 - (33) IS: 12729 High Voltage Switchgear
 - (34) IS: 13234 Short Circuit Calculation in Three Phase AC Systems
 - (35) IS: 13947 (Part-I) Degrees of Protection
 - (36) IS: 2551- 1982 Danger Notice Plates
 - (37) IS: 5424- 1969 Rubber Mats for Electrical Purposes
 - (38) IS: 4648-1968 Guide for Electrical Layout in Residential Buildings
 - (39) SP 31: 1986 Special Publication: Chart on Treatment for Electric Shock
 - (40) IS: 13779 Digital Measuring Instrument and Testing Accessories
 - (41) IS: 13947 Low Voltage Switchgear and Control Gear
 - (42) IS: 13947 (Part-I) Circuit Breakers
 - (43) IS: 15549 Stationary Valve Regulated Lead Acid Batteries
 - (44) IS: 61000 – 2-4 Electromagnetic Capability

2.2.5 Other International Codes

- (1) En 1990-2002 (Eurocode – Basis of Structural Design) – (For Safety, comfort deformation including twist and deflection)
- (2) EN 1991-2-2003 (Eurocode 1 – Action on Structures, part 2 – Traffic Loads on Bridges)- (Natural frequency range and Loading for fatigue estimation)
- (3) EN 1992 – 1:2004 (Eurocode 2 – Design of Concrete Structures, Part – 1 – General Rules and Rules for Buildings)
- (4) EN 1992 – 1-1:2004 (Eurocode 3 – Design of Steel Structures, Part 1 – 1 -1 General Rules) – (Classification of cross sections).
- (5) EN 1993 – 1-8:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 8 Design of Joints) – (Classification of HSFG Bolts).
- (6) EN 1993 – 1-9:2002 (Eurocode 3 – Design of Steel Structures, Part 1 – 9 Fatigue Strength of Steel Structures).
- (7) EN 1993 – 2:2004 (Eurocode 3 – Design of Steel Structures, Part 2 – Steel Bridges) - (Requirements for fatigue assessment, Road and Rail Bridges).
- (8) EN 1994 – 2:2003 (Eurocode 4 – Design of Composite Steel & Concrete Structures, Part 2 – Rules for Bridges) – (Width of effective flange, shear connectors).

- (9) EN 1337-7 (March 2004) – Structural bearings – Part 7 : Spherical and Cylindrical PTFE bearings (In case of Steel Bridges)

2.2.6 UIC Codes

- (1) UIC 774 – 3R –Track Bridge interaction Recommendation for calculation (for Forces due to LWR).
- (2) UIC 772R: Bearings of rail bridges
- (3) UIC 774-3R Track/Bridge interaction

2.2.7 BS Codes

- (1) BS – 3784 Grade “A” Specifications for Polytetra fluroethylene
- (2) BS-5350: Standard Method of test of adhesives, Part C9, Floating roller peel test.
- (3) BS-5400: Part – 1 General Statement.
- (4) BS-5400: Part – 2 Specifications for loads.
- (5) BS-5400: Part – 3 Code of Practice for Steel Bridges.
- (6) BS-5400: Part – 5 Code of Practice for composite Bridges.
- (7) BS-5400: Part- 9 Bridge Bearings.
- (8) BS-5400: Part-10 Code of Practice for Fatigue.
- (9) BS-1449, 3484, 1134, 5296.
- (10) BS-5400: Part 6 Steel, Concrete and Composite Bridges- Specifications for Materials and Workmanship-Steel (In case of Steel Bridges)

BS Codes for Electrical Works

- (11) BS: 6007 Electric Cables; Single Core Unsheathed Heat Resisting Cable for Voltage up to and Including 450/750V, for Internal Wiring
- (12) BS: 6387 Specifications for Performance Requirements for Cables required to Maintain Integrity Under Fire Conditions
- (13) BS: 6724 Specification for 600/1000V and 1900/3300V Armoured Electric Cables having Thermosetting Insulation and Low Emission of Smoke and Corrosive Gases when Affected by Fire
- (14) BS: 7211 Specification for Thermosetting Insulated Cables (non-armoured) for Electric Power and Lighting with Low Emission of Smoke and Corrosive Gases when Affected by Fire
- (15) BS: 7629 Specification for 300/500V Fire Resistant Electric Cables having Low Emission of Smoke and Corrosive Gases when Affected by Fire

The list given above is by no means exhaustive. All IS, IRC and IRS Codes pertaining to the work shall be applicable.

Where the drawings and specifications described a portion of the

work in only general terms and not in complete detail, it shall be understood that only the best general practice is to prevail, materials and workmanship of the best quality are to be employed and the instructions of the Engineer are to be complied with.

NOTE:

- (i) Contractor will procure and keep one copy of these reference codes and manuals at site office for reference and guidance.
- (ii) To ensure implementation of the various rules, codal provisions etc., the Contractor shall develop Design-basis Note and Method Statements for all the items of Work, based on the Specifications, applicable Codes & Standards, Good Industry Practices and shall submit to the Authority's Engineer for his review.

3 Geotechnical Investigation

- 3.1 Geotechnical investigations, as part of a comprehensive geotechnical investigation programme, shall be conducted according to IS: 1892.
- 3.2 Testing of soil/rock samples has to be carried out before designing the bank/cuttings. List of relevant IS Codes for soil testing and rock testing are as per item No. 2 of this document.

4 Earthworks

4.1 General

This section deals with the Selection of Materials for Earthwork, Execution of Earthwork in excavation and formation, Quality Control of the Earth work, Maintenance of Records and Quality Assurance. In principle the earth work shall be carried out as per the provisions of Specifications for Design of Formation No. RDSO / 2007 / GE: 0014 – November 2009 and Earthwork in Railway Projects, GE: G-1 – July 2003 issued by RDSO/ Lucknow except for specific provisions made herein in these Specifications.

- 4.1.1 Blanketing Material: For laying Blanketing materials, RDSOs specification No. GE IRS2 is to be used.

4.2 Excavations in the vicinity of Existing Railway Tracks

While working / carrying out excavation in the vicinity of the existing Railway tracks and structures (including bridges, formation etc.), special care should be taken to ensure that formation of the existing railway tracks is not excavated and any activity of the Contractor shall not endanger the safety of existing running line of Indian Railways. If

excavation or any other activity involving working and or modification and or alteration of the existing permanent way then, before execution of such work, the Contractor shall prepare the protection measure intended to be taken by the Contractor to ensure safety of the existing running line, and seek the review of Engineer. However the effectiveness of design of such protection measures is the sole responsibility of the Contractor and the Contractor shall indemnify the Employer / Engineer / Authority towards the losses incurred due to failure of such protection measure. These protection measures duly indicating the extent of alternation / modification to the existing formation shall be incorporated in the design and drawing submitted during Technical Design submissions as per Authority's Requirement. Such work shall not be undertaken unless and until these drawings are reviewed by the Engineer and Authority.

4.2.1 Other's right-of-way

At locations where the construction is close to irrigation canals and power transmission lines which have their own right-of-way, the Contractor must not, without instructions / review by the Engineer, remove any materials from the right-of-way of other authorities or, by the operation of equipment or otherwise, disturb their installations.

4.3 Ground Improvement

Field tests are required to be conducted on sub-soil strata, such as Plate Load Test for determination of Elastic Modulus at second loading (EV2), Standard Penetration Test to determine N-value and Unconfined Compression Test or Vane Shear Test to determine Unconfined Compressive Strength or Undrained Cohesion C_u . If values of these test parameters as specified hereunder are not achieved, then ground improvement is required

- (1) For ground soil / sub-strata layers with low bearing capacities, assessed by following evaluation parameters, shall require ground improvement:
 - (i) EV2 value less than 20 MPa, Or
 - (ii) Undrained Cohesion (C_u) < 25 kPa, Or
 - (iii) N-value (determined from Standard Penetration Test: SPT) < 5,
- (2) Strengthening of the sub-strata soil layers can be carried out using one or more of the following techniques, subject to review of the Engineer
 - (i) Removal and replacement of weak soil (Excavation and

replacement could be carried out upto 2m)

- (ii) Stage construction of the fill, preloading and surcharging
- (iii) Installation sub-drainage system
- (iv) In-situ pile, Sand Gravel Compaction pile, Stone Columns
- (v) Vibro-floatation
- (vi) Lime Pile, Injection / lime slurry pressure injection / ion exchange
- (vii) Stir & mixing
- (viii) Sand mat, Geosynthetics etc.

- (3) In case the black cotton soil is encountered by the Contractor during the course of geotechnical investigations, the following remedies are suggested:
- (a) Treating top layer of the soil with quick lime so as to reduce the harmful effects of the black cotton soil.
 - (b) Providing a blanket of graded inverted filter at top of the Embankment.
 - (c) Consolidation of black cotton soil at optimum moisture content.
 - (d) Provision of bituminous carpet or similar other intercepting material like polythene sheets etc. so as to intercept the surface water getting in to formation.
 - (e) To provide the drainage conditions of the formation at surface and sub-surface level.
 - (f) Providing a compacted layer of CNS material (Cohesive non-swelling soil) layer suitably designed using specialized literature, at the bottom of embankment fill and in case of cuttings at the bottom of sub grade layer.

4.4 Quality Assurance

- (1) Quality Check on Earthwork : Quality of execution of formation earthwork shall be controlled through exercise of checks on the borrow material, blanket material compaction process, drainage system, longitudinal & cross sectional profiles of the embankment.
- (2) Frequency of Quality Assurance Tests
- (i) CBR test for selection of formation materials and other tests required for ensuring conformation of the materials (blanket, subgrade, embankment fill) as per specifications e.g. size gradation, Cu, Cc, Los Angeles Tests, OMC / MDD etc.

shall be conducted at following frequency;

- a) Embankment Fill: One set of tests for every 5,000 cum and at every change of soil strata
 - b) Compacted earth / Blanket Layers: Atleast one density check for every 200 sqm. for each blanket layer and top one metre of sub-grade and at least one density check for every 500 sqm. for other than blanket and one metre of sub- grade
 - c) Prepared Subgrade: one set of tests for every 2,000 cum
 - d) Blanket Material: one set of tests for every 500 cum
- (ii) Second Step Plate Load Test: This test should be done for E_{v2} measurement at top of each formation layers e.g. at sub-soil, compacted sub-grade, prepared sub-grade, blanket etc. at the frequency of one test per km length of the section as per procedure detailed in DIN 18134-2001.

4.5 Tolerances and Acceptance Criteria

- (1) Soil Formation should meet the following requirements
- (i) The cross fall slope to be at least 1:30 or 3% with tolerance of 0.5%.
 - (ii) The finished top levels of soil formation should be within \pm 30 mm.
 - (iii) The finished top of blanket layer shall be permitted to have variation from design level by + 25mm.

5 Road Works

5.1 General: Road works in colonies, approach to stations, ROB approaches and at level crossings should confirm to the relevant standards of IRC codes as mentioned in item 2.

6 Material for Structures

For Specifications on materials "Indian Railways Unified Standard Specifications (works and materials -2010) Vol I and II" with latest amendment should be referred.

7 Handling & Storage of Materials

All materials shall be stored as per IS:4082.

8 Piling Work

8.1 Description

8.1.1 The method of installing the piles, including details of the equipment shall be submitted by the Contractor and got reviewed from the Engineer.

8.1.2 The work shall be done as per IS:2911 except as modified herein.

8.2 Materials

The basic materials like cement, coarse aggregates, fine aggregates, reinforcing steel, structural steel, water and concrete admixtures shall confirm to the requirements as specified in the Clause 6: Materials for Structures of these Specifications.

8.3 Precast Concrete Piles

The pile should be cast in one continuous operation.

8.4 Bored Cast-in-situ Concrete Piles

8.4.1 Boring for Pile

IS 1493-Design of bored and cast in-situ piles should be followed.

8.4.2 Concreting for Pile

Concreting for the piles shall be done by tremie method.

8.4.3 Pile Tests / Acceptance of Pile

For acceptance of piles, vertical and lateral load, testing of piles as required will be carried out as per procedure laid down in IS:2911(Pt-IV) "Code of Practice for Design and Construction of Pile Foundation-Load test on piles."

9 Concrete Works

9.1 General

This section refers to the construction of concrete structures including concrete mix design, trial mix, testing and workmanship for concreting.

Prior to the start of construction, the Contractor shall design the mix as per IS 10262 and submit to the Authority's Engineer for review, the proportions of materials, including admixtures to be used. Water-reducing admixtures (including plasticisers or super-plasticisers) may

be used at the Contractor's option, subject to the review of the Authority's Engineer. Other types of admixtures shall be prohibited, unless specifically permitted by the Authority's Engineer.

9.2 Materials

All the materials shall confirm to the relevant IS codes.

9.3 Ready Mixed Concrete:

- (1) Ready Mixed Concrete may be used subject to prior review of the Authority's Engineer. It shall confirm to the specifications of concrete as specified herein and IS:4926.
- (2) The quality of admixtures like water-reducing agent, retarders, superplasticisers-cum retarders etc. should meet the requirement of Clause 6: Materials for Structures of these Specifications and its suitability tested as per IS:9103 at the time of finalizing the mix design.

9.4 Steel Reinforcement

All the materials for steel reinforcement shall confirm to the relevant IS codes.

9.5 Backfill Material and Approach Slab:

- (1) Backfill Behind Abutment, Wing Walls, Retaining Wall and Return Walls:

Behind abutments, wing walls and return walls/Retaining wall, boulder filling and backfill material shall be provided as per Code of Practice for the Design of Sub-structures and Foundations of Bridges. Boulder filling shall consist of well hand packed boulders & cobbles to thickness not less than 600 mm with smaller size towards the back. Behind the boulder filling, backfill material shall consist of granular materials of GW,GP,SW groups as per IS:1498-1970.

- (2) Approach Slabs:

In order to reduce impact effect and to obtain improved running, properly designed approach slab may be provided on both the approaches of non-ballasted deck bridges having spans 12.2 m or more. One end of the approach slab may be supported on the abutment and other end on formation. Length of the approach slab shall be minimum 4 meters.

10 Pre-stressing

10.1 Prestressing concrete shall be carried out as per IS 1343 and IS14268.

10.2 Record Keeping

In order to ensure proper manufacture and quality of the pre-stressed concrete members, a system of records as mentioned below shall be maintained by the Contractor besides such records as may be directed by the Engineer during the progress of the work. Two copies of such record shall be made and one copy duly signed by the Contractor and the site Representative of the Engineer shall be submitted to the Engineer.

- (1) Each pre-stressed member shall be identified by bed and date of cast and an identification number which shall refer to design calculation, drawing, tensioning records, concreting records, cube strength records. Maintaining of these records shall be the responsibility of the Contractor.
- (2) Certified test report of the materials such as pre-stressing steel, anchorages, sheathings, admixtures, expansion joints, aggregates, etc. brought by the Contractor and used in the structure. These reports shall show that the materials conform to the relevant specifications. Keeping record of all these test reports including those of cement and reinforcing steel, shall be the responsibility of the Contractor.
- (3) An accurate record of tensioning and grouting operations for each and every cable shall be kept. These shall include but not be limited to the following:
 - (i) Date of tensioning/grouting
 - (ii) Cast bed identification
 - (iii) Description, identification and number of the girder
 - (iv) Manufacture, size and class of tendon.
 - (v) Identification of all the tensioning equipment.
 - (vi) Identification and number of the cable/duct being tensioned / grouted.
 - (vii) Cube strength on the date of tensioning.
 - (viii) Design elongation and gauge pressure for the particular cable under tension.
 - (ix) Chart indicating actual gauge pressure and corresponding measured elongation at each end and at each stage of tensioning with graph showing actual gauge pressure vs measured elongation and correction value of elongation for initial tension before marking.
 - (x) Slip of anchorages at each end.

- (xi) The actual net elongation and shortfall or otherwise from the design value for each cable.
 - (xii) All data on the date of grouting e.g. time of start and completion, initial and final pressure of grout injection, total cement consumption, etc.
 - (xiii) Any un-natural occurrences encountered during tensioning or grouting; such as failure of equipment, snapping of tendons, excessive slippage, blockage of ducts resulting in heavy shortfall in elongation or excessive increase in pressure of grout injection, or any other problem that may have direct or indirect influence on the net stress or effective grouting.
- (4) Records of concreting operations and tests shall be kept so that the following data be recorded for each member or each group of members cast on one bed.
- (i) Date, time and duration of concreting.
 - (iii) Identification of casting bed and member.
 - (iii) Design Mix proportion.
 - (iv) Adjustments in water content in the mix due to bulking of sand or absorbed water in coarse aggregate
 - (v) Identification and numbering of work strength testing cubes.
 - (vi) Various field tests conducted at site like workability test, determination of water content in sand and coarse aggregate, etc.
 - (vii) Weather condition, ambient temperature, concrete temperature.
 - (viii) Method and duration of curing.
 - (ix) Strength of cubes at 7 days, 28 days and on the date of pre-stressing.
 - (x) Failure of equipment and interruption in continuous concreting.
 - (xi) Total cement consumption.
 - (xii) Any un-natural occurrence that may have direct or indirect effect on the overall quality of the work.
- (5) All equipment used in the work shall be calibrated. The record for calibration done shall show the following:-
- (i) Date of calibration.
 - (ii) Agency and laboratory performing the calibration.

- (iii) Method of calibration.
- (iv) A curve showing full range calibration with gauge readings plotted against actual load.

11 Architectural and Building Works

11.1 General Requirements

The general requirements for the Building Works shall be but not limited to the following:

- (a) Building layout plan and detailed design with adequate ventilation.
- (b) Site clearance & levelling shall be as per requirement.
- (c) Excavation (in soil / soft rock / hard rock) for foundations, pipes, drains, cables and backfilling and disposal of surplus earth shall be carried out as per requirement.
- (d) Filling in plinth and under floors shall be provided as per requirement.
- (e) Anti-termite treatment (pre-construction) shall be provided as per requirement.
- (f) Foundation work including Damp Proof Course.
- (g) All masonry work shall be with cement-sand mortar.
- (h) Reinforced cement concrete shall be of design mix as required.
- (i) Doors, windows & ventilators frames shall be of required quality.
- (j) All doors shall have flush door shutters.
- (k) All the windows shall have pelmets with curtain rods or vanishing blinds / strips, as required and all the doors shall have curtain rods with pelmets.
- (l) All the external doors, windows & ventilators shall have wire gauge shutters and shall also be provided with RCC sun-shade.
- (m) Wood work in contact with masonry shall have preservative / anti termite treatment.
- (n) All windows and ventilators shall have glass pan shutters and MS safety grill.
- (o) Windows shall be designed such that the air-conditioners and / or desert coolers can be fixed.
- (p) All steel works shall be painted with synthetic enamel paint.
- (q) All the residential buildings shall be provided with fixed type storage cupboards as required.

- (r) All the office buildings shall be provided with partitions as / if required.
- (s) All wood work shall be painted with synthetic enamel paint or sprit polished as required.
- (t) Roofing, basements / underground structures (if required) shall have appropriate water proofing treatment.
- (u) All the RCC Roofs shall be accessible through lockable staircase and shall have parapet wall of height not less than 1 meter.
- (v) All the staircases shall be as per the requirements of National Building Code.
- (w) Landscaping shall be provided as per requirement.
- (x) Washrooms / toilets shall be provided with;
 - i) white vitrified ceramic sanitary fittings
 - ii) looking glass of standard size
 - iii) exhaust fans
 - iv) all other fittings and fixtures as required
- (y) All the kitchens / pantry rooms shall be provided with kitchen shelves with top, fixed type storage cupboards and exhaust fans.
- (aa) Kitchen sinks in residential buildings / pantry rooms shall be of stainless steel with drain board and size not less than 460x915mm with bowl depth 178mm.
- (bb) Storage Geysers (wherever required) shall be of capacity not less than 15 liters.
- (cc) Ceiling fans shall be of size not less than 1200mm.
- (dd) Fire detection & alarm system including fire points shall be provided as per requirement.
- (ee) All the individual residential quarters shall be provided with:
 - i) Independent overhead water storage tank of capacity as indicated in the requirement. Overhead water storage tanks shall be kept at the roof top.
 - ii) Water supply lines directly from the source as well as from overhead water storage tank.
- (ff) Any other requirements as considered necessary by the Engineer from safety and operational considerations.
- (gg) The work shall be carried out as per CPWD Specifications – 2009 as published by Director General of Works, Central Public Works Department, Government of India.

12 Fixing RCC Land Boundary Pillars along Railway Boundary:

All the land along the track and at Stations shall be provided with pre-cast RCC Land Boundary pillars. Land Boundary pillars shall be engraved with the letters as advised by the Authority's Engineer. The Land Boundary pillars shall be fixed as per the drawings in such a way that 750mm of the total pillar height shall be exposed above the existing ground level. The exposed portion of the pillars shall also be duly painted.

13 Track Works:

13.1 Design Standards:

- 1) All equipment, materials and components shall conform to the specifications and international standards as applicable. The quality control and testing records related to manufacturing of each component shall be submitted to the Engineer for review.
- 2) The track layout shall be based on the provisions contained in Indian Railways Permanent Way Manual, Track Manual & relevant IRS specifications with latest amendments/corrections.
- 3) Where the design features differ from these specifications, such deviations are to be fully justified to the satisfaction of the Engineer.
- 4) The final designs of the track layouts, including horizontal and vertical alignment, station yard layout, LWR/CWR plans, etc. shall be reviewed by the Authority's Engineer and Authority before execution of track works.
- 5) For Interlocking of switches, earthing and bonding of electrical circuit arrangements in the track, the Contractor shall maintain necessary interface with the other agencies (if any).

13.1.1 Track structure Requirements:

- (1) **Rails** complying Indian Railway Specification for flat bottom rails i.e. IRS-T-12-2009 shall be used.

The rails in the Main Line tracks shall be Continuous Welded Rails (CWR) laid on mono- block pre-stressed concrete sleepers at nominal 600mm spacing (1660/km).

- (2) **PSC sleepers** conforming to RDSO T2496 shall be used.

- (3) **Ballast** confirming to Specifications of IRS GE1 2004 with latest correction slips is to be used.
- (4) **Turnouts** will be 1 in 12 and 1:8 ½ (curved) with cast manganese crossings and PSC sleeper layout. Check rails shall be installed parallel to the running rails on curves with a radius < 220m.
- (5) **Insulated Liners:**
In general, Metal Liners shall be provided. However, provision of Insulated Liners may be required in track circuited area.

13.2 Switch Expansion Joints (SEJs):

Generally the rails shall be laid as long/continuous welded rails (LWR/CWR). However the Switch Expansion Joints (SEJs) shall be provided and laid in accordance with the International codes and practices and shall be subject to review of Authority's Engineer.

Switch Expansion Joints (SEJs) shall be manufactured from rail compatible with the rail proposed for the CWR.

The indicative design of the SEJ is given in RDSO Drg. No.RT-6902 for 60 Kg (80mm) or RT-6922 for 60 Kg (65mm) & RDSO's Specifications along with corresponding PSC sleepers & fittings thereof as per drawing no. RDSO / T-8224.

The Contractor may propose a equivalent or superior alternative for approval by the Engineer/Authority. In such a case, the Contractor shall submit complete design details along with design criteria & acceptances tests to the Engineer for his prior review before procuring the same. The Engineer shall seek the approval from Authority before communicating the review to the Contractor.

SEJs shall be manufactured and supplied with all PSC sleepers, fittings, fastenings and fixtures as required for easy installation into the track.

13.3 Turnouts:

13.3.1 Turnout Design:

- (1) The Contractor shall be responsible for the detailed design, manufacturing and assembling of the turnouts and shall submit his proposals to the Engineer / Authority for Approval. The Contractor shall procure the turnouts from RDSO approved Manufacturers/Supplier.
- (2) The design shall be compatible with 1:12 and 1:8.5 turnouts which incorporate curved thick web switches. The turnouts shall

be designed to withstand rail induced forces from the CWR. Anti-creep devices shall be installed on the turnout rails as required. The following indicative RDSO drawings may be used as the basis of the Contractor's design:

- (i) 1 in 12 Xing, PSC Sleepers
- | | |
|-------------------------|--------|
| Layout | T 4218 |
| Switch Assembly | T 4219 |
| CMS Xing | T 4220 |
| Thick Web Switch Layout | T 6154 |
| Thick Web Switch | T 6155 |
- (ii) 1 in 8.5 Xing, PSC
- | | |
|-------------------------|--------|
| Layout | T 4865 |
| Switch Assembly | T 4966 |
| CMS Xing | T 4967 |
| Thick Web Switch Layout | T 6279 |
| Thick Web Switch | T 6280 |

- (3) Speed potential of the turnouts shall not be less than the values as per the design of currently available turnouts (laid on PSC sleepers) on the Broad Gauge of Indian Railways. These are as follows:

- a) 1:12 turnout with thick web tongue rail = 50 km/h.
- b) 1:8 ½ turnout with thick web tongue rail = 25 km/h.

(4) **Elastic Fastenings:**

Fastenings for the turnouts shall be elastic type and compatible with the main line rail to sleeper fastening system.

(5) **Groove Rubber Sole Pads (GRSP):**

The GRSPs shall be procured from the RDSO approved suppliers. The Contractor may submit alternative design equivalent or superior to RDSO design for review by the Engineer and approval by Authority.

(6) **Electrical Insulation:**

Minimum ballast resistance per km of track should not be less than 2 ohms per km in Station yard and 4 ohms per km in the block section in line with the provisions of para 17.2.8 of Signal

Engineering Manual Part II of Indian Railways.

Relevant specifications / standards shall be adopted subject to review of the Engineer for electrical installations between inserts in pre-stressed concrete sleepers as well as for insulated Glued Joints.

13.4 Track Work Installation:

13.4.1 Planning for Construction, Methods and Procedures for Track Work:

Mechanized method of track laying shall be used. This will involve "Laying or re-laying of rail panels of 250 / 260 meters or more welded by mobile / stationary / flash butt welding plant under control conditions in depots. Track linking to be done by use of rail threader, track laying machines and use of tamping machines, dynamic track stabilizers and shoulder ballast compactors for making track fit for traffic movement.

The mechanized track laying shall include welding, de-stressing and fastening, laying of concrete sleepers, ballasting including tamping & compaction (suitable for operation of 25 tonne axle load at the maximum permissible speed of 160 KMPH for the main lines and connecting lines and 50KMPH for the lines other than main lines & connecting lines), track boards & signages etc.

13.4.2 Track Laying Tolerances shall be as per relevant Para of IRPWM.

14 Miscellaneous Works:

14.1 Bridge Bearings:

14.1.1 Scope:

This work shall consist of furnishing and fixing bearings in position in accordance with the details shown on the drawings, to the requirements of these specifications and as reviewed by the Engineer.

14.1.2 Elastomeric Bearings:

The manufacturers of the bearings shall be got reviewed from the Engineer. The elastomer shall conform to the properties specified in Clause 4.3.1 of the IRICEN publication titled "Bearings for Railway Bridges" and relevant IS codes.

14.2 Stone Pitching / Revetment on Slopes:

The work shall consist of covering the slopes of banks with stone, boulders, cement concrete blocks over a layer of granular material called filter. Pitching shall be done as per specifications "Indian Railways Unified Standard Specifications (works and materials) Vol. I and II.

14.3 Boulder Aprons, Sausages:

This work shall consist of laying boulders on the bed of rivers for protection against scour. The stones used in Apron shall be sound, hard, durable and fairly regular in shape. Stone subject to marked deterioration by water or weather shall not be used. The size of stone should conform to clause 5.3.7.2 of IRC: 89. The size of stone shall be as large as possible. In no case any fragment shall weigh not less than 40 Kg.

14.3.3 Gabion Wall / Gabion Apron:

The Contractor shall be required to provide complete design including its foundation and details engineering with working drawing in required numbers. This shall be supported by certificate from the supplier of gabions that he has proven experience in supplying and placing gabions for major railway/ highway projects and providing technical backup using in house facilities.

Gabion Wire Mesh System being a specialised work, the Contractor shall ensure expert supervision by specialist from the technology provider time to time.

The Gabion wall shall be designed with the given specification using proven system design certified with ISO 9001/2 or equivalent as reviewed by the Engineer. The designer may adopt system design for Gabion wall following any proprietary patented technique.

14.4 Protective Screens on Road Over Bridges / Foot Over Bridges:

Each Road Over Bridge across IR tracks shall be provided with protective screens all along the path / hand railing on both sides of the carriageway of the ROB as per EN 50122 / Railway Board Guidelines. Protective screens shall be provided for the protection against falling objects on the electrified conductor of Railways tracks only. Height of the protective screens shall not be less than 1.8m from the footpath level and shall cover the entire length of the spans of the ROB through which existing tracks and running tracks of IR are passed through.

Protective screens shall be fabricated as per RDSO drawing no. RDSO/ETI / C / 0068. Steel for the protective screens shall conform to IS: 226 or IS; 2062-1984 (Gr. A) and fabrication shall be in accordance with the latest version of IS: 1800-62.

14.5 Public Utility Diversion (if required):

The diversion work shall be carried out by the Contractor as per the standard specifications of the concerned public utility company.

14.6 Pre-cast RCC Safety Wall between Circulating Areas of IR / Habitation Area

The Contractor shall provide precast RCC safety wall of height not less than 1800mm above ground level and as per the design and drawings prepared by the Contractor and reviewed by the Engineer. The wall shall be provided on one side or on both sides of the IR tracks at the identified locations to isolate from circulating areas of IR / habitation area for safety considerations.

The pre-cast RCC panels of the safety wall shall be fixed in the grooves of the pre-cast RCC posts in such a way that the top of the wall shall be at the same level irrespective of the existing ground profile and there is always a gap of 150mm above the existing ground level for drainage purpose.

14.7 Bearings for Steel Bridges:

- (1) Railway bridge bearings shall be designed to transfer all loads as defined in IRS 'Bridge Rules' and codes listed elsewhere in this specification.
- (2) The bearings should be easy to install, easy to inspect and practically maintenance free during the life of the bearing.
- (3) The expected life of the bearing shall be 35 years. R.D.S.O. (Research Design and Standard Organization) has issued guidelines on spherical bearings vide their no. CBS/Bearing dt. 22.06.2011, which may be adopted for design and provision of the bridge bearings. It is however, to be clearly understood that merely complying the provisions of guidelines/ codes will not relieve the Contractor of his responsibility for the soundness and performance of the bearings.
- (4) In case of any ambiguity or clarification reference to following

European Standards be made:

EN 1337 – 1:2000	Structural Bearing – Part I General Design Rule
EN 1337-2 : 2004	Structural Bearing – Part 2 : Sliding Elements
EN 1337-5: 1996	Structural Bearing – Part 5
EN 1337-7 : 2004 (E)	Structural Bearing – Part 7: Spherical and Cylindrical PTFE bearings
EN 1337-8	Guide bearings & Restraint bearings

15 Well Foundation:

The work shall consist of construction of well foundation in concrete by taking it down to indicated levels by open dredging of soil and other materials or by pneumatic sinking, pressure sinking technique and by plugging the bottom and top of well and filling the inside in accordance with details shown in drawings reviewed by the Engineer.

The work of well foundations shall be designed and constructed as per IRS- Sub structure and foundations code and IRS-Manual on design and construction of well and pile foundations.

16 Structural Steel Works for Railway Bridges

16.1 General:

- (1) The work shall include furnishing, fabricating, transporting, assembling, erecting and painting of structural steel and other incidental metal construction for railway bridges.
- (2) Technical Drawings, to be submitted by the Contractor and reviewed by the Engineer, shall show as appropriate the salient dimensions, design loads, sizes of members, location of openings at various levels and other necessary information required for the preparation of shop drawings, fabrication drawings and erection details.
- (3) General requirements relating to the supply of material shall conform to the specifications of IS: 1387.
- (4) Unless specified otherwise, high tensile steel rivet conforming to IS:1149 shall be used for members of high tensile steel conforming to IS: 961 and shall not be used for mild steel members. Unless specified otherwise, bolted connection of structural joints using high tensile friction grip bolts shall comply with requirements of IS: 4000. Cast iron shall not be used in any

portion of the bridge structure, except where it is subject to direct compression.

16.2 Applicable Codes of Practice:

The applicable specifications, standards and codes are as mentioned in chapter 2.

16.3 Materials:

All the materials for Structural Steel Works shall conform to the specifications as specified in Chapter 2. Special requirements are given below:

(1) Structural Steel:

Structural steel conforming to IS: 2062 (2006) – Hot Rolled Low, Medium & High Tensile Structural Steel- shall be used for all members of truss structure. The Contractor may, at his discretion, propose the usage of High Tensile Strength Steel up to Grade Fe 490.

(2) Bolts and Nuts:

For splicing of any structural member wherever required HSFG bolts and nuts of property class-8.8 conforming to IS: 3757 and IS: 6623 (1985) respectively shall be used. Unless specified otherwise, the bolts shall be hexagonal.

All anchor bolts shall be of property class of 8.8 and nuts shall conform to IS: 1363 (1992), IS: 1364 (1992) and IS: 1367, as applicable, and unless specified otherwise, shall be hexagonal. All nuts shall conform to property class compatible with the property class of the bolt used.

(3) Washers:

For HSFG bolts, washer shall be conforming to IS: 6649 (1985). Plain washers shall be conforming to IS: 5369 (1975), unless otherwise specified. One washer shall be supplied with each bolt and, in case of special types of bolts, more than one washer as needed for the purpose shall be supplied. An additional double coil helical spring washer, conforming to IS: 6755 (1980), shall be provided for bolts carrying dynamic or fluctuating loads and those in direct tension.

(4) Stud Shear Connectors:

The stud shear connectors shall be high tensile steel and the testing procedure shall be as per BS: 5400-6-1999. The headed studs for shear connection shall have minimum properties:

- i) Ultimate strength f_u = 495 MPa
 - ii) Yield strength f_y = 385 MPa
 - iii) Elongation = 18%
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