(SQ1, SQ2, SQ3) and CBR value of soil as obtained in laboratory as per IS: 2720 (part 16) 1967. The quality of soil is defined as below;

Table ERD – 4-1: Quality of Soils

Soil Quality	Description w.r.t. fine particles (<75 micron)	Soil as per IS-Classification
SQ1	Soils containing fines > 50%	CL, ML, CL-ML, CI, MI, CH, MH
SQ2	Soils containing fines, 12-50%	GM, GC, SM, SC
SQ3	Soils containing fines < 12%	GW, GP, SW, SP, GW-GM, GW-GC, SW-SM, GP-GM, GP-GC, SP-SM, SP-SC

For the blanket layer, which is the top layer of formation, the specifications of material are given in Clause 12 of report No. RDSO/2007/GE-0014 (Nov. 2009).

ii) Design of Formation: Designed thickness of layers with desired degree of compaction and deformation modulus (Ev2) for top layer of embankment fill, embankment fill, prepared subgrade (optional) and Blanket Layer are to be provided to ensure safety against shear failure and accumulated / plastic deformations under repetitive axle loads.

Sub-soils / subgrade is also to be of sufficient strength so as not to allow any shear failure

iii) The 2 alternative designs namely, Single Layer System and Two Layer System to be adopted based on suitability / economy to specific locations, as per RDSO Report No. RDSO/2007/GE:0014 (November 2009) are as below:

Table ERD – 4-2: Design Concept of Formation

Layers	Single Layer System	Two Layer System
Blanket (Specification Clause – 12 of RDSO Report No. RDSO/2007/GE:0014 (November 2009), CBR = 25	80 cm. for SQ3 and 100 cm for SQ2. SQ2/SQ3 soils preferred soils below Blanket Blanket compacted up to 100% MDD Min. EV2 = 120 MPa (In-situ assurance test)	45 cm for SQ3 and 60 cm for SQ2. SQ2/SQ3 soils preferred soils below Blanket Blanket compacted up to 100% MDD Min. EV2 = 120 MPa (In-situ assurance test)
Prepared Sub-grade (Good / Imported Soils)	Not Applicable	Thickness = 100cm. SQ2/SQ3 soil, CBR>8 generally but not <7 in isolated cases. Compacted up to 98% of

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Layers	Single Layer System	Two Layer System
		MDD. Min. EV2 = 60 MPa. For cutting sections, naturally occurring soil of sufficient strength may be used as sub-grade.
Embankment Fill – "Top layer"	Thickness = 75 cm. SQ2/SQ3 soil, CBR>7 generally but not <6 in isolated cases. Compacted up to 98% of MDD. Min. EV2 = 45 MPa	Not Applicable
Embankment Fill	SQ1/SQ2/SQ3, CBR = 2-3. Compacted up to 97% MDD	CBR > 5 generally but not <4 in isolated cases for SQ2/SQ3. CBR>3 generally but not <2 in isolated cases for SQ1. Compacted up to 97% of MDD. Min. EV2 = 30 MPa
Ground / Sub-soil strata	Min. EV2 = 20 MPa or Min. un-drained cohesion of soil = 25 Kpa	Min. EV2 = 20 MPa or Min. un-drained cohesion of soil = 25 Kpa
Min. Thickness of uniform layers	175 cm.	175 cm.

Note:

1. In case of the difference between formation level and ground level is less than minimum required thickness of uniform layers i.e. 1.75 m and naturally occurring soil at ground level meets the requirement of formation design at that level, the existing ground layer may not be cut further to achieve 1.75 m thickness of uniform layer.

   In the above case, if the naturally occurring soil at ground level does not meet the requirement of formation design at that level even after suitable mechanical compaction etc., the ground will be required to be excavated to provide the formation layers of requisite thickness and requirements mentioned above in the Table.

16.8.3 Drainage

(1) Top of the formation shall be finished to cross slope of 1 in 30 from centre of formation to both sides in case of single/double line. However, in case of multiple lines, the cross slope shall be from one end to the other towards cess/drain provided in between.

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(2) Once the top surface of the formation has been finished to proper slope and level, movement of material vehicle for transportation of ballast, sleepers etc. shall be avoided as these movements could cause development of unevenness, ruts on surface which will accumulate water and weaken the formation.

(3) At locations, where the water table is high and fill soil is fine grained, it may be desirable to provide a granular layer of about 30 cm thickness at the base, above the sub-soil across the full width of formation.

(4) Blanket material shall conform to the laid down Specifications.

(5) In the double track section, the longitudinal drain between two tracks shall not be provided, however between IR and DFC tracks (in case of parallel Section), it shall be provided as per the requirements as specified below and as per the provisions of IR Permanent Way Manual (IRPWM):

a) In case the toe of the DFC embankment is sufficiently away from the toe of the IR embankment, suitably designed side drain shall be provided in between the DFC embankment and IR embankment.

b) In case the toe of the DFC embankment overlaps the toe of the IR embankment, longitudinal saucer drain of suitable capacity shall be designed and provided between DFC embankment and IR embankment. The saucer drain shall have stone pitching on the sloping sides of DFC embankment and IR embankment up to 300mm above the design discharge level.

c) In case of the approach embankments for Important Bridges, Major Bridges and Rail Flyovers overlapping the approach embankment for IR bridges, the saucer drain between DFC embankment and IR embankment shall have stone pitching with PCC lining of M 15 grade on full sloping height of the DFC embankment and IR embankment for a length not less than 100m of the approach embankment on both side of the bridge.

(6) In case of formation in embankment or formation in cuttings, properly designed side drains and catch water drains shall be provided as per the Specifications. The Contractor shall firm up the location, type and size of the drains including the outer drains (between embankment and country side) and shall submit his proposal for consent by the Engineer.

(7) All the drains shall be lined.

(8) In yard, surface drains shall be generally open with suitable perforated covers for ease of cleaning and inspection.

(9) All the drains shall slope towards the nearest culvert or natural low ground longitudinally or natural outlets existing nearby where the water shall be discharged with appropriately designed outfall arrangement duly consented by the Engineer. Where ever situation arise that, it shall not be possible to drain out the water on culvert/low ground/natural outlets due any reason and water could get locked in between IR & DFC embankment (in case of parallel Section), the Contractor shall provide the suitable cross drain arrangement across the DFC formation duly consented by Engineer and approved by the Employer.

16.8.4 Planning for All Weather Service Road Along the Alignment

Design and construction of All Weather Service Road along the Alignment is not in the Scope of Work for this Package, and shall be taken up by the Employer in future. However while designing the Alignment & Embankment, the Contractor shall ensure that adequate space is left for providing the All Weather Service Road at a later stage all along the alignment within the Right of Way except at the locations of bridges. Planning of the Service Road shall be done generally for a carriageway width of 3.5m with a 1.2m shoulder on the inside (DFC side) and 1.5m shoulder on outside (total 6.2m width) but in any case not less than a total width of 3.5m at the locations.

having restricted Right of Way.

16.9 Railway Bridges

16.9.1 The basis for the design of structure, foundation, sub-structure, superstructure, protection works etc. for Major Bridges, Important Bridges, Minor Bridges, RUB's and ROBs, RFOs shall be based on relevant IRS, IRC and IS standards.

16.9.2 Classification of Bridges

There are seven types of bridges planned in this Project. The bridges are defined based on their span/location as per the provisions of Indian Railways Bridge Manual, as follows:

Table ERD-5: Classification of Bridges

S. No.	Type	Definition
1.	Important Bridge	Having a linear waterway[1] of 300 meters or more or a total waterway area of 1,000 m2 or more. Classifications may also depend on considerations of depth of waterway, extent of river training works and maintenance.
2.	Railway Flyover (RFO)	Railway bridge over other railways, (a type of bridge structure for railway to cross over the DFC track and for DFC track to cross over the existing IR tracks, as applicable)
3.	Major Bridge	Having either a total linear waterway[1] of 18.3 meters (60ft) or more or they have a clear opening[2] of 12.2 meters (40 ft) or more in any one span.
4.	Road Over Bridge (ROB)	Road bridges going over railways,
5.	Road Under Bridges (RUB)	a) Major RUB: A major RUB is a RUB having total linear length of 18.3 meters (60ft.) or more or having a clear opening of 12.2 meters (40ft.) or more in any one span, set under Railways b) Minor RUB: Minor RUB is a RUB having Box culverts or having a total linear length less than 18.3 meters (60ft.) or having a clear opening less than 12.2 meters (40 ft.) in any one span, set under railways,
6.	Minor Bridge	Bridges that do not fall into the above categories and including RCC box culverts and hume pipes
7	Viaduct	A series of spans used to carry a rail over a wide valley, ravines, gorges, low areas, populated areas, to be built instead of high embankment etc.

1. A linear waterway means the length available in the bridge between the extreme edges of water surface at the highest flood level, measured at right angle to the abutment faces. [IRC: 5 – 1985 Standard Specifications and Code of Practice for Road Bridges, Section 1, General Feature of Design];
2. A clear opening means a horizontal distance between faces of piers or an abutment and a pier next to each other.

16.9.3 Design Criteria

The design criteria for the railway bridges shall be as under:

(a) All the bridges shall be designed with ballasted deck. Clearances below Rail Level shall be as per Schedule of Dimensions for Dedicated Freight Corridor (Western) – January 2013.This may be required to be increased for bridges on curved track, with girder spans being of straight geometry.

(b) Design shall be suitable for DFC Loading (32.5 tonne axle load) with PSC sleepers. Load condition includes the live load, earth pressure and longitudinal forces due to braking and traction considering the wind load etc. as per relevant codes.

(c) All the bridges having girders of individual span of 30.5m clear span or below shall be of pre-stressed /reinforced cement concrete only. Use of 'U' girders shall not be permitted. Use of steel composite superstructures shall not be permitted except in case of:

(i) Road Over Bridges; and

(ii) Three Major / Important bridges as specified below, where the Contractor shall have the option of using either PSC Box Girder or Under Slung Steel Composite Girder superstructure of 45.7m span

d) Major Bridge No. 222 at Chainage 138/885.393 (in Section 5) across Vishvamitry River

e) Important Bridge No. 133 at Chainage 39/894 (in Section 6) across Vatrak River

f) Major Bridge No. 7 at Chainage 3/250 (in Section 8N) across Narmada Canal

(d) All bridges shall have simply supported spans and shall be designed to accommodate curvature of the track alignment wherever required.

(e) All bridges shall be capable of carrying LWR / CWR as per the provisions of UIC 774-R(3), Code for Track / Bridge Interaction – Recommendations for calculations or any other International Code and practice applicable to conditions available on the project.

(f) Railway bridges shall be designed as per the Design Criteria specified herein, IRS Bridge Rules and IRS Code of Practice for Plain, Reinforced & Prestressed Concrete for General Bridge Construction (Concrete Bridge Code)', IRS Code of Practice for Design of Sub-structure and Foundations of Bridges, IRS Bridge Manual with latest correction slips and other relevant Codes as applicable.

(g) The interaction of continuously welded track and bridge has to be considered in the design of the bridge as per UIC-774(3) R. This may at times be having over-riding consideration for selection of the foundations, sub- structure and super-structure. Some of the considerations are as under,

(i) Behaviour under temperature variations

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The length of the rail and bridge deck may expand/contract differently due to different temperature range and coefficient of expansion. The CWR track will however, not contract or expand even at different temperature.

(ii) Behaviour of supports

Resistance of supports to Horizontal displacement

The stiffness of the supports, including its foundations, to displacement along the longitudinal axis of the bridge shall be worked out considering the following,

Δp - the displacement at the head of the support due to elastic deformation

$\Delta\phi$ - the displacement at the head of support due to rotation of foundation at founding level

Δh - the displacement of the support due to the horizontal movement of the foundation

Δa - the relative displacement between the upper and lower parts of the bearing

The absolute and relative displacement of the bridge deck and track, in order to prevent excessive deconsolidation of track ballast have to be limited as per the UIC 774(3)R. the limits are,

- The maximum permissible displacement between rail and bridge deck or embankment under braking/tractive forces is 4mm.

- For the same forces the maximum absolute horizontal displacement of the deck Δ deck is +5 mm. if the rails run across one or both ends of the bridge/embankment transition.

- In case of Continuously welded rails (CWR) with expansion devices on ballasted deck, the maximum permissible absolute horizontal displacement of the deck under the above referred longitudinal loads is 30mm.

(iii) Bending behaviour of the deck

The vertical traffic loads on the bridge generate large track/bridge interaction forces as a result of deck bending, which cause longitudinal displacement of the upper edge of the deck end. These have to be worked out in terms of paragraph 1.3.3 of UIC-774(3)-R. Under vertical traffic load the displacement of the upper edge of the deck end must be limited to maintain ballast stability. Thus, the effect of this displacement must be added to the effect of temperature variations and of braking/ acceleration results. This also results in a maximum permissible value for deck end rotation Δ (ϕH) =8mm.

(h) The Pile foundations and Well foundations shall be designed as per IRS Manual on the Design & Construction of Well and Pile Foundation and IS: 2911 with latest correction slips. Factor of Safety for calculating the ultimate load capacity of the pile shall be as per IS: 2911. The levels of the Pile Caps shall be designed as per the provisions of IRC: 78

(i) No external strands shall be allowed for permanent pre-stress

(j) Footpath/ walkway width shall be provided on either side of Up and Down track. Its width shall not be less than 900mm.

(k) Hand railing for the footpath and maintenance staff platform on bridges shall be in structural steel duly hot dip galvanized. Railing height shall not be less than 750mm for the footpath and 900mm for the maintenance staff platform / refuge. The design

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shall be such that it can be easily maintained and replaced, if required.

(l) Fe 500 grade steel conforming to IS 1786: 1985 shall be used as reinforcement. Use of protective coatings for steel and corresponding increase in lap lengths shall be decided based on site conditions.

(m) Length of laps shall be as per Specifications and IRS Concrete Bridge Code

(n) Backfill on bridge approaches shall be placed in accordance with "Code of Practice for the Design of Sub-structure and Foundations of Bridges" (IRS). However, Approach Slab, minimum 4 m long shall be provided on all Major Bridges (having superstructure resting on bearings) and shall be designed as per DFC loading standards and shall be consented by the Engineer.

(o) All RCC surfaces, coming in contact with earth, shall be painted with Bitumen or Coal Tar of approved quality @ 1.464 kg/m2

(p) Clear cover to main reinforcement shall be as per the Specifications and IRS Concrete Bridge Code

(q) Depth and size of foundation, return walls, levels of upstream and downstream shall be decided based on site conditions

(r) Tolerances shall be followed as specified in the Specifications and per the IRS Concrete Bridge Code

(s) Grade of concrete shall be as per the exposure conditions as specified in Specifications and IRS Concrete Bridge Code.

(t) Grade of concrete for Plain Cement Concrete (PCC) shall be as specified in Specifications and IRS Concrete Bridge Code.

(u) The Contractor shall provide the earthing bars and earthing lugs as per the design provided by the Other Contractors. A typical arrangement for the same shall be as indicated in Clause 7.2 [Traction earthing] of Employer's Requirements – Functional. The Contractor shall co-ordinate with Other Contractors for the same.

16.9.4 The data like Bridge Length, High Flood Level, Total Waterway and indicative Span Configuration etc. in respect of the proposed bridges for DFC and the existing IR bridges are shown in the indicative General Arrangement Drawings for the Bridges as included in Reference Drawings (Volume V of the Bid Documents). The Bridge Length in respect of all the proposed bridges for DFC have been provided in the Attachment 2 to the Scope of Work (included in Employer's Requirements – Functional). While designing the bridges, it shall be obligatory that in case of parallel section, the Total Bridge Length and High Flood Level for an individual bridge for DFC tracks shall not be less than that of the corresponding IR bridge. Also the Span Configuration for the proposed bridges shall be such that it does not obstruct the span configuration of the corresponding IR bridge.

16.9.5 In case the bridge is at a location where the Right of Way is restricted, special type of abutment / pier / return wall / wing wall shall have to be proposed subject to consent of the Engineer

16.9.6 Adequate arrangement shall be made on the bridges for passage and protection of all the cables including that of Signalling & Telecommunication cables as required. All the Bridges (except for open deck bridges) shall be provided with cable ducts boxes of size 300mmX300mm (clear inside dimensions) on both outer sides. The Contractor shall co-ordinate with the Other Contractor (Signaling & Telecommunication contractor) for the same. At the places where provision and protection of Signaling & Telecommunication cables is proposed, the same shall also be provided for Electrical cables.

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16.9.7 Bridges shall be designed and provided among others with the followings

(a) Safety Refuge, Maintenance Staff Refuge / Platform in case of all Major Bridges / Viaducts / RUBs / RFOs of length more than 50m

(b) Supports for locating OHE mast

(c) Lighting in case of bridges in the urban areas

(d) Signages / Bridge Plaques

(e) Inspection steps at approaches / ladders (duly hot dip galvanized) to the bearing area.

(f) Drainage arrangement at deck

(g) Wearing course at bridge deck

(h) Bridge bearings

(i) Jacking arrangements for spans

(j) Earthquake restraints

(k) Expansion joints

16.10 Loading for Railway Bridges

16.10.1 General

The design loading accommodating DFC Loading (32.5 ton axle load) shall be applied to the design of the Civil Works. To the design of the Track Works, however, 25 ton axle load shall be applied.

The loading standards applied to the Railtrack Structures and Railtrack Formations shall generally be in accordance with **Bridge Rules [second reprinting 2008, incorporating correction slips upto 39]** and Bridge Design Manual [1998] along with the latest Correction Slips issued by Research Design and Standards Organization, Ministry of Railways, Government of India, upto 28 days prior to the submission of the Bid Proposals, as specified in Clause 2.1 [Introduction] of specifications (Volume III of the Bid Documents).

The design loading accommodating 32.5 ton axle load is further described below for the structure designs of the Civil Works under the Contract.

16.10.2 Superimposed Dead Load

The Contractor shall propose the superimposed dead load to be applied in this Contract to the Engineer for review. The Contractor shall coordinate with the Other Contractors in the early stage of the design phase and confirm the superimposed dead load with respect to the works carried out by the Other Contractors.

The Employer is in the process of appointing Other Contractors (System Contractors). Until the time Other Contractors (System Contractors) are in position, it may not be possible for the Contractor to coordinate with Other Contractors in early stage of Design Phase for confirming the superimposed dead load. In such eventualities, the Contractor shall liaison with the Engineer for superimposed dead loads or any other design coordination issue.

The superimposed dead load to be applied to the structures shall include, but not necessarily limited to;

(1) Running rails including guard rails
(2) Sleeper including rail fastenings
(3) Concrete bed, if applicable

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(4) Concrete trough (with cables inside)
(5) Parapet and railing
(6) Overhead Equipment (OHE)
(7) Wearing Coat
(8) Ballast
(9) Walkways
(10) Transformers (if any, for Important / Major Bridges / Viaduct)
(11) Signalling and Telecommunication cables and signaling and telecom track side equipment, if any, including but not limited to signal post, track circuit equipment etc. for Important / Major Bridges / Viaduct

Weight of Ballast, Rails and Sleepers etc. shall be increased by 20% for design.

16.10.3 Railway Live Loads

(1) Limit State Design

As per Clause no. 10 of IRS Concrete Bridge code, the structures shall be designed for following limit state concept:

(i) Ultimate Limit State

(ii) Serviceability Limit State

The design of RCC elements shall be carried out by Ultimate Limit State concept as per Clause no 10.3 of IRS Concrete Bridge Code.

For serviceability limit state RCC elements shall be checked for permissible crack widths as per Clause 10.2.1(a) of IRS Concrete Bridge code.

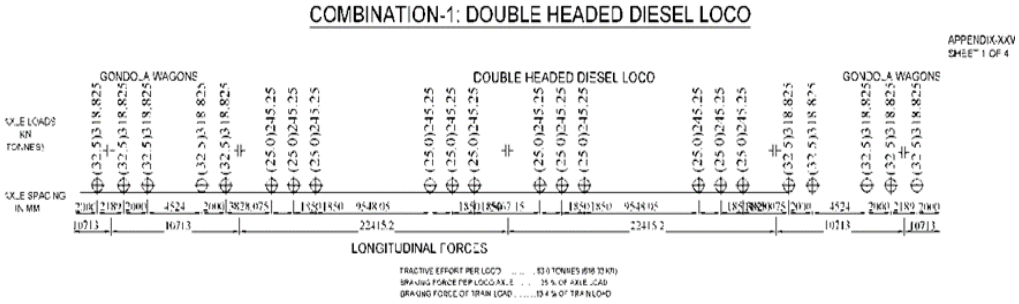
Application of the live load shall be strictly complied with the IRS Bridge Rules and other bridge design Codes as applicable.

(2) **Nominal Loads**

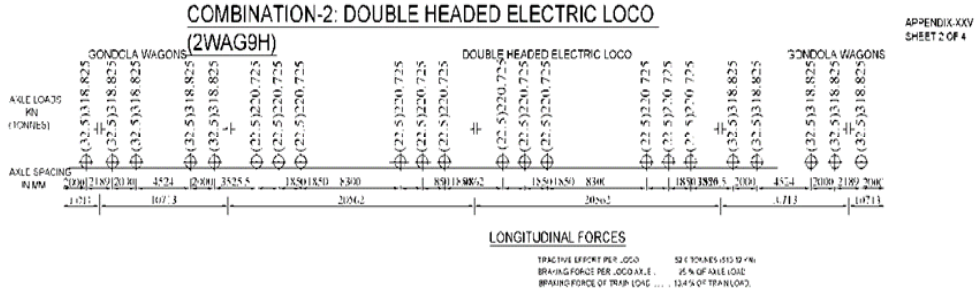
(i) **Static Loading**: The nominal loading for the design of members shall comprise fully loaded locomotive(s) and wagons each having four, six and eight axles as shown in the Bridge Rules [DFC Loading (32.5t Axle Load)] .

Five (5) different combinations of the coupled locomotive(s) and wagons (as indicated below in **Figure ERD-2** below) shall be applied to the structure so as to give the most adverse effect on the element being considered. Note that the loading due to rolling stock may be modified, therefore the Contractor shall confirm the finalized rolling stock with the Other Contractors prior to commencement of the Technical Design.

Figure ERD-2: Five Different Load Combinations



"DFC LOADING (32.5t AXLE LOAD)"



"DFC LOADING (32.5t AXLE LOAD)"

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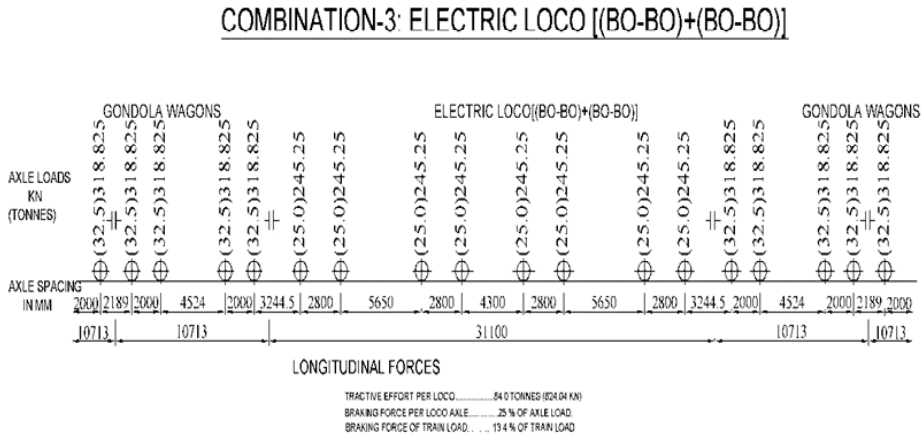
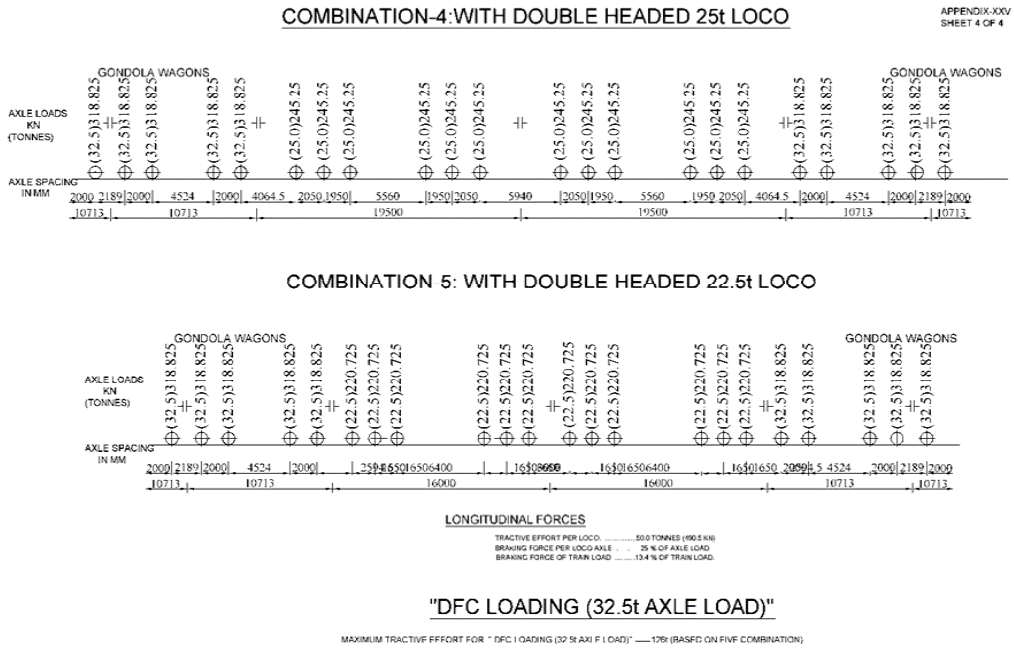


"DFC LOADING (32.5t AXLE LOAD)"



(ii) **Dynamic Loading**: The Static Loading given above shall be multiplied by an appropriate dynamic factor as detailed in Clause 2.4 [Dynamic Effect] of the Bridge Rules.

(iii) **Longitudinal Braking and Traction Loads**: Longitudinal loads from braking and traction shall be in accordance with Clause 2.8 of [Longitudinal Effects] of the Bridge Rules. Five (5) different combinations of the coupled locomotive(s) and wagons as prepared for the DFC Loading (32.5t Axle Load) shall be considered.

Traction Effort per Loco:	63t (618.03 kN), 52t (510.12 kN) or 84t (824.04 kN) depending on the combination
Braking Force of Loco Axle:	25% of Axle Load
Braking Force of Train Load:	13.4% of Train Load

(iv) **Centrifugal load**: The centrifugal load shall be calculated in accordance with in Clause 2.5 [Forces due to Curvature and Eccentricity of Track] of the Bridge Rules.

(3) **Wind Loading**

The bridge structure shall be designed for wind loading in accordance with Clause 2.11 [Wind Pressure Effect] of the Bridge Rules.

(4) **Temperature Loading**

The bridge structure shall be designed for temperature loading in accordance with Clause 2.6 [Temperature Effect] of the Bridge Rules. Overall temperature and differential temperature shall be determined and applied as loading based on the variation of temperature assumed by the Contractor taking into account of all conceivable conditions on each objective structure. The temperature limits as specified in Clause 218 of IRC: 6-2000 shall be adopted

(5) **Seismic Loading**

The bridge structure shall be designed for seismic loading as per seismic zone for the area in which the proposed bridge is located and in accordance with Clause 2.12 [Force and Effects due to Earthquake] of the IRS Bridge Rules. Appendix XV of IRS Bridge Rule may also be referred in this regard.

(i) Provisions for Ductile Detailing of Reinforcement and Bearing Seating Dimensions

The following clauses may be added in IRS-Bridge Rules:

2.12.9 - The reinforced and prestressed concrete components shall be under-reinforced so as to cause a ductile failure. Further, they should be designed to ensure that premature failure due to shear or bond does not occur. Provisions for appropriate ductile detailing of reinforced concrete members given in Appendix- (A) shall be applicable to substructures. Bridges shall be designed such that under severe seismic shaking plastic hinges form in the substructure, rather than in the deck or the foundation.

2.12.9.1 - Masonry and plain concrete arch bridges with spans more than 12m shall not be built in the seismic zones IV and V.

2.12.9.2 Conceptual Considerations

Conceptual design suggestions in terms of configuration, superstructure, substructure and ground conditions are given in Table below, along with the non preferred types, for which special design and detailing are required. These considerations shall be followed as much as practically possible and a balance shall be maintained between functional requirements, cost and seismic resistance features.

Seismically preferred and not Preferred Aspects of Bridges

	Seismically preferred	Seismically not preferred
	Configuration	
1.0	Straight bridge alignment	Curved bridge alignment
1.1	Normal piers	Skewed piers
1.2	Uniform pier stiffness	Varying pier stiffness
1.3	Uniform span stiffness	Varying span stiffness
1.4	Uniform span mass	Varying span mass
2.0	**Superstructure**	
2.1	a) Simply supported spans	Continuous spans
	b) Integral bridges	
2.2	Short spans	Long spans
2.3	Light spans	Heavy spans
2.4	No intermediate hinges within	Intermediate hinges
	span	
3.0	**Substructure**	
3.1	Wide seats	Narrow seats
3.2	Multiple column	Single column
4.0	**Ground conditions**	
4.1	Stiff, Stable soil	Unstable soil

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2.12.9.3 - Vertical Hold-Down Devices

In zone IV and V, vertical hold-down devices shall be provided at all supports where resulting vertical force due to the maximum elastic horizontal and vertical seismic forces opposes and exceeds 50% of the dead load reaction.

- Where vertical force *U*, due to the combined effect of maximum elastic horizontal and vertical seismic forces, opposes and exceeds 50%, but is less than 100%, of the dead load reaction *D*, the vertical hold-down device shall be designed for a minimum net upward force of 10% of the downward dead load reaction that would be exerted if the span were simply supported.

- If the vertical force *U*, due to the combined effect of maximum horizontal and vertical seismic forces, opposes and exceeds 100% of the dead load reaction *D*, then the device shall be designed for a net upward force of *1.2(U-D)*; however, it shall not be less than *10%* of the downward dead load reaction that would be exerted if the span were simply supported.

2.12.9.4-Horizontal Linkage Elements

In case of Railway Bridges, Track and guard rail are likely to provide good resistance to sliding and overturning of spans.

2.12.9.4.1 - Reaction blocks (or seismic arrestors) when used as anti-dislodging elements shall be designed for seismic force equal to 1.5 times the elastic seismic coefficient multiplied by tributary weight of spans corresponding to that pier/abutment.

2.12.9.5 Minimum Seating Width Requirements

The widths of seating *W* (in *mm*) at supports measured normal to the face of the abutment/pier/pedestal of bearings/restrained portion of superstructure from the closest end of the girder shall be following:
(a) the value specified below:

$$W = \begin{cases} 300 + 1.5L + 6Hp \text{ for seismic zones II and III} \\ 500 + 2.5L + 10Hp \text{ for seismic zones IV and V} \end{cases}$$

where

L = Length (in meters) of the superstructure to the adjacent expansion joint or to the end of superstructure. In case of bearings under suspended spans, it is sum of the lengths of the two adjacent portions of the superstructure. In case of single span bridges, it is equal to the length of the superstructure.

For bearings at abutments, Hp is the average height (in meters) of all columns supporting the superstructure to the next expansion joint. It is equal to zero for single span bridges. For bearings at columns or piers, Hp is the height (in meters) of column or pier. For bearings under suspended spans, Hp is the average height (in meters) of the two adjacent columns or piers. Graphical representation of seating widths is shown in Fig. below,

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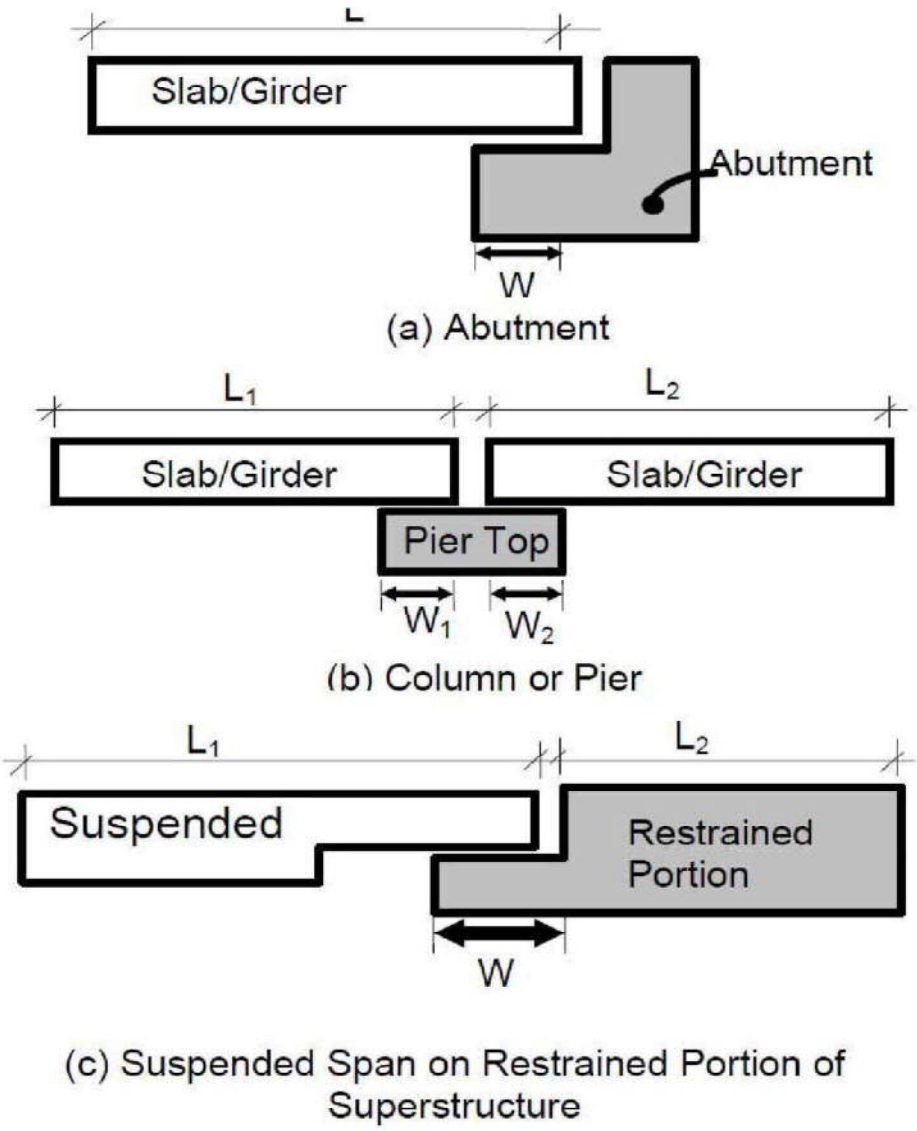

Fig.: Minimum Width of Seating of Spans on Supports

Appendix – (A) Ductile Detailing Specifications

1. General

The detailing rules given have been chosen with the intention that reliable plastic hinges should form at the top and bottom of each pier column, or at the bottom only of a single stem pier under horizontal loading and that the bridge should remain elastic between the hinges (Fig. A-1). The aim is to achieve a reliable ductile structure. Repair of plastic hinges is relatively easy.

Design strategy to be used is based on assumption that the plastic response will occur in the substructure. However, in case of a wall type substructure, the nonlinear behaviour may occur in the foundation-ground system.

2. Specification

2.1 Minimum grade of concrete should be M25 (f_{ck} = 25 MPa).

2.2 Steel reinforcement of grade Fe 415 (see IS 1786: 2008) or less only shall be used. However, high strength deformed steel bars of grades Fe 500 & FE 550, having elongation more than 14.5 percent and conforming to other requirements of IS 1786 : 2008 may also be used for the reinforcement.

3. Layout

(a) The use of circular column is preferred for better plastic hinge performance and ease of construction.

(b)The bridge must be proportioned and detailed by the designer so that plastic hinges occur only at the controlled locations (e.g., pier column ends) and not in other uncontrolled places.

4. Longitudinal Reinforcement

The area of the longitudinal reinforcement shall not be less than 0.8 percent nor more than 6 percent, of the gross cross section area A_g. Splicing of flexural region reinforcement is not permitted in the plastic hinge region. Lap shall not be located within a distance of 2 times the maximum column cross-sectional dimension from the end at which hinging can occur. The splices should be proportioned as a tension splice.

4.1 Curtailment of longitudinal reinforcement in piers due to reduction in seismic bending moment towards top.

4.2 The reduction of longitudinal reinforcement at mid-height in piers should not be carried out except in tall pier.

4.3 In case of high bridge piers such as of height equal to 30m or more, the reduction of reinforcement at mid height may be done. In such cases the following method should be adopted:

(i) The curtailment of longitudinal reinforcement shall not be carried out in the section six times the least lateral column dimension from the location where plastic hinge is likely to occur.

(ii) The interval between hoop ties is specified to be less than 150mm in a reinforcement position. The interval between hoop ties shall not change abruptly, the change must be gradual.

5. Transverse Reinforcement

The transverse reinforcement for circular columns shall consist of spiral or circular

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hoops. Continuity of these reinforcements should be provided by either (Fig. A-2(a) or A-2(b)):

(a) Welding, where the minimum length of weld should be 12 bar diameter, and the minimum weld throat thickness should be 0.4 times the bar diameter.

(b) Lapping, where the minimum length of lap should be 30 bar diameters and each end of the bar anchored with 135° hooks with a 10 diameter extension into the confined core.

Splicing of the spiral reinforcement in the plastic hinge region should be avoided.

In rectangular columns, rectangular hoops may be used. A rectangular hoop is a closed stirrup, having a 135° hook with a 10 diameter extension at each end that is embedded in the confined core (Figure A-2(c). When hoop ties are joined in any place other than a corner the hoop ties shall overlap each other by a length 40 bar diameter of the reinforcing bar which makes the hoop ties with hooks as specified above.

Joint portion of hoop ties for both circular and rectangular hoops should be staggered.

6. Design of Plastic Hinge Regions

6.1 Seismic Design Force for Substructure

Provisions given in this Appendix for the ductile detailing of RC members subjected to seismic forces shall be adopted for supporting components of the bridge. The design shear force at the critical section(s) of substructures shall be the lower of the following:

(a) Maximum elastic force at the critical section of the bridge component divided by the response reduction factor for that component (refer Table 1).

(b) Maximum shear force that develops when

(i) the substructure has maximum moment that it can sustain (*i.e.,* the overstrength plastic moment capacity as per Clause 6.2) in single-column or single-pier type substructure.

(ii) plastic moment hinges are formed in the substructure so as to form a collapse mechanism in multiple-column frame type or multiple-pier type substructures, in which the plastic moment capacity shall be the over strength plastic moment capacity as per Clause 6.2.

In a single-column type or pier type substructure, the critical section is at the bottom of the column or pier as shown in Figure A-1(a) and, in multi-column frame-type substructures or multi-pier substructures, the critical sections are at the bottom and/or top of the columns/piers as shown in Figure A-1(b).

6.2 Over strength Plastic Moment Capacity

The over strength plastic moment capacity at a reinforced concrete section shall be taken as 1.3 times the ultimate moment capacity based on the usual partial safety factors recommended by relevant design codes for materials and loads, and on the actual dimensions of members and the actual reinforcement detailing adopted.

6.3 Special Confining Reinforcement:

Special confining reinforcement shall be provided at the ends of pier columns where plastic hinge can occur. This transverse reinforcement should extend for a distance from the point of maximum moment over the plastic hinge region over a length *l0*. The length *l0* shall not be less than,

(a) 1.5 times the column diameter or 1.5 times the larger cross sectional dimension where yielding occurs

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(b) 1/6 of clear height of the column for frame pier (i.e. when hinging can occur at both ends of the column)

(c) 1/4 of clear height of the column for cantilever pier (i.e. when hinging can occur at only one end of the column)

(d) 600 mm

6.4 Spacing of Transverse Reinforcement

The spacing of hoops used as special confining reinforcement shall not exceed

(i) 1/5 times the least lateral dimension of the cross section of column,

(ii) 6 times the diameter of the longitudinal bar,

(iii) 150 mm

The parallel legs of rectangular stirrups shall be spaced not more than 1/3 of the smallest dimension of the concrete core or more than 350 mm centre to centre. If the length of any side of the stirrups exceeds 350 mm, a cross tie shall be provided. Alternatively, overlapping stirrups may be provided within the column.

6.5 Amount of Transverse Steel to Be Provided

6.5.1 The area of cross section, A_{sh}, of the bar forming circular hoops or spiral, to be used as special confining reinforcement, shall not be less than

Ash = 0.09SDk [Ag/Ac – 1.0] fck/fy

Or

Ash = 0.024SDk fck/fy

whichever is the greater

where

A_{sh} = area of cross-section of circular hoop

S = pitch of spiral or spacing of hoops in mm

D_k = Diameter of core measured to the outside of the spiral or hoops in mm

f_{ck} = characteristic compressive strength of concrete

f_y = yield stress of steel (of circular hoops or spiral)

A_g = gross area of the column cross section

Ac= Area of concrete core π/4 Dk^2

6.5.2 The total area of cross-section of the bar forming rectangular hoop and cross ties, A_{sw} to be used as special confining reinforcement shall not be less than

$$A_{sw} = 0.24Sh\left[\frac{A_g}{Ar} - 1.0\right]\frac{f_{ck}}{f_y}$$

Or,

$$A_{sw} = 0.096Sh\frac{f_{ck}}{f_y}$$

whichever is the greater

where

h = longer dimension of the rectangular confining hoop measured to its outer face
A_r= Area of confined core concrete in the rectangular hoop measure to its outer side dimensions.

Note: Crossties where used should be of the same diameter as the peripheral hoop bar and A_r shall be measured as the overall core area, regardless the hoop area. The hooks of crossties shall engage peripheral longitudinal bars.

6.5.3. Unsupported length of rectangular hoops shall not exceed 300mm.

6.5.4. For ductile detailing of hollow cross-section of pier special literature may be referred. Some of the provisions for hollow RC piers are:

i) For hollow cylindrical piers, in the plastic hinge region, the ratio of internal diameter to thickness should not exceed 8.0.

ii) For wall type hollow piers, in the plastic region, the ratio of clear width of the wall to thickness should not exceed 8.0.

7. Design of Components between the Hinges

Once the position of the plastic hinges has been determined and these regions detailed to ensure a ductile performance, the structure between the plastic hinges is designed considering the capacity of the plastic hinges. The intention here is:

(i) To reliably protect the bridge against collapse so that it will be available for service after a major shaking.

(ii) To localize structural damage to the plastic hinge regions where it can be controlled and repaired.

The process of designing the structure between the plastic hinges is known as "capacity design"

7.1 Column Shear and Transverse Reinforcement

To avoid a brittle shear failure design shear force for pier shall be based on overstrength moment capacities of the plastic hinges and given by:

$$V_u = \frac{\sum M_O}{h}$$

where

$\sum M_O$ = the sum of the overstrength moment capacities of the hinges resisting lateral loads, as detailed. In case of twin pier this would be the sum of the overstrength moment capacities at the top and bottom of the column. For single stem piers the overstrength moment capacity at the bottom only should be used.

h = clear height of the column in the case of a column in double curvature; height to calculated point of contra-flexure in the case of a column in single curvature.

Outside the hinge regions, the spacing of hoops shall not exceed half the least lateral dimension of the column, nor 300 mm.

8. Design of Joints:

Beam-column joints should be designed properly to resist the forces caused by axial loads, bending and shear forces in the joining members. Forces in the joint should be determined by considering a free body of the joint with the forces on

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the joint member boundaries properly represented.

The joint shear strength should be entirely provided by transverse reinforcement. Where the joint is not confined adequately (i.e. where minimum pier cap and pile cap width is less than three column diameters) the special confinement requirement should be satisfied.

8.1 Ductility of all the joints in the structure may be ensured by offsetting the splices / couplers where the area of reinforcement provided is at least twice the area required by analysis staggered 600 mm minimum.

8.2 The pier-foundation joint or the slab-pier joint (in case of integral slab bridges) must be checked for principal tensile stress in the concrete around the junction, following an appropriate prevailing method. The un-cracked joint may be designed by keeping the principal stresses in the joint region below direct tensile strength of concrete. If the joint cannot be prevented from cracking, additional vertical stirrups may be added to the external concrete region around the column.

The joint stresses may be assumed to disperse 45º around the column as per prevailing practices.

Table 1: Response Reduction Factor *R* for Bridge Components and Connections

	R
Substructure	
RCC Piers with ductile detailing	
- Single Column, Wall Type	2.5
- Frame Type	3.25
RCC Piers without ductile detailing	
- Single Column, Wall Type	2
- Frame Type	2.5
Steel Framed Construction	2.5
Steel Framed Piers (with properly designed cross bracings)	3.5
Masonry/PCC piers (unreinforced)*	1.5
RCC Abutment	2
Masonry/PCC Abutment	1.5
Connections (including bearings)	
Superstructure to abutment	0.8
Superstructure to column or pier	1
Columns or piers to foundations	1
Expansion joints within a span of the superstructure	0.8
Superstructure	1
Foundations **	1.5

* This pier is not allowed in seismic zone IV and V

** For stability analysis of well foundation by conventional method, seismic forces can be further reduced by a factor of 2.0.

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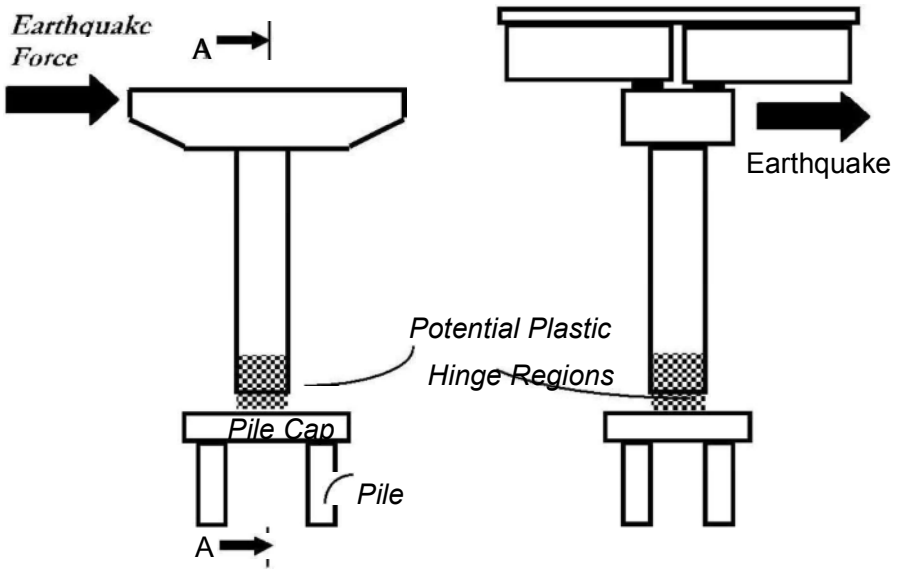
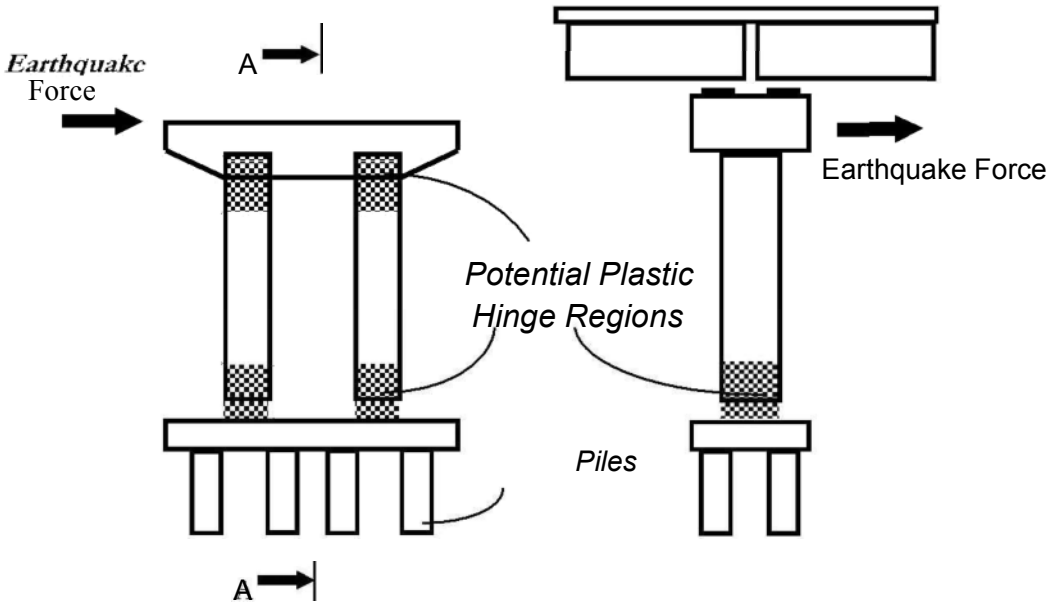


Elevation **Section AA**

(a) Single column or pier type substructures



Elevation **Section AA**

(b) multi-column or frame type substructures

Fig. A-1: Potential location of plastic hinges in substructures

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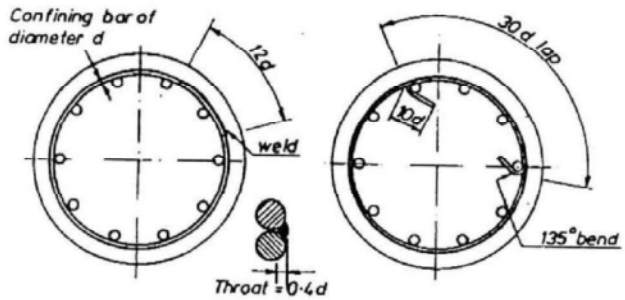
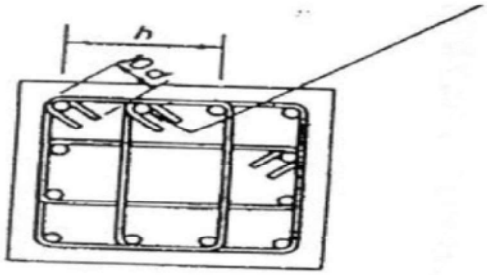


a) Welding in Circular hoops **(b) Lapping in circular hoops**



(c)Rectangular hoops

Fig. A-2: Transverse reinforcement in column

(6) **Other Loadings**

(i) **Derailment Loading**

Derailment Loading applied to the bridge structures shall be in accordance with Clause 2.14 [Derailment Loads] of the Bridge Rules.

(ii) **Racking Forces**

The bridge structure shall be designed for Racking Forces in accordance with Clause 2.9 [Racking Forces] of the IRS Bridge Rules.

(iii) **Construction Loads**

During construction stage, dead loads shall include but not limited to weight of form work, fixed appendages and stored material. The dead weight of mobile equipment that shall be fixed at a stationary location for long durations shall also be considered.

Live loads during construction stage shall include but not limited to the weight of workers and all mobile equipment, such as vehicles, hoist, cranes, and structure components used during the process of erection.

(iv) **Accidental Load**

Collision loads on Piers: Piers or other guide ways support elements that are situated on the edges should be designed to withstand the horizontal static forces, unless protected with suitable barriers.

This condition occurs with the dead load of structures but does not need to be applied concurrently with other applied loads.

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(v) **Rail Structure Interaction**

The continuous welded rail is stressed by temperature variation and by local loads due to the train wheels. The Rail Structure interaction has to be worked out as per UIC- 774-3R Code or any other International Code and practice applicable to conditions available on the project. This governs:

a) The possible location of structural expansion joints;

b) The maximum rotation of bridges at structural expansion joints

c) The possible displacements under traction / braking forces and rigidity (sizes, shapes) of foundations, pier shafts and bearings

d) Stress induced in the rail and bridge elements by interaction over and above the normal stresses due to live load, temperature variation, curved track etc.

In general it is desirable to eliminate the number of expansion joints in the rails. There is a limit to the relative longitudinal movement that can be tolerated between the deck and the rail and this shall be one of the criteria that govern the position of structural joints and design of Bridge foundation and sub-structure

(vi) **Footpath / Walkways on Bridges**

Consideration of the loads due to pedestrian traffic as indicated in Clause 2.3.2 [Footbridges and Footpath on Bridges] of the IRS Bridge Rules shall be taken into account.

(vii) In addition to the above the following forces shall also be considered for design of structures:

(a) Live Load Surcharge

(b) Frictional resistance for expansion bearing

(c) Erection Forces and their Effects

(d) CWR/ LWR Loads on Bridge

(e) Plassers Quick Relay System (PQRS)

(f) Earth Pressure (as per Clause 5.7 of IRS "Code of Practice for design of Sub-structure and foundations of Bridges"

(g) Earth pressure due to surcharge, on abutments, on return walls, on wing walls

(h) Earth Pressure due to Seismic Effects

(i) Light water pipe and other services (the weight to be considered @ 1000kg/RM for design purpose)

(7) Load combinations

The load combinations are adopted as per Clause 11.2 of IRS Concrete Bridge Code. Partial safety factors for ultimate limit state of collapse and for serviceability limit state for different load combinations shall be considered.

In case of steel bridges having steel composite superstructures, the worst combinations possible of dead load with live load, impact effect and forces due to curvature and eccentricity of track. Longitudinal and racking forces due to live load are deemed to be included in live load wherever applicable, as per clause 3.2 of IRS-Steel Bridge Code for design of Steel Superstructure.

For design of Foundations and sub-structure and the load combinations shall be as per clause 5.13 of IRS-Foundation and Sub-structure Code. For other elements of the bridge, relevant code of practice shall be used

(8) Load combinations for Box Culvert Bridges

The box culverts are subjected to earth pressure from outside, water pressure from inside, surcharge due to earth fill, permanent way and live load in addition to dead loads and live loads.

(9) Idealization of Structure

The IRS codes provide a simplified approach to design and analysis of steel bridges, amenable to hand calculations. For the computer calculations, the structures may be idealized as plain frame/ space frame with loadings in vertical and horizontal directions where applicable. The nodes at founding level shall be idealized as spring supports considering elastic soil springs.

(10) Soil Structure Interaction Modeling and Analysis Procedure:

Where the soil structure interaction is to be considered, the soil shall be idealized as a classical Winkler foundation - beam on springs. The soil passive resistance is considered to be offered by linear elastic springs. Spring constants for the bottom raft are calculated based on modulus of sub grade reaction of the soil strata. After performing the analysis, the forces in the springs shall be compared with the allowable bearing pressure.

16.10.4 Differential Settlements

Consideration of the forces resulting from differential settlement shall be made where the nature of the chosen foundation system and the ground conditions indicate that such a condition may arise. The effects of differential settlement between adjacent structures shall be assessed in accordance with followings;

Differential settlement between adjacent structures shall be evaluated and due allowance incorporated into the size of the structures and detailing of joints to ensure that the Structure Gauge is not infringed within the design life.

16.10.5 Safety Against Deformation and Differential Settlements

The foundation should deform within acceptable limit of total and differential settlements. These acceptable limits depend on the type of structures and substrata involved and should be decided judiciously. The settlement shall not normally exceed 25mm after the end of the construction period for bridges with simply supported spans.

In case of structures sensitive to differential settlement, the tolerable settlement limit has to be fixed based on the conditions in each case.

16.10.6 Bridge foundations with open excavation such as raft, isolated footing, Box –culverts, slab culverts, pipes on BCS sub-soil shall be permitted only after improving the sub-soil conditions as per Clause 5.9.4 of the specifications (Vol. III of bid documents). The permitted residual settlement at foundation level, after completion of "Integrated testing and commissioning" shall be limited to 50mm.

16.11 Design of Road Under Bridges (RUBs), Pedestrian Subways & Box Culverts with Railway Loading

16.11.1 Primary Loads

In addition to the above loads in Clause 16.10 above, following loads due to Highway vehicles shall be considered on the base slab for the design of RUB's as per IRC 6: 2000

(1) The design shall cater for the loading standards as applicable to the type of the existing road or Class A / Class 70R loading as per Table 2 of IRC 6 -2000 as the case may be. The impact forces shall be considered as per Clause : 211 of IRC 6- 2000.

(2) Live load on foot paths: Basic intensity of footpath live load shall be taken as 500 kg/sq m. as per Clause 209.1 of IRC 6-2000.

16.11.2 Load Combination

The load combinations shall be adopted as per Clause 11.2 of IRS Concrete Bridge Code.

16.11.3 Vertical Clearances for RUBs / Pedestrian Subways

(1) The minimum vertical clearances for RUBs / Underpasses for different highways / roads shall be as under

National Highways – 5.5 meter

State Highways – 5.0 meter

Village Roads, other roads and for non-vehicular traffic – 3.6 meter to 4.5 meter (subject to consent of Engineer)

(2) A reference to IRC 54 - 1974 "Lateral and Vertical Clearances At Underpasses for Vehicular Traffic" and IRC 11 - 1962 "Design and Layout of Cycle Tracks" may also be made in this regard.

(3) In parallel section where RUB / Bridge is proposed for passage of vehicular / double decker, it shall have a minimum Vertical Clearance as available under the bridge of adjacent track and as per NOC from State Government/Local Authority.

(4) Vertical Clearance for Pedestrian Sub-ways: Minimum Clear Height of 2.5 meter shall be provided for pedestrian crossings.

16.11.4 Other Requirements

(a) The width of Pedestrian Subways shall not be less than 6m. It shall be provided with ramp and stairs along with hand railing. Width of the ramp shall not be more than 1.5m.

(b) Entire length of the approaches on either side of the Pedestrian Subways shall be provided with fiber glass transparent sheet roofing and ventilation arrangement.

(c) The approaches / approach ramps to the RUBs and Pedestrian Subways shall be of concrete

(d) Suitable Height Gauges shall be provided on both sides of RUBs, in case of detour section and on DFC side of the RUB in case of parallel section and as per the applicable Codes

(e) Crash Barriers / medians / footpaths / railings shall be provided as per the requirements of IRC Codes

(f) Inspection Steps shall be provided wherever required

(g) Lighting shall be provided in case of all the Pedestrian Subways. In case of RUBs, lighting shall be provided for the RUBs in the populated areas.

(h) Signages shall be provided as per applicable Codes / Manuals

(i) Aesthetics design of the RUBs and Pedestrian Subways shall merge with the local environment / surroundings

(j) Drainage system including discharge arrangement

16.11.5 Drainage, Protection Works / Ancillary Works

(1) In case of RUBs and Pedestrian Subways across the Alignment (DFC tracks), suitable drainage system including sump and discharge arrangement (as required) and protection works / ancillary works shall be designed and provided for the same.

(2) In case of RUBs below ground level, and pedestrian subways, it shall also be provided with suitably designed fascia, filter beds etc.

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16.11.6 Design of RCC Box Culvert

(1) Design criteria

In addition to the loading as specified in Clause 16.10 above, design criteria shall be as follow.

(a) The Contractor shall carry out standardization of the sizes and undertake their design as per the Design Philosophy and Design Criteria

(b) Preparation of bed below the culvert shall be based on actual site conditions to achieve the necessary Safe Bearing Capacity.

(c) Barrel length of the culvert shall be decided based on the fill height

(d) Suitable Bed slope shall be provided.

(2) Design load condition for the cast-in-situ single cell box culvert.

(i) Dimensions of the Box - The dimensions of the box refers to the clear inner dimensions. The height of box shall include 150mm thick wearing coat provided inside the box

(ii) Fill Depth - It shall be the height of fill from the bottom of the sleepers to the top of the box fill and shall be inclusive of depth of ballast and depth of soil fill as per Cl. 2.4.2.1, Note 1 of IRS Concrete Bridge Code (CBC)

(iii) SIDL: Weight of Ballast, Rails and Sleepers etc. shall be increased by 20% for design. Ballast depth of 350mm shall be considered for design

(iv) Live Load: The live load and longitudinal forces due to braking and traction shall be taken from IRS Bridge Rules.

(v) Curvature: The design for curvature and cant to be provided shall be as per the Design Criteria for the same as specified above.

(vi) Wind load: The wind load acts only on the live load since the box structure is buried. The over-turning moment due to wind shall be resisted by vertical reactions on the wheels, one upward and the other downward. The increase in vertical reaction due to downward force shall be considered in design since uplift is not an issue in box culverts

(vii) Coefficient of Earth pressure: As per Clause no 5.7 of IRS "Code of Practice for Design of Sub-structures and Foundations of bridges"

(viii) Modeling of supports - The supports are modeled as a series of springs. The spring stiffness shall be calculated by taking a deflection of 25mm under a load of 100kN/m2 to represent soil of poor bearing capacity and 25mm deflection under 1000kN/m2 to represent soil of very good bearing capacity.

16.12 Design of Road Over Bridges (ROBs) and Foot Over Bridges (FOBs)

16.12.1 Design of Road Over Bridges

For design of ROBs, in the Scope of Work of the present Package, the following criteria shall be followed:

(1) The Clearances shall be as specified in Clause 16.5 above. Schedule of Dimensions for Dedicated Freight Corridor (Western) – January 2013 and IR Schedule of Dimensions shall also be referred as applicable

(2) **Primary Load**

The following loads due to Highway vehicles shall be considered as per IRC 6: 2000

(a) The design shall cater for Class A / Class 70R loading as per Table 2 of IRC 6 - 2000. The impact forces shall be considered as per Clause: 211 of IRC 6- 2000.

(b) Live load on foot paths: Basic intensity of footpath live load shall be taken as 500 kg/sq. m. as per Clause 209.1 of IRC 6-2000

(3) Road Over Bridges shall be designed as per the relevant IRC Codes and IS Codes

(4) Road Over Bridges in the populated areas shall have footpaths on either side. Width of the footpaths shall be as per applicable Codes & Standards

(5) Pile Foundations shall be designed as per IS: 2911 and IRC: 78

(6) Expansion joints shall be provided as per the requirements specified in IRC Codes

(7) Approaches / ramps of ROBs shall have stilts and / or Reinforced Earth Wall which shall be designed as per applicable Codes

(8) Surfacing / Road work shall be designed as per applicable IRC Codes and Standards

(9) **Other Requirements**

(a) Lighting shall be provided in case of bridges in the populated areas

(b) Signages shall be provided as per applicable Codes & Standards

(c) Aesthetics design of the ROBs shall merge with the local environment / surroundings

(d) Protective screens along parapets of the ROBs with 25 kV caution boards as per Specifications and applicable standards

16.12.2 Design of Foot Over Bridges (FOBs)

For the design of Foot Over Bridges, the following criteria shall be followed

(1) The Clearances shall be as specified in Clause 16.5 above. Schedule of Dimensions for Dedicated Freight Corridor (Western) – January 2013 and IR Schedule of Dimensions may also be referred as applicable.

(2) FOB shall be designed as per IR Works Manual

(3) Width of FOBs as specified in **Attachment 2** (including Attachment 2.1.8 and 2.2.8) to the Scope of Work shall be the clear width of the FOB

(4) Lighting shall be provided for all the FOBs as per applicable Codes & Standards

(5) Signages shall be provided as per applicable Codes & Standards

(6) Protective screens along parapets of the FOBs with 25 kV caution boards as per Specifications and applicable standards

16.13 Bridge Bearings and Movement Joints

Bridge bearings and movement joints shall have a minimum design life of 50 years apart from minor components which can be replaced without complete removal and without interruption to traffic. Such components shall have a service life of 20 years.

(1) Movement Joints

Movement joints and other necessary measures to control shrinkage and thermal effects shall be incorporated in the structural design so that the performance of architectural finishes or of any services are not adversely affected during normal working conditions. Movement joints shall be designed to be easily maintained and replaceable.

(2) Bearings

a) All bearings shall be replaceable without major disruption to railway operating or to any activity underneath the bridge. Bearings shall be placed on bearing pedestals designed in accordance with applicable Codes. Appropriate jacking points on the pier / abutment cap as well as on the girders shall also be provided. For railway bridges to be suitable for carrying Continuous Welded Rails, normally it is essential that the spans are provided with fixed bearings (not permitting longitudinally / transverse movement but allowing only rotation) on one end and free bearing (permitting longitudinal movement as well as rotation) on other end

b) Where Elastomeric bearings are to be used, design of bearing shall be carried out as per UIC – 772 (R). For span less than or equal to 30.5m, Elastomeric Bearings with provision of appropriate mechanism to restrict the longitudinal/transverse movement and permitting only rotation at one end of span. For span greater than 30.5, Spherical Bearings shall be provided.

c) In case of steel truss railway bridges (if required):

(i) The "Spherical Bearings" are best suited for steel truss railway bridges allowing for rotation both in transverse and longitudinal direction and shall be provided as per the Specifications, detailed in Clause 14.11 [Bearings for Steel Bridges] of the Specifications (Volume III of Bid Documents).

(ii) This work shall consist of design supply and fixing in position of bearings for bridges truss girders in accordance with details shown on drawings and to the requirements of the Specifications (Volume III of the Bid Documents), codes and standards quoted therein and as consented by Engineer.

(iii) Bearing plates, assemblies and other expansion or fixed devices shall be constructed in accordance with details shown on drawings.

(iv) When bearing assemblies or plates are shown on drawings to be placed (not embedded) directly on concrete, the concrete bearing area shall be constructed slightly above grade and shall be finished by grinding.

(v) It shall be ensured that the bearings are set truly level and in exact position as indicated on drawings so as to have full and even bearing on the seats. This shall be checked with spirit level in both directions. Thin epoxy mortar pads (not exceeding 5 mm) may be made to meet with this requirement.

(vi) It shall be ensured that the bottoms of truss girders to be received on the bearings are plane at the location of these bearings and care shall be taken that the bearings are not displaced while placing the girders.

(3) Bearing Inspection Platform

Bearing inspection platforms shall be provided along with access ladder from bridge deck to ensure the safe access to monitor the bearing inspections.

16.14 Wayside Signs

The Contractor shall design and install the Wayside Signs in accordance with the requirements as specified in relevant IRS Codes and Manuals. The list of the Wayside Signs indicated herein below and in the Reference Drawings is not exhaustive and the Contractor shall provide all the Wayside Signs as per the IRS Codes and Manuals as applicable. Details of these signs shall be developed and submitted to the Engineer as part of the Technical

Design for consent. The Contractor shall take into account the visibility of the signs (in particular by the locomotive drivers); their stability (support post and foundations); durability and maintenance aspects. Design of reflective-type signs, incorporating clear numerals, located on non-corrosive supports, with parallel and perpendicular to the track as indicated in the Reference Drawings shall be developed in accordance with the requirements of relevant IRS Codes and Manuals.

(1) **Kilometer Post:** Kilometer Posts shall be located at every km point along the alignment on the left hand side of the track toward the termination of DFC line. The distance from the Zero Chainage shall be shown in numerals increasing from Zero to the termination engraved 6 mm deep on both sides of the post.

(2) **Hectometer Post:** Hectometer posts shall be located at every 100m between the Kilometer Posts. Letters in numerals are engraved 6 mm deep on both sides of the post.

(3) **Gradient Post:** Gradient posts shall be located at every change of gradient along the vertical alignment on the left hand side of the track toward the termination of DFC line. Letters showing forthcoming gradients shall be engraved 6 mm deep on both sides of the post as indicated in the Reference Drawings.

(4) **Curve Board:** Curve boards shall be located at the middle point of a horizontal curve. They shall include Curve Number, Radius of Curvature, Cant, Circular Curve Length and Tangent Curve Length, which shall be embossed onto a metal plate, or similar as indicated in the Reference Drawings.

(5) **Transition Curve Post:** Transition posts shall be located at the beginning and end of each transition curve. Letters painted in white indicating “BTC” or “ETC” are engraved in front of a black- painted wooden post with the Chainage written on the back side in the same way.

(6) **Fouling Mark:** Fouling marks shall be located between two converging tracks within the ballast to indicate the safe stabling limit for trains approaching the convergence point. This point shall ensure that no contact shall be made with a train passing on the adjacent track. Its location shall be based on the width of the MMD as described in the Specifications between the two track centre lines. The letters “FM” shall be engraved 6 mm deep on the marker as indicated in the Reference Drawings.

(7) **Bridge Number Plaque:** Bridge number plaques showing the bridge number which shall be embossed onto a metal plate, or similar shall be attached diagonally on the top surface of the both abutments as indicated in the Reference Drawings.

(8) **Inscription Plaques on Bridges :** Inscription plaques on all bridges of span 3.0m and above showing nature and depth of foundations shall be inscribed on cement concrete or stone slab fixed on each pier and abutment as per Indian Railway Bridge Manual para 1103.4

(9) **Flood Gauges :** Flood gauges with marking of danger level and HFL shallbe painted on each of the abutment and every fourth pier in case of multi-span bridges as per IRS Manuals

(10) **Station Name Board:** Station Name Boards (which shall be provided at both ends of the Station and at the Station Building) on which the name of the station shall be embossed onto a metal plate, or similar shall be placed at both ends of the Station at the main Station Building in the station area facing to the Main Line and shall comprise a metal plate, a metal frame supported on steel posts, or similar as indicated in the Reference Drawings. The Name shall be written in English and Hindi.

(11) **Rail Posts Indicating Tangent Points:** On the inside of the curve, rail posts shall be erected on each approach of the curve, to indicate the positions of the beginning and end of transition curves. These rail posts may be painted in red and white colours respectively.

(12) **Indication of Cant on Track:** Super-elevation or Cant shall be indicated by painting its value on the inside face of the web of the inner rail of the curve and at every versine

station, beginning with zero at the commencement of the transition curve. The value of Cant shall be indicated on the circular curve at its beginning and at the end. In the case of long circular curve the cant value shall be indicated at intermediate stations at a distant not exceeding 250 metres

(13) **Whistle indicator:** Whistle boards shall be provided at the rear of all places where the view of the Drivers is obstructed by cuttings or tunnels or curves and where it is necessary to give audible warnings of the approach of a train to those working on the track. The whistle boards are fixed at a distance of 600 meters. The whistle indicator shall consist of two 600 mm. square boards painted yellow and bearing letter W/L in black. Its height shall be 2100 mm. from the rail level to the underside and the post on which it is fixed, painted with 300 mm. high bands in white and black

(14) **Whistle indicator for Level Crossings:** Whistle boards shall also be provided on the approach of all unmanned level crossings and in case of manned level crossings, where a clear view is not obtained. These bear the letters 'W/L'. The details of these whistle boards are described in Para 916(1) / Chapter IX - Level Crossings and Gateman of IRPWM

(15) **Stop Boards:** Stop Boards shall be provided on the DFC side of the road approaches to all unmanned 'C' class Level Crossing. This shall consist of a board 675mm X 525mm on a suitable post bearing the indication of an engine and the legend **'Stop, look out for trains before crossing',** in English, Hindi and Regional language. The paint used shall preferably be of luminous variety. The other details of these Stop Boards are described in Para 916(2) / Chapter IX - Level Crossings and Gateman of IRPWM

(16) **Shunting Limit Boards:** Shunting Limit Boards shall be provided at an adequate distance in advance of the trailing points. This shall consist of 600 mm. x 1000 mm. rectangular board painted yellow with a black cross on the top and words "shunting limit" written in black below it. Its height should be 2 metres from the rail level to the underside of the portion containing the cross and the post on which it is fixed, painted with 300 mm. high bands in white and black. It shall be fitted with a lamp showing white light in both directions

(17) **Switch Expansion Joint (SEJ) Boards**

(18) **Long Welded Rail (LWR) Boards**

(19) **Bridge Boards**

(20) **Engineering Restrictions Boards (if any)**

(21) **Section Limit Boards**

(22) **Road Sign Boards**

(23) **Project Sign Boards**

(24) **Any other board as per the requirement of relevant IR codes/manuals**.

16.15 Level Crossing

16.15.1 The design of Level Crossings shall be carried out by the Contractor in accordance with the applicable codes and stipulations indicated in Chapter IX – Level Crossings and Gateman of Indian Railway Permanent Way Manual.

16.15.2 The Contractor shall design / modify / remodel the Level Crossings including shifting of the duty hut and gate lodges of existing Indian Railways Network (wherever required) referring to the following four (4) types of typical Level Crossing drawings as indicated in the Reference Drawings taking into account of all conditions including, but not limited to, grade and width of the road crossing, a condition of the existing Level Crossing across the IR tracks, and submit the design to the Engineer for consent.

Especially when the objective Level Crossing is to be installed by extending the existing level crossing across IR tracks, the Contractor shall consult with IR and provide sufficient temporary measures including temporary diversions including facilitation for installation of gates / temporary gates (by Other Contractors) as required to ensure the safety of the traffic across the DFC tracks as well as that of the IR moving trains during the construction. Design and procedure of the temporary measures and / or Temporary Works, as required, shall be submitted to the Engineer for consent together with the design of the Permanent Works.

16.15.3 The four (4) types of typical level crossing each of which is indicated in the Reference Drawings are as follows:

(1) "SPL" Class Level Crossing : The minimum width of the gates at right angle to the center line of the road shall be 9 m or width of the carriageway + 2.5m whichever is more;

(2) "A" Class Level Crossing : The minimum width of the gates at right angle to the center line of the road shall be 7.5m or width of the carriageway + 2m whichever is more;

(3) "B" Class Level Crossing : The minimum width of the gates at right angle to the center line of the road shall be 7.5m or width of the carriageway + 2m whichever is more ;

(Note: "A" and "B" are differently identified by the TVU anticipated); and

(4) "C" Class Level Crossing: The minimum width of the gates at right angle to the center line of the road shall be 5m or width of the carriageway + 1.25m whichever is more (for the road width of 5.5 meters).

16.15.4 Other Requirements

(a) The type and standard of the approaches to the Level Crossing shall be similar to the existing approaches.

(b) Suitable Height Gauges shall be provided on both sides of Level Crossing for protection against electrified tracks of DFC as per the applicable Codes.

(c) Lighting shall be provided as per Specifications and applicable IRS Standards.

(d) Signages shall be provided as per applicable Codes and Standards.

(e) Check rail shall be provided as per applicable IR standards. The minimum length of the check rail for square crossing shall be 2m more than the width of gate. In case of skew Level Crossing, the length of check rail shall be increased in accordance with the formula as specified in Chapter IX – Level Crossings and Gateman of Indian Railway Permanent Way Manual.

(f) Width of surfacing between the gates shall be same as that of the width of gates.

(g) Width of surfacing outside gate shall be tapering off to the existing carriageway width within a distance of 30m from gate.

(h) 15m long G.I. barbed wire fencing with RCC posts on both sides of Level Crossing on DFC side.

(i) Double Wall Corrugated HDPE pipes for track crossing & road crossing of cables at LC Gates as specified in Clause 7.3 of Employer's Requirements – Functional (Volume II of the Bid Documents).

16.16 Design of Stations and Station Facilities

16.16.1 Rail Level Platform of size 150m (length) x 6m (width) shall be provided at each Station and in front of the Station Building.

16.16.2 Layout Criteria

a) The layouts of the Station Buildings and Service Buildings / IMDs / IMD Sub-depots as included in the Reference Drawings (Volume V of the Bid Documents) are indicative. The Contractor shall develop the layout meeting the area requirements of various

facilities within the Station Buildings and Service Buildings / IMDs / IMD Sub-depots (as indicated in the Scope of Work included in the Employer's Requirements – Functional, Volume II of the Bid Documents) depending upon the site conditions and get it consented by the Engineer and approved by the Employer;

b) Architecture and profile of all buildings shall conform to local aesthetics, cultural ethos, local architecture and environment and shall be subject to consent of the Engineer and approval of the Employer;

c) The buildings shall be maximum two (2) storey height. Even for the single storied buildings, the foundations shall be designed for at least 2 storey;

d) All residential buildings shall be double storey (i.e. G+1) with each block of maximum 4 residential quarters;

e) Each types of residential buildings shall be grouped separately;

f) 6ft. high masonry boundary wall shall be provided all around the residential buildings area with controlled access;

g) The Plinth Level of the Station Buildings shall be 300mm above the rail level platform;

h) The Plinth Level of residential buildings and Service Buildings / IMDs / IMD Sub-depots etc. shall be 600mm above the existing natural ground level or 300mm above HFL (high flood level), whichever is higher;

i) Ceiling height of the individual residential quarter shall be 11ft.;

j) Ceiling height of Station Buildings, Service Buildings / IMDs / IMD Sub-depots, Sheds etc. shall be 14ft.;

k) OFC equipment room along with associated power supply equipment room and battery room shall be located near the Relay Room cum Axle Counter room;

l) DG room, electrical switch room and electrical sub-station shall be located adjacent to each other. DG room may be the last one to keep vibrations and exhaust at one end;

m) Inside layout of the equipment room including provision of E&M services, door opening sizes etc. shall be co-ordinated with Other Contractors; and

n) All the layouts shall be consented by the Engineer. The Engineer shall seek the approval of the Employer before communicating his consent to the Contractor

o) IMD shall have the boundary wall towards the track side only for providing controlled access.

16.16.3 The functional and structural design of all the Station buildings shall be carried out as per the provisions of National Building Code and the bye-laws of the local authorities to the extent of their applicability.

Method of structural analysis shall be appropriate for the structure or component to be analysed and shall be carried out by the Contractor using well established software duly consented by the Engineer.

16.16.4 Loading due to earthquake (as applicable for the earthquake zone in which the Station falls) shall be assessed based on the provisions of IS: 1893 (Part I) with latest revision.

16.16.5 Loads and load combinations shall be for most unfavorable effects and shall comply with relevant Indian Standards including IS: 456-2000 and IS: 800-1984.

16.16.6 The overall stability and serviceability requirements shall be checked in accordance with the provisions of relevant Indian Standards.

16.16.7 All buildings shall be designed to be secure during staff absence.

16.16.8 All buildings shall be capable of maintenance with minimum efforts.

16.16.9 All the buildings shall be provided with concealed ducts / pipes for wiring of telecomm facilities in addition to the wiring for power supply & distribution. Concealed ducts / pipes for wiring of

telecomm facilities shall be provided in consultation with the Other Contractor (Signaling & Telecomm contractor).

16.16.10 False ceiling shall be provided at a clear height of about 10ft. in the rooms being provided with air-conditioning with a view to helping in energy conservation.

16.16.11 Station signages shall be designed as per the IR standards.

16.16.12 Environmental Considerations

(a) Sub-depot shall be designed to incorporate a separate facility for safe storage of oil, grease and any other potential toxic materials within sealed and bounded area

(b) Sub-depot design shall include such features as may be required to comply with the requirements of 'Manufacture, Storage and Import of Hazardous Chemicals (Amendments) Rules 2000' and any other legislation as applicable.

16.16.13 HVAC Requirements for Station Building

Station buildings shall equip ventilation systems in all the rooms, except for Signalling/ Telecommunication / UPS/ IPS/ Battery Rooms as required and independent air conditioning in the rooms as identified in the specifications for Electrical Works (Clause 15.1.6 of Volume III of the Bid Documents) in which the control equipment are to be installed by the Other Contractors.

The ventilation system shall be designed adopting the following criteria:

Sl. No.	Room usage	Times of air changes per hour
1	Offices	4 to 6
2	Workshops	6 to 10
3	D.G. Set	15 to 30
4	Storage Area	1 to 2
5	Residential	2 to 4
6	Domestic Kitchen	10 to 15
7	Lavatories / Wash Rooms	6 to 8

For other usage of the Rooms, the ventilation system shall be designed as per the requirements specified in ASHARE / National building Code.

The Contractor shall coordinate with the Other Contractors as to the air conditioning requirements for the rooms in which the control equipment are to be installed.

Based on ambient temperature and closed room temperature, S&T Contractor (Contract Package ST P-5) shall devise a scheme of air ventilation (with 100% standby) for Signalling/ Telecommunication/ UPS/ Battery Rooms at Stations and in block section to maintain the closed room temperature to the desired level. In case it becomes essential to provide air-conditioning, the same shall be provided with panel air-conditioning system with 100% standby by S&T Contractor. Room temperature and working of air ventilation/ panel air-conditioning system shall be monitored through TMS. Air ventilation shall be provided by Civil Contractor (CT P-3 (R) Contractor).

16.16.14 Air-conditioning Requirements

a) The capacity of the air-conditioning units shall be such that the maximum temperature in the air-conditioned rooms shall not exceed 25 degree Celcius.

b) Since the air-conditioning shall be required round the clock, 100% standby provisions shall be required. Accordingly the air-conditioners shall be fully duplicated to run 12 hrs. each alternatively.

c) In case the total load of air-conditioning at a particular Station is more than 10 tonnes, energy efficient VRV type air-conditioning units shall be provided.

d) All the air-conditioning equipment used for HVAC system shall be highest star rated as per BEE certification.

16.16.15 The floors of the following rooms shall be provided with cable troughs of 150mm (height) x 300mm (width) size along with 3mm thick Aluminum chequered plate covers,

a) ASM / Panel Room

b) Relay Room cum Axle Counter Room

c) IPS and Data Logger Equipment Room

d) Battery Room

e) OFC (Telecom) Equipment Room

f) Electrical Switching Room / Panel Room

The requirements of numbers and length of the cable troughs shall be coordinated by the Contractor with Other Contractors in coordination meeting during design stage.

16.16.16 Cable entry holes shall be provided in Relay room cum Axle Counter Room and IPS and Data Logger Equipment Room and OFC (Telecom) equipment room.

16.16.17 The other requirements shall be as under:

(1) The minimum requirement of the facilities for Operation and Maintenance shall be as specified below. Minimum area requirements for each of the facility shall be as indicated in the Scope of Works included in Employer's Requirements-Functional

(2) Residential units of Type IV and above shall have minimum two (2) toilets

(3) All buildings within the Station area shall be provided with suitable rain water harvesting system duly consented by the Engineer

(4) External Development of the Station area shall include but not limited to the followings

(a) Providing RCC Land Boundary Pillars of size 200mm x 200mm x 1500mm all around the Stations (except along IR side in case of parallel section) and to be fixed @ 25m center to centre and at every change in direction (to be fixed as per Specifications)

(b) Entrance to each Station

(c) Internal Roads and Footpaths per applicable standards and statutory requirements

(d) Street Lighting including High Mast Lighting per applicable standards and statutory requirements. Illumination of all service roads shall be as per IS: 1944-1981

(e) Potable water supply system with borewells, overhead and underground water tanks and pumping system

(f) Storm water collection, carriage and disposal system as per applicable standards and statutory requirements

(g) Sewage collection, carriage, treatment and disposal system as per applicable standards and statutory requirements

(h) Landscaping as required

(i) Connecting road from entrance of the each Station to the existing public road for providing road access to the Station

16.16.18 All the internal roads within the Station area and connecting road to nearest existing public road shall be at least single lane bituminous roads.

16.16.19 Use of Asbestos shall not be permitted in any form.

16.16.20 The Table below indicates the minimum operational and maintenance facilities proposed at the Junction and Crossing Stations. For other facilities and further details, **Attachment 5** to the Scope of Work (included in Employer's Requirements – Functional) may be referred.

Table ERD-6:

Proposed Operation and Maintenance Facilities at Stations for Iqbalgarh - Vadodara Section (Package CT P-3 (R))

SECTION	JS / CS	Junction & Crossing Station Names	DFC Chainage (Km)	IMD No.	Sub Depots	OHE Depots			Ballast Depot/ Siding	Track Machine Depots	Hot Axle Siding	Track Machine Siding	Tower Wagon Siding	Wiring Train Siding	Accident Relief Train Siding	MMU	Sub Depot S & T	CS Loop (at the Beginning)
					Civ. Eng	Main	Sub	WT										
Section 5	JS1	Makarpura	133.001	1	No	Yes	No	Yes	No	Yes	Yes (D/U)	Yes (D/U)	Yes	Yes	No	Yes	No	No
	CS1	Vasad	168.224		Yes	No	Yes	No	No	No	Yes (D)	Yes (U/D)	No	No	No	No	Yes	Yes (U/D)
	CS2	Changa	196.651		Yes	No	Yes	No	No	No	Yes (U)	Yes (U/D)	Yes	No	No	Yes	Yes	Yes (U/D)
Section 6	CS3	Timba	56.958		Yes	No	Yes	No	Yes(U)	No	Yes (D)	Yes (U/D)	No	No	No	No	Yes	Yes (U/D)
	JS2	Sabarmati South	80.692	2	No	Yes	No	No	No	No	Yes (D)	Yes (One for D&U)	Yes	No	Yes	Yes	No	No
Section 7	JS3	Sabarmati North	98.636		No	No	No	No	No	No	Yes (U)	Yes (D/U)	No	No	No	No	No	No
Section 8N	CS4	Ghumasan	17.504		Yes	No	Yes	No	No	No	Yes (D)	Yes (U/D)	No	No	No	No	Yes	Yes (U/D)
	JS4	Mahesana	57.628		Yes	No	Yes	No	No	No	Yes (D/U)	Yes (D/U)	No	No	No	Yes	Yes	No
	CS5	Malosana	100.729		Yes	No	Yes	No	No	No	Yes(U)	Yes (U/D)	No	No	No	Yes	Yes	Yes (U/D)
Section 8	JS5	Palanpur	12.151	3	No	Yes	No	No	No	No	Yes (D/U)	Yes (D/U)	Yes	No	No	Yes	No	No
	Station	Chadotar	1.325		No	No	No	No	No	No	Yes (D)	Yes (U)	No	No	No	No	No	Yes (U/D)

16.16.21 Quarters for Key Men on IR & DFCCIL Stations

The minimum requirements of Key Men quarters (Type II Residential Building) at IR and DFCCIL Stations are as identified in the Scope of Works included in the Employer's Requirements – Functional

16.17 Requirements from Signalling, Telecommunication, Electrical and Mechanical

The relay room shall be two (2) story high (maximum) and the upper floor shall be surrounded by glass windows which are installed 750 mm high above the finished floor so as to enable clear vision of the entire yard from the room

The entrance doors for the rooms in which machinery and equipment are installed shall be 3.6 meters wide with full height and swing-open. The Contractor shall provide an earthing per every five (5) square meters for rooms in which earthing shall be required in the buildings. Size and grade, and exact locations to be installed in the room shall be provided by the Other Contractor through the Engineer.

The earthing wire shall be installed by the Contractor and the end of the earthing wires above the finished floor shall be extended more one (1) meter with precautionary measures of theft.

16.18 Other Design Considerations

16.18.1 Hydrological Design Considerations and Design of Protection Works

(1) Discharge Estimation and Water Way Calculation

Estimation of design discharge shall be required for proper design, construction, and maintenance of bridge water ways, foundations, approaches and training works. Parameters like Vertical clearances also depend on the design discharge. RDSO Technical Monograph 50 - "Hand Book for Estimation of Design Discharge for Railway Bridges" shall be used for the determining Discharge.

(2) Bridge Protection Works and River Training Works

a) Bridge protection works are required to protect the bridge structure and its approaches from damage due to flood waters. River training works are required to confine and guide the river course through the bridge. The bridge protection works and river training works are to be designed based on the design discharge and the nature of flow characteristics. Normal elements are i) Guide bunds ii) Launching aprons iii) Spurs or Groynes iv) approach banks protection v) marginal bunds vi) revetment of banks and /or vii) protection of piers from scour.

The need for any special bridge protection on major/important bridges shall be investigated and suitably designed protection works/ river training works provided. The design of these works may be done using any standard code and practice applicable to river characteristics available on the Project. The publication "River training and protection works for Railway bridges" (June 2007) by Indian railway institute of Civil Engineering, Pune may also be referred to for guidelines.

Notwithstanding the result of such investigation, requiring no special protection/ river training works, the approach embankment shall be fully provided with stone boulder pitching for a minimum length of 30m behind abutment as per specifications and drawings.

For waterways other than rivers like canals, nallahs, drains and balancing culverts, the approach embankment/ cutting of the bridge shall be protected for a length equal to the bridge opening, on both upstream and downstream. In case of part length is protected by return/ wing wall, the length of boulder pitching can be reduced to the extent of the length of such wall.

b) All minor bridges with open foundations shall be protected by a well-designed flooring system. The concrete floor shall be protected by curtain wall at upstream side and Drop

wall at Down Stream side. The embankment on approaches shall be protected by stone pitching and Toe wall shall be provided at the end of the embankment slope.

(3) Scour Depth Calculations

For hydraulic design, most important parameters are discharge, HFL and Scour. Depth of the scour shall be calculated as per relevant Codes.

16.18.2 Clearance for Roads

The Contractor shall refer the Standard Specifications and Code of Practice published by the Indian Roads Congress and/or consult with the competent authority to maintain the appropriate clearance over the road as required accordingly.

16.18.3 Clearance for Existing Railways

With regard to the clearance over the existing IR railways, the Contractor shall comply with the provisions provided in Clause 16.5 above.

16.18.4 Clarification of Design Assumptions

(1) Stresses in partially completed structures shall be analyzed for appropriate critical conditions at various stages of the construction. Any restriction on the construction operations resulting from design assumptions shall be clearly specified on the drawings and specifications.

(2) Piles / Wells shall be designed as per as per IRS Manual on the Design and Construction of Well and Pile Foundation (1985), IRS Sub-structure code and IS: 2911 and the other criteria as specified in the Clause 8 [Piling Work] and Clause 17 [Well Foundation] in the specifications (Volume III of Bid Documents)

(3) Large diameter piles (>1.20m diameter) can also be considered when foundations have to be built quite deep and there is not much scour at the bed level. Larger diameter piles are required to be designed to give minimum deflection under longitudinal/ transverse loads of moving trains. Large diameter piles can also be provided to depths beyond normal working depths of pneumatic sinking of well foundations

(4) While calculating the load carrying capacity of the Piles (in case of pile foundations) by static formula (as per IS: 2911 Part 1 Section 4)

a) Pile shall be designed as per submerged conditions

b) 'K' factor (coefficient of earth pressure) shall be taken as 1

(5) **Steel Composite Superstructure (if required)**

IRS steel bridge code is based on working stress approach and the open web girder is to be designed as per provisions of the IRS-Steel Bridge Code. The IRS concrete bridge code however is based on limit state approach. The concrete deck slab therefore needs to be designed based on working stress method using IRC-21-2000. The parameters which may control the design of composite action are as follows:

a) Effective flange width of concrete deck: the effective width of deck slab acting compositely shall be as per Clause 603.3 of IRC 22-2008.

b) Flexural stiffness of composite section:

- The elastic section properties of the composite cross section with concrete in compression shall be expressed as those of an equivalent steel cross section by dividing the contribution of the concrete component by the relevant modular ratios (modular ratio= E for steel/E for concrete).

- The effect of creep of concrete is to be taken into account by using appropriate modular ratio (m) for the concrete. This will be suitably chosen for permanent and transient loadings.

- shrinkage effect of concrete has to be accounted, as shear connectors don't allow free movement of concrete. A net shrinkage strain of 2x10-4 as per Clause 304.9 of IRC-21-2000 may be taken.

c) Shear Connectors:

Stud shear connectors may be designed as per IRC 22-2008. For checking the fatigue as per relevant Clause of IRC 22-2008, the factor l, shall be same as for top member of the girder on which the shear studs are welded.

d) Deflection and deformation:

This shall be as per IRS Steel bridge code. Reverse Camber shall also be provided at the stage of fabrication.

e) Provision of fatigue in steel members:

Presently, the fatigue provision in the IRS steel bridge code is based on minimum and maximum stress level in the member. This however is under revision and the stress range concept is being brought in, which is more logical and based on latest technology. Either the modified provision of IRS code or relevant British code should be used.

f) Top Chord of truss design:

The design of the top chord may be carried out for the composite section. Under dead load including dead load of slab, as steel section alone and under live loads as a composite section.

g) The contractor may improve on the above parameters based on proven technology adopted elsewhere in the world, with the consent of the Engineer.

(6) If any other clarification is required with respect to various design assumptions, the Contractor shall propose the same with reference to the provisions of various Codes, Standards and Manuals as applicable and seek the consent of the Engineer before undertaking the Technical Design

16.18.5 Deck Drainage

In case of the Important Bridges, Rail Fly Overs, Major Bridges and ROBs, a complete drainage system for the entire deck shall be provided to ensure that the drainage water is disposed off quickly from the deck to safe location. For bridges level in longitudinal profile, minimum cross slopes in deck shall be kept at 2.5%

The rainwater run-off from bridge decks shall be collected and piped to a suitably designed storm water drainage system. This drainage system shall be easily accessible for safe inspection and routine maintenance without entering the Railway Envelope or otherwise interrupting the operation of the railway. The gaps between decks shall be suitably covered so that the rainwater shall not run down from the gaps.

16.18.6 Vertical Clearance and Free Board in Bridges

In terms of Paragraph 312 (Vertical Clearances) and Paragraph 313 (Freeboard) of the Indian Railways Bridge Manual 1998, it is directed that:

i) **Vertical Clearance for Bridges**

Minimum vertical clearance for bridges excluding arch bridges, siphons, pipes / box culverts from the water level of design discharge (Q) including afflux shall be as under:

Discharge (Cumecs)	Vertical Clearance (mm)
0 - 30	600
31 - 300	600 – 1200 (pro-rata)
301 - 3000	1500
Above 3000	1800

ii) **Free Board**

The freeboard from the water level of the design discharge (Q) to the formation level of the Railway embankment or the top of the guide bund including afflux shall not be less than 1m. In cases where heavy wave action is expected, freeboard shall be increased suitably.

In special circumstances, where the freeboard can be safely reduced and where adoption of the prescribed values would result in serious difficulties in construction, the freeboard may be relaxed, at the discretion of the Employer through Engineer, as indicated in Table ERD-7 below:

Table ERD-7: Minimum Freeboard by Discharge

Discharge (Cumecs)	Minimum free board (mm)
Less than 3	600
3 to 30	750
More than 30	"No relaxation shall be permissible"

While executing works other than rebuilding a bridge or extending it for doubling purpose, the existing free board may be retained after taking measures for safety as considered necessary with the acceptance of the Engineer / Employer

In no case, it should be less than the free board available in the existing corresponding IR Bridges if the existing freeboard is already less than 1m.

16.18.7 Cess Width

The cess width shall not be less than 900mm.

16.18.8 Retaining Structures

Where the formation level of the proposed Alignment is at higher elevation than the existing Indian Railway formation level on the parallel sections and sufficient space is not available to provide a stable slope for the formation for the Alignment without encroaching on the cess of the existing Indian Railway formation, suitable earth retaining structure as per the IRS-Bridge Substructure & Foundation Code shall be provided.

Earth retaining structure if required at any other critical location, shall be proposed by the Contractor and shall be subject to approval of the Employer through Engineer.

The earth retaining structures, if required, shall be designed as per the following criteria:

(a) In case the location of the earth retaining structure is within Axle Load Impact Line, it shall be designed suitable for DFC loading (32.5 tonne axle load)

(b) In case the location of the earth retaining structure is beyond the Axle Load Impact Line, it shall be designed suitable for retaining the earth.

Design shall be done as per the Design Criteria specified herein and IRS Bridge Rules, IRS Code of Practice for Plain, Reinforced & Prestressed Concrete for General Bridge Construction (Concrete Bridge Code)', IRS Code of Practice for Design of Sub-structure and Foundations of Bridges, IRS Bridge Manual with latest correction slips and other relevant Codes as applicable.

16.18.9 OHE Mast

While designing the Bridge, necessary provisions for the OHE mast shall be made and requirements for OHE shall be coordinated with the Other Contractors.

16.18.10 Traction Earthing and Bonding of RCC / PSC Bridges and Viaduct Structures

Traction earthing and bonding of RCC / PSC bridges and viaduct structures shall be provided as described in Clause 7.2 [Traction Earthing] of Employer's Requirements – Functional (Volume II of the Bid Documents).

16.18.11 Machine Maintenance Depot Unit Pit (MMU-pit)

The Contractor shall install a pit - a twenty five (25) meters long RC channel structure under the ground for the Machine Maintenance Unit (MMU) to enable the underside of the rolling stock and the wheels to be observed and checked by maintenance personnel in the designated Junction and the Crossing Stations as indicated in the List of Buildings in Junction and Crossing Stations enclosed herewith. The MMU-pit shall have inner dimensions of 1300 mm wide and 1500 mm deep from the Rail Level and the centre of the inner dimension shall be placed at the track centerline. Rails shall be fixed appropriately at the top of the side walls of the RC channel structure. At least two (2) slopes or staircases shall be installed from the ground level for the maintenance personnel to access to the MMU-pit.

The Contractor shall layout the MMU-pit in the Machine Siding at MMU locations as indicated in the List of Buildings in Junction Stations and Crossing Stations enclosed in the Scope of Works included in the Employer's Requirements – Functional and design the MMU-pit in detail, and submit to the Engineer for consent as part of the Technical Design.

16.18.12 Pre-cast RCC Safety Wall Between DFC and Circulating Areas of IR / Habitation Area

The design requirements for the pre-cast RCC safety wall shall be as under:

a) The height shall be 1800mm above existing ground level;

b) The total height shall be so designed that the top level shall remain same irrespective of the existing ground profile;

c) The concrete mix and thickness shall be as designed by the Contractor and consented by the Engineer;

d) Shall be engraved with the letters as consented by the Engineer and approved by the Employer;

16.18.13 Partition Wall / Gravity wall / Retaining Wall Between DFC Embankment and existing Gas / Oil Pipelines

The Contractor shall design the suitable partition wall / gravity wall / retaining wall with a view to isolate the existing gas / oil pipelines from the DFC embankment and submit to the Engineer for his consent.

16.19 Non-Traction Power Supply & Distribution

16.19.1 Service Conditions

All the Plant shall be designed for following service conditions that are generally prevailing at Site:

(1) Outdoor Conditions

a)	Maximum altitude.	=	1000 meters
b)	Maximum ambient temperature	=	50° Celsius
c)	Maximum humidity	=	100 %
d)	Minimum ambient temperature.	=	0° Celsius
e)	Wind Velocity	=	50m/sec

f) Pollution = Medium to heavy pollution, dusty environment

(2) Indoor Conditions

a) Maximum Ambient temperature = 45° Celsius

b) Maximum humidity = 95%

(3) All the Plant / equipment shall be capable of continuous operation under environmental & power supply conditions of voltage & frequency variation as per the provisions of the Indian Electricity Act and relevant Indian Standard Specifications (ISS)

EMPLOYER'S REQUIREMENTS

CONSTRUCTION

1 Contractor's Responsibilities

1.1 The Contractor shall take full responsibility for adequacy, stability, safety and security in respect of all the:

(a) Works including the Permanent Works and Temporary Works

(b) Site Operations

(c) Methods of construction, manufacture / fabrication & erection, transportation, installation including testing and commissioning

(d) Plants and

(e) Contractor's Equipment

irrespective of any Notice of No Objection by the Engineer

1.2 The Contractor shall, whenever required by the Engineer, submit to the Engineer details of the arrangements and methods which the Contractor proposes to adopt for execution of the Works for his consent. No alteration to these arrangements and methods shall be made without the consent of the Engineer.

1.3 Before starting the Work at Site, it shall be essential on part of the Contractor to ensure that there are no charted and uncharted utilities infringing the Permanent Works particularly the cables carrying the working circuits within the Right of Way (ROW). Diversion of all the chartered and unchartered utilities shall be handled as specified herein below and in Appendix 15 [Requirements for Construction].

2 Contractor's Organization during Construction Phase

2.1 Project Organization Plan

(1) The Contractor's Personnel shall be deployed maintained as described in Sub-clause 6.9 [Contractor's Personnel] and sub -clause 6.10 [Records of Contractor's Personnel and Equipment] of the General Conditions in Volume I of the Bid Documents. The Contractor's Superintendence shall be also properly deployed and maintained to carry out the construction activities as described in Sub-clause 6.8 [Contractor's Superintendence] in the General Conditions in Volume I of the Bid Documents.

(2) The Contractor shall submit an updated Project Organization Plan which includes complete project organization chart during the Construction Phase adding functions and personnel necessary to perform the Works during the Construction Phase in accordance with the conditions of the Contract included in Volume I of the Bid Documents. This plan shall be updated and resubmitted whenever there are changes to the staff and / or the organizational structure. The plan shall show the management structure and state clearly the duties, responsibilities and authority of key staff member.

(3) Full details regarding qualification and experience in respect of all the key staff shall be submitted to the Engineer for his consent. As per Sub-clause 6.9 [Contractor's Personnel] of General Conditions in Volume I of the Bid Documents, If the Engineer asks (in writing) the Contractor to remove a person of his work force stating the reasons, the Contractor shall ensure that the person leaves the Work Area within seven days and shall have no further connection with the Works in the Contract. The Engineer shall also seek prior

consent of the Employer in this regard.

(4) During the Construction Phase, the Contractor shall maintain the Design Team in his organization independent of the Construction Team to deal with his design development including the Variation and changes to his design as shall be performed through the Design Changes and Variation Procedure as described in Appendix 14 [Requirements for Design] to the Employer's Requirements and as described in Sub-clause 13.3 [Variation Procedure] in the General Conditions and Sub-clause 13.3 of Particular Conditions in Volume I of the Bid Documents .

2.2 **Requirements During Construction Phase**

(1) The principal requirements relating to the Contractor's Documents during the Construction Phase are the submissions by the Contractor of the followings :

(a) Working Drawings and Documents,

(b) the technical submissions as required under the Contract,

(c) the compilation of the multiple design submissions for the different Work Segments and submission of the final design with related documentation and the submission of the As-Built Drawings / Document.

(2) Working Drawings and Documents shall be prepared as required under the Contract.

(3) The Contractor shall endorse the Working Drawings and Documents as being in accordance with the Technical Drawings which have received "Notice of No Objection" or "Notice of No Objection with Comments" from the Engineer after the comments duly resolved.

(4) The Contractor shall endorse the submissions required under the contract that "all effects of the designs comprising the submission, on the design of adjacent or other parts of the works have been fully taken into account in the design of these parts".

(5) The Contractor shall submit the Construction Design and Drawings as specified in Clause 4 of the Employer's Requirement-Design.

(6) The Contractor shall maintain all records necessary for the preparation of the As-Built Drawings and Documents.

(7) Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings and Final Documents.

(8) All such drawings and documents shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all Temporary Works that shall remain on the site.

(9) The Contractor shall maintain all records necessary for the physical and financial completion and commissioning. These records shall consist of as a minimum:

(a) The implemented work according to activities, places and price; and

(b) Used materials – type, name of manufacturer along with batch No., place & price etc.;

(10) Prior to the commencement of construction operations, the Contractor shall obtain all necessary clearances from the concerned Authorities.

(11) Contractor shall take all measures and precautions to ensure that the construction activities do not cause any infringement to the operations and maintenance of Indian Railways. Any construction activity involving the existing embankment/formation of the

Indian Railways shall be permitted only with specific authorization by the Engineer with the approval from Employer and Indian Railways.

3 Earth Work

3.1 Prior to start of the construction operations, the Contractor shall submit all relevant technical details including but not limited to the following for review and evaluating the proposed construction methods and quality control procedures.

(a) Geological Investigation Report and evaluation of sub-surface conditions for Permanent Works along the alignment.

(b) Geological Investigation Report for borrow areas

(c) Material test report for embankment fill, prepared subgrades and blanket material

(d) Slopes stability calculations

(e) Analysis of stability and settlement of embankments and design of remedial measures (if required)

(f) Details of construction equipments.

(g) Construction quality control plan

3.2 Contractor shall be responsible for reviewing and validating the information provided, taking all necessary measures and precautions of satisfactory completions of the Works meeting the performance requirements in the stipulated time including but not limited to carrying out all the investigations as required, changes in the design, ground treatment or improvement, modification of construction methods etc. required due to site conditions. He shall also be responsible for all the temporary works, dewatering and drainage arrangements.

3.3 Availability of Embankment Fill Material

The Contractor shall procure the materials suitable for sub-grade and embankment fill after carrying out the necessary tests required as per Specifications, and confirming their suitability.

4 Checking of the Contractor's Temporary Works Design

4.1 The Contractor shall, prior to commencing the construction of the Temporary Works as detailed in Appendix 9 [Temporary Works], fully check the design and go through the Internal Authorization Process as described in Appendix 7 [Quality Assurance] and submit design to the Engineer for consent as part of the Technical Design. Through those process and procedures, the Contractor shall ensure that his Temporary Works have been properly and safely designed and checked the effect of the Temporary Works on the Permanent Works.

4.2 In addition to the above the Contractor shall also submit a Design Certificate to the Engineer, duly signed by Chief Design Engineer of the Contractor's Design Team and Contractor's Representative as part of Contractor's Internal Authorisation process (as specified in Appendix 7 – Quality Control to the Employer's Requirements) certifying that the Temporary Works have been properly and safely designed and checked including the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.

5 The Site and the Work Areas

5.1 The Work Areas, Site including timings, sequence and conditions relating to the Contractor's Possession of the Site during the Construction Phase, his access to the Site prior to the Site possession, and his acquisition of the Work Areas outside Right of Way are detailed in

Appendix 1 [Alignment of Trackways and Work Areas] and Appendix 15 [Requirements for Construction] to the Employer's Requirements

5.2 In case of parallel section, the availability of the traffic possession , if required to execute the Permanent Works infringing the IR operations shall be as specified in Appendix 1 [Alignment of Trackways and Work Areas] to the Employer's Requirements and shall be in accordance with Appendix 17 [DFC Railway Envelope Hand Over and Access] to the Employer's Requirement.

6 Safety, Health and Environment (SHE) Requirements

6.1 The Contractor shall comply with all the requirements as specified in the Employer's Requirement - General and Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents)

6.2 The Contractor shall prepare and submit to the Engineer for review his proposed SHE plan including Site Safety Plan and Programme within the period as specified in Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents). It shall, as a minimum, meet the requirements as specified in Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents). The Contractor's SHE Policy, SHE Plan and Site Safety Plan shall be consented by the Engineer and other concerned authorities before start of the Work at Site.

6.3 The Contractor's Site Safety Plan shall cover the following aspects

(a) Statement of Contractor's Safety Policy

(b) Senior management responsibility for safety

(c) Appointment, duties and responsibilities of Site safety staff

(d) Policy for identifying Hazards

(e) Safety training

(f) Safety equipment

(g) Safety of the Contractor's construction and office equipment

(h) Safety of the workmen and staff at site

(i) Safety procedures for sub-contractors

(j) Disciplinary procedures

(k) Accident reporting

(l) First aid and emergencies

(m) Safety promotion and awareness

(n) Site security

(o) Labour safety

6.4 The Contractor's Site Safety Plan shall also incorporate the requirement of Safety while having interface with the running tracks of Indian Railways (wherever required) and complying with

(a) Indian Railway's rules and regulations for track, signalling and operations possessions

(b) operating a system of permit to work for all works which may affect the operations of the

existing railway and

(c) requirements of safety aspects for working near the running tracks of Indian Railways as specified herein below

6.5 Engineer reserves the right to order (in writing) the immediate removal and replacement of any of the Contractor's equipment or temporary works which in his opinion is unsatisfactory or not required for the Work for its purpose and / or is in unsafe condition.

6.6 Contractor shall be fully responsible for safety of the Works and shall treat safety measures as a priority in all his activities throughout the execution of the Works.

6.7 Contractor shall have full regard for the safety of all his personnel, sub-contractor's personnel, the public and all the personnel directly or indirectly associated with the Works on or in the vicinity of the Site and the Work Areas (including without limitation to the persons to whom access to the Site has been allowed by the Contractor), to comply with all relevant safety regulations, including provision of safety gear, and insofar as the Contractor shall be in occupation or otherwise is using areas of the Site and the Work Areas, to keep the Site and the Work Areas (so far as the same are not completed and occupied by the Employer) in an orderly state appropriate to the avoidance of injury to all persons and shall keep the Engineer/ Employer indemnified against all the injuries to such persons.

6.8 Contractor shall provide and maintain all lights, guards, fences and warning signs and watchmen when and where necessary or required by the Engineer or by laws or by any relevant authority for the protection of the Works and for the safety and convenience of the public and all persons on or in the vicinity of the Site and the Work Areas.

6.9 When the Work would otherwise be carried out in darkness, the Contractor shall ensure that all parts of the Site and the Work Areas where the Work is being carried out are so lighted as to ensure the safety of all the persons on or the vicinity of the Sites, the Work Areas and of such Work to the satisfaction of the Engineer.

6.10 Contractor shall be required to take note of all the necessary provisions in the Employer's Safety, Health and Environment requirements as specified in Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents) and the Contract Price shall be deemed to be inclusive of all the necessary costs to meet the standards and requirements as prescribed therein. In case the Contractors fails to meet the above requirements, the Employer shall provide the necessary arrangements and recover its costs from any bills due to the Contractor.

7 Safety Requirements for Working Near Running Tracks of Indian Railways

7.1 Operational Safety

Where the work to be executed is in proximity of the running railway track, the Contractor shall be required to observe all precautions and carryout all works that may be necessary to ensure the safety of the running track/trains etc. without imposition of any speed restriction thereon as may be directed by the Engineer. No claim whatsoever shall be entertained for either any inconvenience caused to the Contractor or for the re-scheduling of the operations or for any other reasons on this account. The Contractor shall ensure that the materials are not stacked close to the railway track, which may endanger the safety of trains and workmen.

7.2 Where the Schedule of Dimensions of Indian Railways for the running tracks of IR are likely to be infringed by the Contractor, the following safety measures shall be ensured

7.2.1 Measures prior to start of the Work:

(i) Contractor shall arrange to provide necessary training to their supervisors and staff including lookout man / flagman etc. for safety requirements as per IRPWM

for working near IR tracks. Such training can be arranged at ZEC / DTC or any other authorized institute of Indian Railways. Employer shall assist the Contractor in organizing such training and all the charges for such training shall be borne by the Contractor. The Contractor shall ensure that the safety norms are followed for working in the premises of IR and in the vicinity of running tracks and electrified territories

(ii) Inform the Engineer / Employer about :

(a) Name and address of the Contractor's supplier / sub-contractor assigned to execute the work

(b) Name of the vehicle drivers / equipment operators identified for the work

(c) Location, duration and timings during which the SOD of IR is to be infringed

(iii) Provide the Engineer / Employer with

(a) copy of detailed planning of work including protection of IR track and safety measures proposed (duly consented by the Engineer and approved by the Employer)

(b) copy of the competency certificate of the Contractor's Supervisor incharge of the work (to be issued by the Engineer)

(iv) Demarcate the working area at site in consultation with the Engineer / Employer

(v) Barricade / temporary fencing along the stretch of the concentration of the work area along the IR track, as consented by the Engineer

(vi) Provide adequate watch and ward, flagmen, lighting etc. including signage boards

7.2.2 Measures during execution of Work

(i) It shall be ensured that no workmen and staff is working on line / trackside unless proper 'Permit to Work' shall be issued for those lines by the Indian Railways and Engineer.

(ii) It shall be ensured that the moving dimensions of IR shall not be infringed. In case of track crossing, the work is required, the same shall not be carried out without permission from the Engineer and IR. Safety of all the existing fixed structures near the vicinity of the Site shall also be ensured.

(iii) No vehicles shall be plied within 6m of the centre of the IR track without the specific approval from Engineer / Employer. Individual vehicle / construction equipment shall not be left un-attended. No vehicle shall ply from sun-set to sunrise and during the period when the visibility is impaired, except in case of emergency and with the consent of the Engineer.

(iv) Where the construction vehicles are required to ply along the existing running tracks of IR, the Contractor shall deploy the adequate patrolmen to prevent tendency of the vehicle drivers to come close to the tracks and infringe.

(v) All the drivers of the road vehicles / machines plying near the running tracks of IR shall be provided with a red flag / red lamp so that in the event of any obstruction, they shall stop the incoming train.

(vi) It shall be ensured that the line of demarcation shall not be infringed by the road vehicles / construction equipment

(vii) It shall be ensured that only eligible and competent staff shall be employed for the work and they must wear identity card while working near running tracks of IR.

(viii) For working during night, sufficient illumination shall be provided for the entire work area for safety of the workmen and public.

(ix) Temporary Engineering signals as required shall be provided.

(x) Existing engineering indicator boards shall be lit as per Permanent Way Manual (PWM) of Indian Railways.

(xi) Lookout man with red and green flags / hand signals and whistle shall be deployed wherever required.

(xii) No part of the stacked material shall infringe the moving dimensions of IR. Material shall be stacked to such a height that it does not lead to infringement of SOD in case of accidental toll off.

(xiii) Any temporary arrangement shall not infringe with the moving dimensions of IR.

(xiv) Where the work is planned to be done within 3.5m from the centre of the IR tracks, it shall require traffic block and all the necessary safety precautions shall be ensured as per the requirements of Para No. 806 and 807 of PWM of Indian Railways.

(xv) First aid kit shall be readily available at the site.

(xvi) In case any cable / utility is found while working, the Contractor shall inform the Engineer immediately. In case a large number of cables / utilities are found during excavation, the work shall be carried out in the presence of representative from the concerned owning agency of the utility / cable.

(xvii) It shall be ensured that the existing emergency sockets of IR are not damaged

7.2.3 Additional measures required during traffic block

(i) Any work when infringing the moving dimensions of IR shall be started only after traffic block has been imposed and IR track is protected.

(ii) All the work intended to be completed during traffic block shall be completed within the duration of the traffic block and the duration of the traffic block shall not be exceeded.

(iii) Traffic block shall be considered as cleared only when all the temporary arrangements / machinery are cleared of the moving dimensions and the IR track is left with proper track geometry to allow IR trains to run safely.

7.2.4 Safety measures while working in OHE area

(i) While working near the OHE area, the safety guidelines as specified in para 20301, 20327, 20334, 20335, 20529, 20612, 20614, 20714, 20825, 20833, 21206 and 21207 of Volume II, Part 1 of AC Traction Manual of Indian Railways shall be followed.

(ii) No electric work close to the live OHE shall be carried out without power block and specific approval from Engineer / Employer.

(iii) A minimum distance of 2m shall be maintained between live OHE wire and any body part of the workmen or tools or metallic support etc.

(iv) No electric connection shall be tapped from OHE.

7.3 Excavation Affecting Existing Tracks

While doing excavation near the vicinity of the existing tracks including for bridges and other structures, special care has to be taken to ensure that formation of the existing Railway line

is not excavated, for that matter any activity involved in construction / execution of the project 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 a drawing clearly indicating such alternation / modification of the existing permanent way, and the protection measure intended to be taken by the Contractor to ensure safety of the existing running line. The effectiveness of design of such protection measures is the sole responsibility of the Contractor and the Contractor shall indemnify the Engineer / Employer 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 preliminary design submission as per the Contract. Such work shall not be undertaken unless and until these drawings are consented by the Engineer

7.4 The Contractor shall indemnify the Engineer / Employer against any damage to the existing tracks / structures / utilities etc. caused by the actions of the Contractor or his Sub-contractors, and shall make good the same, as directed by the concerned authorities, at his own cost and shall also pay any penalty(ies) / demurrages if levied by the concerned authorities

8 Safety Requirements for Electrical Works

(i) The Indian Electricity Rules 1956, as amended up to date, shall be followed. The detailed instructions on safety procedures given in I.S.S. and Indian Electricity Rules, respective State Electricity Authorities' regulation with up to date amendment shall be applicable.

(ii) The LT/HT distribution diagrams of sub stations shall be prominently displayed. The substation premises, main switch rooms and D.B. enclosure shall be kept clean whenever works are carried either inside or outside.

(iii) No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act.

(iv) Rubber insulating mats of suitable size and thickness shall be provided in front of the main switch boards of sub-station or any other control equipments of medium voltage and above.

(v) Protective and safety equipment such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus, safety goggles etc., shall be provided as per the requirement of the Work.

(vi) Necessary number of caution boards such as "Man working on line, Don't switch on" shall be readily available in the vicinity of electrical installation.

(vii) Standard first aid boxes containing materials as prescribed by the St. John's Ambulance Brigade or Indian Red Cross shall be made available.

(viii) Charts displaying methods of giving artificial respiration to a recipient of electrical shock (one in English and another one in the regional language) shall be prominently displayed at appropriate places

(ix) No work shall be undertaken on live installations, or on installation, which could be energized unless one another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.

(x) No work on live L.T. bus bar or pedestal switch board in the sub stations shall be handled by a person below the rank of a Licensed Wireman and such a work shall preferably be done in the presence of a qualified engineer.

(xi) When working on or near live installations, suitable insulated tool shall be used and special care shall be taken to see that those tools accidentally do not drop on live

terminals causing shock or dead short.

(xii) The electrical switch controls in distribution boards shall be clearly marked to indicate the areas being controlled by them.

(xiii) Before starting any work on the existing installation, it shall be ensured that the electric supply to that portion is cut off. Precautions, like displaying "Men at Work" caution boards on the controlling switches, removing fuse carrier from these switches shall be taken against accidental operation. Caution boards shall be kept with the person working on the installation.

(xiv) All electrical panels & switchgear shall conform to relevant IEC standard.

(xv) All external enclosures shall have degree of protection not less than IP-54.

(xvi) All equipment/system shall conform to relevant IEC standard on Electromagnetic Compatibility (EMC).

(xvii) Cable routes of all the newly laid cables by the Contractor shall be identified with electronic or concrete markers.

9 Legislation and Codes of Practice

9.1 The Contractor shall comply with all the safety and industrial health legislation including without limitation to the Rules and Regulations of National Safety Council of India. The Contractor shall keep at each site office sufficient copies of Safety and Industrial Health Regulations and related documents.

9.2 All regulations and documents as referred above shall be translated in to languages which are understood by the operators engaged by the Contractor or sub-contractor and such translations shall be displayed or kept alongside those in Hindi, English and Regional language.

10 Protection For Indian Railway Lines

The Contractor shall design and install the temporary fencing / barricades for protection of the existing Indian Railway (IR) lines where the construction activities, adjacent to the line, are taking place. The fencing / barricades shall be installed as indicated in the Reference Drawings and the fencing shall be movable and reusable and stable enough not to lean and infringe the structure gauge of the IR lines. The fencing pole / barricades shall be colored to enhance visual precautionary effects. The Contractor shall develop the design of the temporary fencing / barricades as part of the Technical Design and submit the Engineer for consent.

11 Damage and Interference

11.1 Works shall be carried out in such a manner that there shall be no damage to or interference with:

(a) watercourses or drainage systems;

(b) public utilities;

(c) structures (including foundations), roads, including street fixtures, or other properties;

(d) public or private vehicular or pedestrian access,

(e) monuments, graves or burial grounds other than to the extent that shall be necessary

for them to be removed or diverted to permit the execution of the Works, and

(f) Existing tracks, Bridges, Fixtures / OHE Masts of the existing tracks of Indian Railways

11.2 Heritage structures shall not be damaged or disfigured on any account. The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but which the Contractor considers necessary to be removed or diverted to enable the Works to be carried out. Such items shall not be removed or diverted until the consent of the Engineer to such removal or diversion has been obtained.

11.3 Assets / items of the Employer, Indian Railway, Other Contractors and any other entities which are damaged due to Contractor's operations / negligence during construction or are interfered with or removed to enable the Works to be carried out shall be replaces / reinstated by the Contractor at his own cost to the same condition as existed before the Work started and to the satisfaction of the Engineer and the concerned entity.

In case of damage to the existing cables, the Contractor shall have suitable arrangement of joining the cable under technical supervision of IR / relevant authority. In addition to this, the Contractor shall also be responsible for any penal action or any claim or legal action as a result of the damage and shall indemnify the Engineer, Employer, Indian Railway, Other Contractors and any other entities in this regard.

11.4 In case of obstructions due to interference, the Contractor shall comply with the requirements described in Appendix 15 [Requirements for Construction] to the Employer's Requirements. Followings are the major required items as detailed therein;

(a) Uncharted Public utilities

(b) Alternative Access

(c) Protection of Trees

(d) Removal of trees, graves and other obstructions

(e) Protection of adjacent structures

12 Care of Works

Care of Works, including protection of Works from weather and protection of finished Works shall be as specified in Appendix 15 [Requirement for Construction] to the Employer's Requirement**s.**

13 Handling of Public Utilities and Interferences

13.1 The existing public utilities identified within the Right of Way shall, in principle, be relocated and/or diverted by the relevant public utility agencies at their risk and responsibility prior to the Contractor's possession of the Site except for

a) Those power lines of 33kV and below requiring permanent diversion as Listed in the **Attachment 6** to the Scope of Work included in Employer's Requirements – Functional; and

b) Other charted public utilities presently existing within Right of Way and requiring diversion/disposal as listed in the **Attachment 9 and Attachment 13** to the Scope of Work included in Employer's Requirements – Functional and indicative list of trees having girth 300mm and more to be cut and disposed as included in Data Book-Volume IV of the Bid Documents

which are in the Scope of Work for the Contractor. The costs of relocation and/or diversion of all the other utilities, which are not in the Scope of Work of the Contractor and as having

been done prior to the Contractor's possession of the Site shall be paid by the Employer to the relevant public utility agencies separately.

13.2 Alternative access which may be needed for all public or private premises when interference with the existing access occurs to enable the Works to be carried out shall be arranged by the Contractor as described in Appendix 15 [Requirements for Construction] to the Employer's Requirements.

13.3 Trees, graves and other obstructions which may remain at the Site or the Work Areas shall be appropriately removed as described in Appendix 15 [Requirements for Construction] to the Employer's Requirements.

13.4 Identification of uncharted public utilities within ROW shall be undertaken by the Contractor by trial trenching and / or using cable locator as consented by the Engineer. The results shall be summarized in 'Uncharted Utility Report' and submit as part of the Technical Design as specified in Appendix 14 [Requirements for Design] to the Employer's Requirements. The diversion of the identified un-charted utilities shall be handled as specified in Appendix 15 [Requirements for Construction] to the Employer's Requirements.

14 Use of Roads

The Contractor shall comply with the requirements as described in Sub-clause 4.14 [Avoidance of Interference] of General Conditions in Volume I of the Bid Documents, Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents) and Appendix 15 [Requirements for Construction] to the Employer's Requirements.

15 Security

The Contractor shall comply with the requirements described in Sub-clause 4.22 [Security of the Site] of General Conditions in Volume I of the Bid Documents and Appendix 15 [Requirements for Construction] to the Employer's Requirements.

16 Site Establishments

16.1 The Contractor shall provide and maintain the Temporary Facilities and Temporary Utility Services, which comprise part of the Temporary Works for use of the Employer and Engineer as specified in Appendix 9 [Temporary Works] of the Employer's Requirements.

16.2 The Contractor shall provide and maintain all Temporary Works as required by him and as specified but not limited to those detailed in Appendix 9 [Temporary Works] of the Employer's Requirements, for execution of the Works.

16.3 Latrines and wash places:

Contractor shall provide latrines and wash places for the use of his personnel and all persons who will be on the site as per the requirements specified in Clause 16 [SHE Requirements] of the specifications (Volume III of the Bid Documents)and in accordance with the local laws and regulations.

17 Testing of Works

17.1 The Contractor shall be responsible for all on-site and off-site testing and for all in-situ testing. Daily on-site testing shall be coordinated with the Engineer. A programme of proposed tests shall be provided on a weekly basis, at least one week in advance of such events.

17.2 Notification of required Factory testing shall be made in writing to the Engineer, including full details of test requirement, at least 15 days in an advance of the test.

17.3 The Contractor shall comply with all requirements described in Employer's Requirements - Manufacturing, Installation, Testing and Appendix 7 [Quality Assurance] and Appendix 5 [Project Programme Requirements] and Appendix 15 [Requirements for Construction] to the Employer's Requirements.

18 Provisions for Other Contractors

18.1 The Contractor shall construct the Works in full coordination with the Other Contractors and shall comply with the requirements described in Appendix 10 [Contractor's Coordination with Others] to the Employer's Requirements.

18.2 Provision of Masts for OHE

For the mast installation to be done by the Other Contractor on bridges, the Contractor shall prepare all necessary provisions as part of the Permanent Work. The Contractor shall ensure that this provision and the masts to be installed by the Other Contractor do not infringe the Structure Gauge as specified in the Design Criteria included in Employer's Requirements - Functional. This provision is not indicated in the Reference Drawings. Prior to design of the provision, the Contractor shall take all necessary steps to ensure that the provisions of the mast installation is coordinated and integrated with the works to be done by the Other Contractor(s) as described in Appendix 10 [Contractor's Coordination with Others] to the Employer's Requirements.

19 Restoration of Work Areas Disturbed by Construction

Unless otherwise directed by the Engineer, any areas disturbed by the construction activity, either inside or outside the Right of Way, shall be reinstated as follows:

All areas affected by the construction work shall be reinstated to their original condition, with new materials, including but not necessarily limited to, sidewalks, parking lots, access roads, adjacent roads, properties and landscaping. Grass cover shall be provided for any bare earth surface areas, along with proper provisions for surface drainage.

EMPLOYER'S REQUIREMENTS

MANUFACTURING, INSTALLATION, TESTING AND COMMISSIONING

1 General

1.1 Within 60 days of the Commencement Date of the Works, the Contractor shall submit for review by the Engineer a Design, Procurement and Manufacturing Programme that shall be an integrated part of the overall Works Programme.

1.2 The Design, Procurement and Manufacturing Programme shall show the interdependencies between engineering disciplines as well as between the Contractor and its sub-contractors and suppliers. This programme shall demonstrate compliance with the requirements of the overall Submissions Programme and commissioning of the system.

1.3 The Contractor shall submit a weighted bar chart of the Contractor's design, procurement and manufacturing activities. Each activity weight shall normally not be more than 5% of the total man-hour content or value of the respective work.

1.4 The Design, Procurement and Manufacturing Programme shall include a separate breakdown, supported by the material control schedule, which shall be a complete amplification of the Contractor's programme and equipment list, including those items which are subject to long lead time or component parts which are manufactured from countries outside the country of assembly and testing.

1.5 The material control schedule shall be automated, and shall detail the following information for each permanent major and minor material and significant component. The format of such a schedule shall include:

(1) name, description, supplier/sub-supplier details;

(2) drawing information (where appropriate), title, drawing status, submission dates, shop drawings/ fabrication drawing preparation, etc.;

(3) the manufacturing process, manufacturing of test pieces, trial production, Engineer's inspection, monthly production of components and monthly supply of components;

(4) the assembly process, erection and assembly sequences (particularly for the first pieces) prior to shipment, test assemblies, monthly assembly requirement, Engineer's inspection, testing of assemblies; and

(5) transportation process, quality release from factory, factory storage, transport to dock, shipment.

1.6 The Contractor shall continuously maintain this schedule and report upon the status of each item as part of the Contractor's regular progress reporting.

1.7 From this base data, the Contractor shall prepare an exception report detailing all components that are in delay. This report shall be annotated with the reason for the delay and indicate what action the Contractor shall be taking to recover the lost time.

1.8 The Contractor shall submit, as part of the Design, Procurement and Manufacturing Programme, a Factory Testing Programme that shall support all aspects of the Factory Testing Plan. This Programme shall clearly demonstrate the logic and include the logics

listed in Clause 5.6 of Employer's Requirements – Manufacturing, Installation, Testing and Commissioning

2 Manufacturing

2.1 Management

The Contractor shall establish procedures and controls that govern the procurement, integration, manufacture and testing, quality assurance and delivery of Plant & equipment, manufactured items and spares to be supplied under the Contract. This shall include the administration and supply of spare parts and warranty in accordance with the Contract.

The procedure for manufacturing management of the track components including but not limited to PSC sleepers, liners, track fittings, SEJs, turnouts, glued joints, ballast etc. shall be as specified in Clause 13 of specifications (Volume III of the Bid Documents).

The Contractor's Manufacturing Management and Quality Assurance Plans shall be submitted to the Engineer for consent within 42 days after the Commencement Date as a preliminary plan and as part of the Technical Design for the final Plans for each plant, equipment and manufactured item as described in Appendix 7 [Quality Assurance] to the Employer's Requirements.

2.2 Procurement and Subcontract Management

The Contractor's management systems and procedures shall be based on ISO 9000-2000 standards and shall incorporate procedures for materials procurement and sub-contracting, sufficient to ensure technical, administrative, quality and contractual controls consistent with those under this contract. The Contractor's management system shall be auditable for materials sources, lot numbers, serialized equipment, etc. Sub-contract amendments shall be effected whenever contractual changes are made bi-laterally by the parties involved subject to consent of the Engineer.

2.3 Manufacturing and Production Management

The Contractor's manufacturing and production management system shall encompass all points of receiving, raw material and components processing, fabrication, assembly, test and all points of in-process inspections. The Contractor shall submit manufacturing data as part of the Manufacturing Management and Quality Assurance Plans as specified in Appendix 7 [Quality Assurance] of the Employer's Requirements, which shall contain but not limited to:

(a) a brief description of all inspection hold points and test points, and a correlation with the Programme Schedule;

(b) a list of all sub-contractors; and

(c) a delivery schedule of each item of equipment to match installation plan

The manufacturers shall have the qualification and experience in the design, assembly and testing of the similar equipment / material, as being offered, complying with the Specifications and shall be subject to the consent of the Engineer

2.4 Testing

A Comprehensive Testing Programme shall be provided by the Contractor that shall include the works equipment, their subsystems and components and material to assure conformance with the Specifications. The testing Programme shall be subject to the consent of the Engineer and shall be submitted as part of Technical Design Submission. The purpose of the Comprehensive Testing Programme shall be to:

(a) substantiate design and performance characteristics;

(b) ensure operational compatibility;

(c) complete equipment verification and acceptance requirements; and

(d) complete all reliability, maintainability and safety demonstration requirements.

Testing shall comply with the requirements as specified herein in this Employer's Requirements.

2.5 Inspection by Engineer

The Contractor shall prepare an inspection programme which shall be consented by the Engineer and shall provide the opportunity for the Engineer and Employer to have access at key hold points during the production and manufacture of items / materials and Plant & equipment to examine, inspect, measure, and test the materials and workmanship, and check progress, as necessary.

Where such an inspection takes place on completion of production or manufacture this may be combined with the testing programme.

2.6 Quality Assurance and Controls

(1) The Contractor's management systems shall emphasize quality assurance and controls and shall be based on ISO 9000-2000 standards. The Manufacturing Management and Quality Assurance Plan together with the Comprehensive Testing Programme, shall adequately ensure an acceptable level of quality of the manufactured items and equipment supplied. The concept of total quality assurance shall be based on the principle that quality shall be a basic responsibility of the Contractor's organization and system employed, and shall be evidenced by:

(a) producible and inspectable designs;

(b) firm procurement and job performance specifications;

(c) firm procedures for transmission of information and data to sub-contractors and ensuring their compliance;

(d) adequate testing to ensure repetitive product conformity to design requirements; and

(e) total programme of surveillance and verification of physical performance and configuration accountability.

(2) Adequate records shall be kept by the Contractor to provide evidence of quality and accountability. These records shall include results of inspections, tests, process controls, certification of processes and personnel, discrepant material; and other quality control requirements.

(3) Inspecting and testing records shall, as a minimum indicate the nature of the observations made, and the number and types of deficiencies found and action proposed to correct deficiencies. Also, records for monitoring work performance and for inspecting and testing shall indicate action taken for the correction of deficiencies.

(4) All the requirements for testing for acceptance in respect of bridge bearings shall be as specified in Clause 14.1.3 of specifications included in Volume III of the Bid Documents

(5) The Contractor shall submit to the Engineer a request for a "Notice of No Objection to Supply" for all manufactured items along with all the manufacturer's test certificates and inspection certificates including but not limited to those stated in sub-para (2) & (3) above, prior to shipping / transporting. This shall be accompanied by a Verification Submission which shall provide sufficient documentary demonstration of the suitability of the Plant & equipment and manufactured items for supply. Such Notice shall be issued by the

Engineer in respect of the completion of manufacturing of a major and distinctive element comprising part of the Permanent Works. However, supply shall not be commenced until the original copies of the appropriate Submission have been endorsed:

(a) by the Contractor as "Good for Supply"; and

(b) by the Engineer that he has no objections to the supply.

2.7 **Shipping / Transporting**

The Contractor shall comply with the requirements as described in Sub-clause 4.16 [Transport of Goods] of General Conditions in Volume I of the Bid Documents, The Contractor shall safeguard the material / Plant & equipment against likely damages to be met during transit on account of environmental conditions and climatic influences during shipment. The Contractor's quality control personnel shall verify the inspection and preparation for shipment.

2.8 **Handling, Storage and Delivery**

The Contractor shall provide adequate storage facilities by way of covered areas (to the extent specified by the manufacturer) at his own cost for storing all the Plant, Material & equipment and manufactured items to be supplied as part of the Contract. Employer shall not provide any storage facility. Means shall be provided for protection against deterioration or damage to Plant & equipment in storage. Where shelf life of the Plant & equipment / Material is limited, this shall be clearly stated on the shipment.

3 Manufacture and Supply Verification Submission

3.1 On completion of the manufacture of Plant & equipment and manufactured items, and the associated testing, and quality assurance and control processes, a 'Manufacture & Supply' Verification Submission' shall be prepared which shall provide sufficient documentary demonstration of the suitability of the Plant & equipment and manufactured items for subsequent installation, this shall include, but not be limited to:

(a) confirmation that the Plant & equipment and manufactured items produced fully comply with the Working Drawings relating to manufacture;

(b) confirmation that all relevant testing has been successfully completed, with supporting completed test documentation;

(c) confirmation that all Quality Assurance and Controls processes have been completed with the required level of satisfaction, with supporting completed quality assurance documentation;

(d) confirmation that the Plant & equipment and manufactured items have not suffered damage or deterioration during transit to site.

3.2 The Contractor shall not commence the subsequent installation until he has received a Notice of no Objection from the Engineer in respect of the Manufacture & Supply Verification Submission.

3.3 Such Notice may be issued by the Engineer in respect of completion of the manufacturing and supply of a major and distinctive element comprising part of the Permanent Works.

4 Installation

4.1 **Installation Plan and Programme**

The Contractor's installation plan which shall be part of Comprehensive Testing Programme and shall be consented by the Engineer. It shall show how the Contractor proposes to organise

and carry out the Installation and complete the whole of the Works by the given Coordinated Dates.

The Contractor shall submit the installation plan for the review of the Engineer at least 90 days prior to the start of installation on site.

Contractor shall attend meetings with the Engineer to finalise the work details prior to the start of the installation at site

4.2 Installation Method Statement

(1) Installation Method Statements which shall be part of the Construction Method Statement shall be submitted to the Engineer for review at least 30 days prior to the installation activity commencing on site. This shall show in particular the loadings and modes and delivery routes of the Plant & equipment and manufactured items.

(2) Prior to proceeding with installation, the Contractor shall submit, for the Engineer's consent, six copies of drawings showing all installations including dimensions, supports, hardware, installation methods and documents confirming the availability and location of special installation tools and equipment and all other pertinent data.

(3) The manufacturer's rigging or erection instructions shall be carefully followed.

(4) The Contractor shall make certain that the installation of all supports, gaskets, hardware, etc., are accomplished so as to assure safe, accurate and trouble-free installation. Installation shall be undertaken preferably in the presence of the manufacturer's field service representative.

(5) Equipment that is improperly installed shall be removed, checked / tested and reinstalled. Any damage caused due to improper installation and removal shall be rectified before reinstallation at no extra cost to the Employer.

4.3 Asset Identification

(1) The Contractor shall submit an asset database for review by the Engineer. The database shall contain the complete asset listing for all aspects of the Contract Works.

(2) The database shall provide the minimum information as follows:

(a) asset details;

(b) failure history;

(c) date installed; and

(d) date(s) tested.

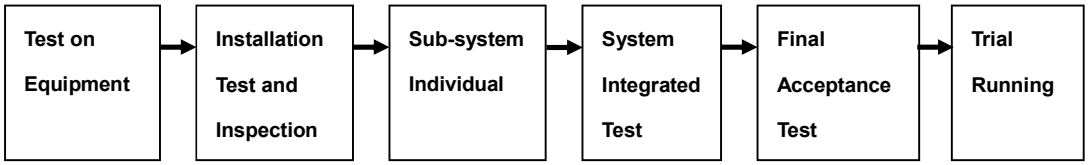
(3) All equipment and software shall have a unique identification number that shall be identified electronically and manually.

5 Testing and Commissioning

5.1 General

(1) The Contractor shall provide and perform all forms of testing procedures applicable to the Works relating to Plant & equipment and manufactured items and various components and the interfacing of the Works relating to Plant & equipment and manufactured items with the Other Contractors and shall conduct all necessary factory, site and acceptance tests.

(2) The commissioning activity shall include a period of the Integrated System testing followed by a period of Trial Running attended by the Commissioner of Railway Safety (CRS) or other Authorized Official and for staff training and familiarisation and timetable proving purposes. Accordingly a typical test sequence shall be as indicated below :



(3) Within 6 months from the Commencement Date , the Contractor shall submit a comprehensive Testing and Commissioning programme, which shall be part of Comprehensive Testing Programme defining the personnel, procedure and format of testing

(4) All testing procedures shall be submitted at least thirty (30) days prior to conducting any Test. The testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the acceptance criteria, the relevant drawing (or modification) status and the location.

(5) The testing procedures shall be submitted by the Contractor and amended, if required subsequently by the Contractor during the duration of the contract to reflect changes in design for track works, interface systems or the identification of additional testing requirements, if needed.

(6) The Engineer shall have the facilities for monitoring all tests and have access to all testing records.

(7) Sufficient time shall be allowed within the testing programmes for necessary alterations to equipment, sub-systems and designs to be undertaken, together with re-testing prior to final commissioning.

(8) The Contractor is reminded that at some point of time, the electric Traction System shall be energized and the additional precautions for the safety and co-ordination of the activities after 'power-on' shall be anticipated in his installation, testing and commissioning programmes.

(9) All costs associated with the testing shall be borne by the Contractor, unless otherwise specified, including the services of any specialised personnel or independent assessors. The Contractor shall also bear any expenses incurred due to resetting / retesting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance.

(10) In the event of any tests being performed in the countries other than India, the Contractor shall give sufficient notice to the Engineer for witnessing the tests. The Contractor shall not be required to bear the cost of the Engineer's visit.

(11) Unless agreed in writing by the Engineer, the personnel engaged on testing shall be independent of those directly engaged in the design or installation of the same equipment.

(12) All testing equipment shall carry an appropriate and valid calibration labels. They shall be periodically checked for calibration accuracy.

(13) All reports of the tests shall be signed by the Contractor's Representative.

5.2 Testing of Track Components

Testing of the track components including but not limited to PSC sleepers, liners, track fittings,

SEJs, turnouts, glued joints, ballast etc. shall be as specified in Clause 13 of specifications (Volume III of the Bid Documents).

5.3 **Inspection and Testing Philosophy For Electrical works**

(1) The inspection of various items shall be carried out by the agencies as consented by the Engineer in the following manner:

Sl. No.	Description	Location
1	Major equipment	The Contractor shall arrange type testing at recognized labs & routine tests at OEM's premises.
2	Minor equipment / sub-assemblies	At site at the time of final testing & commissioning.

(2) All field tests shall be witnessed by authorized representative of the Engineer / Employer & recorded. The Contractor shall give due prior notice. An appropriate format shall be prepared by the Contractor for this purpose. The test format shall have prior consent from Engineer. All tools & instruments for carrying out the tests shall be arranged by the Contractor to the satisfaction of the Engineer. Test results shall be witnessed and signed by the Contractor and the Engineer.

(3) Test Schedules and Procedures are to be submitted for consent of the Engineer and are to include details of testing equipment to be provided.

(4) All switchboards shall be factory inspected by Engineer before finishing and dispatch.

(5) Certificate for all routine and type tests in accordance with the relevant IS shall be furnished.

(6) All panels/cables shall be meggered phase to phase and phase to neutral using a 1000/500V megger with all outgoing feeders in closed position. The megger value shall not be less than 2.5 MΩ between phases and 1.5 MΩ between phases and neutral. All meters and relays shall be calibrated and tested through secondary injection tests.

(7) Prior to shipment of equipment, the Engineer reserves the right to inspect the equipment at the manufacturers' works and the Contractor shall provide and secure every reasonable access and facility at the manufacturers' works for such inspection by the Engineer.

(8) Test Certificates and Reports: The Contractor shall submit manufacturer's type and routine test certificates and reports for each equipment and devices. Complete test results are to be submitted in clearly identified and organized booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures. Test reports shall also include the Quality Assurance Certification, the standards to which the equipment comply, and the standards to which the equipment was tested.

5.4 **Sequence of Tests**

The sequence of tests shall comprise as appropriate the following:

(a) type tests;

(b) factory acceptance tests (FAT) or works test;

(c) installation tests;

DFCC NEW DELHI
NK CONSORTIUM NJPI

(d) partial acceptance tests (PAT)

(e) functional tests;

(f) integration tests;

(g) dynamic tests;

(h) system / sub-system acceptance tests (SAT);

(i) tests on completion (integrated System tests); and

(j) tests after completion (Trial Running).

5.5 **Type Tests**

(1) Should the Contract include any equipment not previously proven in service or of any modified design, the Contractor shall undertake thorough testing of pre-production units to the satisfaction of the Engineer.

(2) The Contractor shall identify in the Contractor's Proposal any equipment in this category, or equipment that differs significantly from that already in service elsewhere.

(3) Type tests including prototype testing shall be performed prior to full production and before FAT.

(4) Type testing shall be used to confirm that the proposed equipment complies with the design criteria specified and meets the requirements of the Contract.

5.6 **Factory Acceptance Test (FAT)**

(1) Works Tests shall include but not be limited to:

(a) Physical inspection;

(b) Dimension check;

(c) Electrical check;

(d) Calibration;

(e) Output check;

(f) Operational performance;

(g) Full Load test;

(h) Flash-over test;

(i) Insulation test;

(j) Soak test; and

(k) Any other test required as per relevant standards or codes.

(2) A Factory Test Plan shall be submitted for the Engineer's review within six (6) months from the Date for Commencement of the Works.

(3) All materials, components, sub-assemblies, unit assemblies (including software, cables and wiring) shall be subject to testing and certification. Notification of these Tests shall be submitted to the Engineer thirty (30) days in advance of carrying out any Test. The Engineer shall then determine which, if any, items that shall be accepted based on previous supply or experience.

(4) The FAT shall demonstrate that each equipment / sub-system meet its functional specification.

(5) No equipment or software shall be delivered to the Site until the Contractor has demonstrated to the satisfaction of the Engineer that the equipment or software conforms to the specification by carrying out the FAT.

(6) Where processor based equipment shall be used, the Works Tests shall include also verification of software used in this application.

5.7 Installation Tests

(1) Prerequisites for Installation:

(a) Prior to installation, the Contractor shall ensure that equipment delivered to Site has not been damaged in transit and ensure for their dimensional accuracy.

(b) Designs for the Sections under test shall be completed and submitted to the Engineer for review prior to Installation.

(2) Inspection:

(a) The inspection shall verify that equipment has been installed to the procedures and design that have been reviewed without objection by the Engineer and that equipment is correctly located and labelled.

(b) The inspection shall verify that any false feed, temporary wiring and redundant items have been removed and that equipment is correctly protected against interference, damage and deterioration.

(c) The Contractor shall maintain inspection records to demonstrate that each item of equipment has been inspected and found to be satisfactory, and attach to this record a detailed list of any discrepancies found and remedial work carried out.

(d) As defects are rectified, these shall be recorded on the appropriate inspection record.

(3) Installation Tests

(a) The Contractor shall carry out installation tests for each sub-system following Installation but before Functional Testing to demonstrate that the installation has been carried out correctly and equipment is properly housed and fixed.

(b) During and on completion of installation, the Contractor shall undertake testing of all cables, wiring and equipment, instrumentation and protection devices, in a progressive sequence and in accordance with the overall-testing programmes.

(c) These tests shall culminate in Functional Tests to verify the correct operation of all apparatus and, where appropriate, correct response to the respective control commands or monitored function.

(4) Partial Acceptance Tests (PAT)

(a) Installation work shall be completed and inspection records submitted to the Engineer for review before the commencement of each PAT.

(b) The PAT Plan shall be submitted for the Engineer's review at least one hundred and twenty (120) days before the commencement of each PAT.

(5) Functional Tests

(a) The functional tests of the PAT shall be carried out on installed equipment before system / sub-system acceptance tests (SAT) to demonstrate that the Section of the Works operates correctly in accordance with the Specifications.

(b) The functional tests shall sequence through all required operations to prove that the system / sub-system performs in accordance with the Specification and that the local configuration data (for example, control tables) is correct.

(c) Where necessary, input conditions shall be simulated.

(d) The functional tests shall be specified and carried out by Contractor's personnel independent of design and installation.

(6) Testing & Commissioning of Track Work

Testing & commissioning of the completed track work shall be as specified in Clause 13.12.5 of the specifications included in Volume III of the Bid Documents.

(7) Integration Tests

(a) Partial Acceptance Test (PAT) shall include integration tests to integrate the various sub-systems of the system and demonstrate correct operation of all internal and external interfaces.

(b) Following satisfactory completion of these Tests, the Contractor shall prepare the installation for formal demonstration in the presence of the Engineer.

(8) System Acceptance Tests (SAT)

(a) The Contractor shall prepare and organise a comprehensive programme of Tests to demonstrate to the Engineer that all systems, sub-systems and apparatus defined under the Contract, when installed, connected and configured as a complete system meet the specified performance requirements in all respects.

(b) Prerequisites and requirements for SAT to be satisfied before the commencement of the system acceptance tests (SAT) shall be as follows:

i. All documentation for the system safety report shall be submitted to the Engineer for review;

ii. All PAT shall be completed and test records submitted to the Engineer for review;

iii. Facilities for the maintenance of the system shall be in place; and

iv. The SAT Plan shall be submitted to the Engineer for review at least one hundred and twenty (120) days before the commencement of the SAT.

(c) The system acceptance tests for the Electrification System shall include, but not be limited to, verification activities which demonstrate that the required criteria have been met for normal and credible failure modes in respect of:

i. The control of the electrification system;

ii. Electrical sectioning;

iii. System voltages and currents;

iv. Accessible and touch voltages; and

v. Switchgear and protection operation under load and short circuit conditions.

(d) All the tests shall be conducted by the Contractor in the presence of the Engineer

5.8 **Samples for Testing**

(1) Samples that have been tested shall be incorporated in the Works provided that:

(a) the sample complies with the specified requirements;

(b) the sample is not damaged;

(c) the sample is not required to be retained under any other provision of the Contract; and

(d) Consent of the Engineer has been obtained

(2) Additional samples shall be provided for testing if in the opinion of the Engineer:

(a) material previously tested no longer complies with the specified requirements; or

(b) material has been handled or stored in such a manner that it does not comply with the specified requirements.

(3) Unless agreed otherwise, all Tests shall be carried out by the Contractor in the presence of the Engineer.

(4) Attendance on Tests, including that by Engineer / Employer, and the Contractor, shall be as laid down in the Quality Assurance procedures.

5.9 **Records of Tests**

Records of Tests carried out shall be kept by the Contractor and a report and all Test results shall be submitted to the Engineer no later than 15 days after completion of the Test, in addition to any other requirements, the report shall contain the following details:

a) material or part of the Works tested;

b) location of the part of the Works;

c) place of testing;

d) date and time of tests;

e) technical personnel supervising or carrying out the tests;

f) equipment used and method of testing;

g) readings and measurements taken during the tests;

h) test results, including any calculations and graphs;

i) specified acceptance criteria;

j) other details stated in the Contract or as required by the Engineer.

5.10 **Integrated System Tests**

(1) Tests on Completion shall include Integrated Testing including but not limited to the work of Civil, Building & Track Work and the Work of Other Contractors as specified in sub-clause 1.2 above. The Contractor shall, following satisfactory completion of tests on his works, equipment, sub-systems or system, perform, at the direction of the Engineer, programme of tests to verify and confirm the compatibility and complete performance of his works, equipment, sub-systems or system with the works, equipment, sub-systems or system provided by others.

(2) The Contractor shall submit to the Engineer requirements and procedures, in respect of the Contractor's scope of work, for Integrated System Tests in conjunction with the Other Contractors to demonstrate that the complete system provided under the Contract is fully operational and meets the specified performance criteria.

(3) The integrated tests shall be undertaken at an operating speed of 110 kmph for the Main Line. The tests shall be as identified by the Contractor and consented by the Engineer vide Sub-clause 1.2 above and shall include but shall not be limited to the following

a) Measurement of track geometry by track recording car (gauge, unevenness, twist, and alignment).

b) The vertical and lateral acceleration by oscillograph car / Portable Accelerometers

The total number of vertical and lateral accelerations peaks of greater than 0.2g should be less than 1.5 peaks per km, as specified in para 618 of IR Permanent Way Manual.

c) Differential settlement as specified in Clause 16.10.5 of Design Criteria included in the Employer's Requirements – Design (Volume II of the Bid Documents) and shall be within the tolerance limits

d) Maximum deflection and percentage of recovery in respect of the individual pre-cast units for Important Bridges, Major Bridges and Rail Flyovers (RFOs) as specified in Clause 9.20 of Volume III of the Bid Documents and same shall be within the limits as specified therein.

e) Electrical insulation properties of track form for the Main Line and loop lines and shall meet the requirements of Signalling and Power Supply System as specified in Clause 13.1.2 of Volume III of the Bid Documents

f) Loop lines, connections with IR and connection up to factory sidings for the respective speed

(4) The conducting of these Integrated System Tests, by the Contractor and the Other Contractors, shall include a period of Trial Running.

(5) Completion of Test Results

The results of the Integrated Testing and Commissioning shall be compiled and evaluated by the Engineer and the Contractor.

(6) Retesting

If the Works, or a part thereof, or a Section, or a Plant & equipment and manufactured items fail to pass the Integrated Testing and Commissioning, the Engineer shall require such failed Tests, to be repeated under the same terms and conditions. If such failure and retesting result from a default of the Contractor and cause the Employer to incur additional costs, the same shall be recoverable from the Contractor by the Employer, and shall be deducted by the Employer from any monies due, or to become due, to the Contractor.

(7) Failure to pass Test

If the Works, or a part thereof, or a Section, or a Plant & equipment and manufactured item fail to pass Integrated Testing and Commissioning and the Contractor in consequence proposes to make any adjustment or modification to the Works or a part thereof, or a section, or the Plant & equipment and manufactured item, the Engineer shall, with the approval of the Employer, instruct the Contractor to carry out such

adjustment or modification, at his own cost and to satisfy the requirements of Integrated Testing and Commissioning within such time as the Employer / Engineer may deem to be reasonable.

(8) Statutory Requirements

The Contractor along with others shall carry out all statutory tests and trials, under the supervision of the Engineer, necessary for obtaining sanction of the competent authority, if required, for opening the railway system.

5.11 Trial Running and Commissioning

(1) Following satisfactory completion of the acceptance Tests and the Integrated System Test the Employer shall commence an extended period of trial running to prove all technical systems, to the satisfaction of the Engineer and CRS or any other Authorized Official, and to allow all technical systems to settle and to train staff in working procedures.

(2) For the purpose of assessing the riding quality of the track and recording combined values of various track parameters an electronic track recording car will be arranged and run by Employer. This run will be scheduled after the floating parameters recorded in Table 13.6 of specifications, included in Volume III of the Bid Documents, are found to be within acceptable limits. The readings of this trial run shall fall within the following category limits (specified in Chapter VI of IR Permanent Way Manual for electronic recording car) to qualify the track for acceptance.

a) Track length outside Station limits – Minimum 90% length in Category A as defined in Para 607 of IR Permanent Way Manual

b) Track length with in Stations limits - Minimum 90% length in Category B (as defined in Para 607 of IR Permanent Way Manual) and above

Station limits for this purpose shall mean the length between the two outermost stop signals.

c) The Track Geometry Index(TGI) calculated based on Track recording car run, including track within Station limits shall be within the following threshold limits (R.D.S.O. Report No.TM-115)

Sl. No.	INDICES	TGI Value
1.	60% CFD at the time of testing (i.e. Minimum 40% of track shall have TGI)	≥ 115
3.	10% CFD at the time of testing (i.e. Minimum 90% of track shall have TGI)	≥ 75

In case the track fails to qualify within the respective categories or the thresholds of TGI laid down, then a rerun of the recording car shall be scheduled after a month to record these parameters.

(3) The Contractor shall allow for attendance in respect of the Contractor's scope of work over the whole of this period, which shall be expected to include maintenance and repair activities and also further opportunity for technical staff training.

6 Maintenance Support Plan

6.1 The Contractor shall provide a maintenance support plan that shall include such items as:

a) procedures for maintaining each item, unit / equipment including routine inspection, periodical overhaul and test running;

b) technical manuals;

c) initial provision of spares, facilities, test equipment, tools, jigs and fixtures as per consented list;

d) training requirements;

e) procedures for removal and replacement of components;

f) periodic running of equipment and machines which would otherwise deteriorate because of non-operation for more than a week;

g) procedure for handling rail fracture;

h) manpower plan required for maintenance.

6.2 On completion of the Works the Contractor shall deliver up to the Engineer copies of all manufacturing drawings, schedules and software for all components, as well the As-Built Drawings as specified in Appendix 8 [CAD and Documents Standards].

7 Operation and Maintenance (O&M) Manuals

7.1 In addition to the various existing Codes and Manuals applicable to Indian Railways for operation and maintenance of Permanent Civil, Buildings and Track Works, the Contractor shall produce additional Manuals covering the additional provisions (if any) over and above the various existing Codes and Manuals of Indian Railways in respect of the following for Operation and Maintenance of various assets created under the Contract.

7.2 The Contractor is required to disclose to the Engineer or the Employer confidential information as follows:

All information reasonably necessary for the Employer and Engineer to have an understanding of the design and technical operation for review and approval purposes and for the Employer to properly operate the Plant and be able to conduct routine servicing, maintenance and repairs.

7.3 With reference to the requirements as above :

(1) The Contractor shall produce manuals for all Permanent Works, Plant & equipment and manufactured items and systems / sub-systems supplied (if any) for their efficient operations and maintenance. These shall include, but shall not necessarily be limited to, the following:

(a) Manual for Maintenance of Rail Track Formation

(b) Manual for Maintenance of Bridges

(c) Manual for Maintenance of Track

(d) Manual for Maintenance Depots

(e) Manual for Buildings Maintenance

(f) Manual for E & M equipment

(g) Manual for Building Services

(h) Manual for Drainage System

(i) System / sub-system Manuals - A comprehensive description of all system principles at block diagram level.

(j) Operating/User Manuals - broken into as many sub-sections as may be necessary and providing sufficient information to enable non-technical staff to exploit fully the facilities of each system.

(k) Workshop Manuals - installation and circuit descriptions, full schematics, circuits, wiring diagrams, mechanical construction drawings and itemized parts list to enable all maintenance rectification and setting-up to be carried out.

(l) Software System Manuals - for each software package and each piece of equipment which incorporates programmable devices and for which bespoke software has been prepared specifically for this application. Source code listings with comprehensive comments shall be provided for all bespoke software together with configuration listings for all configured standard software packages.

(m) Equipment Room Manuals - all wiring diagrams and circuits, equipment layout, terminal and cable listing and including such external equipment as may be necessary for completeness.

(n) Maintenance and Servicing Manuals - to specify requirements, procedures and servicing intervals for planned preventative maintenance and in addition to convey sufficient information on equipment principles and practice to enable first line fault diagnosis and rectification by technician staff.

(2) Operation & Maintenance manual shall also contain the following

(a) Technical description of each system and item of equipment installed, written to ensure that the Employers staff fully understands the scope and facilities provided.

(b) Diagrammatic drawings of each system indicating principle components and items of equipment

(c) Name, addresses, telephone, e-mail and fax numbers of the manufacturer of every item of equipment

(d) Manufacturer's service manual for each major item of equipment, assembled specifically for the project, including detailed drawings, illustrations, circuit details, operating and maintenance instructions, modes of operation, control provisions, sequences and interlocks and preventative maintenance program

(e) Schedules of all fixed and variable equipment settings established during commissioning

(f) Procedures for fault finding, where applicable, data or recommended maintenance procedures, maintenance intervals and maintenance tools

(g) All test results conducted on the relevant equipment whether at the manufacturer's place or at site

(h) Manufacturers' lists of recommended spare parts for items subject to wear and deterioration, giving expected running period and indicating specifically those items, which may involve extended deliveries.

(3) The sub-systems / systems and Operating/User Manuals and a summary (suitable for use at technician level) of the Maintenance and Servicing Manuals shall be prepared in both English and Hindi languages unless otherwise instructed by the Engineer.

(4) The Contractor shall submit all the Manuals for review by the Engineer prior to Factory Acceptance Tests except for the Rail Track Formation, Rail Track Structures, Building Maintenance and Drainage System manuals which shall be submitted not later than 6 months from the targeted date of start of Trial Running for the Engineer's consent

(5) The Contractor shall provide 6 controlled copies of all Manuals for the use of the Engineer.

(6) The Contractor shall maintain all Manuals in an up-to-date condition throughout the Contract Period wherever applicable.

(7) O&M Manuals and drawings as submitted by the Contractor shall be updated by him during the Defects Notification Period, if required, and shall be re-submitted to the Engineer for review without any extra cost to the Employer.

8 Spares, Special Tools and Test Equipment

8.1 General

(1) After completion of the Works and before taking over of the Works by the Employer, the Contractor shall provide all material, unit exchange spares and emergency spares required for maintenance of all systems and structures constructed under this contract, as per the list of Spares as included in Section 5 of Schedule 6: Financial Submission of Volume I.

(2) The Contractor shall also supply all the mandatory spares, materials, jigs and fixtures not later than 6 (six) weeks before the operation of the systems.

(3) -Deleted-

8.2 Tools and Test Equipment

(1) The Contractor shall provide, six weeks before start of trial running, special tools and test equipment, as per the list included in '**Table ER-MITC-1: List of Tools and Equipment**' below, which are essential for day to day use in both corrective and preventive maintenance.

Table ER-MITC-1: List of Tools and Equipment (*)

Sr. No.	Description	Reqd. nos. per IMD	Total nos. required
1	**Communication Equipment**		
1.1	Walkie Talkie (Set)	2	6
2	**Rail cutting/Drilling**		
2.1	Abrasive rail cutter with 10 spare discs	2	6
2.2	Rail Cutting Machine(Saw Type) along with 10 spare blades for HH rails	2	6
2.3	Rail Drilling Machine	2	6
2.4	Chamfering Kit/ Machine with 5 no. spare HT Bolts	2	6
3	**Rail Welding Equipment(AT Weld)**		
3.1	Rail welding equipment(AT Weld) with 1 spare crucible	2	6

Sr. No.	Description	Reqd. nos. per IMD	Total nos. required
3.2	Double action weld trimmer for AT Weld	2	6
3.3	Rail Profile weld grinder	2	6
4	**Spot tamping with lifting/lining (set)**		
4.1	Off track Hand held Tamper with Generator	4	12
4.2	Track lifting jacks(Hydraulic) 15T capacity	8	24
4.3	Lifting and slewing device(Hydraulic)	1	3
4.4	Electronic toe load measuring device	2	6
5	**Destressing Equipment (Set)**		
5.1	Hydraulic Rail Tensor(Non-infringing) 70 T capacity	2	6
5.2	Hydraulic Sleeper spacer	1	3
6	**Material/personnel Handling Eqpt.(Nos.)**		
6.1	Rail dolly (set)	6	18
6.2	Monorail wheel barrow	4	12
6.3	Self-propelled light weight trolley	2	6
7	**Gas cutting Equipment with I set of spare gas cylinders(Set)**	1	3
8	**Points and crossing reconditioning equipment(Set)**		
8.1	Portable DC Welding Generator, 15HP with an auxiliary AC unit	1	3
8.2	Arc Welding equipment with spare electrodes	1	3
8.3	Hand held rail grinder machine	2	6
9	**Ultrasonic rail flaw detection equipment (No.)**		
9.1	Double Rail tester, mounted on a push trolley, with multi-channel facility having threshold arrangement LED screen and audio warning in addition to CRT screen, along with following probes/accessories,	1	3
	Normal probes (0°) -4 No.		

Sr. No.	Description	Reqd. nos. per IMD	Total nos. required
	45° Probe- 4No.		
	70° Probes- 12No.		
	37o Probes-4 No.		
	Battery and Battery charger-1 no.		
	Connecting Cable(Flaw detector to Junction Box)-20 nos.		
	BNC connector(Jn. Box to probes) -20 nos.		
9.2	Digital Data Logger	1	3
10	**Track measurement tools**		
10.1	Track gauge cum level dial type (Insulated)	4	12
10.2	Permanent way measuring kit	4	12
10.3	Rail wear Gauges	4	12
10.4	Rail versine measuring kit	4	12
10.5	Rail welding straight edges	4	12
10.6	Magnetic based Rail thermometer	12	36

(*) The brand, make and specifications of the tools and equipment shall be as consented by the Engineer.

(2) The Contractor shall submit a schedule of all tools and equipment with details of calibration and supplier along with the Bid.

8.3 **Spares List**

(1) The Contractor shall submit a schedule of recommended spare parts required duly indicating the quantities required for each item of spares, its description, part number, drawing number, lead time, shelf life and number of units required for the period of five years (beyond DNP), name and addresses of principal as well as secondary sources of supply of each spare.

(2) As a minimum, the Contractor shall supply the spares required for day to day running and operation of the system as specified in Volume 1 of the Bid Documents, as part of the Contract.

(3) This recommended schedule shall include all types of, unit exchange and emergency spares, the Contractor shall also advise the recommended inventory having regard to the lead time of the respective items.

(4) The Contractor shall:

(a) submit to the Engineer a list of spares required for the life of the Plant & equipment manufactured items and system / sub-system;

(b) base the spares calculations on the reliability and availability data and the criticality of the equipment;

(c) submit to the Engineer for review the calculations and spares list;

(d) submit to the Engineer a system for easy identification of spares.

(5) The Spares list shall:

(a) be grouped by Plant & equipment, manufactured items and system / sub-system, test equipment and special tools as applicable for stocking identification;

(b) have detailed description with drawing references and correlation with the maintenance manuals.

(6) In the event that any of the spares identified have a particular shelf life or special storage requirement, this shall be made known to the Engineer with the submission of the spares list, including the necessary action for disposal or storage.

(7) All spare equipment identified on the spares list, shall conform to Identification and Configuration Control requirements established by the Contractor for the equipment provided under the Contract.

8.4 **Testing of Spares**

The Contractor shall ensure that all spares are correctly calibrated, tested and labelled prior to their delivery. Test certificates for each one of the equipment shall be submitted to the Engineer.

8.5 **Plant / Equipment Identification**

All plant & equipment and manufactured items supplied shall be indelibly labelled or otherwise identified to show its identity, type, version, function, location, rating or limitation as appropriate.

9 Training

9.1 The Contractor shall be required to arrange technology transfer (wherever required) to the Employer's staff in respect of design, manufacture, construction, handover, operations and maintenance of the Plant & equipment and manufactured items provided under the Contract, these staff shall include the Employer's management, operation, technical and instructional staff.

9.2 The Contractor shall train, or to arrange training for, the Employer's staff who shall be nominated by the Employer.

9.3 This shall require the Contractor to train the Employer's Staff in sufficient detail to enable the staff to :

a) appreciate, understand and monitor the technical, operational, maintenance, management and business aspects of the system;

b) operate, maintain and manage the system efficiently and safely.

10 Plant & Equipment Protection

10.1 All Plant & equipment shall be capable of continuous operation in the prevalent environment at Site and achieve its stated service life.

10.2 It is a basic requirement that the minimum of Plant & equipment shall be mounted on the lineside. Any lineside Plant & equipment shall be limited to essential rail connected apparatus and sleepers. All other Plant & equipment and manufactured items shall in general be mounted in equipment rooms provided at each Station or in easily accessible warehouses.

10.3 The Contractor shall be responsible for ensuring that the Plant & equipment and systems are not adversely affected by the harsh environmental conditions caused by the localized heat or vapor emissions or moisture from other adjacent Plant & equipment whether provided under the Contract or otherwise.

Attachments to Employer's Requirements

ATTACHMENT 1A

WIDTH OF AVAILABLE RIGHT OF WAY FOR PERMANENT WORKS

IQBALGARH - VADODARA SECTION

ROW Offsets for Section 9

DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
8697	43.38	Ajmer Unit Starts	ROW as per land acquired by CPM Ahemdabad for RFO. Land for Chadotar to New Palanpur Junction station connecting lines (Palanpur Bye Pass) is not included in this ROW. It has been included separately.
8700	43.38		
8750	43.20		
8800	43.02		
8850	42.83		
8900	42.65	Offset	
8900	37.65		
8950	37.49		
9000	37.32		
9050	37.16		
9100	36.99		
9150	36.83		
9172.77	36.76	Offset	
9172.77	96.76		
9200	90.76		
9250	82.64		
9300	74.37		
9350	66.77		
9375	63.71		
9400	61.72		
9400	54.72	Offset	
9450	51.91		
9500	53.72		
9550	53.00		
9600	51.78	Offset	
9600	53.65		
9650	55.50		
9700	52.58		
9750	85.00		
9765	67.00		
9800	67.00		ROW as per land acquired by CPM Ajmer incl. land to be acquirred for New Palanpur yard
9850	67.00		
9900	67.00		
9950	67.00		
10000	67.00		
10150	67.00		
10200	67.00		
10250	67.00		
10300	67.00		
10350	67.00		
10400	67.00		
10450	67.00		
10500	67.00		
10528	90.00	SSP	
10550	90.00	SSP	
10572	90.00	SSP	

ROW Offsets for Section 9

DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
10600	90.00		ROW as per land acquired by CPM Ajmer incl. land to be acquirred for New Palanpur yard
10650	90.00		
10700	90.00		
10750	90.00		
10800	90.00		
10850	90.00		
10850	90.00		
10900	90.00		
10950	90.00		
11000	90.00		
11050	100.00		
11100	100.00		
11150	100.00		
11200	100.00		
11250	100.00		
11300	100.00		
11350	100.00		
11400	100.00		
11450	100.00		
11500	100.00		
11550	100.00		
11600	100.00		
11650	100.00		
11700	76.00		
11750	76.00		
11800	76.00		
11850	76.00		
11900	76.00		
11950	76.00		
12000	76.00		
12017	76.00		
12050	125.00		
12100	125.00		
12150	125.00		
12200	125.00		
12217	125.00		
12250	85.00		
12300	85.00		
12350	85.00		
12400	63.00		
12450	63.00		
12475	63.00		
12500	90.00		
12550	90.00		
12600	90.00		
12650	90.00		
12663	90.00		
12700	130.00		
12750	130.00		
12800	130.00		
12850	130.00		
12900	130.00		
12915	130.00		
12950	90.00		
13000	90.00		
13050	90.00		
13100	90.00		
13150	90.00		
13200	90.00		
13250	90.00		
13300	90.00		
13350	90.00		
13400	90.00		
13450	90.00		
13485	90.00		
13500	90.00		
13550	90.00		
13600	90.00		
13650	100.00		
13700	100.00		
13720	100.00		
13750	60.00		
13800	60.00		
13850	60.00		
13900	60.00		
13950	60.00		
14000	60.00		
14050	60.00		
14100	60.00		
14150	60.00		
14200	60.00		

ROW Offsets for Section 9			
DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
14222	60.00		
14300	33.93		
14350	33.95		
14400	33.98		
14450	34.01		
14500	34.05		
14550	34.03		
14600	34.01		
14650	34.04		
14700	34.06		
14750	34.07		
14800	34.07		
14850	34.08		
14900	34.09		
14950	34.13		
14950	50.00	Offset	
15000	50.00		
15050	50.00		
15100	50.00		
15150	50.00		
15200	50.00	offset	
15200	45.00	CH15192 Br859	
15250	45.00		
15300	45.00		
15350	45.00		
15350	40.00		
15400	40.00		
15450	40.00		
15500	40.00		
15500	35.00		
15550	35.00		
15600	35.00		
15650	35.00		
15700	35.00	CH15686 Br858	
15750	35.00	CH15728 Br857	
15800	35.00		
15800	35.00	Offset	
15850	35.00		
15900	35.00		
15950	35.00	CH15925 LC 161	
16000	35.00	CH16016 Br856	
16050	35.00		
16100	35.00		
16150	35.00		
16200	35.00		
16250	35.00		
16300	35.00	offset	
16300	40.00	offset	
16350	40.00		
16400	40.00		
16450	40.00	CH16437 Br855,	
16450	45.00	CH16437 Br855,	
16500	45.00		
16550	45.00	offset	
16550	50.00	offset	

ROW Offsets for Section 9			
DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
16600	50.00		IR CHITRASANI 641/0 TO 639/9
16650	50.00	CH16635 LC 160	
16700	50.00		
16750	50.00	offset	
16750	45.00	offset	
16800	45.00		
16850	45.00		
16900	45.00		
16950	50.00		
17000	50.00		
17050	50.00		
17100	50.00		
17150	50.00		
17200	50.00		
17250	50.00		
17300	50.00		
17350	50.00		
17400	50.00	CH17382 LC 159	
17450	50.00		
17500	50.00		
17550	50.00	offset	
17550	45.00	offset	
17600	45.00	CH17620 Br850	
17650	45.00	offset	
17650	40.00	offset	
17700	40.00	offset	
17700	35.00	offset	
17750	35.00		
17800	35.00	CH17805 Br849	
17850	35.00		
17900	35.00		
17950	35.00		
18000	35.00		
18050	35.00		
18100	35.00	CH18075 Br848	
18150	35.00		
18200	35.00		
18250	35.00		
18300	35.00		
18350	35.00	offset	
18350	30.00	offset	
18400	30.00		
18450	30.00		
18500	30.00	CH18438 LC 158	
18550	30.00	BAWS	
18600	30.00	BAWS	
18650	30.00	BAWS	
18700	30.00	BAWS	
18750	30.00	BAWS	
18800	30.00	BAWS	
18850	30.00	BAWS	
18900	30.00	BAWS	
18950	30.00	BAWS	
19000	30.00	BAWS	
19050	30.00	BAWS	
19100	30.00	BAWS	
19150	30.00	BAWS	
19200	30.00	BAWS	
19250	30.00	BAWS	
19300	30.00	BAWS	
19350	30.00	BAWS	

ROW Offsets for Section 9

DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
19400	30.00	BAWS	
19450	30.00	BAWS	
19500	30.00	BAWS	
19550	30.00	BAWS	
19600	30.00	BAWS	
19650	30.00	BAWS	
19700	30.00	BAWS	
19750	30.00	BAWS	
19800	30.00	BAWS	
19850	30.00	BAWS	
19900	30.00	BAWS	
19950	30.00	BAWS	
20000	30.00	BAWS	
20050	30.00	BAWS	
20100	30.00	BAWS	
20150	30.00	BAWS	
20200	30.00	BAWS	
20250	30.00	BAWS	
20300	30.00	BAWS	
20350	30.00	BAWS	
20400	30.00	BAWS	
20450	30.00	BAWS	
20500	30.00	BAWS	
20550	30.00	BAWS	
20600	30.00	BAWS	
20650	30.00	BAWS	
20700	30.00	BAWS	
20750	30.00		
20800	40.00	CH20805 LC 157	IR JETHI 636/8 TO 635/7
20850	40.00		
20900	40.00		
20950	40.00	offset	
20950	45.00	offset	
21000	45.00	offset	
21000	50.00	offset	
21050	50.00		
21100	50.00	offset	
21100	55.00	offset	
21150	55.00		
21200	55.00		
21250	55.00		
21300	55.00		
21350	55.00		
21400	55.00	CH21377 Br843	
21450	55.00		
21500	55.00		
21550	55.00		
21600	55.00		
21650	55.00		
21700	55.00	CH21680 Br842	
21750	55.00		
21772.5	75.47	SSP, Offset	
21800	74.96	SSP	
21827.5	74.56	Offset, SSP	
21850	55.00		
21900	55.00	offset	
21900	50.00	offset	
21950	50.00		
22000	50.00	offset	

ROW Offsets for Section 9

DFC Chanaige	DFC East/ Right ROW from IR M/L Track (m)	Remarks	
22050	45.00		
22100	45.00	offset	
22100	40.00	offset	
22150	40.00		
22200	40.00	offset	
22200	35.00	offset	
22250	35.00		
22300	35.00	CH22275 Br841	
22350	35.00		
22400	35.00		
22450	35.00		
22500	35.00	CH22511 Br840	
22550	35.00		
22600	35.00		
22650	35.00		
22700	35.00		
22750	35.00	offset	
22750	32.00	offset	
22800	32.00		
22850	32.00		
22900	32.00		
22950	32.00		
23000	32.00		
23050	32.00		
23100	32.00	CH23070 Br839	
23150	32.00		
23200	32.00		
23250	32.00		
23300	32.00		
23350	32.00		
23400	32.00		
23450	32.00	CH23440 LC155	
23500	32.00		
23550	32.00		
23600	32.00		
23650	32.00		
23700	32.00		
23750	32.00		
23800	32.00	CH23810 Br838A	
23850	32.00		
23900	32.00		
23950	32.00		
24000	32.00		
24050	32.00		
24100	32.00		
24150	32.00		
24200	32.00		
24250	32.00		
24300	32.00		
24350	32.00		
24400	32.00		
24450	32.00	CH 24440 Br838	
24500	32.00		
24550	32.00		
24600	32.00		
24650	32.00		
24700	32.00		
24750	32.00		
24800	32.00		
24850	32.00		
24900	32.00		
24950	32.00		
25000	32.00		
25050	32.00		
25100	32.00	CH25100 LC154	
25150	32.00		
25200	32.00		
25250	32.00		
25300	32.00		
25350	32.00		
25400	32.00		
25450	32.00		
25500	32.00		
25550	32.00		
25600	32.00		
25650	32.00		
25700	32.00		
25750	32.00		
25800	32.00		
25850	32.00		
25900	32.00	CH 25876 Br837	
25950	32.00		
26000	32.00		
26050	32.00		
26100	32.00	CH 26089 Br836	
26150	32.00	offset	
26150	35.00	offset	
26200	35.00	offset	
26200	40.00	offset	
26250	40.00	offset	
26250	46.00	offset	
26300	46.00		
26350	46.00		
26400	46.00		
26450	46.00		
26500	46.00		

ROW of Detour section					
Section 8 N					
Village	DFC Chaina From (m)	DFC Chaina To (m)	ROW of Left side from DFC Line (m)	ROW of Right side from DFC Line (m)	Total Width of ROW (M)
Vansjada Kalol	0	113	24.5	30.5	55.0
WAMAJ	113	1304	38.0	38.0	76.0
Ramnagar	1304	2760	29.0	35.0	64.0
Piyaj	2760	3100	33.0	39.0	72.0
Piyaj	3100	3200	19.5	25.5	45.0
Piyaj	3200	4400	29.5	35.5	65.0
Piyaj	4400	4497	25.0	31.0	56.0
Borisana	4497	5615	25.0	31.0	56.0
Kalol	5615	5715	25.0	31.0	56.0
Kalol	5715	6000	25.0	31.0	56.0
Kalol	6000	6305	19.5	25.5	45.0
Pratappura	6305	6600	27.0	33.0	60.0
Pratappura	6600	7100	29.0	35.0	64.0
Pratappura	7100	7400	31.0	37.0	68.0
Pratappura	7400	7662	35.0	41.0	76.0
Chhatral-II	7662	7990	36.0	42.0	78.0
Chhatral-II	7990	8279	35.0	41.0	76.0
Ola	8279	8579	35.0	41.0	76.0
Ola	8579	8779	33.0	39.0	72.0
Ola	8779	8955	31.0	37.0	68.0
Chhatral-I	8955	9100	29.0	35.0	64.0
Chhatral-I	9100	9900	27.0	33.0	60.0
Chhatral-I	9900	10355	25.0	31.0	56.0
Isand	10355	10554	32.5	38.5	71.0
Vadavswami	10554	11000	17.5	23.5	41.0
Vadavswami	11000	11200	19.5	25.5	45.0
Vadavswami	11200	11500	22.0	28.0	50.0
Vadavswami	11500	12050	25.0	31.0	56.0
Vadavswami	12050	12178	21.5	27.5	49.0
Pansar	12178	12300	21.5	27.5	49.0
Pansar	12300	13200	21.5	27.5	49.0
Pansar	13200	13300	14.0	20.0	34.0
Pansar	13300	13900	14.0	20.0	34.0
Pansar	13900	14010	14.0	29.0	43.0

ROW of Section Parallel to IR (With reference t					
Section 8 N					
Village	DFC Chaina From (m)	DFC Chaina To (m)	Width Land acquired by DFC (m) L	Width Land acquired by DFC (m) R	Remarks
JHULASAN	14010	14210	35.00		PARALLEL IR
JHULASAN	14210	15000	33.00		
JHULASAN	15000	15110	38.00		
JHULASAN	15110	15200	32.00		
JHULASAN	15200	15600	32.00		
JHULASAN	15600	15770	35.00		
JHULASAN	15770	16000	43.00		
JHULASAN	16000	16200	40.00		
JHULASAN	16200	16600	38.00		
JHULASAN	16600	16800	40.00		
JHULASAN	16800	16945	40.00		
GHUMASAN	16945	17000	40.00		
GHUMASAN	17000	17335	40.00		
GHUMASAN	17335	17580	65.00		
GHUMASAN	17580	17800	70.00		
GHUMASAN	17800	18800	40.00		
GHUMASAN	18800	19000	53.00		
GHUMASAN	19000	19400	43.00		
GHUMASAN	19400	19500	45.00		
GHUMASAN	19500	19536	39.00		
DANGARVA	19536	19880	39.00		
DANGARVA	19880	20200	34.00		
DANGARVA	20200	20230	38.00		
DANGARVA	20230	22775	48.00		
ANANDPURA	22775	22850	48.00		
ANANDPURA	22850	23000	46.00		
ANANDPURA	23000	23105	40.00		
TANAKIYA	23105	23200	33.00		
TANAKIYA	23200	23510	35.00		
TANAKIYA	23510	23630	31.00		
TANAKIYA	23630	23800	35.00		
TANAKIYA	23800	23960	35.00		
TANAKIYA	23960	24140	38.00		
TANAKIYA	24140	24400	41.00		
TANAKIYA	24400	24643	41.00		
KAIYAL	24643	24730	61.00		AV=(41+81 DUE TO CURVED R
KAIYAL	24730	24800	95.50		AV=(91+10 DUE TO CURVED R
KAIYAL	24800	24870	102.00		AV=(100+10 DUE TO CURVED R
KAIYAL	24870	25000	86.50		AV=(93+80 DUE TO CURVED R
KAIYAL	25000	25200	66.00		AV=(80+52 DUE TO CURVED R
KAIYAL	25200	25300	52.00		
KAIYAL	25300	25400	42.00		
KAIYAL	25400	25630	45.00		
KAIYAL	25630	25890	32.00		
KAIYAL	25890	25905	35.00		
NAVI SEDHAV	25905	26030	35.00		
NAVI SEDHAV	26030	26590	33.00		
NAVI SEDHAV	26590	27240	38.00		
NAVI SEDHAV	27240	27695	33.00		
JORNANG	27695	27770	33.00		
JORNANG	27770	28590	39.00		
JORNANG	28590	28730	36.00		
JORNANG	28730	29230	35.00		
JORNANG	29230	29400	38.00		
JORNANG	29400	29540	41.00		AV=(40+42 DUE TO CURVED R

ROW of Section Parallel to IR (With reference to nearest IR track)

Section 8 N

Village	DFC Chainage From (m)	DFC Chainage To (m)	Width of Land acquired by DFC (m) L	Width of Land acquired by DFC (m) R	Remarks
JORNANG	29540	29580	64.00		
JORNANG	29580	29630	140.00		
JORNANG	29630	29720	190.00		
JORNANG	29720	29800	40.00		
JORNANG	29800	30034	40.00		
AMBALIYASAN	30034	30200	16.00		AV=(10+22)/2 DUE TO CURVED ROW
AMBALIYASAN	30200	30600	10.00		
AMBALIYASAN	30600	30800	22.00		
AMBALIYASAN	30800	30970	26.00		
CHALUVA	30970	31000	26.00		
CHALUVA	31000	31200	28.00		
CHALUVA	31200	31240	30.00		
CHALUVA	31240	31410	32.00		
CHALUVA	31410	31620	36.00		
CHALUVA	31620	31800	34.00		
CHALUVA	31800	31864	34.00		
DHOLASAN	31864	31880	34.00		
DHOLASAN	31880	32220	32.00		
DHOLASAN	32220	32470	34.00		
DHOLASAN	32470	33200	34.00		
DHOLASAN	33200	33810	34.00		
DHOLASAN	33810	33940	33.00		
DHOLASAN	33940	34120	36.00		
DHOLASAN	34120	34400	32.00		
DHOLASAN	34400	34550	34.00		
DHOLASAN	34550	34567	32.00		
GERATPUR	34567	34680	32.00		
GERATPUR	34680	34717	34.00		
DHOLASAN	34717	34941	32.00		
GERATPUR	34941	35070	34.00		
GERATPUR	35070	35200	32.00		
GERATPUR	35200	35343	33.00		
DITASAN	35343	35360	33.00		
DITASAN	35360	35480	34.00		
DITASAN	35480	35600	33.00		
DITASAN	35600	35820	33.00		
DITASAN	35820	36000	34.00		
DITASAN	36000	36160	32.50		AV=(34+31)/2 DUE TO CURVED ROW
DITASAN	36160	36890	32.00		
JAGUDHAN	36890	37000	36.00		
JAGUDHAN	37000	39770	42.00	38.00	RTR ON DETOUR
MEVAD	39770	40000	45.00	38.00	
MEVAD	40000	40230	45.00	38.00	
MEVAD	40230	40280	48.00	38.00	
MEVAD	40280	40400	48.00	40.00	
MEVAD	40400	40800	48.00	50.50	RIGHT SIDE AV= (61+40)/2
PUNASAN	40800	41030	48.00	58.00	RIGHT SIDE AV= (55+61)/2
PUNASAN	41030	41200	45.00	55.00	
HEBUVA	41200	41402	45.00	55.00	
HEBUVA	41402	41500	45.00	52.00	
HEBUVA	41500	41535	41.00	52.00	
SOBHASAN	41535	41600	41.00	49.00	
SOBHASAN	41600	41800	40.00	48.00	
SOBHASAN	41800	42000	42.00	45.00	
SOBHASAN	42000	42100	42.00	42.00	
SOBHASAN	42100	42200	33.00	41.00	
SOBHASAN	42200	42450	35.00	30.00	
SOBHASAN	42450	42800		40.00	
SOBHASAN	42800	43000		40.00	
SOBHASAN	43000	43400		40.00	
SOBHASAN	43400	43600		38.00	
SOBHASAN	43600	43800		35.00	
KUKAS	43800	44000		30.00	
KUKAS	44000	44200		32.50	AV=(35+30)/2 DUE TO CURVED ROW

ROW of Section Parallel to IR (With reference to nearest IR track)

Section 8 N

Village	DFC Chainage From (m)	DFC Chainage To (m)	Width of Land acquired by DFC (m) L	Width of Land acquired by DFC (m) R	Remarks
KUKAS	44200	44272		35.00	
HEDUVA HANUMANT	44272	44400		35.00	
HEDUVA HANUMANT	44400	44600		31.50	AV=(35+28)/2 DUE TO CURVED ROW
HEDUVA HANUMANT	44600	44800		34.50	AV=(28+41)/2 DUE TO CURVED ROW
HEDUVA HANUMANT	44800	45000		35.50	AV=(41+30)/2 DUE TO CURVED ROW
HEDUVA HANUMANT	45000	45400		60.00	
HEDUVA HANUMANT	45400	45500		60.00	
HEDUVA HANUMANT	45500	45740		80.00	
HEDUVA HANUMANT	45740	45900		61.00	
HEDUVA HANUMANT	45900	45929		68.00	
MEHSANA	45929	46000		72.00	
MEHSANA	46000	46100		102.00	
MEHSANA	46100	46200		82.00	
MEHSANA	46200	46300		62.00	
MEHSANA	46300	46400		62.00	
MEHSANA	46400	46500		47.00	
MEHSANA	46500	46600		35.00	
MEHSANA	46600	46620		35.00	
MEHSANA	46620	46700		29.00	
MEHSANA	46700	46840		29.00	
MEHSANA	46840	46950		37.00	
MEHSANA	46950	47050		43.00	
MEHSANA	47050	47220		22.00	
MEHSANA	47220	47280		20.00	
MEHSANA	47280	47500		30.00	
MEHSANA	47500	47600		31.00	
MEHSANA	47600	47700		34.00	
MEHSANA	47700	47800		34.00	
MEHSANA	47800	47900		34.00	
MEHSANA	47900	48000		43.00	
MEHSANA	48000	48100		45.00	
MEHSANA	48100	48150		45.00	
MEHSANA	48150	48330		43.00	
MEHSANA	48330	48700		45.00	
MEHSANA	48700	48800		42.00	
MEHSANA	48800	49000		32.00	
MEHSANA	49000	49220		27.00	
MEHSANA	49220	49400		29.00	
MEHSANA	49400	49530		33.00	
MEHSANA	49530	49900		27.00	
MEHSANA	49900	50000		30.00	
MEHSANA	50000	50250		35.00	
MEHSANA	50250	51152		40.00	
RAMOSANA	51152	51200		40-48	
RAMOSANA	51200	51300		43.00	
RAMOSANA	51300	51449		41.00	
TALETI	51449	53564		41.00	
NANI DAU	53564	53970		41.00	
NANI DAU	53970	54140		43.00	
NANI DAU	54140	54200		48.00	
NANI DAU	54200	54390		37.00	
NANI DAU	54390	54900		41.00	
NANI DAU	54900	55000		130 TO 65	decreasing
NANI DAU	55000	55190		65 to 54	
NANI DAU	55190	55264		49.00	
MOTI DAU	55264	55300		55.00	
MOTI DAU	55300	57000		49.00	
MOTI DAU	57000	57200		49.00	
MAHESANA	57200	57255		57.00	AV=(33+57)/2 DUE TO CURVED ROW
MAHESANA	57255	57425		11[illegible]	
MAHESANA	57425	57500		65.00	

ROW of Section Parallel to IR (With reference to nearest IR track)

Section 8 N

Village	DFC Chainage From (m)	DFC Chainage To (m)	Width of Land acquired by DFC (m) L	Width of Land acquired by DFC (m) R	Remarks
MOTI DAU	57500	57600		68.00	
MOTI DAU	57600	57700		64.00	
MOTI DAU	57700	58300		64.00	
MOTI DAU	58300	58458		68.00	
BHANDU	58458	58630		68.00	
BHANDU	58630	58690		107.00	
BHANDU	58690	58850		66.00	
BHANDU	58850	58900		70.00	
BHANDU	58900	59100		68.00	
BHANDU	59100	59150		64.00	
BHANDU	59150	59200		48.00	
BHANDU	59200	59300		46.00	
BHANDU	59300	59400		36.00	
BHANDU	59400	59491		32.00	
BHANDU	59491	59618		19.63	
BHANDU	59618	59900		40.00	
BHANDU	59900	60430		39.00	
BHANDU	60430	60900		36.00	
BHANDU	60900	61000		34.00	
BHANDU	61000	61948		33.00	
JETALVASNA	61948	62650		33.00	
JETALVASNA	62650	62770		36.00	
JETALVASNA	62770	63000		41.00	
JETALVASNA	63000	63230		42.00	
JETALVASNA	63230	63340		59.00	
JETALVASNA	63340	63600		38.00	
JETALVASNA	63600	63800		37.00	
JETALVASNA	63800	63980		36.00	
JETALVASNA	63980	66000		33.00	
JETALVASNA	66000	66500		34.00	
JETALVASNA	66500	66700		37.00	
JETALVASNA	66700	66800		38.00	
JETALVASNA	66800	66900		36.00	
JETALVASNA	66900	67000		34.00	
JETALVASNA	67000	67400		34.00	
JETALVASNA	67400	67600		33.00	
JETALVASNA	67600	67800		32.00	
JETALVASNA	67800	67910	30.00	31.00	
JETALVASNA	67910	68110	30.00	32.00	
JETALVASNA	68110	68150	30.00	35.00	
JETALVASNA	68150	68430	40.00	38.00	
JETALVASNA	68430	68520	90.00	38.00	
JETALVASNA	68520	68700	70.00	38.00	
JETALVASNA	68700	68920	70.00	38.00	
JETALVASNA	68920	69030	70.00	35.00	
JETALVASNA	69030	69100	26.00	33.00	
JETALVASNA	69100	69300	26.00	33.00	
JETALVASNA	69300	69350	26.00	26.00	
JETALVASNA	69350	69420	26.00	28.00	
JETALVASNA	69420	69500	26.00	26.00	
JETALVASNA	69500	69700	26.00	23.00	
JETALVASNA	69700	69780		23.00	
JETALVASNA	69780	70260		21.00	
JETALVASNA	70260	71400		23.00	
JETALVASNA	71400	71500		24.00	
JETALVASNA	71500	71600		25.00	
JETALVASNA	71600	71700		28.00	
JETALVASNA	71700	71800		34.00	
JETALVASNA	71800	72000		31.00	
JETALVASNA	72000	72060		33.00	
JETALVASNA	72060	72130		62.00	

ROW of Section Parallel to IR (With reference to nearest IR track)

Section 8 N

Village	DFC Chainage From (m)	DFC Chainage To (m)	Width of Land acquired by DFC (m) L	Width of Land acquired by DFC (m) R	Remarks
JETALVASNA	72130	72200		33.00	
JETALVASNA	72200	72700		33.00	
JETALVASNA	72700	72800		31.00	
JETALVASNA	72800	73000		33.00	
JETALVASNA	73000	74400		33.00	
JETALVASNA	74400	74700		32.00	
JETALVASNA	74700	74800		32.00	
JETALVASNA	74800	75000		32.00	
JETALVASNA	75000	75200		33.00	
JETALVASNA	75200	75700		33.00	
JETALVASNA	75700	76000		32.00	
JETALVASNA	76000	76100		32.00	
JETALVASNA	76100	76400		33.00	
JETALVASNA	76400	76500		32.50	AV=(32+33)/2
JETALVASNA	76500	76600		32.50	
JETALVASNA	76600	76650		33.00	
JETALVASNA	76650	76700		35.00	
JETALVASNA	76700	76750		37.00	
JETALVASNA	76750	76800		39.00	
JETALVASNA	76800	76900		44.00	
JETALVASNA	76900	77000		49.00	
JETALVASNA	77000	77100		50.00	
JETALVASNA	77100	77500		50.00	
JETALVASNA	77500	77600		49.00	
JETALVASNA	77600	77700		48.00	
JETALVASNA	77700	77800		46.00	
JETALVASNA	77800	77900		39.00	
JETALVASNA	77900	78000		34.00	
JETALVASNA	78000	78040		32.00	
KHALI	78040	78500		23.00	
KHALI	78500	78890		25.00	
KHALI	78890	78950		55.00	
KHALI	78950	79470		30.00	
KHALI	79470	79930		30.00	
KHALI	79930	80480		33.00	
KHALI	80480	80670		42.00	
KHALI	80670	80730		38.00	
SIDDHPUR	80730	81228		38.00	
SIDDHPUR	81228	81666		38.00	
SIDDHPUR	81666	81690		55.00	
SIDDHPUR	81690	82235		55.00	
SIDDHPUR	82235	82421		31.00	
SIDDHPUR	82421	82465		35.00	
SIDDHPUR	82465	82553		38.00	
SIDDHPUR	82553	82726		23.00	
SIDDHPUR	82726	82884		20.00	
SIDDHPUR	82884	84080		35.00	
SIDDHPUR	84080	84565		22.00	RLY Land
SIDDHPUR	84565	84800		35.00	
SIDDHPUR	84800	85000		33.00	
SIDDHPUR	85000	85100		37.00	
SIDDHPUR	85100	85200		35.00	
SIDDHPUR	85200	85300		33.00	
SIDDHPUR	85300	85555		25.00	
SIDDHPUR	85555	85585		33.00	
SIDDHPUR	85585	86000		33.00	
SIDDHPUR	86000	86500		33.00	
SIDDHPUR	86500	87000		33.00	
SIDDHPUR	87000	88026		33.00	
SUJANPUR	88026	88400		36.00	
SUJANPUR	88400	88580		40.00	
SUJANPUR	88580	88825		50.00	
SUJANPUR	88825	89500		45.00	
SUJANPUR	89500	89558		45.00	
Dharewada	89558	89742		45-220	
Dharewada	89742	89842		220-137	
Dharewada	89842	89928		137-52	
Dharewada	89928	89988		52-30	
Dharewada	89988	90200		35.00	
Dharewada	90200	90580		38-25	
Dharewada	90580	90734		30.00	
Manpura	90734	91250		28.00	
Manpura	91250	91400		30.00	
Manpura	91400	91600		32.00	
Manpura	91600	92451		32.00	
Pasvadal	92451	93144		32.00	
Kotadi	93144	93506		32-45	
Kotadi	93506	93816		45-40	
Kotadi	93816	94175		40-33	
Kotadi	94175	94350		33-35	
Kotadi	94350	94750		35-40	
Kotadi	94750	94984		40.00	
Chhapi	94984	95121		40-53	
Chhapi	95121	95600		42.00	
Chhapi	95600	96110		42-22	
Chhapi	96110	96570		22-[illegible]	
Chhapi	96570	97091		5[illegible]-35	Yard
Chhapi	97091	97668		3[illegible]	
Majadar	97668	97830		35-38	
Majadar	97830	98000		32.00	
Majadar	98000	98350		32-[illegible]	
Majadar	98350	98575		32.00	
Majadar	98575	98600		32-38	
Majadar	98600	98790		38-[illegible]	

ROW of Section Parallel to IR (With reference to nearest IR track)					
Section 8 N					
Village	DFC Chainage From (m)	DFC Chainage To (m)	Width of Land acquired by DFC (m) L	Width of Land acquired by DFC (m) R	Remarks
Majadar	98790	98820		68-38	
Majadar	98820	98910		38-34	
Majadar	98910	98960		34-25	
Majadar	98960	99100		30-38	
Majadar	99100	99280		38-32	
Majadar	99280	99595		32-38	
Malosana	99595	100480		36-40	
Malosana	100480	101180		80.00	
Malosana	101180	102000		40-38	
Malosana	102000	102140		38.00	
Jasleni	102140	102200		38-36	
Jasleni	102200	102600		36-50	
Jasleni	102600	103000		50-36	
Jasleni	103000	103140		36-40	
Jasleni	103140	103180		46-62	
Jasleni	103180	103515		62-50	
Sedrasana	103515	103700		50-45	
Sedrasana	103700	104300		45-50	
Sedrasana	104300	104700		50-67	
Sedrasana	104700	105240		67-45	
Sedrasana	105240	105360		45-35	
Sedrasana	105360	105470		35-45	
Jagana	105470	105744		45-40	
Jagana	105744	106285		40-48	
Jagana	106285	106530		48-36	
Jagana	106530	106790		36-40	
Jagana	106790	106985		40-37	
Jagana	106985	107035		37-33	
Jagana	107035	107240		33-40	
Jagana	107240	107450		40-35	
Jagana	107450	107550		35-33	
Jagana	107550	108570		33-30	
Palanpur	108570	109735		30-36	
Palanpur	109735	109870		36-33	
Palanpur	109870	110215		33-38	
Palanpur	110215	110960		38-31	
Palanpur	110960	111625		31-25	
Palanpur	111625	111849		27.00	
Palanpur	111849	114490		30	Existing RLY boundry at Palanpur yard
Palanpur	114490	114580		36-46	
Palanpur	114580	115000		46-38	
Palanpur	115000	115286		38-48	
Sadarpur	115286	115800		48-37	
Sadarpur	115800	116040		37.00	
Sadarpur	116040	116350		37-97	
Sadarpur	116350	116580		37.00	

ROW of Detour section					
Section 7					
Village	DFC Chainage From (m)	DFC Chainage To (m)	ROW on Left side from Dn Line (m)	ROW on Right side from Dn Line (m)	Total Width of ROW (M)
Godhavi	86825 i.e. 95000 new (Section 7)	95740 i.e. 87565 old chainage	57.0	63.0	120.0
Vansjada Dhedhiya	95740	95800	22.0	28.0	50.0
Vansjada Dhedhiya	95800	96320	27.0	33.0	60.0
Garodiya	96320	97040	24.0	30.0	54.0
Vansjada Dhedhiya	97040	97360	27.0	33.0	60.0
Unali	97360	97675	27.0	33.0	60.0
Unali	97675	98260	87.5	63.0	150.5
Unali	98260	98560	57.0	63.0	120.0
Nasmed	98560	99560	57.0	63.0	120.0
Nasmed	99560	100280	25.0	31.0	55-60
Nasmed	100280	100500	19.5	25.5	45.0
Nasmed	100500	101200	17.0	23.0	35-45
Nasmed	101200	102800	24.5	23.5	55.0
Nasmed	102800	103400	22.0	28.0	50.0
Jethlaj	103400	103600	22.0	28.0	50.0
Jethlaj	103600	104180	24.0	30.0	54.0
Jethlaj	104180	105150	28.0	34.0	62.0
Jethlaj	105150	105800	22.0	28.0	50.0
Jethlaj	105800	106410	29.5	35.5	65.0
Karoli	106410	106800	34.5	40.5	75.0
Karoli	106800	107000	32.0	38.0	70.0
Karoli	107000	107200	29.0	35.0	64.0
Karoli	107200	107900	24.5	30.5	55.0
Karoli	107900	108190	32.0	38.0	70.0
Motibhoyan	108190	108680	29.0	35.0	64.0
Motibhoyan	108680	109915	31.0	37.0	68.0
Hajipur	109915	110156	27.0	33.0	60.0
Motibhoyan	110156	110952	31.0	37.0	68.0
Vansjada Kalol	110952	111500	19.5	25.5	45.0
Vansjada Kalol	111500	112134	24.5	30.5	55.0

ROW of Detour section					
Section 6					
Village	DFC Chainage From (m)	DFC Chainage To (m)	ROW on Left side from Dn line (m)	ROW on Right side from Dn Line (m)	Total Width of ROW (M)
Deva Vanta	23785	23900	39.5	45.5	85.0
Deva Vanta	23900	24000	37.5	43.5	81.0
Deva Vanta	24000	24100	37.0	43.0	80.0
Deva Vanta	24100	24200	36.0	42.0	78.0
Deva Vanta	24200	24300	34.5	40.5	75.0
Deva Vanta	24300	24400	33.5	39.5	73.0
Deva Vanta	24400	24529	33.5	39.5	73.0
Deva Talpad	24529	24630	33.5	39.5	73.0
Deva Talpad	24630	24730	33.0	39.0	72.0
Deva Talpad	24730	24930	32.5	38.5	71.0
Deva Talpad	24930	25080	31.5	37.5	69.0
Deva Talpad	25080	25230	29.5	35.5	65.0
Deva Talpad	25230	25330	29.0	35.0	64.0
Deva Talpad	25330	25430	28.0	34.0	62.0
Deva Talpad	25430	25626	27.0	33.0	60.0
Laval	25626	25850	26.0	32.0	58.0
Laval	25850	26150	25.0	31.0	56.0
Laval	26150	26350	26.0	32.0	58.0
Laval	26350	26550	26.5	32.5	59.0
Laval	26550	26850	27.5	33.5	61.0
Laval	26850	27650	29.0	35.0	64.0
Laval	27650	28281	29.5	35.5	65.0
Khandhali	28281	28781	30.0	36.0	66.0
Khandhali	28781	29032	30.5	36.5	67.0
Heranj	29032	29232	31.0	37.0	68.0
Heranj	29232	29432	31.5	37.5	69.0
Heranj	29432	29832	32.0	38.0	70.0
Heranj	29832	30032	30.5	36.5	67.0
Heranj	30032	30432	27.5	33.5	61.0
Heranj	30432	30732	26.0	32.0	58.0
Heranj	30732	31432	24.5	30.5	55.0
Heranj	31432	31582	23.5	29.5	53.0
Heranj	31582	31784	23.0	29.0	52.0
Machiel	31784	32284	21.5	27.5	49.0
Machiel	32284	32484	23.0	29.0	52.0
Machiel	32484	32584	25.0	31.0	56.0
Machiel	32584	32814	26.5	32.5	59.0
Garmala	32814	33114	27.5	33.5	61.0
Garmala	33114	33505	29.0	35.0	64.0
Traj	33505	33805	29.0	35.0	64.0
Traj	33805	35705	57.0	63.0	120.0
Traj	35705	35905	31.0	37.0	68.0
Traj	35905	36005	29.5	35.5	65.0
Traj	36005	36219	28.5	34.5	63.0
Kasbe Matar	36219	36319	27.0	32.5	59.5
Kasbe Matar	36319	36419	24.5	30.5	55.0
Kasbe Matar	36419	36519	22.5	28.5	51.0
Kasbe Matar	36519	36619	21.0	27.0	48.0
Kasbe Matar	36619	36863	19.5	25.5	45.0
Pipariya	36863	37163	18.0	24.0	42.0
Pipariya	37163	37463	19.0	25.5	44.5
Pipariya	37463	37963	21.0	27.0	48.0
Pipariya	37963	38263	23.0	29.0	52.0
Pipariya	38263	38363	25.5	31.5	57.0
Pipariya	38363	38863	28.5	34.5	63.0
Pipariya	38863	39800	28.0	34.0	62.0
Pipariya	39800	39934	27.5	33.5	61.0

ROW of Detour section					
Section 6					
Village	DFC Chainage From (m)	DFC Chainage To (m)	ROW on Left side from Dn line (m)	ROW on Right side from Dn Line (m)	Total Width of ROW (M)
Vasana Buzarg	39934	40034	32.0	38.0	70.0
Vasana Buzarg	40034	40134	34.0	40.0	74.0
Vasana Buzarg	40134	40234	35.0	41.0	76.0
Vasana Buzarg	40234	40334	33.0	38.5	71.5
Vasana Buzarg	40334	40434	31.0	37.0	68.0
Vasana Buzarg	40434	40534	29.5	35.5	65.0
Vasana Buzarg	40534	40634	42.0	47.5	89.5
Vasana Buzarg	40634	40734	29.0	35.0	64.0
Vasana Buzarg	40734	41008	31.0	37.0	68.0
Vasana Buzarg	41008	41089	29.5	35.5	65.0
Shetra	41089	41189	29.0	35.0	64.0
Shetra	41189	41289	27.5	33.5	61.0
Shetra	41289	41389	26.0	32.0	58.0
Shetra	41389	41489	24.5	30.5	55.0
Shetra	41489	41789	23.0	29.0	52.0
Shetra	41789	41989	22.5	28.5	51.0
Shetra	41989	42289	22.0	28.0	50.0
Shetra	42289	42689	21.5	27.5	49.0
Shetra	42689	42989	21.0	27.0	48.0
Shetra	42989	43373	21.5	27.5	49.0
Govindpura	43373	44292	22.0	28.0	50.0
Naika	44292	44392	22.5	28.5	51.0
Naika	44392	44692	23.0	29.0	52.0
Naika	44692	44992	22.5	28.5	51.0
Naika	44992	45292	22.0	28.0	50.0
Naika	45292	45792	21.5	27.5	49.0
Naika	45792	46392	22.5	28.5	51.0
Naika	46392	46592	22.0	28.0	50.0
Naika	46592	47179	22.5	28.5	51.0
Chalindra	47179	47479	22.5	28.5	51.0
Chalindra	47479	47579	25.5	31.5	57.0
Chalindra	47579	47679	26.5	32.5	59.0
Chalindra	47679	47705	28.0	33.5	61.5
Naika	47705	47805	29.0	35.0	64.0
Naika	47805	48205	30.0	36.0	66.0
Naika	48205	48405	31.5	37.5	69.0
Naika	48405	48734	29.0	35.0	64.0
Chalindra	48734	48834	29.0	35.0	64.0
Chalindra	48834	48934	27.0	33.0	60.0
Chalindra	48934	49034	24.5	30.5	55.0
Chalindra	49034	49134	22.5	28.5	51.0
Chalindra	49134	49234	20.5	26.5	47.0
Chalindra	49234	49334	18.5	24.5	43.0
Chalindra	49334	49734	17.5	23.5	41.0
Chalindra	49734	49834	18.0	24.0	42.0
Chalindra	49834	49934	18.5	24.5	43.0
Chalindra	49934	50165	20.0	26.0	46.0
Dharoda	50165	50365	21.0	27.0	48.0
Dharoda	50365	50565	21.5	27.5	49.0
Dharoda	50565	50665	25.0	31.0	56.0
Dharoda	50665	50765	26.0	32.0	58.0
Dharoda	50765	50865	27.0	33.0	60.0
Dharoda	50865	50973	29.0	35.0	64.0
Kathvada	50973	51273	30.0	36.0	66.0
Kathvada	51273	51373	33.0	39.0	72.0
Kathvada	51373	51473	29.5	36.5	65.0
Kathvada	51473	51673	26.5	32.5	59.0
Kathvada	51673	51773	27.5	33.5	[illegible]
Kathvada	51773	51873	40.5	46.5	87.0
Kathvada	51873	52877	28.0	34.0	61.5

ROW of Detour section					
Section 6					
Village	DFC Chainage From (m)	DFC Chainage To (m)	ROW on Left side from Dn line (m)	ROW on Right side from Dn Line (m)	Total Width of ROW (M)
Mahijada	52877	53000	27.0	33.0	60.0
Mahijada	53000	53100	22.0	28.0	50.0
Mahijada	53100	54800	18.0	24.0	42.0
Mahijada	54800	55937	29.0	34.0	63.0
Timba	55937	57937	47.0	53.0	100.0
Timba	57937	58400	23.0	28.0	51.0
Timba	58400	58960	26.0	32.0	58.0
Miroli	58960	61100	27.0	33.0	60.0
Miroli	61100	61950	-	-	71.0
Kasindra	62371	65310	32.0	38.0	70.0
Bhat	65310	67694	32.0	38.0	70.0
Tajpur	67694	69650	23.0	29.0	52.0
Tajpur	69650	70056	24.0	30.0	54.0
Changoder	70056	70206	10.5	16.5	27.0
Changoder	70206	70400	32.0	30.0	62.0
Changoder	70400	70756	38.0	36.0	74.0
Changoder	70756	71387	38.0	38.0	76.0
Moraiya	71387	71900	30.0	36.0	66.0
Moraiya	71900	73287	24.0	30.0	54.0
Moraiya	73287	74016	22.0	28.0	50.0
Kolat	74016	74677	22.0	28.0	50.0
Kolat	74677	77455	24.0	30.0	54.0
Sanand	77455	78754	23.0	29.0	52.0
Sanand	78754	80309	57.0	63.0	120.0
Kaneti	80309	81822	57.0	63.0	120.0

ROW for Section-6

ROW Offsets from DFC Main Line from Chainage 81822 to 82400					
DFC Chainage From (m)	DFC Chainage to (m)	ROW on Left Side From Dn Line (m)	ROW on Right Side From Dn Line (m)	Total Width (m)	Remarks
81822	82400	37.0	43.0	80.0	

DFC Chainage (m)	ROW is w.r.t. Imaginary Line Going straight from Ch: 82400 (Dn Line Chainage 82400) upto Ch:85546.89 (Merging with Dn Line at Chainage 85700)					Remark
	Imaginary Line Chainage (m)		ROW on Left Side from Imaginary Line (m)	ROW on Right Side from Imaginary Line (m)	Total Width (m)	
82400	82400	82500	32.73	62.36	95.09	ROW includes Both UP main Line & DN Main Line.
-	82500	82600	32.58	62.69	95.27	
-	82600	82700	33.71	63.24	96.95	
-	82700	82800	36.89	64.93	101.82	
-	82800	82900	45.05	71.34	116.39	
-	82900	83000	52.00	81.63	133.63	
-	83000	83025	63.41	92.80	156.21	
UP Line Chainage 83027.5	83025	83100	66.92	28.53	95.45	ROW includes DN Main Line.
-	83100	83200	74.48	28.92	103.40	
-	83200	83300	95.98	29.46	125.44	
DN Line Chainage 83304	83300	83400	108.37	30.00	138.37	ROW does not include UP Main line and Dn Main Line
-	83400	83500	36.47	30.16	66.63	
-	83500	83600	43.73	25.00	68.73	
-	83600	83700	52.19	23.82	76.01	
-	83700	83800	72.64	37.39	110.03	
-	83800	83900	110.10	70.38	180.48	
-	83900	84000	182.85	141.29	324.14	
-	84000	83981	374.39	348.69	723.08	
UP Line Chainage 84012 & Down Line Ch 84000	83981	84100	369.35	340.00	709.35	ROW includes Both UP main Line & DN Main Line.
UP Line Chainage 84164 & Down Line Ch 84152	84100	84200	409.79	384.1	793.89	
-	84200	84300	159.83	189.09	348.92	ROW does not include UP Main line and Dn Main Line
-	84300	84400	85.53	106.75	192.28	
-	84400	84500	55.90	61.34	117.24	
-	84500	84600	32.13	41.03	73.16	
-	84600	84700	30.96	35.34	66.30	
-	84700	84800	30.97	35.34	66.31	
-	84800	84900	29.64	36.91	66.55	
-	84900	85000	30.84	38.33	69.17	
-	85000	85100	31.13	39.96	71.09	
-	85100	85157	31.40	41.46	72.86	
UP Line Chainage 85282	85157	85200	31.45	101.26	132.71	ROW includes Up Main Line
-	85200	85203	32.04	95.68	127.72	
DN Line Chainage 85360	85203	85300	100.31	94.82	195.13	Both UP Line & DN Line ROW included
-	85300	85400	67.42	72.97	140.39	
-	85400	85500	43.84	65.62	109.46	
-	85500	85546.89 (DFC Main Line Ch: 85700)	33.50	61.36	94.86	

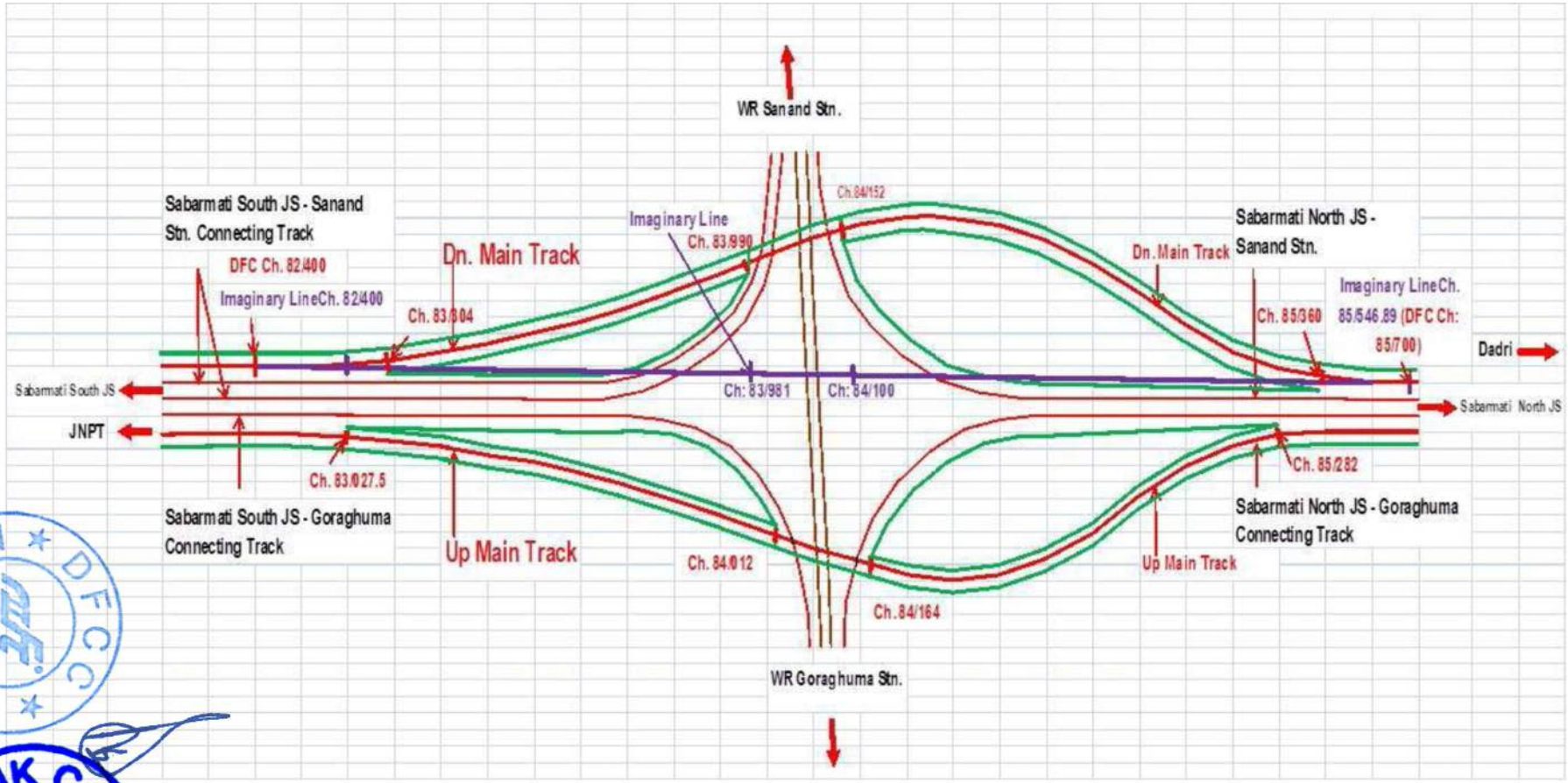
ROW for Section-6

DFC Chainage	ROW Offsets from DFC Main Line from Chainage 85700 to 85853				
		ROW on Left Side from Down Main Line (m)	ROW on Right Side from Down Main Line (m)	Total Width (m)	Remarks
85700		32.24	59.87	92.11	Both UP Line & DN Line ROW
85800		32.07	60.47	92.54	
85853		31.81	60.31	92.12	

ROW Offsets Of DFC Main Line

UP Main line From Chainage 83027.5 to 85300				Dn Main Line from Chainage 83400 to 85400		
DFC UP Main Line Chainage		UP Line Total Width (m)		DFC Down Main Line Chainage		Down Line Total Width (m)
83027.5	83100	67.32		83400	83500	85.12
83100	83200	68.29		83500	83600	87.72
83200	83300	71.01		83600	83700	90.50
83300	83400	71.67		83700	83800	92.40
83400	83500	75.68		83800	83900	92.70
83500	83600	77.43		83900	83990	92.25
83600	83700	74.00		83990	84000	93.55
83700	83800	80.98		84000	84100	Row included in the ROW w.r.t Imaginary Line as specified above
83800	83900	82.49		84100	84152	
83900	84000	84.62		84152	84200	90.67
84000	84012	82.55		84200	84300	91.35
84012	84100	82.36		84300	84400	86.74
84100	84164	Row included in the ROW w.r.t Imaginary Line as specified above		84400	84500	84.58
84164	84200	84.54		84500	84600	82.64
84200	84300	83.40		84600	84700	80.49
84300	84400	79.21		84700	84800	78.71
84400	84500	77.07		84800	84900	76.28
84500	84600	75.00		84900	85000	72.31
84600	84700	76.80		85000	85100	72.12
84700	84800	71.56		85100	85200	71.57
84800	84900	69.75		85200	85300	68.05
84900	85000	67.66		85300	85360	65.41
85000	85100	64.31		85360	85400	65.85
85100	85200	61.68		85400	85500	Row included in the ROW w.r.t Imaginary Line as specified above
85200	85282	60.51		85500	85600	
85282	85300	61.47		85600	85700	
85300		Row included in the ROW w.r.t Imaginary Line as specified above		85700		

Functional Line Diagram indicating the arrangement of DFC Main Line, Imaginary Line, Siding Connecting Sabarmati South to Goraguma, Sabarmati South to Sanand, Goraguma to Sabarmati North and Sanand to Sabarmati North including available Right of Way (ROW) from DFC Chainage 82400 to 85853.



ROW For Section 6				
ROW of Detour Section - ROW of Siding Connecting Sabarmati South to Goraguma, Sabarmati South to Sanand, Goraguma to Sabarmati North and Sanand to Sabarmati North				
Chainage (m)		ROW on Left side from centre line of IR Track (m)	ROW on Right side from centre line of IR Track (m)	Total Width (m)
IR Chainage (Km)	DFC Chainage from Sabarmati South to Goraghuma (m)			
521.81	2600	18.29	18.29	36.58
521.00	3414.61	18.29	18.29	36.58
519.49	4922.54	18.29	18.29	36.58
519.11	5300.59	18.29	22.87	41.16
519.01	5404.24	22.87	22.87	45.74
518.90	5515.52	18.29	22.87	41.16
518.73	5683.21	15.24	22.87	38.11
518.54	5878.33	14.33	14.33	28.66
518.43	5985.04	22.87	22.87	45.74
518.28	6000	22.87	22.87	45.74

Chainage (m)		ROW on Left side from centre line of IR Track (m)	ROW on Right side from centre line of IR Track (m)	Total Width (m)
IR Chainage (Km)	DFC Chainage from Sabarmati South to Sanand (m)			
522.9	2700	18.29	18.29	36.58
523.07	2870	18.29	18.29	36.58
523.17	2969.39	18.29	18.29	36.58
523.27	3068.48	21.34	19.82	41.16
523.36	3166	21.34	19.82	41.16

SECTION 5				
ROW				
DFC Start Chainage (m)	DFC End Chainage (m)	From Down Main Line		Remarks
		Left / East Side (m)	Right / West Side (m)	
205344	197400	33.00	27.00	Start of Vadodara Section Package 3(R)
197400	195400	63.00	57.00	Changa Crossing Station
195400	194348.5	33.00	27.00	
194348.5	194200	33.00	52.00	SSP Mahelav
194200	178941	33.00	27.00	
178941	178800	33.00	57.00	SP Napa Vanto
178800	169400	33.00	27.00	
169400	167400	63.00	57.00	Vasad Crossing Station
167400	163597.5	33.00	27.00	
163597.5	163500	33.00	42.00	ATS Ambali
163500	149225	33.00	27.00	
149225	149000	33.00	177.00	TSS Bhayali
149000	136907.34	33.00	27.00	
136907.34	136900	75.00	27.00	Overlapping with UP Flyover on East side
136900	136848.34	73.00	27.00	
136848.34	136800	60.00	27.00	
136800	136748.34	51.00	27.00	
136748.34	136700	38.00	27.00	
136700	135949.34	33.00	27.00	
135949.34	135900	33.00	71.00	Overlapping with DN Flyover on West side
135900	135873.34	33.00	59.00	
135873.34	135828.34	33.00	46.00	
135828.34	135800	33.00	34.00	
135800	135773.34	33.00	30.00	
135773.34	134212.34	33.00	27.00	
134212.34	131211.34	128.00	122.00	Makarpura Junction Station
131211.34	131000	33.00	27.00	End of Vadodara Section Package 3(R)

DETAILS OF WIDTH OF RIGHT OF WAY FROM DFC CONNECTING LINE (CPM-BRC)			
RIGHT SIDE (EAST SIDE) IN METER	CHAINAGE OF CENTRE LINE (m)	LEFT SIDE (WEST SIDE) IN METER	REMARKS
MAKARPURA DN Flyover			
	0		OVERLAPPING WITH MAIN LINE's ROW
	100		
	200		
	300		
0.0/20.0	311	0.0/20.0	
20	400	20	
20	500	20	
20	600	20	
20	700	20	
20	800	20	
20	900	20	
20	1000	20	
20	1100	20	
20	1200	20	
20	1300	20	
20	1400	20	
20	1500	20	
20	1600	20	
20	1700	20	
20	1800	20	
20	1900	20	
20	2000	20	
20	2100	20	
20	2200	20	
20	2300	20	
20	2400	20	
20	2500	20	
20	2600	20	
20	2700	20	
20	2800	20	
20	2900	20	
20	3000	20	
20	3100	20	
20	3200	20	
20	3300	20	
20	3400	20	
20	3500	20	
20	3600	20	
20	3700	20	
20	3800	20	
20	3900	20	
20	4000	20	
20	4042	20	

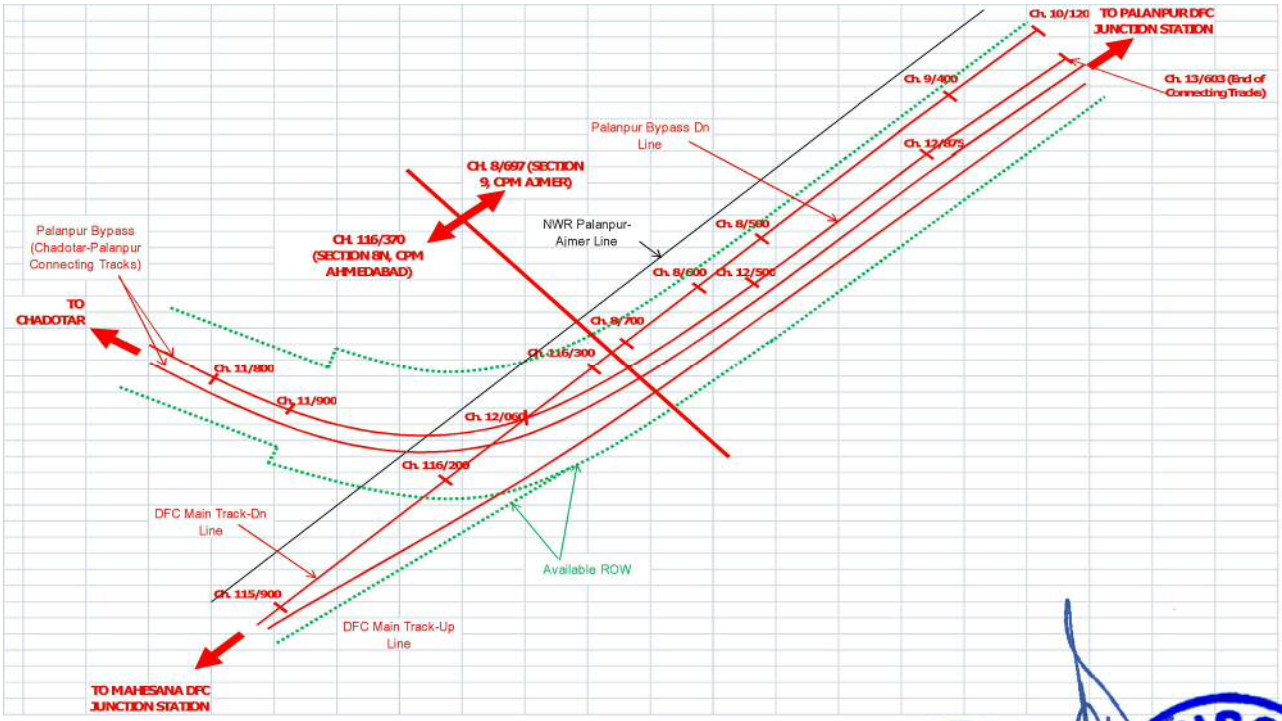
DETAILS OF WIDTH OF RIGHT OF WAY FROM DFC CONNECTING LINE (CPM-BRC)			
RIGHT SIDE (EAST SIDE) IN METER	CHAINAGE OF CENTRE LINE (m)	LEFT SIDE (WEST SIDE) IN METER	REMARKS
MAKARPURA UP Flyover			
	0		OVERLAPPING WITH MAIN LINE's ROW
	100		
	155		
	155		
	200		
	300		
0/20	371	0/20	
20	400	20	
20	500	20	
20	600	20	
20	900	20	
20	1000	20	
20	1100	20	
20	1200	20	
20	1300	20	
20	1400	20	
20	1500	20	
20	1600	20	
20	1700	20	
20	1800	20	
20	1900	20	
20	2000	20	
20	2100	20	
20	2200	20	
20	2300	20	
20	2400	20	
20	2500	20	
20	2600	20	
20	2700	20	
20	2800	20	
20	2900	20	
20	3000	20	
20	3100	20	
20	3200	20	
20	3300	20	
20	3400	20	
20	3500	20	
20	3600	20	
20	3700	20	
20	3800	20	
20	3900	20	
20	4000	20	
20	4100	20	
20	4200	20	
20	4300	20	
20	4400	20	
20	4500	20	
20	4600	20	
20	4700	20	
20	4800	20	
20	4900	20	
20	5000	20	
20	5100	20	
20	5200	20	
20	5300	20	
20	5400	20	
20	5500	20	
20	5536	20	

ROW (Section Parallel to IR)		
Mehsana Connecting Line		
DFC Chainage From (m)	DFC Chainage To (m)	Offsets from nearest IR track
0	550	30.00
550	850	23.00
850	1586	30.00

ROW of Detour section				
Mehsana Connecting Line				
Village	DFC Chainage From	DFC Chainage To	ROW on left side from centre line of DFC Alignment in increasing chainage (m)	ROW on Right side from centre line of DFC Alignment in increasing chainage (m)
Nanidau	1586	1610	42.50	35.00
Nanidau	1610	1850	42.50	35.00
Nanidau	1850	2200	42.5-44.0	37.50
Nanidau	2200	5600	46.00	40.00

ROW (Section Parallel to IR)			
PALANPUR BYEPASS			
Village	DFC Chainage From (m)	DFC Chainage To (m)	Offsets from nearest IR track
Khodla	0	200	45.00
Khodla	200	2600	80.00
Chadotar	2600	5400	70.00

ROW (Detour section)					
PALANPUR BYE PASS					
Village	DFC Chainage From (m)	DFC Chainage To (m)	ROW on Left side from Dn Line (m)	ROW on Right side from Dn Line (m)	Total Width of ROW (M)
Akeshan	5400	5700	30.00	20.00	50.00
Palanpur	5700	6500	35.00	25.00	60.00
Palanpur	6500	7900	30.00	20.00	50.00
Palanpur	7900	8300	30.00	20.00	50.00
Palanpur	8300	8700	35.00	25.00	60.00
Palanpur	8700	9500	30.00	20.00	50.00
Palanpur	9500	10000	35.00	25.00	60.00
Palanpur	10000	11000	40.00	30.00	70.00
Chedrasna	11000	11165	50.00	40.00	90.00
Chedrasna	11165	11900	60.00	50.00	110.00
Chedrasna	11900	12600	45.00	35.00	80.00
Chedrasna	12600	12875	35.00	25.00	60.00



Functional Line Diagram indicating the arrangement of DFC Main Line and DFC Palanpur Byepass (Chadotar-Palanpur Connecting Track) including available Right of Way (ROW) near the junction of Section 8N and Section 9

Attachments to Employer's Requirements

ATTACHMENT 1B

LIST OF TRAVERSE CONTROL POINTS, THEIR LEVELS AND CO-ORDINATES IN WGS-84 SYSTEM, FOR ABOUT 10 KM AND AT SPECIFIED LOCATIONS

FOR

IQBALGARH - VADODARA SECTION

LIST OF TRAVERSE CONTROL POINTS

BETWEEN CHAINAGE186500 AND CHAINAGE 196500 (Section 5)

S NO.	STN.	NORTHING	EASTING	ELEVATION	PILLAR POINT DESCRIPTION
1	GPS-30	2495306.6	278342.33	39.738	Sojitra Road Corner To South Side
2	GPS30A	2495272.4	278501.66	39.49	Karamsad/Anand Corner To South Side
3	GPS31	2491037.5	281835.86	36.186	Open Area
4	GPS31A	2490949.6	281857.79	36.898	28.63m Gate To North to East Side
5	GPS32	2500219.3	274800.12	35.924	Nadiad Road Corner North Side
6	GPS32A	2500264.6	274900.68	36.338	Nadiad Road Corner North Side
7	A-1/5	2495123.9	278567.2	38.505	Near To Laman Garden & Tree
8	A-2/5	2494992.2	278679.12	39.519	Near To The Tree & Fencing Line
9	A-3/5	2494841.3	278808.36	39.498	Near To The Tree & Field Track Corner
10	A-4/5	2494715.6	278929.19	39.596	Near To Tree
11	A-5/5	2494472.3	279012.16	40.933	Field Track Corner
12	A-6/5	2494378.3	279110	39.617	Agriculture Land
13	A-7/5	2494111.1	279299.4	39.814	Field Track Corner
14	A-8/5	2493918.4	279440.67	40.435	4.18m Electric pole To North to East Side
15	A-9/5	2493683.6	279658.77	39.675	9.72m Anand Road To North Side
16	A-13/5	2493112.2	279974.92	42.178	Near To Tree
17	A-14/5	2493007.3	280194.02	40.468	Canal Corner North Side
18	A-15/5	2492631.5	280350.45	40.912	Open Area
19	A-16/5	2492459.9	280426.77	37.241	Near Banana Groove Corner
20	A-17/5	2492433.3	280545.97	37.107	Banana Groove
21	A-18/5	2492095.4	280658.28	35.482	Near To The Pump House Corner
22	A-19/5	2491361.2	281236.19	35.512	Samsariya Road Cornae South Side
23	A-20/5	2491125.2	281527.32	35.104	Banana Groove Corner
24	A-1/6	2495470.9	278423.69	38.474	Open Area
25	A-2/6	2495559.7	278356	39.457	Open Area
26	A-3/6	2495701.3	278360.84	40.413	Indira Awas Village
27	A-4/6	2495785.2	278173.36	39.124	Field Track Corner
28	A-5/6	2495840.5	278093.9	37.099	Open Area
29	A-6/6	2496137	277953.05	37.55	Canal Corner South Side
30	A-7/6	2496319.2	277867.83	39.32	Ghunteli Road Corner South Side
31	A-8/6	2496344.2	277785.44	38.912	Open Area
32	A-9/6	2496466.7	277639.28	38.176	BUSH Area
33	A-10/6	2496680.1	277572.55	36.736	Open Area
34	A-11/6	2496949	277480.89	36.588	Drain Corner North Side
35	A-12/6	2497062.1	277297.4	36.278	Open Area

DFCC NEW DELHI

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LIST OF TRAVERSE CONTROL POINTS

SECTION BOUNDARY 6/7 BETWEEN CHAINAGE 200334 AND CHAINAGE 28800 (10Km)

S NO.	STN.	NORTHING	EASTING	ELEVATION	PILLAR POINT DESCRIPTION
1	GPS27	2548936.9	233961.18	43.46	Open Area
2	GPS27A	2548834.5	233409.2	43.421	Western Railway Corner South Side
3	GPS28	2554156.4	234649.21	47.728	
4	GPS28A	2554235.6	234569.65	47.461	
5	GPS29	2544278.6	233930.587	41.809	Towards Ahmadabad Road Corner To North Side
6	GPS 29A	2544562.4	233823.632	41.603	Towards Ahmadabad Road To North Side & Kacha Road
7	K-1	2548415	233596.19	42.291	Towards Sanand Road Corner South Side
8	K-8	2547263.5	233719.25	43.685	Nala Corner South Side
9	K-9	2547048.4	233756.91	43.468	Open Area
10	K-10	2546820.7	233839.64	43.143	Open Area
11	K-15	2546154.3	234222.02	44.118	Canal & Kacha Road Corner
12	K-16	2545819.3	233924.36	43.888	Open Area
13	K-17	2545635.2	233818.66	43.66	Open Area
14	K-18	2545473.2	233805.2	43.414	Open Area
15	K-19	2545104.2	233776.75	42.45	Open Area
16	K-20	2544806.2	233754.68	42.8	Open Area
17	K-25	2549641.2	233415.78	43.121	Kuchh Road Corner North Side
18	K-40	2551222.7	233716.85	43.708	Open Area
19	K-41	2551387.0	233797.32	43.635	Open Area
20	K-63	2553668.4	234258.77	46.544	Open Area
21	K-65	2553771.3	234290.18	46.653	Open Area
22	K-67	2553994.6	234441.98	47.058	Kacha Road
23	K-69	2554125.9	234569.83	47.312	Kacha Road Corner South Side
24	M-8	2546202.8	234265.74	44.241	Open Area
25	M-22	2548438	233675.47	42.633	Towards Godhavi & River Corner

LIST OF GPS CONTROL POINTS AT KOTNA SIDE AND KANWADI SIDE AT MAHI RIVER

SR.No.	POINT ID	EASTING	NORTHING	REMARKS
1	GPS G-1	300470.252	2475860.777	GPS PILLAR AT KOTNA SIDE
2	GPS G-2	300487.51	2475893.539	GPS PILLAR AT KOTNA SIDE
3	GPS G-3	300445.396	2475956.782	GPS PILLAR AT KOTNA SIDE
4	GPS G-4	300175.54	2476374.351	GPS PILLAR AT KANWADI SIDE
5	GPS G-5	300220.506	2476470.582	GPS PILLAR AT KANWADI SIDE
6	GPS G-6	300122.77	2476434.481	GPS PILLAR AT KANWADI SIDE

LIST OF GPS CONTROL POINTS AT MIROLI SIDE AND KASINDRA SIDE AT SABARMATI RIVER

SR.No.	POINT ID	EASTING	NORTHING	REMARKS
1	GPS S-1	243592.085	2530644.678	GPS PILLAR AT MIROLI SIDE
2	GPS S-2	243456.426	2530689.510	GPS PILLAR AT MIROLI SIDE
3	GPS S-3	243339.737	2530710.887	GPS PILLAR AT MIROLI SIDE
4	GPS S-4	242956.496	2530881.520	GPS PILLAR AT KASINDRA SIDE
5	GPS S-5	242892.888	2530902.942	GPS PILLAR AT KASINDRA SIDE
6	GPS S-6	242757.728	2530730.741	GPS PILLAR AT KASINDRA SIDE

Attachments to Employer's Requirements

ATTACHMENT 2

LIST OF STRUCTURES

FOR

IQBALGARH - VADODARA SECTION

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL/ FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
1	Vadodara	5	-	131,550.000	-	202A	-	1 x 2.0m x 2.0m	2	3	-	RCC Box	Minor Bridge	23.622	1
2	Vadodara	5	-	131,708.340	-	202B	-	1 x 4.0m x 3.7m	4	6	-	RCC Box	RUB-Minor		1
3	Vadodara	5		131,760.000		202C		1 x 2.0m x 2.0m	2	-		RCC Box	Minor Bridge for Road (Class 'A' loading)		2
4	Vadodara	5	-	132,415.000	-	202D	-	1 x 4.0m x 3.7m	4	8	-	RCC Box	RUB-Minor		2
5	Vadodara	5	-	133,365.267	-	209	-	1 x 4.0m x 3.0m	4	8	-	RCC Box	Minor Bridge	23.339	3
6	Vadodara	5	-	134,344.965	-	211	-	1 x 27.0m / 1 x 31.732m (Skew Span) #	31.732	4	-	PSC Girder	ROB		1
7	Vadodara	5	-	135,467.393	-	214	-	1 x 6.1m	7.075	4	-	PSC Solid Slab	Minor Bridge	24.922	4
8	Vadodara	5	-	135,515.393	-	215	-	1 x 4.0m x 3.7m	4	4	-	RCC Box	RUB-Minor		3
9	Vadodara	5	-	136,531.533	-	216	-	2 x 18.3m	39.6	3	-	Post Tensioned Box Girder	Major Bridge	25.040	1
10	Vadodara	5	-	136,941.974	-	217	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor		4
11	Vadodara	5	-	137,039.524		218		2 x 9.15m x 4.5m	18.3	2		RCC Box	Major Bridge	30.356	2
12	Vadodara	5	-	137,338.672	-	219	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		5
13	Vadodara	5	-	137,800.000	-	221	-	1 x 7.0m x 9.25m	7	2	-	RCC Box	RFO		1
14	Vadodara	5	-	138,885.393	-	222	-	3 x 45.7m	144.6	2	-	Post Tensioned Box Girder / UnderSlung Steel Composite Girder	Major Bridge	21.280	3
15	Vadodara	5	-	139,063.393	-	224	-	1 x 4.0m x 3.7m	3	2	-	RCC Box	RUB-Minor		6
16	Vadodara	5	-	139,385.592	-	225	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	25.382	5
17	Vadodara	5	-	139,819.832	-	227	-	1 x 6.1m x 5.1m	6.1	2	-	RCC Box	RUB-Minor		7
18	Vadodara	5	-	140,683.052	-	228	-	1 x 3.0m x 3.0m	3	2	-	RCC Box	Minor Bridge	25.545	6
19	Vadodara	5	-	141,023.804	-	229	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor	25.672	8
20	Vadodara	5	-	141,461.394	-	230	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	26.832	7
21	Vadodara	5	-	142,006.240	-	231	-	1 x 3.0m x 3.0m	3	2	-	RCC Box	Minor Bridge	27.890	8
22	Vadodara	5	-	142,052.980	-	232	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor	26.121	9
23	Vadodara	5	-	142,321.848	-	234	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	27.019	9
24	Vadodara	5	-	142,675.413	-	235	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		10
25	Vadodara	5	-	142,770.375	-	236	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	26.218	4
[illegible]	Vadodara	5	-	143,408.069	-	237	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		11
27	Vadodara	5	-	143,453.049	-	238	-	2 x 4.0m x 3.7m	8	2	-	RCC Box	Minor Bridge	27.941	10
28	Vadodara	5	-	143,985.413	-	240	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		12
[illegible]	Vadodara	5	-	144,253.228	-	242	-	1 x 6.1m x 2.5m	6.1	2	-	RCC Box	Minor Bridge	27.297	11
[illegible]	Vadodara	5	-	145,351.214	-	244	-	1 x 3.0m x 3.0m	3	2	-	RCC Box	Minor Bridge	28.232	12

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL / FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
31	Vadodara	5	-	145,492.737	-	246	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		13
32	Vadodara	5	-	145,960.394	-	247	-	1 x 9.15m x 4.5m + 1 x 4.5m x 4.5m	13.65	2	-	RCC Box	Minor Bridge	28.110	13
33	Vadodara	5	-	146,358.000	-	247A	-	1 x 6.1 m	7.075	2	-	PSC Solid Slab	Minor Bridge		14
34	Vadodara	5	-	146,556.276	-	249	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		14
35	Vadodara	5	-	146,639.250	-	250	-	1 x 6.1m x 5.75m + 2 x 9.15m x 5.75m	24.4	2	-	RCC Box	Major Bridge	28.911	5
36	Vadodara	5	-	146,696.205	-	251	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	RFO		2
37	Vadodara	5	-	146,970.394	-	253	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	RUB-Major		1
38	Vadodara	5	-	147,408.989	-	255	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		15
39	Vadodara	5	-	147,697.609	-	256	-	1 x 9.15m x 4.5m	9.15	2	-	RCC Box	Minor Bridge	28.601	15
40	Vadodara	5	-	147,847.799	-	258	-	1 x 9.15m x 4.5m	9.15	2	-	RCC Box	Minor Bridge	28.917	16
41	Vadodara	5	-	148,387.393	-	260	-	1 x 6.1m x 4.75m	6.1	2	-	RCC Box	Minor Bridge	29.154	17
42	Vadodara	5	-	148,500.000	-	260A	-	1 x 6.1 m	7.075	2	-	PSC Solid Slab	Minor Bridge		18
43	Vadodara	5	-	148,873.836	-	263	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		16
44	Vadodara	5	-	149,246.658	-	264	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		17
45	Vadodara	5	-	149,489.678	-	265	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		18
46	Vadodara	5	-	149,553.893	-	266	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	25.223	6
47	Vadodara	5	-	149,900.394	-	267	-	1 x 3.0m x 4.75m + 1 x 6.0m x 4.75m + 1 x 3.0m x 4.75m	12	2	-	RCC Box	Minor Bridge	29.892	19
48	Vadodara	5	-	150,678.582	-	269	-	2 x 6.1m x 4.75m	12.2	2	-	RCC Box	Minor Bridge	31.216	20
49	Vadodara	5	-	151,283.715	-	272	-	1 x 9.15m x 4.5m	9.15	2	-	RCC Box	Minor Bridge	33.760	21
50	Vadodara	5	-	151,723.718	-	273	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	32.817	22
51	Vadodara	5	-	152,377.751	-	275	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor		19
52	Vadodara	5	-	152,800.394	-	277	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	33.135	23
53	Vadodara	5	-	153,032.452	-	280	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		20
54	Vadodara	5	-	153,230.311	-	280A	-	1 x 9.15m	10.3	2		PSC Voided Slab	RUB-Minor		21
55	Vadodara	5	-	153,595.394	-	283	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		22
56	Vadodara	5	-	154,049.369	-	285	-	1 x 18.3m	19.8	2	-	PSC Box Girder	RUB-Major		2
57	Vadodara	5	-	154,169.856	-	285A	-	1 x 9.15m	10.3	2		PSC Voided Slab	RUB-Minor		23
58	Vadodara	5	-	155,117.734	-	287	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		24
59	Vadodara	5	-	155,475.394	-	289	-	1 x 9.15m + 1 x 30.5m + 1 x 9.15m	54.2	2	-	PSC Voided Slab + PSC Box Girder	Major Bridge	34.570	7
[illegible]	Vadodara	5	-	155,988.374	-	290	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		25

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL/ FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
61	Vadodara	5	-	156,000.000	-	290A	-	1 x 2.0m x 2.0m	2	2	-	RCC Box	Minor Bridge	33.617	24
62	Vadodara	5	-	156378.69	-	290B	-	1 x 9.15m	10.3	2		PSC Voided Slab	RUB-Minor		26
63	Vadodara	5	-	156,830.394	-	292	-	1 x 2.0m x 2.0m	2	2	-	RCC Box	Minor Bridge	37.023	25
64	Vadodara	5	-	156,860.405	-	293	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor		27
65	Vadodara	5	-	157,300.394	-	294	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor		28
66	Vadodara	5	-	157,580.000	-	294A	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	RUB-Minor		29
67	Vadodara	5	-	157,880.391	-	296	-	1 x 18.3m + 1 x 4.57m	25.345	2	-	PSC Box Girder + PSC Slab	Major Bridge	36.022	8
68	Vadodara	5	-	158,188.340	-	296A	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	25.040	26
69	Vadodara	5	-	158,518.000	-	297	-	10 x 30.5m	336	2	-	Post Tensioned Box Girder	Important Bridge	16.350	1
70	Vadodara	5	-	158,928.340	-	297A	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	26.530	27
71	Vadodara	5	-	159,348.340	-	297B	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	24.470	28
72	Vadodara	5	-	159,708.340	-	297C	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	32.540	29
73	Vadodara	5	-	160,338.273	-	299	-	1 x 9.15m x 5.1m	9.15	2	-	RCC Box	RUB-Minor		30
74	Vadodara	5	-	160647.337	-	300A		2 x 6.1m	14.15	2		PSC Solid Slab	RUB-Minor		31
75	Vadodara	5	-	161,108.340	-	300B	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	18.220	30
76	Vadodara	5	-	161,188.340	-	300C	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	25.720	31
77	Vadodara	5	-	162,321.550	-	302	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		32
78	Vadodara	5	-	162,800.814	-	305	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		33
79	Vadodara	5	-	163,135.397	-	306	-	1 x 6.1m x 5.1m	6.1	2	-	RCC Box	RUB-Minor		34
80	Vadodara	5	-	163,210.320	-	307	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	Major Bridge	30.321	9
81	Vadodara	5	-	163,525.547	-	309	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		35
82	Vadodara	5	-	163,849.517	-	310	-	1 x 4.0m x 4.0m	4	2	-	RCC Box	Minor Bridge	35.928	32
83	Vadodara	5	-	164,889.056	-	313	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		36
84	Vadodara	5	-	165,501.262	-	315	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	34.125	33
85	Vadodara	5	-	165,761.532	-	317	-	1 x 9.15m	10.3	2	-	PSC Voided Slab	RUB-Minor		37
86	Vadodara	5	-	166,104.342	-	319	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		38
87	Vadodara	5	-	166,675.690	-	320	-	1 x 12.2m	13.425	2	-	Prestressed Contiguous Box	Major Bridge	35.418	10
88	Vadodara	5	-	166,932.328	-	322	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	RFO		3
89	Vadodara	5	-	166,970.155	-	323	-	1 x 12.2m	13.425	2	-	Prestressed Contiguous Box	Major Bridge	33.158	11
90	Vadodara	5	-	167,024.630	-	324	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		39

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL / FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
91	Vadodara	5	-	167,378.439	-	326	-	2 x 4.0m x 4.0m + 1 x 6.1m x 4.0m	14.1	4	-	RCC Box	Minor Bridge	35.830	34
92	Vadodara	5	-	167,622.723	-	327	-	1 x 9.15 m x 5.0 m	9.150	4	-	RCC Box	Minor Bridge		35
93	Vadodara	5	-	167,969.559	-	330	-	1 x 4.0m x 3.7m	4	5	-	RCC Box	RUB-Minor		40
94	Vadodara	5	-	168,619.580	-	333	-	1 x 12.2m	13.425	4	-	Prestressed contiguous Box	Major Bridge	36.042	12
95	Vadodara	5	-	168635	-	334	-	1 x 6.1m x 3.7m	6.1	4	-	RCC Box	RUB-Minor		41
96	Vadodara	5	-	168635	-	334A	-	2 x 6.1m x 4.0m	12.2	-	-	RCC Box (Road)	Minor Bridge for Road (Class 'A' loading)	36.200	36
97	Vadodara	5	-	169,266.660	-	335	-	1 x 4.0m x 3.7m	4	3	-	RCC Box	RUB-Minor		42
98	Vadodara	5	-	169,624.428	-	336	-	1 x 6.1m x 4.5m	6.1	2	-	RCC Box	Minor Bridge	35.956	37
99	Vadodara	5	-	169,679.363	-	338	-	2 x 18.3m	39.6	2	-	Post Tensioned Box Girder	RUB-Major		3
100	Vadodara	5	-	170,078.357	-	340	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		43
101	Vadodara	5	-	170,150.000	-	340A	-	1 x 6.1m x 4.0m	6.100	2	-	RCC Box	Minor Bridge		38
102	Vadodara	5	-	170,614.532	-	342	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		44
103	Vadodara	5	-	171,108.357	-	345	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		45
104	Vadodara	5	-	171,508.357	-	346	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	35.123	39
105	Vadodara	5	-	171,535.577	-	347	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	RUB-Major		4
106	Vadodara	5	-	172,376.090	-	351	-	1 x 9.15m x 5.1m	9.15	2	-	RCC Box	RUB-Minor		46
107	Vadodara	5	-	173,637.630	-	355	-	1 x 12.2m + 1 x 18.3m + 1 x 12.2m	46.65	2	-	Prestressed contiguous Box + Post Tensioned Box Girder	Major Bridge	34.612	13
108	Vadodara	5	-	174,260.240	-	358	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		47
109	Vadodara	5	-	174,535.569	-	359	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	35.928	40
110	Vadodara	5	-	174,780.059	-	360	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	36.131	41
111	Vadodara	5	-	174,885.935	-	361	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		48
112	Vadodara	5	-	175,428.557	-	366	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		49
113	Vadodara	5	-	175,984.090	-	368	-	1 x 6.1m x 4.1m	6.1	2	-	RCC Box	RUB-Minor		50
114	Vadodara	5	-	176,425.425	-	369	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		51
115	Vadodara	5	-	176,740.000	-	369A	-	1 x 4.0m x 4.0m	4.000	2	-	RCC Box	RUB-Minor		52
116	Vadodara	5	-	176,780.000	-	369B	-	1 x 12.2 m	13.425	2	-	Prestressed contiguous Box	Major Bridge		14
117	Vadodara	5	-	177,162.638	-	372	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		53
118	Vadodara	5	-	177,804.346	-	375	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	Major Bridge	36.674	15
119	Vadodara	5	-	178,651.425	-	378	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		54
120	Vadodara	5	-	179,216.425	-	380	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		55

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL/FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
121	Vadodara	5	-	179,945.400	-	381	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	RUB-Major		5
122	Vadodara	5	-	180,051.425	-	382	-	2 x 12.2m	26.85	2	-	Prestressed contiguous Box	Major Bridge	32.670	16
123	Vadodara	5	-	180,257.899	-	384	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		56
124	Vadodara	5	-	180,500.000	-	385	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	34.526	42
125	Vadodara	5	-	180,597.090	-	386	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	Major Bridge	33.089	17
126	Vadodara	5	-	181,500.000	-	386A	-	1 x 12.2 m	13.425	2	-	Prestressed contiguous Box	Major Bridge		18
127	Vadodara	5	-	181,613.540	-	389	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	34.086	19
128	Vadodara	5	-	182,033.681	-	389A	-	1 x 9.15m	10.3	2		PSC Voided Slab	RUB-Minor		57
129	Vadodara	5	-	182,060.855	-	389B	-	2 x 6.1m	14.15	2		PSC Solid Slab	RUB-Minor		58
130	Vadodara	5	-	182,251.582	-	391	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	32.766	20
131	Vadodara	5	-	182,819.522	-	393	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		59
132	Vadodara	5	-	183,370.468	-	395	-	1 x 6.1m x 4.1m	6.1	2	-	RCC Box	RUB-Minor		60
133	Vadodara	5	-	183,821.495	-	397	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		61
134	Vadodara	5	-	184,515.417	-	398	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	RFO		4
135	Vadodara	5	-	184,556.404	-	399	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		62
136	Vadodara	5	-	184,933.907	-	401	-	1 x 6.1m + 1 x 18.3m	26.875	2	-	PSC Solid Span + Post Tensioned Box Girder	Major Bridge	34.321	21
137	Vadodara	5	-	185,152.838	-	402	-	1 x 9.15m	10.3	2	-	PSC Voided Slab	Minor Bridge	35.103	43
138	Vadodara	5	-	185,431.388	-	404	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		63
139	Vadodara	5	-	185,928.928	-	406	-	2 x 6.1m x 5.1m	12.2	2	-	RCC Box	RUB-Minor		64
140	Vadodara	5	-	186,393.185	-	408	-	1 x 6.1m x 4.6m	6.1	2	-	RCC Box	RUB-Minor		65
141	Vadodara	5	-	186,824.608	-	409	-	1 x 12.2m x 5.1m	13.4	2	-	Prestressed contiguous Box	RUB-Major		6
142	Vadodara	5	-	186,950.213	-	410	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	29.463	22
143	Vadodara	5	-	187,050.000	-	411	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	30.132	23
144	Vadodara	5	-	187,200.000	-	411A	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	30.132	24
145	Vadodara	5	-	187,687.594	-	413	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		66
146	Vadodara	5	-	188,185.258	-	414	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	34.168	44
147	Vadodara	5	-	188,408.406	-	415	-	1 x 9.15m	10.3	2	-	PSC Voided Slab	Minor Bridge	35.856	45
148	Vadodara	5	-	188,669.552	-	416	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	35.015	25
149	Vadodara	5	-	188,976.397	-	419	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		67
150	Vadodara	5	-	189,491.397	-	421	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		68

Sr. No.	CPM	Sec. No.	CHAINAGE		Bridge No.		Clear Spans for Standard Span Bridges / Center to Center Span for ROBs / Dirt Wall to Dirt Wall for Non-standard Span Bridges #		Bridge Length (Dirt Wall to dirt wall, except for RCC Box) (m)	Nos. of Tracks (Proposed for DFC)	STRUCTURE CONFIGURATION		Type of Structure	HFL / FSL (m)	S.No.
			IR	DFC	IR	DFC	Existing IR	Proposed for DFC			Existing IR	DFC			
151	Vadodara	5	-	190,492.367	-	424	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	Major Bridge	35.659	26
152	Vadodara	5	-	190,581.397	-	425	-	2 x 4.0m x 5.0m	8	2	-	RCC Box	Minor Bridge	38.060	46
153	Vadodara	5	-	191,006.397	-	427	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		69
154	Vadodara	5	-	191592.476	-	429	-	1 x 18.3m	19.8	2	-	Post Tensioned Box Girder	RUB-Major		7
155	Vadodara	5	-	191,976.396	-	430	-	1 x 2.0m x 2.0m	2	2	-	RCC Box	Minor Bridge	30.560	47
156	Vadodara	5	-	192,130.224	-	431	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		70
157	Vadodara	5	-	192,557.549	-	433	-	1 x 6.1m	7.075	2	-	PSC Solid Slab	Minor Bridge	35.298	48
158	Vadodara	5	-	192,757.943	-	434	-	2 x 9.15m	20.6	2	-	PSC Voided Slab	RUB-Major	34.408	8
159	Vadodara	5	-	192,878.393	-	436	-	1 x 2.0m x 2.0m	2	2	-	RCC Box	Minor Bridge	34.721	49
160	Vadodara	5	-	193,212.360	-	437	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		71
161	Vadodara	5	-	193,573.316	-	438	-	3 x 12.2m	40.275	2	-	Prestressed contiguous Box	Major Bridge	29.316	27
162	Vadodara	5	-	194,056.194	-	440	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		72
163	Vadodara	5	-	194,911.350	-	444	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	30.464	28
164	Vadodara	5	-	195444	-	445	-	1 x 12.2m + 1 x 18.3m	33.225	2	-	Post Tensioned Box Girder + Prestressed contiguous Box	Major Bridge	32.900	29
165	Vadodara	5	-	195639.537	-	447	-	1 x 4.0m x 3.7m	4	4	-	RCC Box	RUB-Minor		73
166	Vadodara	5	-	196502.643	-	450	-	1 x 4.0m x 3.7m	4	4	-	RCC Box	RUB-Minor		74
167	Vadodara	5	-	196548.393	-	451	-	1 x 2.0m x 2.0m	2	4	-	RCC Box	Minor Bridge	31.740	50
168	Vadodara	5	-	197,134.163	-	453	-	1 x 4.0m x 3.7m	4	4	-	RCC Box	RUB-Minor		75
169	Vadodara	5	-	197,598.397	-	454	-	1 x 2.0m x 2.0m	2	4	-	RCC Box	Minor Bridge	32.830	51
170	Vadodara	5	-	197,679.060	-	455	-	1 x 9.15m x 5.5m + 1 x 6.1m x 5.5m	15.25	3	-	RCC Box	RUB-Minor		76
171	Vadodara	5	-	197,730.213	-	457	-	1 x 9.15m	10.3	3	-	PSC Voided Slab	Minor Bridge	33.856	52
172	Vadodara	5	-	198,017.248	-	458	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		77
173	Vadodara	5	-	198,288.391	-	459	-	1 x 12.2m	13.425	2	-	Prestressed contiguous Box	Major Bridge	33.526	30
174	Vadodara	5	-	198,413.787	-	461	-	1 x 4.0m x 3.7m	4	2	-	RCC Box	RUB-Minor		78
175	Vadodara	5	-	198,660.000	-	463	-	1 x 6.1m + 2 x 12.2m	33.925	2	-	PSC Solid Slab + Prestressed contiguous Box	Major Bridge	31.886	31
176	Vadodara	5	-	198,959.791	-	464	-	1 x 9.15m	10.3	2	-	PSC Voided Slab	Minor Bridge	33.326	53
177	Vadodara	5	-	199,110.994	-	466	-	1 x 6.1m x 3.0m	6.1	2	-	RCC Box	Minor Bridge	32.441	54
178	Vadodara	5	-	199,333.396	-	467	-	1 x 2.0m x 2.0m	2	2	-	RCC Box	Minor Bridge	32.420	55
179	Vadodara	5	-	199,408.000	-	468	-	1 x 6.1m x 3.7m	6.1	2	-	RCC Box	RUB-Minor		79
180	Vadodara	5	-	199,680.615	-	469	-	1 x 6.1m x 3.0m	6.1	2	-	RCC Box	Minor Bridge	32.488	56