Detailed Project Draft Report (DPR) for Gauge Conversion project between Katosan road - Becharaji - Chanasma - Ranuj (65km) line

Draft Feasibility Report

(Technical Specification)

(Volume-II)

G-RIDE
A JV of Govt. of Gujarat & Ministry of Railways

Consultant

GEO DESIGNS & RESEARCH (P) LTD.

B-10 Krishna Industrial Estate Opp.BIDC, Gorwa, Baroda - 390016. Phone: 91-265-2282305, 2283081, 2290222.
Telefax: 91-265-2282014 E-mail: geo_group@yahoo.com, info@geogroup.in, www.geogroup.in

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1 bridge work

INDIAN RAILWAY STANDARD (CODE OF PRACTICE FOR THE DESIGN OF SUB-STRUCTURES AND FOUNDATIONS OF BRIDGES)

The loads specified herein shall be taken into consideration in calculating the strength of all bridges, including turntable girders and foot-bridges but excluding road bridges in which case, the loads to be considered shall be in accordance with the Standard Specifications and Codes of Practice for Road Bridges (IRC Codes). The details of design shall be controlled by the appropriate Codes of Practice as given below:

(a) The design of steel bridges shall be in accordance with the Indian Railway Standard Code of Practice for the Design of Steel or Wrought Iron Bridges carrying Rail, Road or Pedestrian Traffic (Steel Bridge Code).

(b) The design of concrete bridges shall be in accordance with the Indian Railway Standard Code of Practice for Plain, Reinforced and Pre stressed Concrete for General Bridge Construction (Concrete Bridge Code).

(c) The design of masonry and plain concrete arch bridges shall be in accordance with the Indian Railway Standard Code of Practice for the Design and Construction of Masonry and Plain Cement Concrete Arch Bridges (Arch Bridge Code).

(d) The design of sub-structures of bridges shall be in accordance with the Indian Railway Standard Code of Practice for the design of Sub-structures of Bridges (Bridge Sub-Structure Code).

(e) The design of sub-structures and super-structures of road bridges shall be in accordance with Standard Specification and Codes of Practice for Road Bridges and other codes as specified by the appropriate authorities.

(f) The design of sub-structures and super-structures of rail-cum-road bridges shall be in accordance with the relevant Indian Railway Standard Codes of Practice except that the Standard Specifications and Codes of Practice for Road Bridges issued by

the Indian Roads Congress may apply for the design of such members as are subjected to loads from road traffic alone.

1.1 Loads

For the purpose of computing stresses, the following items shall, where applicable, be taken into account:

(a) Dead load
(b) Live load
(c) Dynamic effects
(d) Forces due to curvature or eccentricity of track
(e) Temperature effect
(f) Frictional resistance of expansion bearings
(g) Longitudinal force
(h) Racking force
(i) Forces on parapets
(j) Wind pressure effect
(k) Forces and effects due to earthquake
(l) Erection forces and effects
(m) Derailment loads
(n) Load due to Plassers Quick Relay System (PQRS)

1.2 Hydrological Design Investigations

Hydrological investigations to the extent necessary, depending upon the type and importance of the bridge shall be carried out as per guide lines. **No table of authorities entries found.** All bridges shall be designed with adequate waterway for design discharge This shall normally be the computed flood with a probable recurrence interval of 50 years. However, at the discretion of Chief Engineer/Chief Bridge Engineer, bridges, damage to which is likely to have severe consequences may be designed for floods with a probable recurrence interval of more than 50 years, while bridges on less important lines or sidings may be designed for floods with a probable recurrence interval of less than 50 years.

1.2.1 **Design Discharge For Foundations (Qf)**

To provide for an adequate margin of safety against an abnormal flood of magnitude higher than the design discharge (Q) the foundations, protection works and training works except free board, shall be designed for a higher flood discharge. The magnitude of this discharge shall be computed by increasing the design discharge (Q) estimated by the percentage indicated below :

Catchment less than 500 Sq.km	30%
Catchment less than 500 Sq.km - 30% Catchment more than 500 Sq.km and upto 5,000 Sq.km.	30% to 20% (decreasing with increase in area)
Catchment more than 5,000 Sq.km. and upto 25,000 Sq.km.	20% to 10% (decreasing with increase in area)
Catchment more than 25,000 Sq.km	Less than 10% (at the discretion of the Engineer).

1.2.2 **Depth Of Scour**

The probable maximum depth of scour for design of foundations and training and protection works shall be estimated considering local conditions.

In calculating design depth of scour, allowance shall be made in the observed depth for increased scour resulting from:

(i) The design discharge being greater than the flood discharge observed.

(ii) The increase in velocity due to the constriction of waterway caused by construction of the bridge.

(iii) The increase in scour in the proximity of piers and abutments.

1.2.3 **Clearance (C)**

The minimum clearance for bridges excluding arch bridges, syphons, pipe culverts and box culverts from the waterlevel of design discharge (Q) shall be in accordance with Table below:

Discharge in cumecs	**Vertical clearance (mm)**
0-30	600
31-300	600-1200 (pro-rata)
301-3000	1500
Above 3000	1800

1.3 **Free Board (F)**

The free-board from the water level of the design discharge (Q) to the formation level of the Railway embankment or the top of guide bund shall not be less than 1m. In cases where heavy wave action is expected, the free-board shall be increased suitably. In special circumstances, where the freeboard can be safely reduced and where adoption of the prescribed values would result in heavy expenditure and/or serious difficulties in construction, the free-board may be relaxed at the discretion of the Chief Engineer/Chief Bridge Engineer as indicated below :-

Discharge (cumecs)	**Minimum free-board (mm)**
Less than 3.	600
3 to 30	750
More than 30	No relaxation is Permissible.

1.4 4.3 Loads, Forces and Stresses

For the purpose of computing stresses and stability of sub-structures and foundations of bridges, loads and effects of forces in accordance with the provisions of the Bridge Rules (Revised 1964 and Reprinted1980) read together with amendments shall be considered and subject to such additions and amplifications as specified in this Code.

1.4.1 Dead Load (DL)

For the purpose of calculations of the dead load, the unit weights of different materials shall be taken as provided in IS : 1911 "Schedule of Unit Weights of building materials".

1.4.2 Live Load (LL)

The live load for design of bridge substructure and foundation shall be as

specified in the Bridge Rules, subject to such addition and amplifications as stated below :-

- For simply supported spans, the live load reaction on an abutment of the gravity type, shall be taken as half of the total equivalent uniformly distributed load (EUDL) for shear on the overall length of the span. In the case of abutments of other than gravity type, the minimum vertical live load reaction corresponding to the axle load position which develops the maximum longitudinal force, shall be considered

- The live load for design of bridge substructure and foundation shall be as specified in the Bridge Rules, subject to such addition and amplifications as stated below :-

- For simply supported spans, the live load reaction on a pier shall be worked out under the

  following conditions:

  (i) when only one span is fully loaded, and

  (ii) when both spans are fully loaded.

1.4.3 **Dynamic Augment (I)**

- For calculating the pressure on the top surface of the bed block, the live load shall be incremented by the appropriate Dynamic augment specified in the Bridge Rules. For the design of gravity type substructure, the dynamic augment shall be multiplied by a factor as under :

1	For calculating the reaction at the bottom surface of bed block	0.5
2	For calculating the pressure on top 3m of substructure below the bed block	0.5 Decreasing uniformly to zero
3	Beyond a depth of 3m below the bed block, no impact need be allowed -	-

- For design of non gravity type Substructure, full dynamic augment effect as specified above shall be considered up to scour level.
- In a slab top culvert, where no bed block is provided and the slab rests direction on the pier or abutment, the top 300mm of Substructure below the bottom of the slab shall be considered as bed- block.
- The dynamic augment for the design of ballast walls up to a depth of 1.5m, shall be Assumed to be 0.5. For the remaining portion of ballast wall, no dynamic augment need be allowed.

1.4.4 **Longitudinal Forces (LF)**

- Where a bridge carries a railway or roadway, provision shall be made for the stresses in the piers and abutments for longitudinal forces as specified in Bridge Rules. In design calculations, it should be determined which of these forces are applicable for the condition of loading under consideration.

- Temperature effects (TMP) need not be considered in the design of sub structures and foundation of bridges if a super structure is free to expand or contract.

1.4.5 **Frictional Resistance**

- Frictional resistance of RC/PSC slabs kept on un-yielding piers/abutments without bearings shall be limited to frictional coefficient times the reaction due to dead load on the pier or abutment. This frictional coefficient shall be as follows :

  a) For concrete over concrete with bitumen layer in between = 0.5

  b) For concrete over concrete not intentionally roughened = 0.6

- Frictional resistance of expansion bearings shall be taken into account in accordance with clause 2.7 of the Bridge Rules and shall be equal to the total vertical reaction due to dead load and the live load multiplied by appropriate values of frictional coefficient as given in clause 2.7.1 of the Bridge Rules

1.4.6 **Earth Pressure (EP)**

- All earth retaining structures shall be designed for the active pressure due to earth fill behind the structure. Angle of Internal friction of soil
- Abutments, wing walls and return walls shall be designed adopting suitable values for angle of internal friction appropriate for the material used in the backfill, determined, where possible, by testing soil samples as per IS : 2720-Pt (XIII).

1.4.7 **Buoyancy Effect (B)**

- For designing of foundation full buoyancy considered upto HFL or LWL as the case may be, depending upon the most critical combination, irrespective of the type of soil. However, if foundations are resting on rock and have adequate bond with it, suitable reduction in buoyancy may be considered at the discretion of Engineer responsible for design but in any case the reduction shall not be less than 50% of full buoyancy.

1.4.8 **Wind Pressure Effect (WL)**

- Wind pressure shall be taken into account for bridges of span 18m and over, and the intensity of pressure, along with the effects to be considered shall be as per Bridge Rules (Revised 1964).

1.4.9 Seismic Forces (SF)

- Bridge as a whole and every part of it shall be designed and constructed to resist stresses produced by seismic force as specified in the IRS Bridge Rules and subject to amplifications given in this Code. The stresses shall be calculated as the effects of force applied vertically or horizontally at the centre of mass of the elements of the structure into which it is conveniently divided for the purpose of design.
- Slab, box and pipe culvert need not be designed for seismic forces. For design of substructures of bridges in different zone, seismic forces may be considered as given below :-
- Zone I to III : Seismic forces shall be considered only in case of bridges of overall length more than 60m or spans more than 15m.
- Zone IV and V, Seismic forces may be considered for all spans.

2 Foundations

2.1 General Design Criteria

- As far as possible, foundations should be located on a firm ground having stable strata. This would not always be possible and, therefore, the foundations must be designed adequately against any expected failures. Following basic requirements should be fulfilled:
- Safety against strength failure: Foundation should be safe against catastrophic failures caused by foundation pressures exceeding the "Bearing Capacity" of foundation soil. It is basically the strength failure of the supporting soil mass.
- Safety against deformations and differential settlements: The foundation should deform within acceptable limits of total and differential settlements. These acceptable limits depend on the type of structure and substrata involved and should be decided judiciously. The settlement shall not normally exceed 25 mm after the end of the construction period for bridges with simply supported spans. Larger settlement may be allowed if adjustment of the level of girders is possible so as to eliminate infringements to track tolerances. In case of structures sensitive to differential settlement, the tolerable settlement limit has to be fixed based on conditions in each case.

Allowable Bearing Pressure: The allowable bearing pressure for foundation supported by rock or soil mass, based on the above two criteria, shall be taken as lesser of the following:

(a) Net ultimate bearing capacity divided by factor of safety of 2.5, or

(b) The allowable pressure (maximum) to which the foundation of the structure may be subjected without producing excessive settlement (i.e. more than 25mm) or excessive differential settlement of the structure.

- In case of open foundation, the resultant of all forces on the base of foundation (for rectangular foundation) shall fall within the middle third if the structure is founded on soil. Depth of foundations in soil strata shall not be less than 1.75 m below the anticipated scour level. Foundation shall not normally rest on compressible soils.

2.2 Design and construction of bridge substructures

2.2.1 Abutments

The length of abutments at the top shall normally be equal to the formation width. The width at the top shall be sufficient to accommodate not only the bearings, but also to carry ballast walls. It shall also be sufficient to provide adequate thickness of masonry or concrete beyond the bearings to resist diagonal shearing. Where pier type abutments are provided without wing walls and return walls, the earth fill around the abutment shall be protected by providing properly designed stone-pitching on the slopes and apron at the toe of the fill.

2.2.2 Piers

The length of piers shall be sufficient to provide proper seating for the girders. The width at the top shall be sufficient not only to accommodate the bearings of the girders, but shall also provide sufficient masonry or concrete on the outside of the bearings to resist diagonal shearing. When necessary, piers shall be provided at both ends with suitably shaped cut waters which shall extend up to at least 1 m above high flood level, including afflux.

2.2.3 Bed Blocks For Abutments And Piers

In girder bridges where concentrated loads are transmitted to the substructure, bed blocks of proper design shall be provided on the top of the piers and abutments under the bearings to ensure proper distribution of the superimposed loads over the

whole length of the abutment or pier. Such bed blocks may be reinforced cement concrete.

2.2.4 **Butt Joints**

In piers and abutments built on shallow open foundations on poor soil, a butt joint shall be provided between the tracks throughout the height of the structure, including the foundations, so as to permit differential settlements. Similar butt joints shall be provided also near the junction of the wing or return walls and the abutments.

In the case of canal crossings, where there are clean joints between the abutments and the wing/return walls such joints shall be filled up with suitable material like bitumen below the full supply level.

2.2.5 **Backfill Material And Approach Slabs.**

Backfill behind abutments, wing walls and return walls. Behind abutments, wing walls and return walls, boulder filling and backfill materials shall be provided The boulder filling shall consist of well hand-packed boulders & cobbles to thickness not less than 600 mm with smaller size towards the back. Behind the boulder filling, backfill materials shall consist of granular materials of GW, GP, SW groups as per IS : 1498-1970.

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

2.2.6 **Weep Holes**

Weep holes shall be provided through abutments, wing or return walls and parapets as may be necessary with adequate arrangements being made to lead the water to the weep holes.

For abutments of canal crossing culverts, weep holes may be provided only above full supply level. No weep holes need be provided below full supply level. To

drain away the water from the backfill of the abutment, wing or return walls, open jointed pipes or boulder drains may be provided at suitable levels.

3 Permanent Way

All works related to permanent way shall generally conform to provisions contained in Indian Railway manual 1986 Reprinted in 2004 with up to date correction slips, Indian Railway Standard Specifications, RDSO Drawings, RDSO Specifications & Guidelines and Indian Railway track manual (all as amended up to date), as applicable. The word IRPWM Wherever used in these specifications shall mean ' Indian Railway Permanent way Manual' 1986 Reprinted in 2004 with up to date correction slips.

3.1 Materials

The track shall consist of the following elements:-

Rails 60kg/90UTS Flat bottom (1st quality/IU as specified in schedule of quantity) as per I.R. Specification with up to date amendments.

3.1.1 Rail Fastenings

- 60kg Fish Plates to RDSO Dr No. T-1898 (M), in Length of 610mm to IRS Specifications No T 1-66
- Fish Bolts 25mm dia with nuts to RDSO Drg. No, 1899-IRS Specification T-23/67

Mono Block Prestressed Concrete sleepers as per IRS Specification T-39/1996

- For plain track on straight & curves of radius > 350m to Drg. No. T-2946 with modifications, if any.
- For Curves Sharper than 50 (Radius <350m) as per Drg. No.RDSO/T-5738 to T-5740 For track gauge of 1675, 1677 & 1679 with use of normal liners.
- For Level Crossings to RDSO Drg. No. T-4148 A with modifications if any

- For Ballasted deck bridges as per RDSO Drg. No. T-4088-4097.
- Sleepers at joints shall be provided as per RDSO Drg No.T-4322 for 52 kg Rails with ERC Clips as per RDSO Drg No. T-4158.
- For Bridge approaches for provision of Guard Rails as per RDSO Drg. No. T-4088 to 4097.
- PSC Sleepers Fittings: The Sleepers shall be of 60Kg Rails as per RDSO Drg. No. T-2496 and sleeper fittings shall be of 60kg Rail section on 60Kg Sleepers as per specification and drawings.
- Grooved Rubber sole plate 6mm thick to RDSO Drg. No. T-3711.
- Elastic Rails clip to RDSO Drg. T-3701. IRS Specification T-31/1992.
- Glass Filled Nylon(GFN) Liners (GFN-66 insulating liners for 60kg Rails on 60Kg Sleepers as per RDSO Drg. No. T-2496 as per RDSO Drg. No. T 2496) as per RDSO Drg. No. T-3707 (GS) & T-3708 (NGS). IR Specification T-44/95
- Metal Liners as per RDSO Drg. No. T-3741 (GS) & T-3742 (NGS).
- Steel Channel Sleepers for Girder Bridges as per RDSO Drg. No. BA1636/R2, BA1636/1/R2, BA1636/2 and Rail Fastening assembly and Guard Rail as per RDSO Drg No. T-5155 to 5164, T-5464, T-5465 to T-5468.
- All other Fittings, Unless other wise specified above shall be as per RDSO Drg. Latest edition.

3.1.2 **Ballast**

- Track Ballast machine crushed, confirming to RDSO Specifications of Track Ballast, June 2004 with up to date modifications there to, shall be procured and used on the work.