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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

GUIDELINES FOR PROVISIONS OF OHE MAST FOR ELECTRIFICATION AT NEW AND EXISTING BRIDGE PIER/ABUTMENT

REPORT NO. BS – 121

OCTOBER - 2015

**BRIDGE & STRUCTURES DIRECTORATE
RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW-226011**



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Issued by

**BRIDGES & STRUCTURES DIRECTORATE
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OCTOBER -2015

FOREWORD

Indian Railways is engaged in rapid electrification as part of infrastructural development for overall economic growth. The provision of overhead electrical Mast at new & existing bridge, Pier/Abutment is identified as one of the interdisciplinary impediment affecting the progress of electrification.

Member Engineering/Railway Board had directed RDSO during Chief Electrical Engineers Conference held in Railway Board on 27/28.02.2015 that provision of fixing arrangement of traction mast on the new constructed bridges to avoid subsequent drillings etc on the pier be standardized.

Based on guidelines issued by Central Organization for Railway Electrification, guidelines issued by Traction Installation Directorate of RDSO, drawings issued by various Railways and comments received on the draft guidelines, consolidated guidelines have been prepared. It is expected that these guidelines will serve as a technical guidance for officials of Engineering & Electrical Department of Indian Railways working in the field.

I am thankful to Sri Qazi Mairaj Ahmad, Director/Urban Transport & High Speed, B&S, RDSO for utilizing his experience in preparation of these guidelines. I am also thankful to Sri Radhey Shyam, Jt. Director/T.I./RDSO, Sri P.P. Singh, ADE/CB-II/RDSO, Sri Binay Kumar, SSE/CB-II/RDSO for their diligence, besides numerous others profound persons associated at various stages upto the final compilation of this document.



(H.L. Suthar)
Executive Director/Structures
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Lucknow

Dated:29.10.2015

Provision of OHE MAST Arrangement at the Bridge Pier/Abutment

1.0 Design Loading on Mast: The Bridge Pier must be checked for design loads on OHE Mast

All OHE masts are required to support overhead equipment consisting of catenary wire, contact wire and droppers. In addition, masts may also be required to carry return conductors, earth wire and 25 kV feeder wire.

The loads acting on the mast are as under:

1.1 Permanent Loads

1.1.1 Permanent Load (Vertical):

- 1.1.1.1 Dead load of overhead equipment consisting of catenary wire, contact wire and droppers which is generally 1.6 kg/m length of overhead equipment.
- 1.1.1.2 Dead load of swiveling bracket, assumed to be 60 kg.
- 1.1.1.3 Dead load of earth wire (if any).
- 1.1.1.4 Dead load of return conductor and insulator for return conductor (if any).
- 1.1.1.5 Dead weight of any 25 kV feeder and insulator for the feeder (if any).
- 1.1.1.6 Dead weight of any small part steel work.
- 1.1.1.7 Self weight of mast.

1.1.2 Permanent Loads (horizontal):

- 1.1.2.1 Radial pull of contact and catenary wires caused by curvature of the track and/or stagger of wires.
- 1.1.2.2 Radial pull of earth wire, return conductor if any and/or 25 kV feeder (if any) caused by the curvature of track.

All Vertical permanent loads act perpendicular to the track. The only horizontal permanent force acting parallel to track is the component of radial pull due to swing of bracket. It may be noted that the swiveling bracket remains in the normal position only at the mean temperature, if the overhead equipment is regulated. In case of unregulated overhead equipment the swing of the cantilever need not be considered.

1.2 Occasional Loads

1.2.1 Occasional Loads (Vertical):

The only occasional load acting vertically is the weight of a workman assumed as 60 kg acting at the end of the bracket

1.2.2 Occasional loads (Horizontal)

The only occasional horizontal loads are due to wind, blowing perpendicular or parallel to the track on the structure, steel work and wires. The two conditions of wind being parallel or perpendicular to track are to be considered separately. The assumed direction of the wind determines whether the loads will be acting perpendicular or parallel to the track.

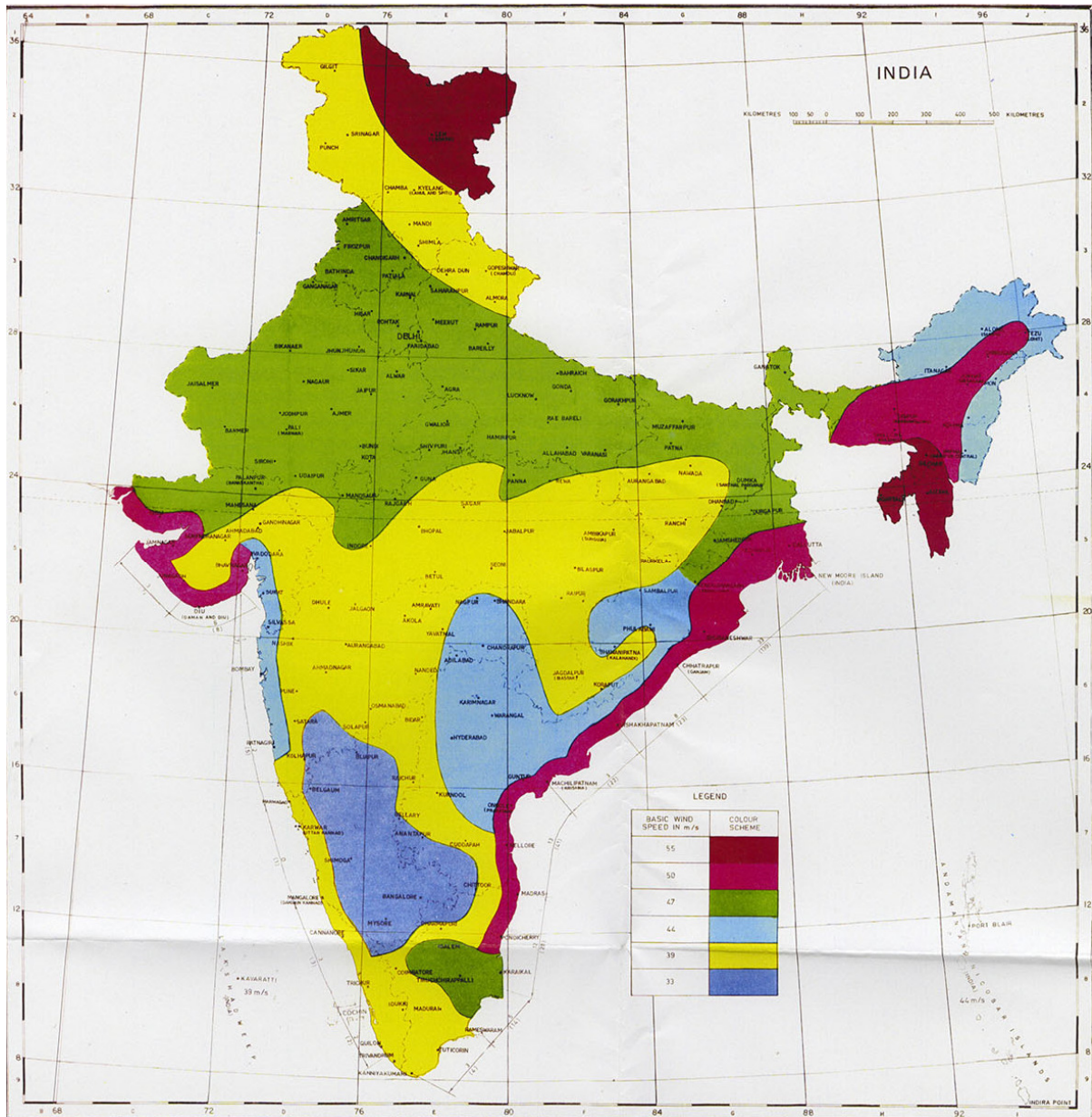
The moments at the top of foundation level under different conditions i.e. with and without occasional loads, with wind blowing perpendicular or parallel to the track are calculated by multiplying the above loads with the appropriate lever arm.

To estimate the loads, it is necessary to know the extreme range of temperature and wind pressure for which the overhead equipment may be designed. It may be necessary to make reference to the meteorological department and ascertain the temperature range and wind pressure recorded over a number of years. As per rules for opening of Railways the conformation of the state government concerned has to be obtained for the wind pressure adopted. IS: 875-(Part-3) - 1987 Reaffirmed -1997 "Code of practice for Design Loads (Other Than Earthquake) for Building and Structures". May be helpful in determining the wind pressure and correlating wind velocity with wind pressure. .

1.2.2.1 WIND LOADS

Wind pressures for design of OHE structure and determination of spans are based on IS: 875-(Part-3) - 1987 Reaffirmed -1997 "Code of practice for Design Loads (Other Than Earthquake) for Building and Structures". Accordingly, the standard wind pressures adopted are as follows for all new works for different Zone as indicated in the specification:-

- | | | |
|-------|------------------|-------------------------|
| (i) | Navy Blue Zone | - 73 kg/m ² |
| (ii) | Yellow Zone | - 105 kg/m ² |
| (iii) | Blue Zone | - 136 kg/m ² |
| (iv) | Green Zone | - 155 kg/m ² |
| (v) | Red Zone | - 178 kg/m ² |
| (vi) | Hatched Red Zone | - 216 kg/m ² |



1.2.2.1.2 For working out wind load, 190% of projected area for the Rolled Structure & Fabricated Structure and 75% of the projected area for conductors and other circular members is to be taken into account.

1.2.2.1.3 The safety of structures are checked for two conditions (i) at 35°C temperature and full wind pressure and (ii) at 4°C temperature and 20% of the full wind pressure.

1.2.2.1.4 The maximum span should be restricted to 54 m for Red Zone and 63m for Navy Blue Zone. In case of curve on banks of such bridges, the span should be 4.5 m less than the maximum span permitted by relevant span and

stagger chart, but should not exceed 54 m for Red Zone and 63 m for Navy Blue Zone. Structural design and analysis of steel masts is to be done as per IS: 800-1984 "Code of practice for general construction in steel".

2.0 Locating OHE masts on Bridges

As per Ministry of Railways, Design Manual for Electric Traction, Volume 3, Traction Overhead Equipment (July 1994), Chapter 3 Para 3.3.2:

"Span: The distance between the centerline of the adjacent supporting structures for the overhead equipment/lines known as span."

The standard spans vary in steps of 4.5m from a minimum of 27m to a maximum of 72m i.e. 27, 31.5, 36, 40.5, 45, 49.5, 54, 58.5, 63, 67.5 and 72 m subject to para 1.2.2.1.4. Standard spans shall be used to the extent possible.

Where structures are located on the Bridge Piers/Abutments of Long Bridges, the span shall be the distance between centers of Bridge Piers/Abutments.

On main track, the lengths of two consecutive spans shall not differ by more than 18m."

Thus OHE Masts may be required to be located on Bridge Piers etc., if unavoidable otherwise

3.0 Guidelines of Railway Electrification (RE) mast over the piers:

The Pier Top Length must have following minimum provisions to avoid obstructions during Bridge rehabilitation, re-girdering and maintenance works at Piers. Minimum clear distances for locating the OHE Mast base plates.

SN	Type of Bridges	Clearances Required	Remarks
1	Steel Girder Bridges of clear spans 12.2m and below (For likely replacement of Girders with PSC slab Units)	Minimum 2450mm from the Centre line of track to the edge of Base Plate.	Implantation of OHE Masts to be decided after giving the minimum clearances.
2	Steel Girder Bridges of clear spans above 12.2m (For likely re-girdering with new Girder)	Minimum Implantation of OHE Masts shall be 3600mm	Special arrangements (Boom type) may be adopted.
3	PSC Box/I Girder Bridges	Minimum Implantation of OHE Masts shall be 2600mm from C/L of track	Minimum clearance for any structure as per SOD

TYPICAL DISTANCES FROM CENTRE LINE OF TRACK

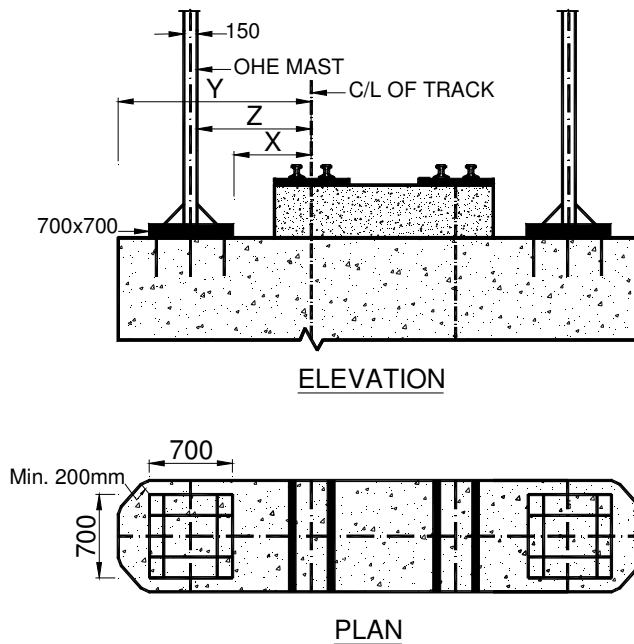


FIGURE : 1

- X ✧ 2600mm for PSC Box/I Girder Bridges.
- ✧ 2450mm for Steel Girder Bridges of clear spans 12.2m and below.
- ✧ 3600mm for Steel Girder Bridges clear spans above 12.2m.
- Y ✧ $X + \text{Width of base plate} + 200\text{mm}$
- Z = $X + \text{Width of base plate}/2 - \text{width of Mast}/2$

4.0 Provision of OHE support on Bridge Super Structure, if it is not possible to provide OHE structure on the Piers.

- 4.1 In case of through type Steel Bridge, the cantilever assemblies which carry the catenary and contact wire, may be fixed either to vertical member or to a drop arm fixed to a cross girder depending upon the position of support required and clearance available.

The strength of Bridge Super Structure to withstand the loadings on account of the OHE structures should be checked and permission of the Chief Engineer be obtained for adoption of any OHE support arrangement on the Bridge Super Structure.

5.0 New Bridges: Provision of OHE Support on Bridge Substructure:-

The Bridge /Bridge Pier to be designed must have provisions for OHE Masts, irrespective of whether Electrification is sanctioned or not. The following two types of foundation arrangement may be considered to provide OHE masts on pier top and abutment.

5.1 OHE Masts foundation (Gravity Type) on top of Piers and Abutments with the OHE masts embedded in the concrete

The foundation is designed like pure gravity foundation except that tension is not permitted in the base, i.e. the resultant of the vertical forces and moments is not permitted to fall outside the middle third of the base of the foundation. Adequate number of dowel bars is provided to have a proper bond between the piers and foundation base. The foundation should be constructed clear of the bearing arrangement for OHE masts. A typical design of Gravity Type Foundation is at Annexure-I

5.2 OHE masts supported on Pier and Abutment by provision of base plate connections and holding down bolts (Ragged type)

On piers and abutments, the OHE masts welded to base plate will be fixed with holding down bolts (Ragged type). The minimum diameter of the holding down bolts (Ragged type) should not be less than 22mm; however, it is preferable to adopt a minimum diameter of 25mm in view of corrosion. The length and diameter of the holding down bolts (Ragged type) are to be decided, to meet the actual tension, shear and bond stresses. Holding down bolts (Ragged type)

Should conform to IS: 2062-92 (Grade 'A') - "Steel for General Structural Purposes-Specification".

Accordingly the holes for holding Base Plate of future OHE must be kept, properly secured against intrusion of kankar, foreign bodies etc. The holdings down bolts (Ragged type) are to be grouted in the core holes made in the Piers/Abutments, by epoxy grouting containing minimum bond stress not less than (M-20) concrete.

The diameter and length of core hole may be kept as 40 mm and 950mm respectively. The length of core hole may be kept slightly more than the length of the holding down bolt(Ragged type), say upto 50mm, for the working convenience, a Typical Design Procedure is at Annexure-II. A Sample Design Calculation is enclosed as Annexure- III.

For new Bridge Piers/Abutments, the drawing of the standard size of base plate i.e. length, width & thickness and hole to hole pitch & edge distance of anchor bolt is enclosed as Annexure -IV, which should be referred for making holes in the piers/Abutments.

The Typical Drawing of OHE Structure mounted directly on Pier, enough space at Pier top as per Eastern Railway Standard Type Drawing:

S No	Scenario of mounting of OHE Structure	Template No
1	OHE Mast on bed block with RCC details, CAO (Con)/ER Drawing No.- 145-99	1

- 5.3 New Bridge Piers/Abutments having the provisions for erection of OHE mast in the approved drawings do not require separate approval of the competent authority for the OHE mast on Bridge Piers/Abutments.

6.0 **Existing Bridges: Provision of Foundation for OHE Masts on Bridge Pier and Abutment:-**

The approval of Chief Engineer/Chief Bridge Engineer should be obtained for adoption of any foundation arrangement on the bridge Piers/Abutments for supporting OHE masts.

- 6.1 If the space available on the Pier/Abutment is not adequate to accommodate the concrete blocks foundation or the base plate with holding down bolts, then following arrangements can also be adopted with the approval of competent authority.

S No	Scenario of mounting of OHE Structure	Template No
1.	Directly on Pier, enough space at Pier Top	2
2.	Through 3 ISMC Channels, directly on Pier	3
3.	Mast Fixing arrangement at Trestle Beam	4
4.	Mast fixing arrangement directly on Channel without any outside projection from Pier.	5
5.	Out rigger arrangements with suitable steel channel	
5.1	On Concrete Pier	6
5.2	Concrete Pier Special Arrangement-1	7
5.3	Masonry Pier Special Arrangement- 2	8

6.2 **Strengthening of Pier and Abutment for support Foundation of OHE Masts**

In each individual bridge, it has to be studied upto what depth below the base plate/pier top/ abutment top, the uplift forces from the holding down bolts may cause any tension/compression and shear stresses. In case of weak concrete or masonry within this depth, the pier/abutment may be strengthened by anyone of the following methods:-

- (i) Cement pressure grouting
- (ii) Epoxy grouting
- (iii) Guniting

In case of stone masonry bridges and old concrete bridges, careful inspection of abutment and pier should be done to check for any cracks or loose masonry or broken concrete, cavities, cracks in joints, in the location where the foundation for OHE masts is to be constructed.

The work of rehabilitation of weak substructure should be undertaken with prior approval of Chief Engineer/Chief Bridge Engineer.

S No	Scenario of mounting of OHE Structure	Template No
	Strengthening Pier (Masonry/concrete) by Concrete Column	
1	Arrangement -1	9
2	Arrangement -2	10
3	Arrangement -3	11

6.3 Special Arrangements:

In case of space constraint to provide direct arrangements of OHE masts on Base Plate, non-possibility of Out Rigger Arrangement due to lack of strength at the Bed Block level, Side Strutting arrangement or Separate-Pile Arrangements may also be considered:

S No	Scenario of mounting of OHE Structure	Template No
1	Side Strutting	12
2.	Separate Pile arrangement	13

7.0 Miscellaneous Items

- 7.1 The earthing arrangement for the OHE Masts structure should be done as per code for bonding and earthing for 25kV AC 50 Hz single phase traction system Code No. ETI/OHE/71(11/90) with latest amendments issued by RDSO.
- 7.2 The Authority for passing, supervision and Inspection must be as observed for '**Important**' Construction Site activities including,
 - a. the inspection of the existing masonry/concrete of the bridge pier/abutment to decide whether rehabilitation is needed,
 - b. ensuring the depth of Excavated core holes in the piers and abutments,
 - c. approving all construction materials brought to site, including holding down bolts(Ragged Type), anchor angle, epoxy grouting material, and
 - d. supervising the construction work of the foundation
- 7.3 All concrete works for foundation of OHE structures on bridges should conform to IS: 456-2000 "Code of Practice for Plain and Reinforced concrete".
- 7.4 The procedure for inspection and Maintenance of foundation for OHE structures on bridges should be similar as for bridge inspection and maintenance by Engineering Department and general instruction to be observed while working In electrified areas should be as per the provisions of Indian Railways Way and Works Manual - 1983 and Indian Railways Permanent Way manual-1986, in addition to the instruction, if any, issued by the Chief Electrical Engineer and Chief Engineer.

8.0 Recommendations

There are several arrangement for the provision of the OHE masts on bridges as discussed in this report. The suitability of any arrangement is to be decided after a proper study of the individual bridges, the bridge span, space constraint on bridge Super Structure and Sub-structure, clearance (Mechanical and Electrical), the strength of existing bridge to carry the additional loading due to the OHE arrangement while ensuring the safety and economy aspects.

TYPICAL DESIGN PROCEDURE OF PURE GRAVITY TYPE FOUNDATION

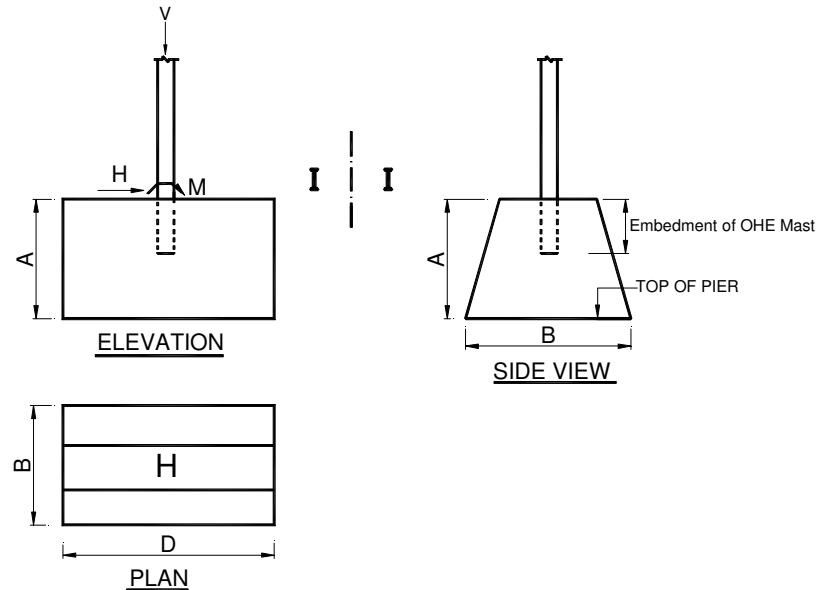


FIGURE : 2

BM= Bending moment at top of foundation in kg-m.

V= Vertical load at top of foundation in kg.

H= Lateral load at top of foundation in kg.

A = 1.50m (as per drawing no.TI/DRG/CIV/FND/RDSO/00001/04/0 of sheet-2)

σ_{cb} = Permissible bearing pressure of material below foundation base. This is to be assumed as per the site condition.

M= Bending Moment at the bottom of foundation = (BM + H x A) kgm.

N = Total Vertical load (V+ weight of concrete block) kg.

$$\text{Eccentricity} = e = \frac{M}{N} \leq \frac{D}{6}$$

$$\text{Maximum stress at base, } P = \frac{N}{BD} + \frac{6M}{BD^2} \leq \sigma_{cb} (\text{Permissible stress in concrete})$$

NOTE:-Adequate number of dowel bar are to be provided to have proper bond between the pier and the foundation base. A typical provision of Dowel Bars is 20mm dia @ 300mm c/c with grip-length 50 cm on either direction.

TYPICAL DESIGN PROCEDURE OF BASE PLATE

When the bending moment is quite large compared to vertical load, the eccentricity $\left(e = \frac{M}{V}\right)$ is also large. In such cases it will be economical to take advantage of holding down bolt.

Depending upon the size of mast, assume the dimensions of base plate, the location of holding down bolts and the permissible bearing pressure.

Assumed, Length of base plate = D
 Width of base plate = B
 Distance of bolt from edge = a
 Maximum bearing pressure
 at the edge of base plate = P
 Bending moment = M
 Vertical load = V

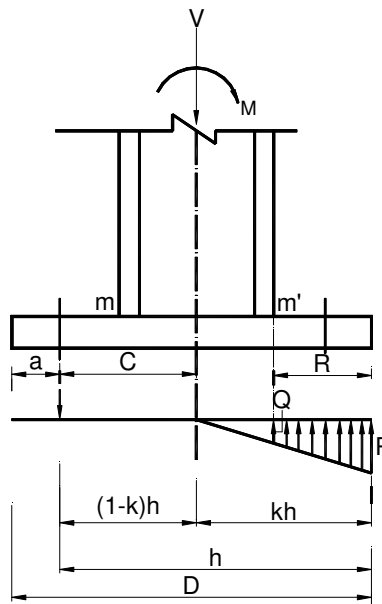


FIGURE : 3

Taking moment about a bolt we get,

$$\frac{1}{2} \times P \times k \times h \times B \times \left(h - \frac{kh}{3}\right) = (V \times C + M)$$

Then find the value of 'k' from above.

Equating the vertical forces to zero, find the value of 'T' (Tension in bolt) from,

$$T + V = \frac{1}{2} \times k \times h \times B \times P$$

Find the value of stress ($\sigma_{st,cal}$) in steel bolt by assuming the modular ratio m as 18.

$$\sigma_{st,cal} = P \times \frac{1-k}{k} \times 18$$

$$\text{Area of steel bolt on one side} = \frac{T}{\sigma_{st,cal}}$$

Arrive at the diameter of bolts by assuming the number of bolts on one side.

Assuming the concrete grout with M-20, the permissible bond stress, τ_{bd} is 0.8 N/mm^2 as per IS: 456-2000 (Table - 21).

$$\text{Length of bolt (in mm)} = \frac{\text{Tension force in one bolt (N)}}{0.8 \times \text{circumference of bolt (mm)}} + 150$$

The thickness of base plate will be designed to take the bearing pressure and bolt tension acting as cantilever. The critical sections are m and m' .

BM at section $m = T \times \text{lever arm}$

BM at section $m' = [Q \times R \times R/2 + 1/2(P-Q) \times 2/3 \times R] \times B$

Where Q is the stress (N/mm^2) at the section m' , R is the distance of section m' from edge of base plate.

Assuming the permissible bending stress $\sigma_{bt} = 157 \text{ N/mm}^2 = 1601 \text{ kg/cm}^2$ [IRS-SBC Table No.2, for plate thickness $> 20 \text{ mm}$].

Find the thickness of plate (t) from equation,

$Bt^2/6 \times f_b = \text{BM at } m \text{ or } m' \text{ whichever is higher.}$

Gusset Plate

Assume a gusset plate of height (E) and thickness (t). The critical point of BM in gusset is at the face of the column flanges.

The load consists of the upward pressure on the base plate in the zone hatched in fig. The intensity of pressure is shown in the pressure diagram.

The eccentricity (location from section m-m') of resultant stress of trapezoidal pressure diagram

$$e = \frac{R(2P + Q)}{3(P + Q)}$$

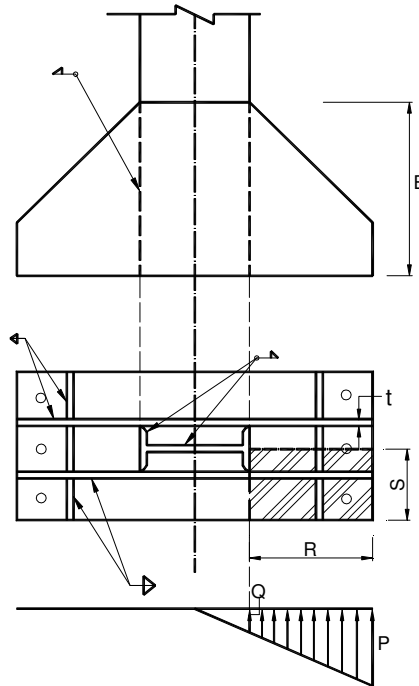


FIGURE : 4

$M_{\max} = \text{load} \times \text{lever arm}$

$$= \left(\frac{(P + Q)}{2} \times R \times S \right) \times e$$

Where S is the half width of base plate.

Section modulus of gusset plate at the end of flange of column, $Z = \frac{t \times E \times E}{6}$

The maximum bearing stress, $\sigma_{sb,cal} = M_{\max}/Z$

This should be less than $189 \text{ N/mm}^2 = 1928 \text{ kg/cm}^2$ [as per IRS-SBC, Table -2]

.The maximum shear stress, $\tau_{ss,cal} = \left(\frac{(P + Q)}{2} \times R \times S \right) \times \frac{1}{t \times E}$

This should be less than 102 N/mm² [as per IRS-Steel Bridge Code Table-2 for thickness >20mm].

Provide necessary stiffeners across the gusset plate, of having thickness equal to thickness of gusset plate.

Design of weld

Assuming all the vertical load is effective, the total force at the junction of column flange and gusset, $F = \frac{V}{2} + \frac{M}{\text{Depth of column}}$

Force per lineal cm of weld = $\frac{F}{\text{Length of weld}}$

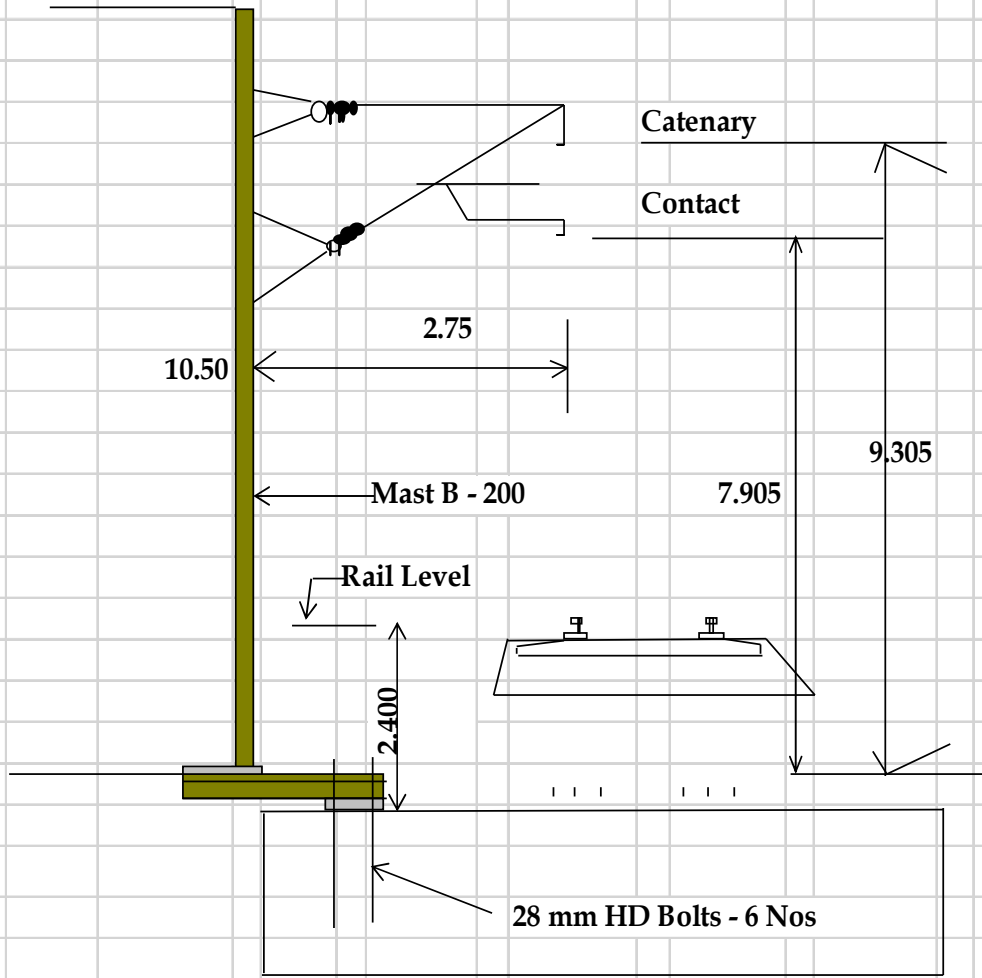
Thickness of weld = $\frac{\text{Force per lineal cm}}{\text{Permissible strength of weld}}$

Note:- This methodology is only for a typical guidance. A detailed design, considering all the data as per site requirement, has to be done

TYPICAL DESIGN CALCULATION FOR BASE- PLATE & HOLDING DOWN BOLT

1.	Type of Mast	=	B-200	
2(a)	Length of Mast	=	10.50 m	
(b)	Addl. Height of Super-mast	=	0 m	
	Total (a) + (b)	=	10.50 m	
(c)	Intensity of wind	=	155 kg/m ²	
(d)	Depth of construction	=	2.4 m Pier top to Rail level	
(e)	Height of contact wire	=	7.905 m from Base plate	
(f)	Height of Catenary wire	=	9.305 m from Base plate	
(g)	Distance of Con. Wire from mast	=	2.75 m from C.L.	
3.	OHE spans on either side			
	(a)	=	37.50 m	
	(b)	=	40.08 m	
	(c) Av. span	=	$\frac{37.50 + 40.08}{2} = 38.79\text{m}$	
4(a)	Tension in Contact Wire	=	1000 kg for Regulated OHE	
(b)	Tension in Catenary Wire	=	1000 kg for Regulated OHE	
(c)	Degree of Curve	=	Nil	
5.	Radial Pull (Due to Staggering)			
	Contact Wire	=	$\frac{0.4 + 0.4}{38.79} \times 1000$	
			20.62	
			Say 21.00 kg	
6.	Load			
(a)	Weight of OHE @ 1.6 kg/m	=	1.6 x 38.79	= 63 kg
(b)	Weight of Bracket			= 60 kg
(c)	Weight of man on the Bracket			= 60 kg
(d)	Weight of mast @ 48.904 kg/m	=	48.904 x 10.50	= 514 kg
(e)	Weight of super-mast @ 40kg/m	=	40.00 x 0.00	= 0 kg
(f)	Weight of super-mast Cantilever arm			= 0 kg
(g)	Weight of RC wire			= 0 kg
(h)	Weight of base plate (=0.7x0.7x0.025x7850x2)			say= 200 kg
	TOTAL VERTICAL LOAD			= 897 kg

TYPICAL SKETCH OF OVER HEAD EQUIPMENT(OHE)



ELEVATION OF PIER WITH OHE MAST

NOT TO SCALE

All Dimensions are in metres.

FIGURE-5

7. Wind Load = 155.00 kg/m² (For Green Zone, as per IS: 875-1987

Part-3)

- (a) On catenary wire (including 5% Wind load on dropper)
 $= 0.75 \times 0.01054(\text{diameter of catenary wire}) \times 155.00 \times 38.79 \times 1.05 = 50 \text{ kg}$
- (b) On contact wire (including 5% Wind load on dropper)
 $= 0.75 \times 0.01224(\text{diameter of contact wire}) \times 155.00 \times 38.79 \times 1.05 = 58 \text{ kg}$
- (c) On RC wire = 0 kg
- (d) On bracket (say) = 40 kg
- (e) On mast and super-mast = 0.00 kg
- (i) Wind load on mast $= 0.200(\text{width of mast}) \times 155.00 \times 10.50 \times 1.9(=190\%)$
 $= 619 \text{ kg}$

8. (a) Vertical Load and Bending Moment:-

SN.	Details of load	Weight (kg)	Lever arm (m)	Moment (kg-m).
1.	Wt. of man	60	2.75	165
2.	Wt. of bracket	60	1.38 (=2.75/2)	83
3.	Wt. of OHE	63	2.75	174
4.	Wt. of mast	514	-	-
5.	Wt. of super-mast	0	-	-
6.	Wt. of cantilever	0	0.00	0
7.	Wt. of RC	0	0.00	0
8.	Wt. of base plate	200	-	-
	Total	897		422

(b) Horizontal Forces & Moments (Perpendicular to Track)

SN	Force in kg		Lever Arm(m)	Moment (kg-m)
1.	Wind load on catenary wire	50	9.305	466
2.	Wind load on contact wire	58	7.905	459
3.	Wind load on mast	619	5.250 (=10.5/2)	3250
4.	Wind on Radial pull Contact	21	7.905	166
5.	RC	0	0.000	0
			Total	4341

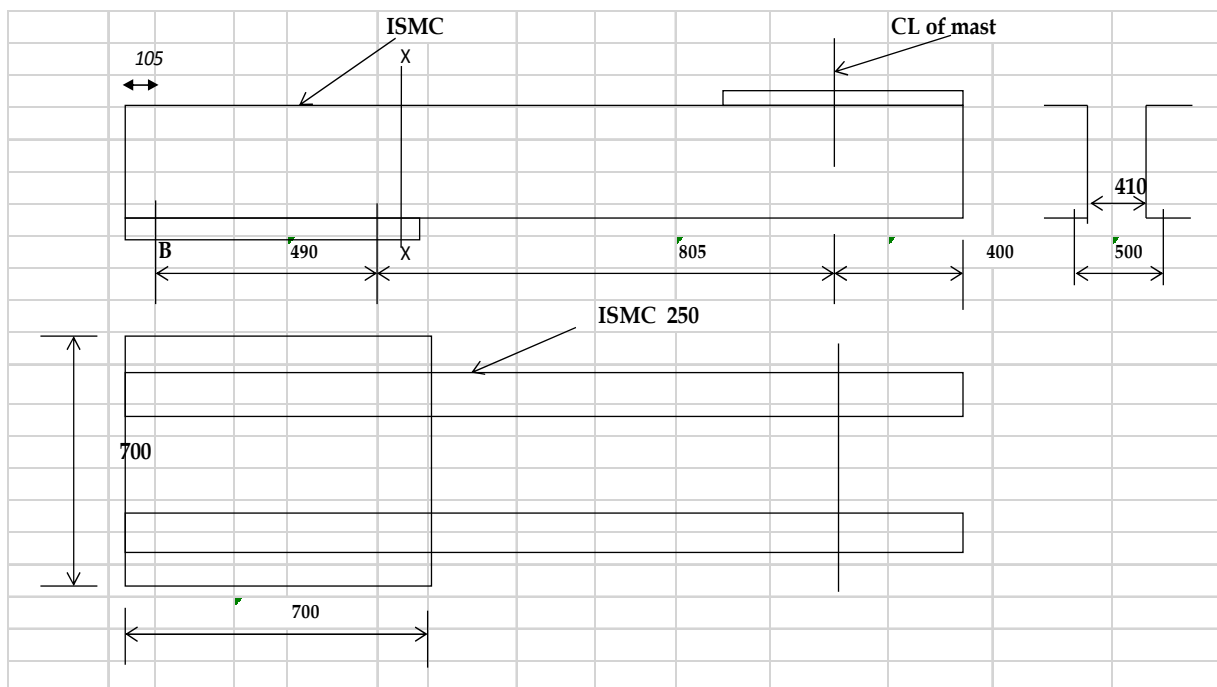
(9) Total Bending Moment

Perpendicular to the track = 4341 + 422 = 4763 kg-m

Parallel to Track = 5% of perpendicular to track bending moment = 239kg

The diagram illustrates a beam-column joint under various loads and internal forces. A horizontal beam is shown with a vertical column intersecting it. The beam is subjected to a uniformly distributed load w acting downwards. A point load X is applied at the left end of the beam. At the joint, a horizontal wind load is applied to the column, and a vertical shear force $V = 897 \text{ kg}$ is shown acting downwards. A curved arrow indicates a bending moment $M = 4763 \text{ kg-m}$ at the joint. To the right, the column is shown with two cross-sections. The left cross-section is labeled with X and Y axes and a value of 410. The right cross-section is labeled with X and Y axes, a value of 23, and a dimension of 410. A dashed line connects the two cross-sections.

FIGURE-6



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- (i) Weight of channel (2 nos.) = $30.6(\text{Weight of ISMC-250x80 per m}) \times 2 \times 1.80$
 $= 110.16$ (say 150 kg)
- (ii) Moment at x-x, $M = 897 \times 0.700 + 150 \times 1.80/2 + 4763 = 5526 \text{ kg-m}$
- (iii) Properties of Channel, ISMC-250x80
- | | | |
|-----------------|---|-----------------------|
| A | = | 39.00 cm ² |
| I _{xx} | = | 3880 cm ⁴ |
| I _{yy} | = | 211 cm ⁴ |
| Z _{xx} | = | 307 cm ³ |
| Z _{yy} | = | 38.5 cm ³ |
- (iv) Moment of Inertia of combined section
- | | | |
|-----------------|---|---|
| I _{xx} | = | 2 x 3880 = 7760 cm ⁴ |
| I _{yy} | = | 2[211 + 39 x (20.5 + 2.3) ²] = 40969.52 cm ⁴ |
- (v) Section Modulus of combined section
- | | | |
|-----------------|---|--|
| Z _{xx} | = | I _{xx} /y = 7760/12.5 = 620.8 cm ³ |
|-----------------|---|--|
- (vi) Actual Bending stress
- | | | |
|-------------------------------|---|--|
| $\sigma_{bx, cal} = M/Z_{xx}$ | = | 5526x100/620.8 = 890 kg/m ² < 2195 kg/m ² (as per IS:800-2007, permissible bending stress = 1650x1.33 kg/cm ²) |
|-------------------------------|---|--|

(B) HOLDING DOWN BOLT

Max. BM at X-X	=	5526 kg-m = 552600 kg-cm
Compressive Force on column	=	897 kg
Spacing between bolt	=	0.49 m = 49 cm
Force in Bolt	=	$\frac{552600}{49} = 11277.55 \text{ kg}$
Using no. of Bolt on oneside	=	3 Nos. on both sides
Axial compression force in one Bolt	=	897/6 = 149.5 kg
Force in each Bolt	=	11277.55/3 - 149.5 = 3609.6 kg
Say 3610 kg		
Permissible tension in each bolt	=	1224 kg/cm ²
Area required	=	$\frac{3610}{1224} = 2.94 \text{ cm}^2$
Provided diameter of holding down bolt	=	28 mm
Provided area	=	6.154 cm ² > 2.94 cm ²

Embedded Length of Bolt (Design Bond stress; M-20 As per 26.2.1 of IS 456:2000-8.15kg/cm²)

$$= \frac{3610}{8.15 \times 1.33 \times 2.8 \times 3.14} = 37.88 \text{ cm}$$

(Permitted Stress increased by 33 1/3 % when wind load is considered as per Annexure B .2.3, IS 456:200)

Total length of bolt = 37.88 + 2.5 + 25 + 15 = 80.38 cm (Length of Bolt extended by thickness of base plate = 2.5 cm, Depth of channel = 25 cm and extra margin 15 cm)

Hence provided embedment length = 90 cm

(C) DESIGN OF BASE PLATE

Max. Tension in each bolt = 3610 kg

Bending moment at critical section X-X = 3 x 3610 x 10.5 = 113715 kg-cm

Permissible bending stress in plate = 1650 x 1.33 = 2195 kg/cm²

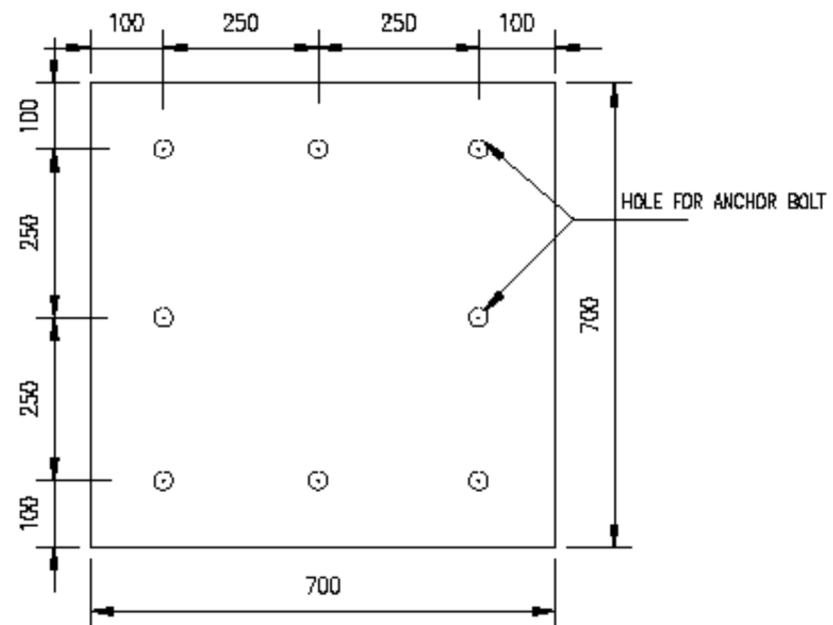
Thickness required = $Bt^2/6 \times f_b = \text{BM at critical section X-X}$

$$t = \sqrt{\frac{113715 \times 6}{2195 \times 70}} = 2.10 \text{ cm} = 21 \text{ mm}$$

Provide 25 mm thick Base plate.

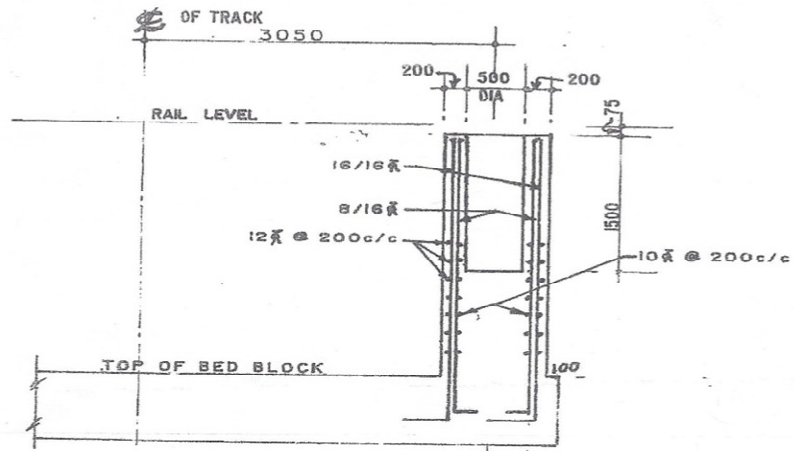
Hence base plate size: 700 mm x 700 mm x 25 mm

ANNEXURE -IV

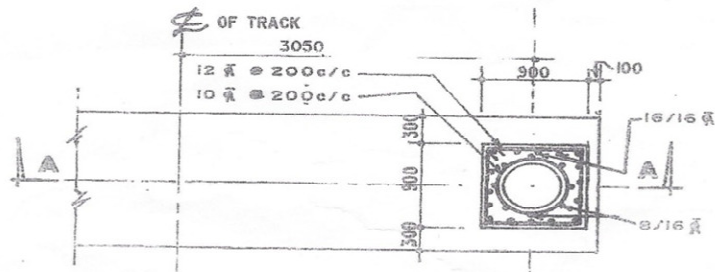


STANDARD SIZE OF BASE PLATE 700 X 700 X 25 mm THICK
WITH ANCHOR BOLT ARRANGEMENT

Ref: ER, CAO(Con)s DRG.No. 145-99

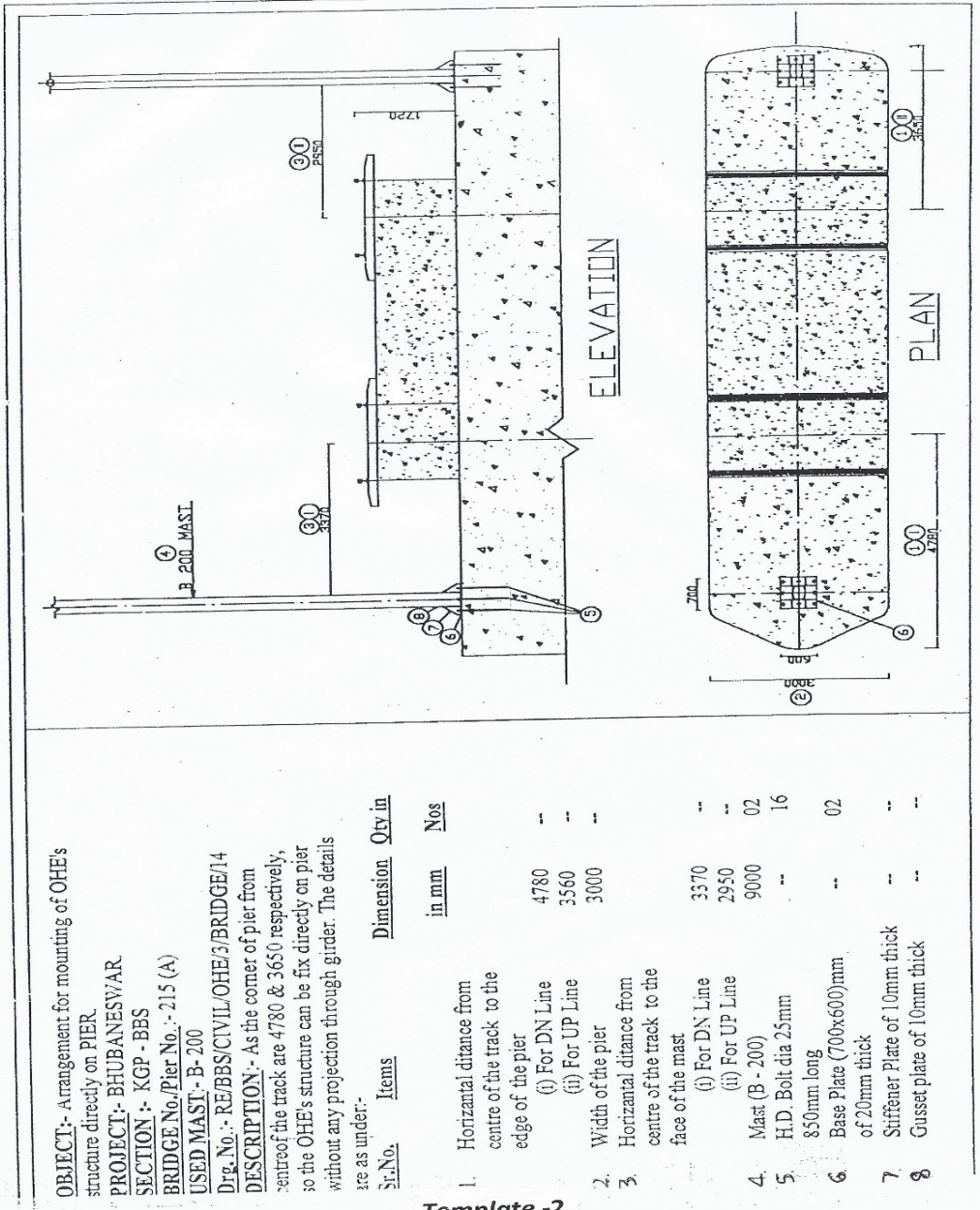


SECTION ON A - A
SCALE :- 1 : 50

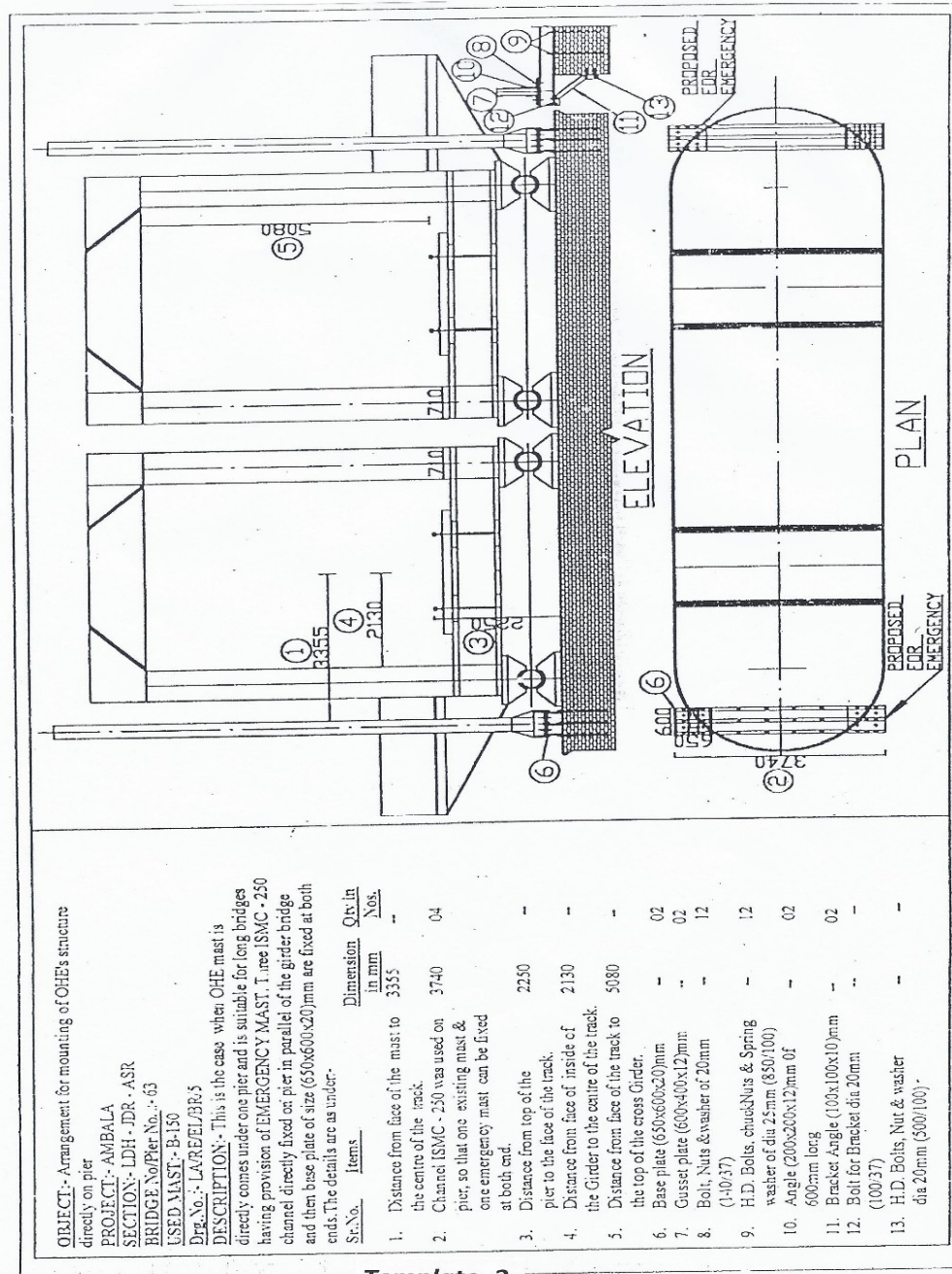


PLAN SHOWING O.H.E MAST FOUNDATION ON BEDBLOCK
SCALE :- 1 : 50

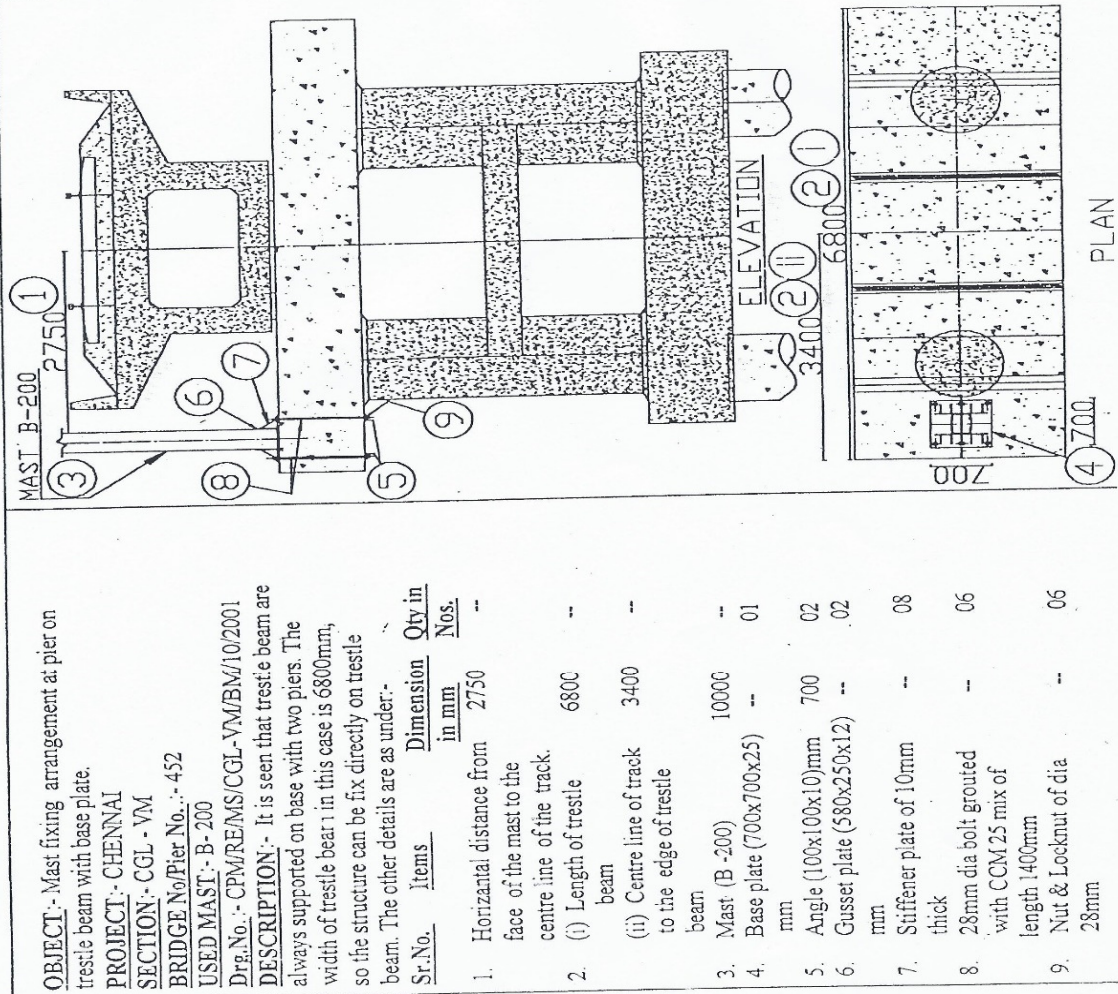
Template - 1



Template -2

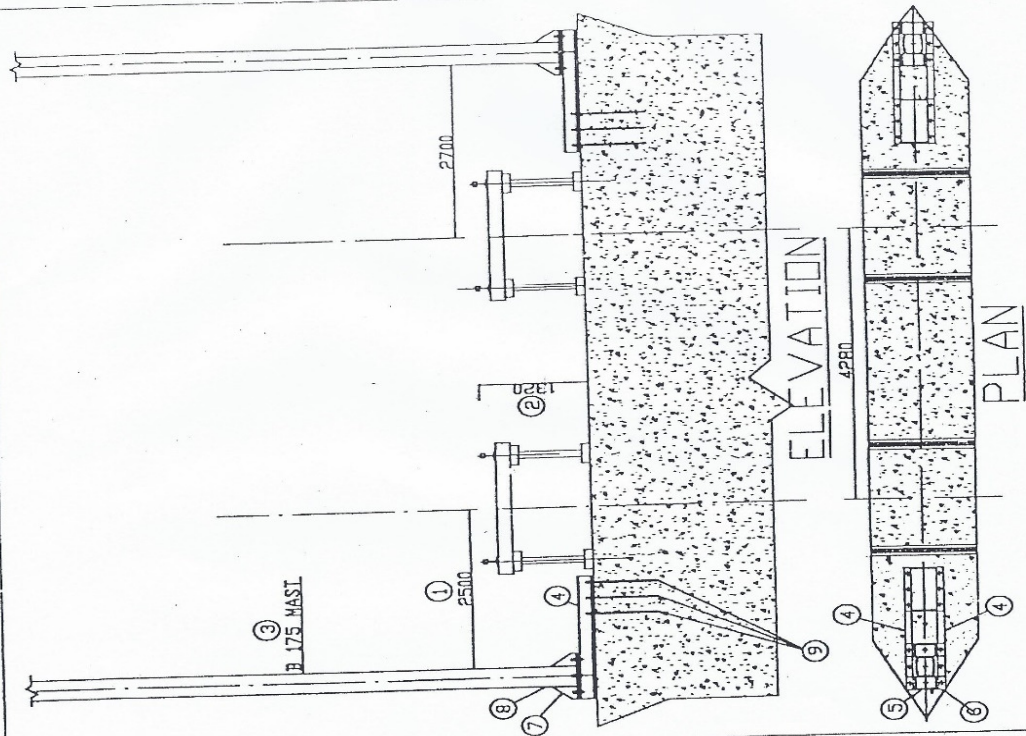


Template - 3



Template -4

Page No. 02-



OBJECT:- Arrangement for mounting of OHE's structure directly on channel without any out side projection from pier.

PROJECT:- Central Railway.

SECTION :- BSL-BD

BRIDGE No./Pier No.:- Chainage No. 528.2

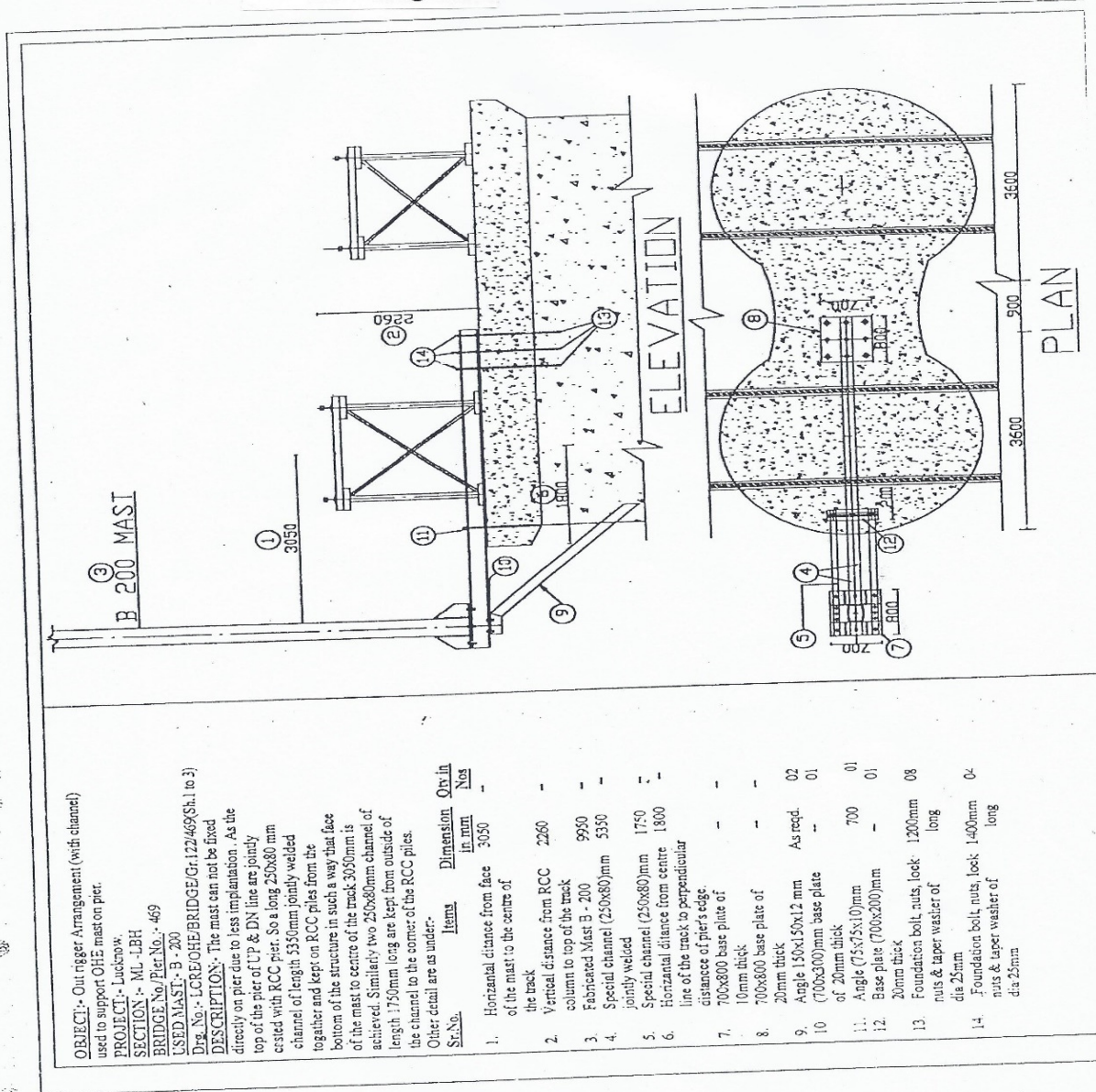
USED MAST:- B-175

Drq. No.:- Layout plan Km 523-528

DESCRIPTION:- As the corner of pier in this case is tapered and the corner of the mast shall be in the edge of the pier, so the arrangement will be of the following as under:-

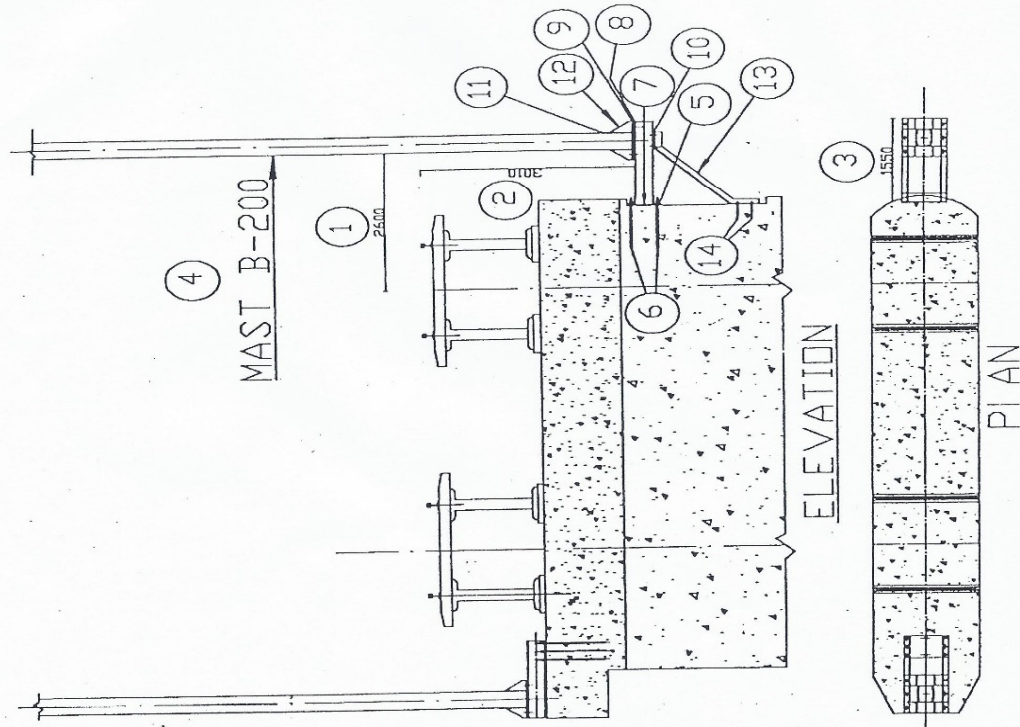
Sr.No.	Items	Dimension in mm	Qty in Nos
1.	Horizontal distance from face of the mast to the centre line of the track	2500	--
2.	Vertical distance from face of the track to the top of the pier.	1320	--
3.	Mast (B - 175)	--	02
4.	Channel (size not given)	--	--
5.	Angle (size not given)	--	--
6.	Base Plate (size not given)	--	--
7.	Stiffener Plate (size not given)	--	--
8.	Gusset (size not given)	--	--
9.	H.D. Bolt dia 25mm 850mm long.	--	--

Template -5

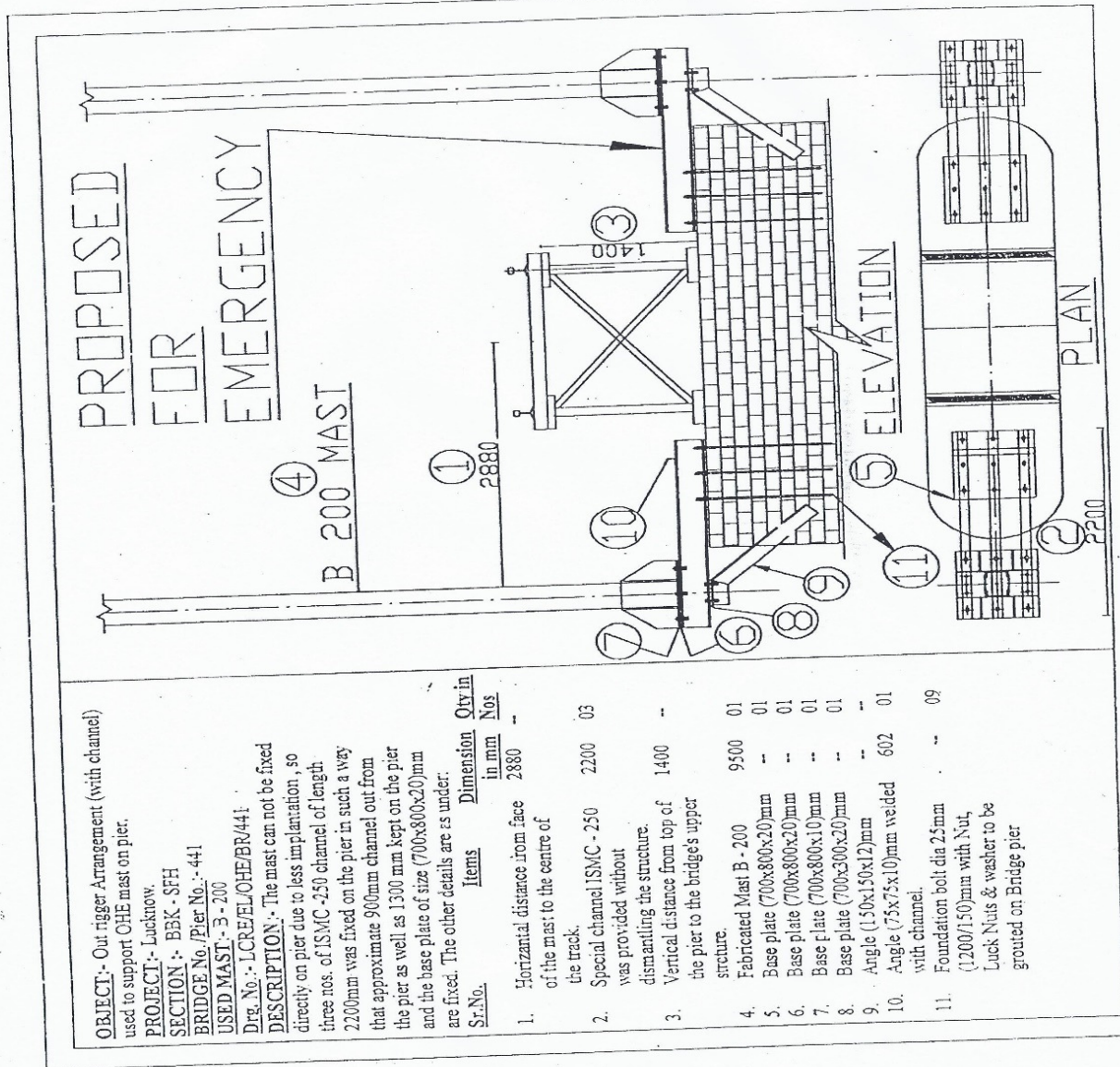


Template -6

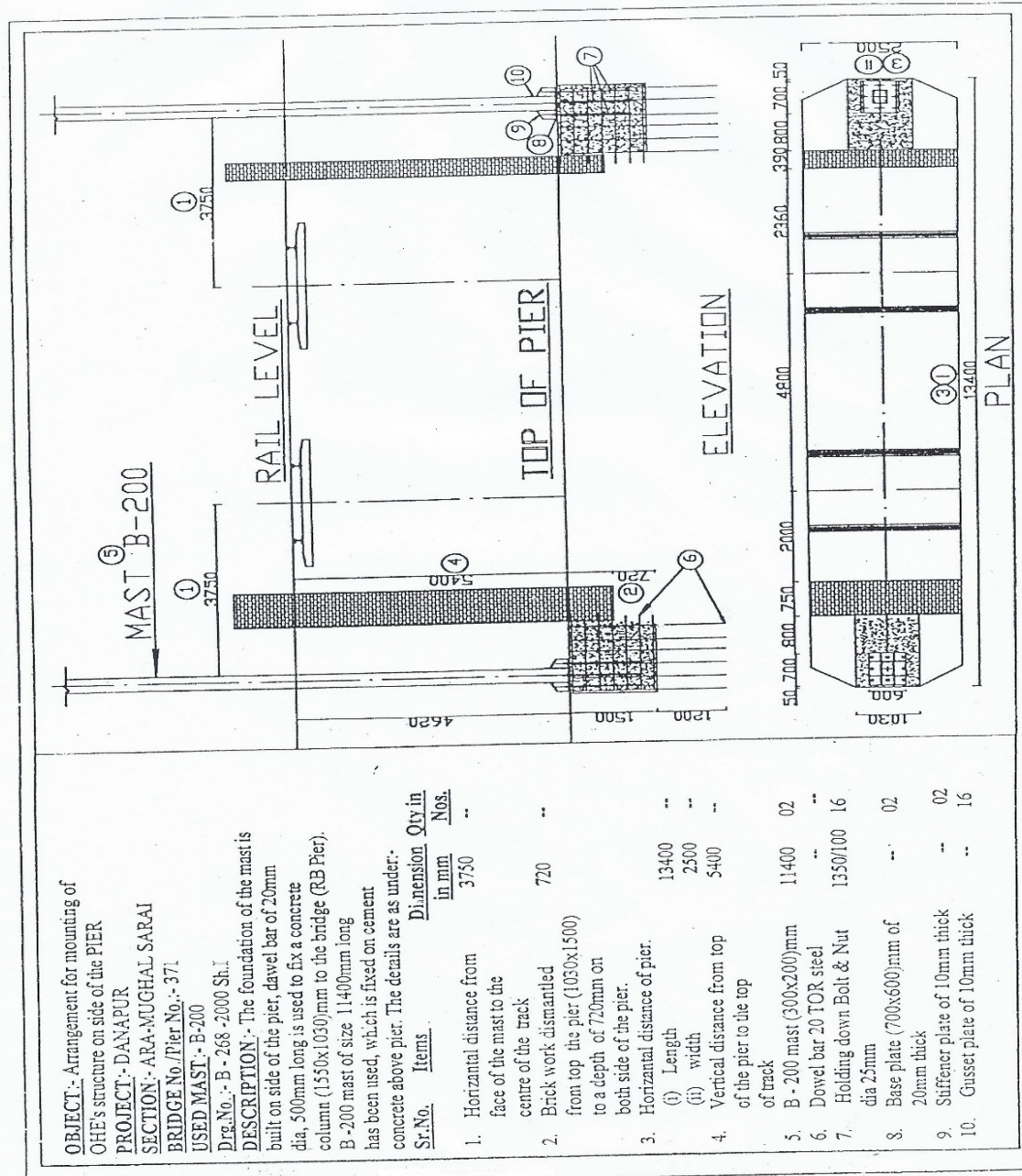
OBJECT:- Special out rigger Arrangement (with channel) to support OHE mast on pier.			
PROJECT:- BHUBANESWAR			
SECTION:- LVD - JER			
BRIDGE No./Pier No.:- 207			
USED MAST:- B - 200			
Drwg. No.:- RE/BBS/CIVIL/OHE/BRIDGE/09/2000			
DESCRIPTION:- This is the case when OHE mast is directly erected in such a way when there is no support to fix, the end of channel. Two nos. of M.S. channel (250x80x8)mm are used which is supported by two angles, one at upper and one at lower of the M.S. channel, duly fixed by HRD Bolts. The other details are as under:-			
Sr.No.	Items	Dimension in mm	Qty in Nos
1.	Horizontal distance from face of the mast to the centre line of the track.	2600	-
2.	Vertical distance from the upper face of the channel to the top of the rail level.	3010	-
3.	Length of M.S. Channel (250x80x8)mm	1550	02
4.	Mast B - 200	10655	01
5.	Angle (150x115x8)mm	500	02
6.	25mm dia HD bolts	350	08
7.	Base plate (vertical) on outside pier (480x600x20)	-	-
8.	Base plate welded on M/S channel (700x400x10)	-	01
9.	Base plate welded with mast (700x600x20)mm	-	01
10.	Plate (300x600x20)mm	-	01
11.	10mm thick Gusset plate	-	02
12.	10mm thick stiffener plate.	-	04
13.	Angle (100x100x8)mm	600	02
14.	20mm dia HD bolts	300	04



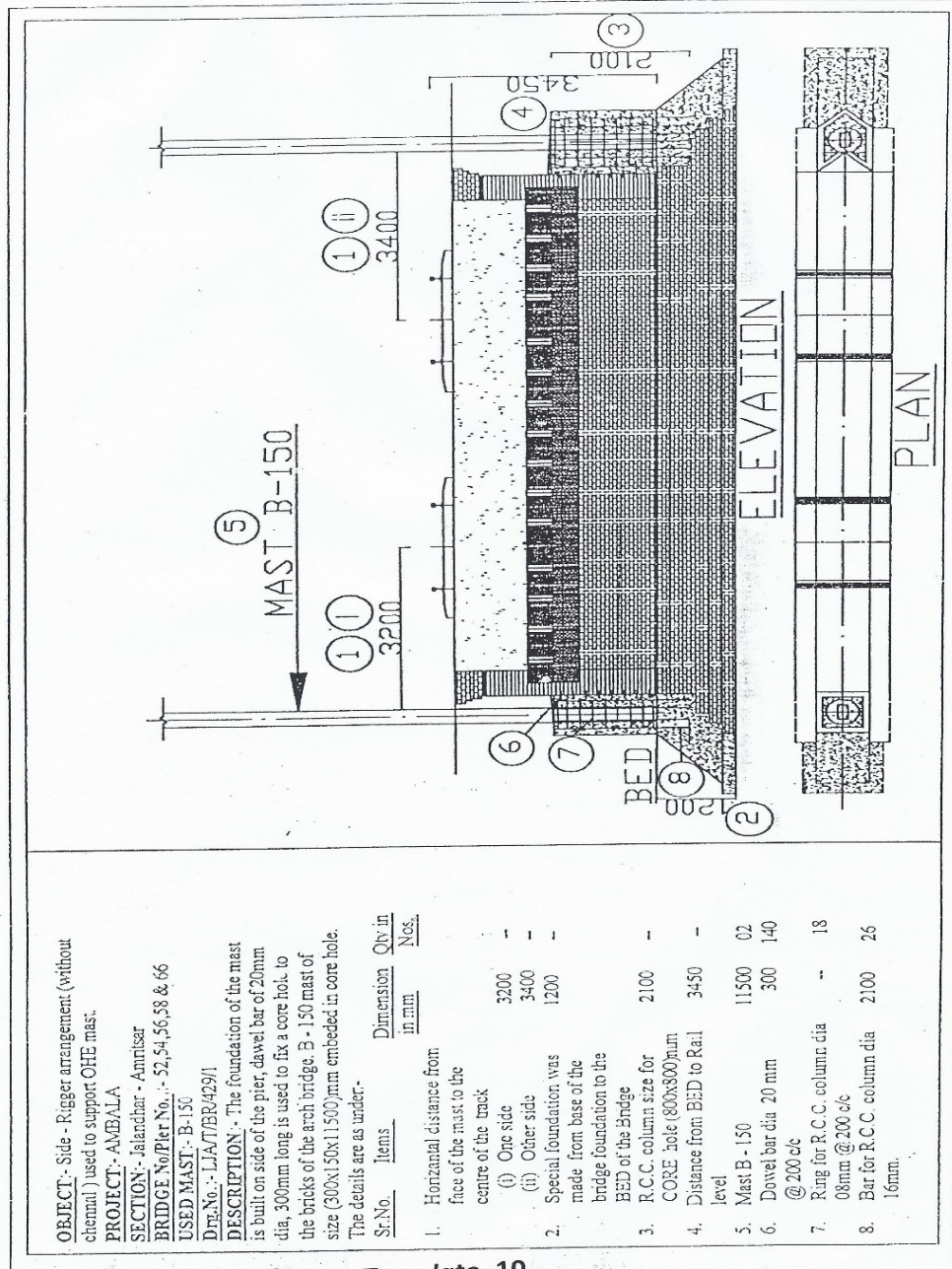
Template -7



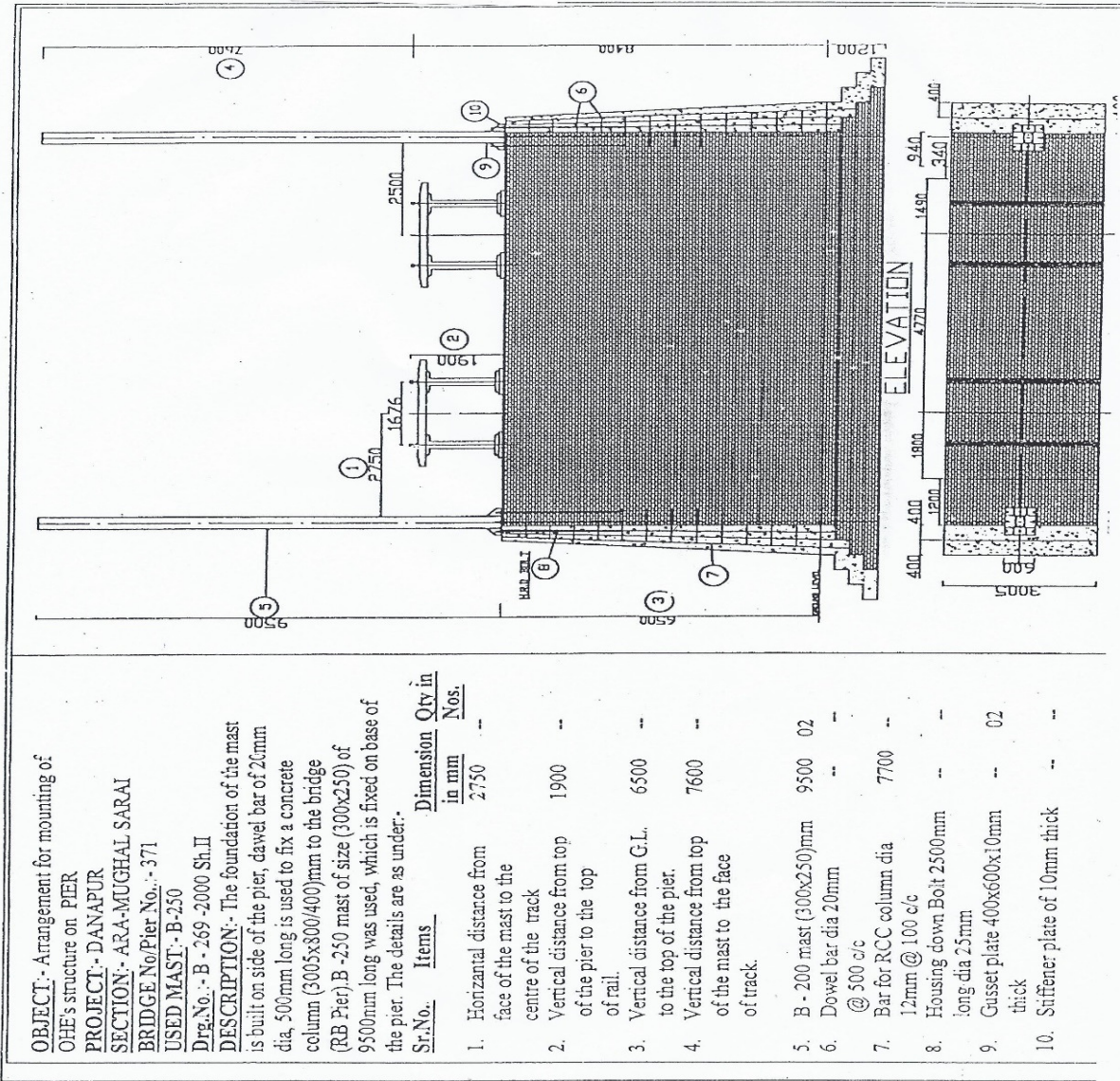
Template -8



Template -9



Template -10



Template -11

NOTES :-

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED.
2. PROPOSED WORK SHOWN IN RED.
3. BEFORE ERECTION OF ONE MAST, IT WILL BE CONSIDERED THAT THE EXISTING MAST IS IN GOOD CONDITION AND NO CHECKS ARE TO BE MADE.
4. THE WORK WILL BE CARRIED OUT IN SUCH A MANNER AS TO CAUSE MINIMUM RESTRICTION TO TRAFFIC.
5. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTRE LINE OF THE TRACK.
6. THE DESIGN OF MAST HAS BEEN DECIDED BY THE R.O. ON THE BASIS OF THE FOLLOWING DATA :-
7. THE MAST IS TO BE OF STEEL TYPE.
8. DRILLING, NO PRECISION DRILLING OR HAMMER SHOD DRILLING.
9. FOR DRILLING, BRIDGE PIER TO BE DONE BY REINFORCING.
10. THE PRESENCE OF AN OPEN LINE.
11. THE PRESENCE OF AN OPEN LINE.
12. GROUTING OF BOLTS TO BE DONE BY REINFORCING.
13. THE MAST IS TO BE OF STEEL TYPE.
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THIS DRAWING SUPERSEDES EARLIER DRAWING OF THIS BRIDGE DATED 18-4

C.E.'S PLAN NO. GML/2015/05306

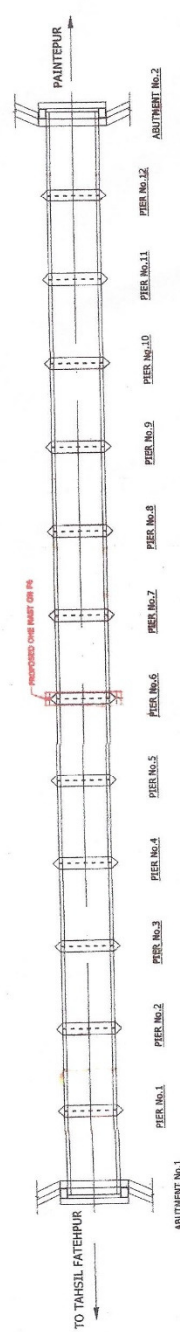
CH/RE	LKO	C.E.	DATE
DY/CE/RE	LKO	DY/CE/RE	DATE
BY/CE/RE	LKO	BY/CE/RE	DATE
APR/RE	LKO	APR/RE	DATE
R.E. OFFICER'S SIGN		R.E. OFFICER'S SIGN	
DESIGNER'S SIGN		DESIGNER'S SIGN	

RAILWAY ELECTRIFICATION LUCKNOW

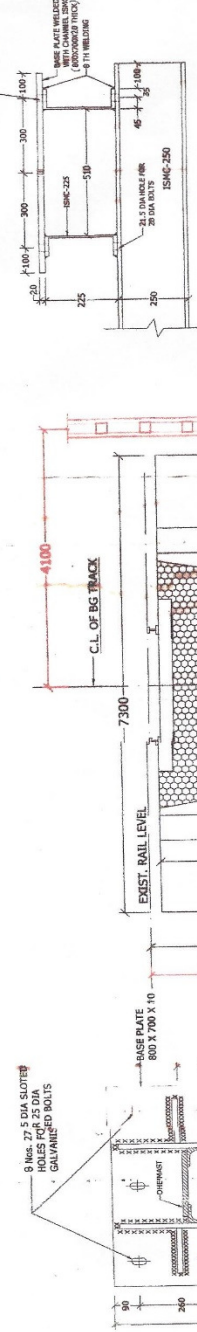
ARRANGEMENT FOR MOUNTING OF
BRIDGE MAST STRUCTURE ON
BRIDGE No. 46 (13 X 6.1m) SLAB AT
K.M. 29/11 BETWEEN
TEHSIL FATEHPUR AND PAINTAPUR
STATIONS
IN BURHWAL - SITAPUR SECTION
(ON PIER NO. 6)

SCALE :- NOT TO SCALE

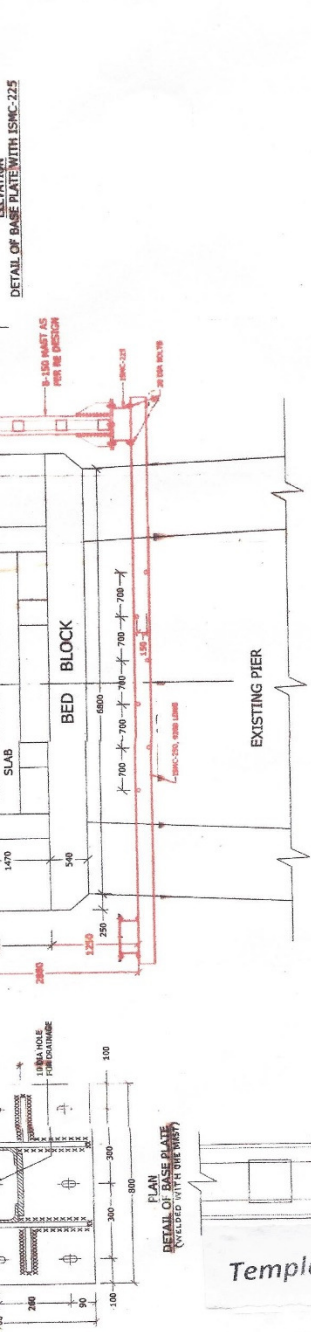
CASE No. LKRE/EL/RSB/B.R.-46/OHE DESIGN



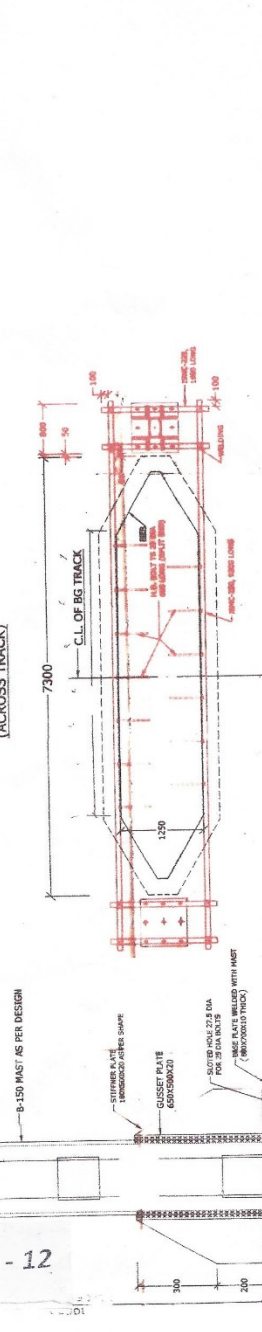
LAYOUT PLAN OF BR. No. 46



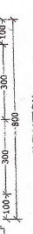
ELEVATION DETAIL OF BASE PLATE WITH ISMC-225



ELEVATION OF PIER NO. 6 (ACROSS TRACK)

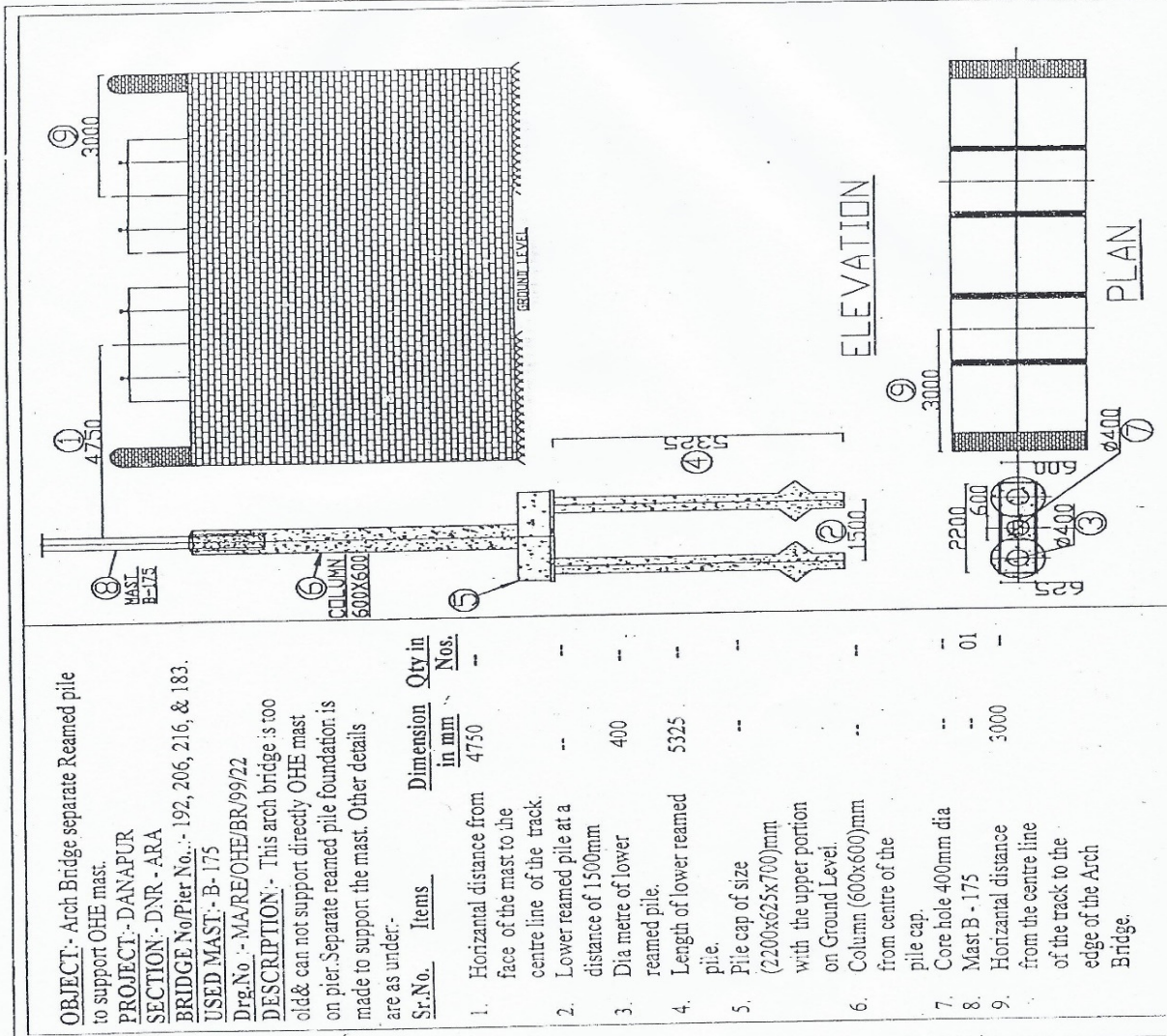


PLAN OF PIER NO. 6



ELEVATION DETAIL OF BASE PLATE WITH OHE MAST

Template - 12



REFERENCES:-

Following References has been used extensively:-

- 1) CORE, Allahabad, Ref. No. ELCORE/ALD/C&D/OHE/DESIGN/9/4/05, Dated: 25.04.05.
- 2) TI Directorate's 'Guidelines for Provision of Foundation for Masts and special portal of overhead electric equipment on Bridges' received vide their letter No. TI/CIV/REWAR/15, Dated :10.03.15
- 3) Ministry of Railways Design Manual for Electric Traction Volume – 3, Traction overhead Equipment July-1994 by RITES.
- 4) Northern Railway approved Plan No. MB-RE/UMB-44
- 5) Eastern Railway (Construction Department) Standard Type : CAO(Con) DRG No. 145-99
- 6) Code No. ETI/OHE/71(11/90) with latest amendments issued by RDSO: code for bonding and earthing for 25KV AC 50 Hz single phase Traction system.
- 7) Proceedings Seminar of Chief Bridge Engineer, 11th & 12th September-2014, held at IRICEN, Pune.
- 8) IRS: Steel Bridge Code (Reprinted-1977) A&C upto 20.
- 9) IS: 875-(Part-3)-1987 Reaffirmed-1997.
- 10) IS : 800- 1984
- 11) IS : 2062-2011
- 12) IS : 456-2000

Note: Codes/Specifications referred in this Guideline should be of latest edition with all amendments.

V.K. Srivastava
वी०के०श्रीवास्तव
Executive Director/Structures
कार्यकारी निदेशक/संरचना



भारत सरकार – रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ – 226011

Government of India-Ministry of Railways
Research Designs & Standards Organisation
Lucknow- 226011
Rly. : 032-421246 Phone / Fax : 0522-2465704
Email : edstructures@gmail.com

No. CBS/DPA

Dated: 09.07.2020

Principal Chief Engineer:

1. Central Railway, Mumbai CST - 400 001
2. Eastern Railway, Fairlie Place, Kolkata - 700 001
3. East Central Railway, Hazipur - 844 101
4. East Coast Railway, Bhubaneshwar - 751 016
5. Northern Railway, Baroda House, New Delhi - 110 001
6. North Central Railway, Allahabad - 211 001
7. North Eastern Railway, Gorakhpur - 273 001
8. Northeast Frontier Railway, Maligaon, Guwahati - 781 061
9. North Western Railway, Jaipur - 302 001
10. Southern Railway, Park Town, Chennai - 600 003
11. South Central Railway, Rail Nilayam, Secunderabad - 500 371
12. South East Central Railway, Bilaspur - 495 004
13. South Eastern Railway, Garden Reach, Kolkata - 700 043
14. South West Railway, Hubli - 580 023
15. Western Railway, Mumbai - 400 020
16. West Central Railway, Jabalpur - 482 001

Sub: Addendum & Corrigendum Slip no. 1 to Report No. BS-121 on “Guidelines for Provisions of OHE MAST for Electrification at New and Existing Bridge Pier/Abutment”.

Ref.: Railway Board's letter No. 2019/27/CE-III/BR/86th/BSC dated 30.01.2020.

Please find enclosed copy of Addendum & Corrigendum Slip no. 1 to the Report No. BS-121 titled “Guidelines for Provisions of OHE MAST for Electrification at New and Existing Bridge Pier/abutment”. This item was discussed as agenda item no. 1091 of 86th BSC and this A&C slip is issued as per recommendation of BSC and approval of Railway Board communicated vide referred letter.

DA: As above.

31-7-20 9/7/2020

(A.K.Ojha)

Director/B&S-VII

for ED/Structures/RDSO

Copy to:- Dir (CE) / B&S, Rly Bd, New Delhi

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(Railway Board)**

**Guidelines for Provisions of OHE MAST for Electrification at New and Existing
Bridge (Report No. BS: 121 of October, 2015)**

ADDENDUM & CORRIGENDIM SLIP No. 1 dated: 09.07.2020

Delete existing clause 3.0 alongwith figure:1 and replace as under:

3.0 Guidelines of Railway Electrification (RE) mast over the piers:

The implantation of OHE mast on bridges may be decided by CBEs on case to case basis keeping in view inspection, maintenance & replacement requirements, adequate clearance between bearing plates edge & side of base plate of OHE mast and adequate margin for providing seismic restrainers (if required) etc subject to adherence to IRSOD.

**LUCKNOW
Dated: 09.07.2020**

BY ORDER


**(V.K. Srivastava)
Executive Director/Structures
B&S Directorate
R.D.S.O., Lucknow**

Copy to:

- (A)
1. OSD/ME for kind information of Member Engineering, Railway Board, Rail Bhawan, New Delhi - 110001
 2. Chief Commissioner of Railway Safety, N.E. Railway Office Compound, Ashok Marg, Lucknow - 226002.
 3. Additional Member (Civil Engg.) Railway Board, Rail Bhawan, New Delhi - 110001
 4. Additional Member (Works) Railway Board, Rail Bhawan, New Delhi - 110001
 5. Advisor (Bridges) Railway Board, Rail Bhawan, New Delhi - 110001
 6. Director, Indian Railway Institute of Civil Engg., Pune - 411 001
 7. Executive Director Civil Engg./B&S, Railway Board, Rail Bhawan, Room No.140A, New Delhi - 110001
 8. General Manager (C), N. F. Railway, Maligaon, Guwahati - 781001
 9. The Director General, National Academy of Indian Railways, Vadodara - 390004
 10. Chief Engineer, Metro Railway, Jawaharlal Nehru Road, Kolkata - 700071
 11. ED/B&S/RDSO, B&S Directorate, RDSO, 2nd Floor, Annexe - II Building, Manak Nagar, Lucknow, Pin - 226011 (UP)

(B) The Chief Administrative Officer (Construction):

1. Central Railway, Mumbai CST - 400 001
2. Eastern Railway, Fairlie Place, Kolkata - 700 001
3. East Central Railway, Mahendrughat, Patna (Bihar) - 800 004
4. East Coast Railway, Bhubaneswar, (Orissa) - 751 016
5. Northern Railway, Kashmere Gate, Delhi - 110 006
6. USBRL Project, Northern Railway, Satyam Complex, Trikuta Nagar Extn., Jammu 180 020
7. North Central Railway, Allahabad, (U.P.) - 211 001
8. North Eastern Railway, Gorakhpur - 273 001
9. North Western Railway, Jaipur, (Rajasthan) - 302 001
10. Southern Railway, Egmore, Chennai - 600008
11. South Central Railway, DRM/Secunderabad Office Compound, Secunderabad - 500 371
12. South Eastern Railway, Garden Reach, Kolkata - 700043
13. South East Central Railway, Bilaspur - 495 004
14. South Western Railway, No. 18 Miller Road, Bangalore, (Karnataka) - 560046
15. Western Railway, Mumbai - 400 020
16. West Central Railway, Jabalpur (M.P.) - 482 001
17. CAO/ERS, Southern Railway, Ernakulam, Kerala - 682506

(C) Chief Bridge Engineers:

1. Central Railway, Mumbai CST - 400 001
2. Eastern Railway, Fairlie Place, Kolkata - 700 001
3. East Central Railway, Hazipur - 844 101
4. East Coast Railway, Bhubaneswar - 751 016
5. Northern Railway, Baroda House, New Delhi - 110 001
6. North Central Railway, Allahabad - 211 001
7. North Eastern Railway, Gorakhpur - 273 001
8. Northeast Frontier Railway, Maligaon, Guwahati - 781 061
9. North Western Railway, Jaipur - 302 001

10. Southern Railway, Park Town, Chennai - 600 003
11. South Central Railway, Rail Nilayam, Secunderabad - 500 371
12. South East Central Railway, Bilaspur - 495 004
13. South Eastern Railway, Garden Reach, Kolkata-700 043
14. South West Railway, Hubli - 580 023
15. Western Railway, Mumbai - 400 020
16. West Central Railway, Jabalpur - 482 001

(D) Commissioner of Railway Safety:

1. Central Circle, 2nd Floor, Churchgate Station Building Mumbai - 400020
2. Eastern Circle, Multistoreyed Building of Eastern Railway, 12th Floor, Strand Road, Kolkata - 700001
3. Northern Circle, near Centre for Railway Information System, Safdarjung Railway Station, New Delhi - 110021
4. North Eastern Circle, DRM Compound, Northern Railway, Hazratganj, Lucknow - 226001
5. Northeast Frontier Circle, 12 Strand Road, Multistoreyed Building of Eastern Railway, Kolkata - 700001
6. Southern Circle, 7 Seshadri Road, Gandhi Nagar, Bangalore - 560009
7. South Central Circle, Opp. Rail Nilayam, Sarojini Devi Road, Secunderabad - 500 071
8. South Eastern Circle, 14 Strand Road, Multistoreyed Building of Eastern Railway, Kolkata-700001
9. Western Circle, 2nd Floor, Churchgate Station Building Annexe, Maharishi Karve Road, Mumbai-400020.

(E) Railway PSUs & Others:

1. The Managing Director, RITES LTD, RITES Bhawan, Plot No.1, Sect.29, Gurgaon (Haryana) - 122001
2. The Managing Director, IRCON, Palika Bhawan, Sector-XIII, R.K. Puram, New Delhi - 110066
3. The Chairman & Managing Director, Konkan Railway Corporation Ltd., Belapur Bhavan, Plot No. 6, Sector-II CBD Belapur, Navi Mumbai - 400 614
4. The Managing Director, Rail Vikas Nigam Ltd., 1st floor, August Kranti Bhawan, Bhikaji Coma Place, Africa Road, R.K. Puram, New Delhi - 110 016
5. The Managing Director, DFCCIL, 5th Floor, Pragati Maidan, Metro Station Building Complex New Delhi - 110001
6. The General Manager, Delhi Metro Rail Corporation Ltd., NBCC Place, Bhishma Pitamah Marg, Pragati Vihar, New Delhi - 110003

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9/7/2020

(A.K.Ojha)

Director/B&S-VII
for ED/Structures/RDSO