

**DESIGN CALCULATION AND DRAWING FOR  
FIXED BEARING  
(Ch. 500+578)**

**PROJECT:** FOUR LANING OF JHANJHI TO DEMOW SECTION OF NH-37 FROM EXISTING CH. K 491+050 TO KM 535+250  
(DESIGN CH. KM 4900+800 TO KM 534+800) IN THE STATE OF ASSAM UNDER EPC MOD

**CLIENT:** *NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (NHIDCL)*

**CONTRACTOR :** *M/S KAMAC-SHIVA HARLALKA (JV)*

**MANUFACTURER:**



*M/S KARMA ENTERPRISE, GUWAHATI, ASSAM*

**Design Calculation of SLS- 2641 KN, ULS- 4497 KN Fixed Bearing**

TYPE OF BEARING :                      FIX  
REVISION :                                00

TYPE: B1  
CH.: 500+578

Conc. Grade for Pedestal M 45  
Conc. Grade for Superstructure M 50

### DESIGN DATA FOR BEARING DESIGN (LOADS)

LOADING PARAMETERS	SLS			ULS	
UNITS	MT	kN		MT	kN
VERTICAL MAXIMUM LOAD	269.30	2641.00		458.56	4497.00
VERTICAL MINIMUM LOAD	141.23	1385.00		213.63	2095.00
VERTICAL PERMANENT LOAD	156.83	1538.00			
HORIZONTAL LOADS					
ACTING IN LONGITUDINAL DIRECTION	8.87	87.00		13.36	131.00
ACTING IN TRANSVERSE DIRECTION	0.00	0.00		0.00	0.00
RESULTANT HORIZONTAL LOADS		87.00			131.00
DISPLACEMENT	0.00			0.00	
LONGITUDINAL (MM)	0.00			0.00	
TRANSVERSE (MM)	0.00			0.00	
ROTATION (RADIAN)	0.0038	+	0	=	0.0038

Assume Permanent Rotation	q p	=	0.52	x	0.004	=	0.002
Assume Varriable Rotation	q v	=	0.48	x	0.004	=	0.002

## MATERIALS

AS PER IS - 1030

HT Bolts shall conform to Grade 8.8 of IS : 1364

**Elastomer shall be of hardness 50 + / - 5 conforming to IRC : 83 (Part III) - 2018 Table - 4.3**

### DIMENSION DETAILS OF BEARING COMPONENTS

### ELASTOMERIC PAD

PAD DIAMETER	=	di	450 mm
PAD THICKNESS	=	hc	32 mm

## CYLINDER

CYLINDER CONCRETE CONTACT DIAMETER	=	Do	540 mm
CYLINDER BASE THICKNESS	=	kb	35 mm
CYLINDER INNER DIAMETER	=	Di = di	450 mm
CYLINDER OUTER DIAMETER	=	do	500 mm
HEIGHT OF CYLINDER	=	hc	44 mm
WALL THICKNESS	=	tcw	25.0 mm

### TOP COMPONENT

TOP COMPONENT CONCRETE CONTACT DIA.	=	Dpetff	515 mm
TOP COMPONENT DIA.	=	Dp	515 mm
TOP COMPONENT ABOVE THICKNESS	=	Tp	30 mm
TOP COMPONENT PROJECTION	=	hp	23 mm
VERTICAL FACE	=	w	6 mm

## ANCHORAGE

BOLTS DIAMETER	=	Dbolt	20 mm
BOLTS LENGTH	=	Lbolt	45 mm
BOLTS PER COMPONENT	=	Nbolt	4 NOS.
GRADE OF BOLTS	=	GR.bolt	8.8
ANCHORAGE COLLOR LENGTH	=	CL	70 mm
ANCHORAGE COLLOR THICKNESS	=	C thk	14 mm
SLEEVE LENGTH ( Superstructure)	=	Ls	110 mm
SLEEVE DIAMETER ( Superstructure)	=	Ds	50 mm
SLEEVE LENGTH ( Pedestal)	=	Lp	120 mm
SLEEVE DIAMETER ( Pedestal)	=	Dp	50 mm

## GENERAL

NO. OF BRASS SEALING RINGS	=	Nbr	2 NOS.
TOTAL THICKNESS OF RINGS	=	Tbr	4.0 mm
GAP BETWEEN CYLINDER & TOP COMPONENT	=	h4	11 mm

**TOTAL BEARING ASSEMBLY HEIGHT** = HT 120 mm



### Design Calculation of SLS- 2641 KN, ULS- 4497 KN Fixed Bearing

#### Calculation for Permissible Stresses in Pedestal Concrete

##### Bottom

Cylinder Concrete Contact Diameter =	540	mm
Loaded area ( $A_{co} = p \times D_b \wedge 2/4$ ) =	229022.11	mm <sup>2</sup>
Required Pedestal Size for Dispersion =	1080.00	x 1080 mm
Dispersed area ( $A_{cl} = p \times d \wedge 2/4$ ) =	916088.42	mm <sup>2</sup>

##### Top

Top Component Contact Diameter =	515	mm
Loaded area ( $A_2 = p \times D_b \wedge 2/4$ ) =	208307.23	mm <sup>2</sup>
Required Superstructure Size for Dispersion =	1030.00	x 1030 mm
Dispersed area ( $A_1 = p \times d \wedge 2/4$ ) =	833228.92	mm <sup>2</sup>

#### DESIGN CALCULATIONS :-

REF. CODE : IRC:83 (Part-III)-2018

##### Design of Pad (Clause - 5.2.3.2)

Effective diameter of Pad	Dpad	450 mm
Area of pad = $p \times d \wedge 2/4$	a	159107.143 mm <sup>2</sup>
Vertical Load	Nsd	4497.00 kN
Direct Pressure Nsd / a	pa	28.27 N/mm <sup>2</sup>
(Nsd / a ) x Ym		36.75 N/mm <sup>2</sup>
fc,k		60.00 N/mm <sup>2</sup>
		OK

##### Check Compression at edge of Neoprene Pad (Clause - 5.2.3.4)

Max. Permitted = 15 % of fc	4.80	mm	
Desired Rotation	0.00380	radians	
Available Rotation in Radius due to Compression of Pad	0.02133	radians	OK
Diameter / Thickness Ratio	14.06	Maximum (Dpad/hc)	15 OK
Check for Min. average Stress (Clause - 5.2.3.3)			
Min. average stress = (Nsd min. / a)	8.70	N/mm <sup>2</sup>	
Permissible Min. average stress =	2.00	N/mm <sup>2</sup>	
		OK	

#### Stress in bottom concrete

Bottom dispersion width	Do	540
Thickness of Bottom Plate	kb	35
Area of Bottom Dispersion = $p \times d \wedge 2/4$	a	229114.286 mm <sup>2</sup>
Section Modulus = $p \times d \wedge 3/32$	Z	15465214.286 mm <sup>3</sup>
Vertical Load	Nsd	4497.00 kN
Horizontal force	Vsd	131.00 kN
Moment of resistance due to rotation:		
Rotation due to dead load	$\theta_p$	0.00199 radians
Live Load	$\theta_v$	0.00181 radians
Ratio = di / hc		14.06
For induced moment	k1	2.05
	k2	85.18
Induced moment due to rotation Mc.d		
$di^3 \times (k1 \times qp + K2 \times qv) / 1000$	Mc.d	14398.94 kN-mm

### Design Calculation of SLS- 2641 KN, ULS- 4497 KN Fixed Bearing

Moment of resistance due to HF:				
Horizontal distance	C	225.00		mm
Resultant HF	Vsd	131.00		kN
Moment of resistance due to HF:	Mr.d	5895.00		kN-mm
$0.2 \times C \times Vsd$				
Total Movement = Me.d+Mr.d =	Mt	20293.94		kN-mm
Direct Pressure Nsd / a	pa	19.63		N/mm <sup>2</sup>
Permissible Stress $(0.67 \times f_{ck}) / 1.5$	fed	20.10		N/mm <sup>2</sup>
		OK		
Bending Stress Mt / Z	pb	1.31		N/mm <sup>2</sup>
Permissible bending stress		14.85		N/mm <sup>2</sup>
		OK		
Area on Pedestal	Ac1	916088.42		mm <sup>2</sup>
Frdu= Aco x fed x (sqrt(Ac1 / Ac0))		9206.69		kN
3 x fed x Aco		13810.03		kN
Frdu <= 3 x fed x Aco		OK		
<b>Stress in top concrete</b>				
Top dispersion width			Dpeff	515
Thickness of Top Plate			TP	30
Area of Top Dispersion = $p \times d^{2/4}$	a		208391.071	mm <sup>2</sup>
Section Modulus = $p \times d^{3/32}$	Z		13415175.223	mm <sup>3</sup>
Vertical Load	Nsd	4497.00		kN
Horizontal force	Vsd	131.00		kN
Moment of resistance due to rotation:				
Rotation due to dead load	$\theta_p$	0.00199		radians
Live Load	$\theta_v$	0.00181		radians
Ratio = di / he		14.06		
For induced moment	k1	2.05		
	k2	85.18		
Induced moment due to rotation	Me.d			
$di^3 \times (k1 \times qp + K2 \times qv) / 1000$		14398.94		kN-mm
Moment of resistance due to HF:				
Horizontal distance	C	225.00		mm
Resultant HF	Vsd	131.00		kN
Moment of resistance due to HF:	Mr.d	5895.00		kN-mm
$0.2 \times C \times Vsd$				
Total Movement = Me.d+Mr.d =	Mt	20293.94		kN-mm
Direct Pressure Nsd / a	pa	21.58		N/mm <sup>2</sup>
Permissible Stress $(0.67 \times f_{ck}) / 1.5$	fed	22.33		N/mm <sup>2</sup>
		OK		
Bending Stress Mt / Z	pb	1.51		N/mm <sup>2</sup>
Permissible bending stress		16.50		N/mm <sup>2</sup>
		OK		
Area on Superstructure	Ac1	833228.92		mm <sup>2</sup>
Frdu= Aco x fed x (sqrt(Ac1 / Ac0))		9304.39		kN
3 x fed x Aco		13956.58		kN
Frdu <= 3 x fed x Aco		OK		
<b>Pot walls subjected to tensile force (Clause 5.3.1.2.3)</b>				
AR = (do - di) x hc	AR	2200.00		mm <sup>2</sup>
Ve,sd = 4 x Nsd x he / $\pi$ x di	Ve,sd	407.37		kN
Vfxy,sd		131.00		kN
Vsd = Ve,sd + Vfxy,sd		538.37		kN
Vrd = fy x AR / Ym	Ym = 1.1	680.00		kN
		OK		
<b>Pot walls subjected to shear force (Clause 5.3.1.2.4)</b>				
$V'sd \leq V_{ka}$				
$V'sd = V_{e,sd} + 1.5 \times V_{fxy,sd} / di$		1.34		kN
$V'_{ka} = (fy \times (do - di)) / (2 \times Ym \times (\sqrt{3}))$	Ym = 1.1	5.15		kN
		OK		
<b>Pot base subjected to tensile force (Clause 5.3.1.2.5)</b>				
$V'sd \leq V_{ka}$				
Ap = do x kb		17500.00		mm <sup>2</sup>
Vsd = Ve,sd + Vfxy,sd		538.37		kN
VRd = fy x Ap / Ym	Ym = 1.1	5409.09		kN
		OK		

# **Design Calculation of SLS- 2641 KN, ULS- 4497 KN Fixed Bearing**

## **Anchor Bolts**

Max Horizontal Force		131.00	kN
Min. Vertical Load		2095.00	kN
Frictional Force		0.00	kN
Diameter of Bolt		20.00	mm
Length of Bolt		45.00	mm
Number of Bolts	n	4.00	Nos.
Thickness of Collar	Ct	14.00	mm
Factor for Net Area	kn	0.78	
Effec. Area of Bolt $(p \times d274^2 \times kn / 4)$	Abolt	245.14	mm <sup>2</sup>
$\sigma_v$		0.60	
$f_{ub}$		800.00	N/mm <sup>2</sup>
$Y_{m^2}$		1.25	
$f_u$		570.00	N/mm <sup>2</sup>
k2		0.90	
Shear resistance $F_{v,Rd} = \sigma_v \times f_{ub} \times A / Y_{m^2}$	$F_{v,Rd}$	94.13	kN
Resultant horizontal force / bolt $V_{fy,sd} / n$	$F_{v,sd}$	32.75	kN
		OK	
Bearing resistance $F_{b,Rd} = 1.25 \times f_u \times d \times t / Y_{m^2}$	$F_{b,Rd}$	159.60	kN
Resultant horizontal force / bolt $V_{fy,sd} / n$		32.75	kN
		OK	
Tension resistance $F_{t,Rd} = k2 \times f_{ub} \times A_s / Y_{m^2}$	$F_{t,Rd}$	141.20	kN
Design tension resistance	$F_{t,sd}$	8.70	kN
Combined shear and tension $= F_{v,sd} / F_{v,Rd} + F_{t,sd} / (1.4 \times F_{t,Rd})$		0.39	
		OK	

## **Anchor Sleeves (Clause - 5.3.6.4.2)**

<b>Top Plate</b>			
Length of Sleeve		110.00	mm
Diameter of Sleeve		50.00	mm
Number of Sleeves		4.00	Nos.
Resistance offered by concrete $FR_{du} = 1.33 D \times L \times f_{cd} / \sqrt{3}$		94.32	kN
Design resistance in shear		32.75	kN
		OK	
<b>Bottom Plate</b>			
Length of Sleeve		120.00	mm
Diameter of Sleeve		50.00	mm
Number of Sleeves		4.00	Nos.
Resistance offered by concrete $FR_{du} = 1.33 D \times L \times f_{cd} / \sqrt{3}$		92.61	kN
Design resistance in shear		32.75	kN
		OK	

## **Requirement of clearance**

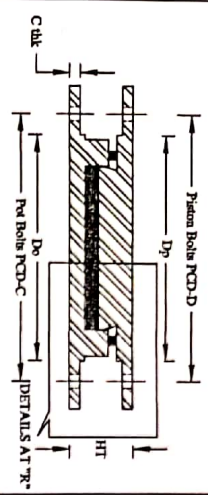
$\delta = 0.01 \times D_i$	min. = 3	4.50	<	10	mm
$h_c - h_e - (w - w_e) \times 0.5 - (\theta \times 0.5 \times D_i)$		8.52			mm
$\delta$		4.50			mm
		OK			
$h_p - (h_c - h_e) - (\theta \times 0.5 \times D_p)$		10.02			mm
$\delta$		4.50			mm
		OK			

## **Curved Contact Surface (Clause - 5.3.1.4.2)**

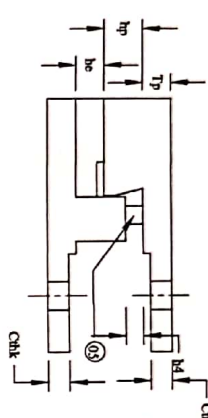
$V_{sd} \leq V_{rd}$	R	=	225.00	mm
	$f_u$	=	570.00	N/mm <sup>2</sup>
	$\theta$	=	0.004	Radian
	$Y_m$	=	1.10	
$V_{rd} = 15 \times f_u^2 \times R \times D_i / E_s \times Y_m^2$		=	2039.0	kN
$V_{sd}$		=	131.00	kN
			OK	
$w_e = 3.04 \times (\sqrt{1.5 \times V_{sd} \times R / E_s \times D_i})$		=	0.75	mm
$w_e + \theta \times D_i$		=	2.46	mm
Provided	w	=	6.00	mm
			OK	



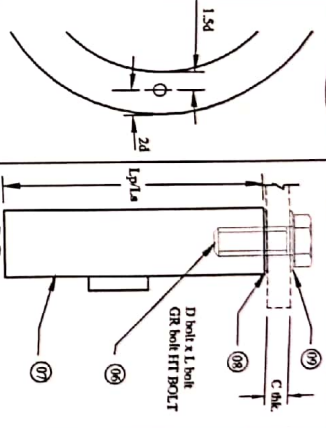




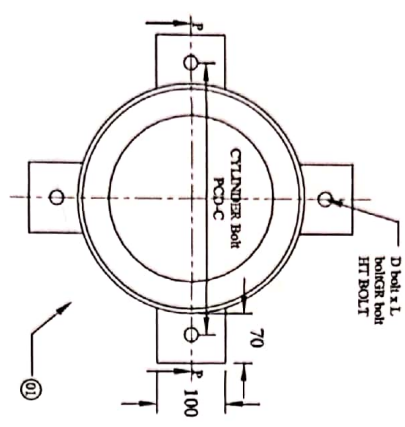
SECTIONAL ELEVATION OF BEARING ASSEMBLY



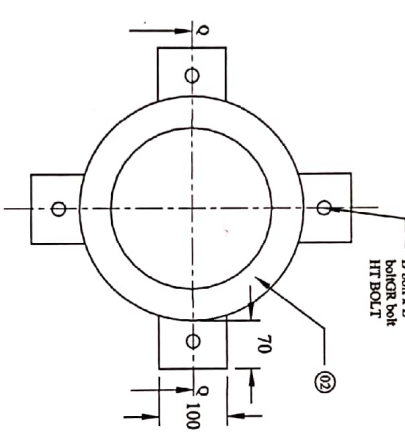
DETAILS OF BEARING ASSEMBLY AT 'R'



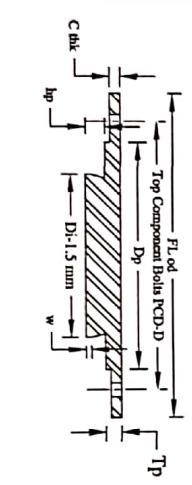
DETAILS OF FLANGE  
DETAILS OF ANCHORAGE



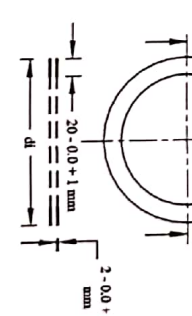
SECTIONAL ELEVATION OF BOTTOM CYLINDER AT P-P



SECTIONAL ELEVATION OF TOP COMPONENT AT Q-Q



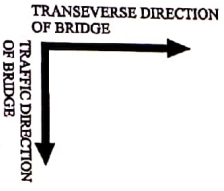
PLAN OF BRASS RING (TOP VIEW)



PLAN OF PAD (TOP VIEW)

CAPACITY	4497 KN-FIX	540	35	450	500	44	25	600	680	515	30	23	06	575	655	450	32	04	02	50	120	50	110	20	45	04/04	8.8	14	11	120				
		Do	Kb	Di	do	bc	Tcw	PCD	FL od	Dp	TP	hp	w	PCD	FL od	di	he	Tbr	Nbr	Dp	Lp	Ds	La	Dbolt	Lbolt	Nbolt	GRbolt	Chk	ba	HT				
	DIMENSION DETAILS OF CYLINDER				TOP COMPONENT DIM.										PAD & BRASS RING										ANCHORAGE & SLEEVE									

TYPE :- FIXED BEARING  
TYPE :- BI  
CHL :- 500+578



Project	Fixed Bearing of Bridge in Durgam Cheruvu, Hyderabad, India.
Client	State of Andhra Pradesh, India.
Contractor	State of Andhra Pradesh, India.
Manufacturer & Supplier	VARMA ENTERPRISES, GURUVAHATI

1) ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE MENTIONED.  
2) PCD - PITCH CIRCLE DIAMETER  
3) TOLERANCES  
a) PLAN DIMENSIONS : -0 TO +3mm  
b) OVERALL HEIGHT : -0 TO +3mm  
c) HEIGHT OF ELASTOMER : -0/+3%  
d) HEIGHT OF ANY STEEL COMPONENT : -0 TO +1mm  
e) MACHINED : CLASS 1 OF IS 4897  
f) UNMACHINED : CLASS 2 OF IS 4897


TESTS:  
a) TESTS ON CASTING: TESTS SPECIFIED IN IS 1020 WILL BE PERFORMED. CASTINGS SHALL BE ULTRASONICALLY TESTED & CERTIFICATES SUBMITTED (QUALITY LEVEL 3) AS PER IS 9843.  
b) ACCEPTANCE TEST ON BEARINGS  
c) ALL TESTS ON BEARINGS WILL BE CARRIED OUT IN PRESENCE OF REPRESENTATIVE OF DPT./P.M.C. NECESSARY TEST CERTIFICATES FOR RAW MATERIALS SHALL BE FURNISHED AT THE TIME OF SUPPLY.  
d) TEST ON WELDING: WELDING WILL BE TESTED BY DYE PENETRATION METHOD. BUTT WELDING WILL BE TESTED BY ULTRASONIC METHOD. SOUNDNESS OF WELDING SHALL BE CERTIFIED BY THE MANUFACTURER.

NOTES:  
1. CONFINED ELASTOMER INSIDE POT WILL HAVE FOLLOWING PROPERTIES  
a) HARDNESS : 30 (DIN 53400 PART II)  
b) MIN. TENSILE STRENGTH : 15.5 MPa (DIN 53400 PART II)  
c) MIN. ELONGATION AT BREAK : MAX. COMPRESSION SET & ACCELERATED AGING WILL BE AS PER TABLE 1 - PROPERTIES OF ELASTOMER IN (DIN 53400 PART II)  
2. ANCHORING: HIT BOLTS OF GR. 8.8 & SLEEVE MATERIAL AS PER IS 5062.  
3. ACCESSORIES TO IS 226 / 2062.  
4. CONCRETE GRADE FOR PIER/ABUTMENT IS M40.  
5. CONCRETE GRADE FOR STRENGTH STRUCTURE IS M40.

WELDING:  
ALL WELDING WILL BE MANUAL METAL ARC PROCESS CONFORMING TO IS 814 PRE HEATING & POST WELD STRESS RELIEVING TO BE DONE IF REQUIRED.

FINISHING:  
a) ALL NONWORKING SURFACES WILL BE COATED WITH 2 COATS OF EPOXY PRIMER & ONE OR MORE COATS OF EPOXY INTERMEDIATE AND FINISH PAINT. TOTAL DRY FILM THICKNESS > 160 MICRONS.  
b) ANCHOR SLEEVES WILL BE CEMENT COATED AT SITE IF REQUIRED.

Sl. No.	DESCRIPTION	MATERIAL	QTY	SPECIFICATION
1	ELASTOMER	STEEL	04	STD
2	ELASTOMER	STEEL	04	STD
3	ELASTOMER	STEEL	04	STD
4	ELASTOMER	STEEL	04	STD
5	ELASTOMER	STEEL	04	STD
6	ELASTOMER	STEEL	04	STD
7	ELASTOMER	STEEL	04	STD
8	ELASTOMER	STEEL	04	STD
9	ELASTOMER	STEEL	04	STD
10	ELASTOMER	STEEL	04	STD
11	ELASTOMER	STEEL	04	STD
12	ELASTOMER	STEEL	04	STD
13	ELASTOMER	STEEL	04	STD
14	ELASTOMER	STEEL	04	STD
15	ELASTOMER	STEEL	04	STD
16	ELASTOMER	STEEL	04	STD
17	ELASTOMER	STEEL	04	STD
18	ELASTOMER	STEEL	04	STD
19	ELASTOMER	STEEL	04	STD
20	ELASTOMER	STEEL	04	STD

B1		FIXED BEARING
B2		TRANS GUIDED BEARING
B3		LONG GUIDED BEARING
B4		FREE BEARING
B5		PIN BEARING
B6		METALLIC GUIDED BEARING



4/18/01-08	
REVISION R10	
FOR MINOR	
578	