DESIGN CALCULATION AND DRAWING FOR PIN BEARING

(Ch. 516+938)

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

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Design Calculations of 5548 - 2755 KN Pin Bearing

Bearing Type : Pin　　　　**Bearing Mark :** B5

Rev. : 0　　　　**CH. :** 516+938

1. DESIGN INPUTS

A)	Vertical Load Max (SLS)	=	0.00	MT
B)	Vertical Load Min. (SLS)	=	0.00	MT
C)	Vertical Load Max (ULS)	=	0.00	MT
D)	Vertical Load Min. (ULS)	=	0.00	MT
E)	Horizontal Load Long. (SLS)	=	0.00	MT
F)	Horizontal Load Trans. (SLS)	=	0.00	MT
G)	Horizontal Load Long. (ULS)	=	565.73	MT
H)	Horizontal Load Trans. (ULS)	=	280.93	MT

Based on the above design Inputs a Pin Bearing of Horizontal Load Capacity equal to 'R' is to be designed.

$R = \sqrt{H_L^2 + H_T^2}$

'R' in Normal Case = $\sqrt{H_L^2 + H_T^2} = \sqrt{0 \times 0 + 0 \times 0}$ = 0.00 MT 0.00 kN

'R' in Seismic Case = $\sqrt{H_L^2 + H_T^2} = \sqrt{565.72956 \times 565.72956 + 280.92735 \times 280.9273}$ = 631.64 MT 6194.38 kN

DESIGN INPUTS :

Inside Clearance Dia. (mm) =		530				
Inside Clearance Thickness (mm) =		15				
Pot Base Thickness (mm) =		49				
Pot depth (mm) =		115				
Pot Wall Thickness (mm) =		135				
Pot wall Outer Diameter (mm) =		800				
Pot Bolt PCD (mm) =	908	910				
Pot Base effective dia (actual in mm) =	1054	1055				
Clearance between pot Rim to underside of Piston (mm) =		15				
Piston Thickness above spiggot (mm) =		83				
Piston intermediate above spiggot (mm) =		67				
Total Piston above Thickness (mm) =		150				
Spiggot Projection (mm) =		115				
Vertical face of Piston (mm) =		40				
Piston Intermediate Diameter (mm) =		800				
Piston Bolt PCD (mm) =	908	910				
Piston effective contact area dia. (mm) =	1054	1055				
Bolt Diameter =		36	Gr.	10.9	Top Bolt Lg. 120	Bottom Bolt Lg. 90
No. of Bolts per component =		36				
Bearing Total Height (mm) =		329				
Size of Concrete Embedment Plate for Bottom (mm) =		1140	x	1140		
Thickness of Bottom Embedment Plate (mm) =		36			401	
Size of Concrete Embedment Plate for Top (mm) =		1140	x	1140		
Thickness of Top Embedment Plate (mm) =		36				
No. of Anchor Studs in each Plate =		100				
Diameter of Anchor Studs (mm) =		30		with	75 mm dia forged / welded head	
Length of Anchor Studs =		180		270		
Grade of Cast Steel =	Grade 340 - 570 W of IS : 1030	Yield strength =		340	MPa	
Grade of Mild Steel =	Grade B of IS : 2062	Yield Strength =		240	MPa	
Maximum Permissible Value of Stress in Weld =	110	MPa				

Design Calculations of 5548 - 2755 KN Pin Bearing

Grade of Concrete for Pedestal = M 45

Grade of Concrete for Superstructure = M 50

Solid Concrete thickness of the Superstructure above the Bearing = 350 mm

Design Checks :

SLS | ULS

(1) **Piston**

Spiggot Major Dia. = 528.5 mm

Spiggot Projection = 115 mm

Horizontal force, H = 0.00 kN | H = 6194.38 kN

Eccentricity at base of Piston Spiggot Projection, e =

$$e = 115 - \frac{40}{2} = 95 \text{ mm}$$

Movement at Base of Piston Spiggot Projection, M =

SLS: $= 0.00 \times 1000 \times 95$; $= 0.00$ N - mm

ULS: $= 6194.38 \times 1000 \times 95$; $= 588465988.2$ N - mm

$$\text{Area} = \frac{\pi}{4} \times 528.5 \times 528.5 = 219371.33 \text{ mm}^2$$

$$Z = \frac{\pi}{32} \times 528.5 \times 528.5 \times 528.5 = 14492218.37 \text{ mm}^3$$

SLS

$$\text{Shear Stress} = \frac{0.00 \times 1000}{219371.33} = 0.00 \text{ MPa} < 153 \text{ MPa}$$

$$\text{Bending Stress} = \frac{0.00}{14492218.37} = 0.00 \text{ MPa} < 224.4 \text{ MPa}$$

ULS

$$= \frac{6194.38 \times 1000}{219371.33} = 28.24 \text{ MPa} < 153 \text{ MPa}$$

$$= \frac{588465988.16}{14492218.37} = 40.61 \text{ MPa} < 224.4 \text{ MPa}$$

(2) **Top Plate**

Using hit and trial method, the Netural Axis from the centre of plate is assumed to be at a distance of 327.08 mm
The moment of the areas in compression zone about the N. A. are compared with the areas in tension for the purpose of cross checking. Assuming distance of N.A. from Centre = 327.08 mm

Vertical Distance of the N. A. from the centre line = 327.08

Radius of the circular Bottom Plate, r = 527.5   0.00

Angle, θ = 103.36

Half Angle = 51.68

Length of Chord, C = 827.71

For moment of area in Compression Zone

$$\text{Area} = \frac{r^2}{2} \times \left(\frac{\pi \theta}{180} - \sin \theta \right)$$

$$\text{Area} = \frac{527.5 \times 527.5}{2} \times \left(\frac{3.14 \times 103.37}{180} - \sin 103.37 \right)$$

$$\text{Area} = \frac{278256.25}{2} \times (1.80 - 0.97)$$

$$\text{Area} = 115620.94 \text{ mm}^2$$

Distance of centroid from centre point (C o) =

$$C_o = \frac{C^3}{12 \times A} = \frac{827.72^3}{12 \times 115620.95} = 408.71 \text{ mm}$$

$$A\bar{y} = 115620.94 \, (408.71 - 327.1) = 9438972.32 \text{ mm}^3$$

Moment of Area of Bolts in tension and Bolts in compression

No of bolts used = 36 Nos.

Diameter of the Bolt = M 36 Gr. 10.9

C. Sec. Area of one Bolt = 817 mm²

Dia. of Hole to be provided for M 36 Bolt is 39 mm

PCD of Bolts	=	910	mm
Distance of first set of Bolts	=	6.91	mm
Distance of first set of Bolts from N. A.	=	782.08	mm
Distance of second set of Bolts	=	27.44	mm
Distance of second set of Bolts from N. A.	=	775.16	mm
Distance of third set of Bolts	=	60.96	mm
Distance of third set of Bolts from N. A.	=	754.64	mm
Distance of fourth set of Bolts	=	106.45	mm
Distance of fourth set of Bolts from N. A.	=	721.12	mm
Distance of fifth set of bolts	=	162.53	mm
Distance of fifth set of Bolts from N. A.	=	675.63	mm

Design Calculations of 5548 - 2755 KN Pin Bearing

Area of Hole = $\frac{\pi}{4}$ x 39 x 39 = 1194.59 mm^2

Distance of sixth set of bolts	=	227.50	mm
Distance of sixth set of Bolts from N. A.	=	619.55	mm
Distance of seventh set of bolts	=	299.38	mm
Distance of seventh set of Bolts from N. A.	=	554.58	mm
Distanceof eighth set of bolts	=	375.99	mm
Distance of eighth set of Bolts from N. A.	=	482.70	mm
Distanceof ninth set of bolts	=	455.00	mm
Distance of ninth set of Bolts from N. A.	=	406.09	mm
Distanceof tenth set of bolts	=	534.01	mm
Distance of tenth set of Bolts from N. A.	=	327.08	mm
Distanceof eleventh set of bolts	=	610.62	mm
Distance of eleventh set of Bolts from N. A.	=	248.07	mm
Distanceof twelth set of bolts	=	682.50	mm
Distance of twelth set of Bolts from N. A.	=	171.46	mm
Distanceof 13 set of bolts	=	747.47	mm
Distance of 13 set of Bolts from N. A.	=	99.58	mm
Distanceof 14 set of bolts	=	803.55	mm
Distance of 14 set of Bolts from N. A.	=	34.61	mm
Distanceof 15 set of bolts	=	849.04	mm
Distance of 15 set of Bolts from N. A.	=	-21.47	mm
Distanceof 16 set of bolts	=	882.56	mm
Distance of 16 set of Bolts from N. A.	=	-66.96	mm
Distanceof 17 set of bolts	=	903.09	mm
Distance of 17 set of Bolts from N. A.	=	-100.48	mm
Distanceof 18 set of bolts	=	910.00	mm
Distance of 18 set of Bolts from N. A.	=	-121.01	mm
Distance of 19 Bolt from N. A.		-127.92	

Taking Moment of the areas of Bolts about N.A.

= (1 x 817 x 782.08) + (2 x 817 x 775.17) + (2 x 817 x 754.64) + (2 x 817 x 721.12)
(2 x 817 x 675.63) + (2 x 817 x 619.55) + (2 x 817 x 554.58) + (2 x 817 x 482.7) + (2 x 817 x 406.09)
(2 x 817 x 327.08) + (2 x 817 x 248.07) + (2 x 817 x 171.46) + (2 x 1194.6 x 99.58)
(2 x 1194.6 x 34.61) + (2 x 1194.6 x -21.48) + (2 x 1194.6 x -66.97) + (2 x 1194.6 x -100.49)
(2 x 1194.6 x -121.02) + (1 x 1194.6 x -127.93)

= 638957.05 + 1266619.1 + 1233077.4 + 1178308.01 + 1103975.17 + 1012337.4 + 906179.11
+ 788725.82 + 663546.32 + 534444.106 + 405341.896 + 280162.39 + 237907.92 +
+ 82686.728 + -51303 + -159990 + -240072.01 + -289115.66 + -152815.4
= 9438972.322 mm^3

As, A y is approximately equal to $A_1 y_1$, Hence the N. A. thus assumed is O. K.

Movement of Inertia of Top Plate about N.A.

For Compression Zone

$$Icg = \frac{r^4}{16}\left(\frac{\pi\ \theta}{90} - \text{Sin } 2\theta\right) - \frac{20\ r^4\ (1-\cos\theta)^3}{\pi\theta - 180\ \text{Sin}\ \theta}$$

$$Icg = \frac{77426540664}{16}\left(\frac{.14 \times 103.37}{90} - \text{Sin } 2\ (103.37)\right) - \frac{1.54853E+12\ (1-\text{Cos } 103.37) \times (1-\text{Cos } 103.37) \times (1-\text{Cos } 103.37)}{3.14 \times 103.37 - 180 \times \text{Sin } 103.37}$$

$$Icg = 4839158792\ (3.61 - -0.45) - \frac{1.54853E+12 \times 1.24 \times 1.24 \times 1.24}{149.59}$$

$$Icg = 4839158792\ (3.61 - -0.45) - 1.54853E+12 \times 0.0125$$

$Icg =$ 321133416.23 mm^4

$I_{N.A.C} = Icg + A\bar{y}^2$

$I_{N.A.C} =$ 321133416.23 + 115620.94 (408.71 - 327.1 $)^2$

$I_{N.A.C} =$ 1091704878 mm^4

For Tension Zone

$I_{N.A.T} =$ (1x817x782.08x782.08) + (2x817x775.17x775.17) + (2x817x754.64x754.64) + (2x817x721.12x721.12)
(2x817x675.63x675.63) + (2x817x619.55619.55) + (2 x817x554.58x554.58)+(2x817x482.7x482.7) + (2x817x406.09x406.09)
(2x817x327.08x327.08)+(2x817x248.07x248.07)+(2x817x171.46x171.46)+(2x1194.6x99.58x99.58)
(2x1194.6x34.61x34.61)+(2x1194.6x-21.48x-21.48)+(2x1194.6x-66.97x-66.97)+(2x1194.6x-100.49x-100.49)
(2x1194.6x-121.02x-121.02)+(1x1194.6x-127.93x-127.93)

$I_{N.A.T} =$ 499713728 + 981838440 + 930526207 + 849699984 + 745875871 + 627189127 + 502546250
+ 380715069 + 269457598 + 174804469 + 100552052 + 48036086 + 23690199 +
+ 2861689.6 + 1101631.5 + 10713634 + 24123148.1 + 17492993.6 + 19548578

$I_{N.A.T} =$ 6210486756 mm^4

Total $I_{N.A.}$ = $I_{N.A.C} + I_{N.A.T}$

Total $I_{N.A.}$ = 1091704878 + 6210486756

Total $I_{N.A.}$ = 7302191634 mm^4

	SLS			**ULS**	
Horizontal force, H =	0.00	kN	H =	6194.38	kN

Eccentricity at base of Piston top, e =

$$e = 83 + 67 + 115 - \frac{40}{2} = 245 \text{ mm}$$

SLS	ULS
Moment at Base of Piston Spiggot Projection, M =	
= 0.00 x 1000 x 245	= 6194.38 x 1000 x 245
= 0.00 N - mm	= 1517622812 N - mm
Maximum Compressive stress in Top Plate =	
$= \frac{0.00}{7302191634} \times (527.5 - 327.0771765)$	$= \frac{1517622812}{7302191634} \times (527.5 - 327.0771765)$
= 0 x 200.42282	= 0.20783114 x 200.42282
= 0.00 MPa	= 41.65 MPa
Maximum Tensile stress in Extreme Bolts =	
$= \frac{0.00}{7302191634} \times (455 + 327.0771765)$	$= \frac{1517622812}{7302191634} \times (455 + 327.0771765)$
= 0 x 782.07718	= 0.20783114 x 782.07718
= 0.00 MPa	= 162.54 MPa

Check for the Thickness of Piston =

(a) At a distance of 127.5 mm from the Face

$M = \frac{0 \times 200.4228235}{2} \times \left(127.5 - \frac{200.42282}{3}\right)$	$M = \frac{1.66 \times 200.42282}{2} \times \left(127.5 - \frac{200.42282}{3}\right)$
M = 0 N - mm	M = 253343.1882 N - mm
Permissible Compressive stress	
= 0.66 x 340 = 224.4 MPa	= 0.66 x 340 = 224.4 MPa
$Z\ req. = \frac{0}{224.4} = 0.00\ mm^3$	$Z\ req. = \frac{253343.1882}{224.4} = 1128.98\ mm^3$
Thickness required,	
$= \frac{1}{6} \times d^2 = 0.00$	$= \frac{1}{6} \times d^2 = 1128.98$
= d = 0.000 < 83 mm (Provided)	= d = 82.30 < 83 mm (Provided)
Hence O. K.	Hence O. K.

(b) At a distance of 266.75 mm from the Face

$M = \frac{0 \times 200.4228235}{2} \times \left(266.75 - \frac{200.42282}{3}\right)$	$M = \frac{1.66 \times 200.42282}{2} \times \left(266.75 - \frac{200.42282}{3}\right)$
M = 0 N - mm	M = 834602.8435 N - mm
Permissible Compressive stress	
= 0.66 x 340 = 224.4 MPa	= 0.66 x 340 = 224.4 MPa
$Z\ req. = \frac{0}{224.4} = 0.00\ mm^3$	$Z\ req. = \frac{834602.8435}{224.4} = 3719.26\ mm^3$
Thickness required,	
$= \frac{1}{6} \times d^2 = 0.00$	$= \frac{1}{6} \times d^2 = 3719.26$
= d = 0.00 < 150 mm (Provided)	= d = 149.38 < 150 mm (Provided)
Hence O. K.	Hence O. K.

(3) **Bottom Plate**

Total N.A. = 7302191634 mm^4 (Same as for Piston)

SLS	**ULS**
Horizontal force, H = 0.00 kN	H = 6194.38 kN

Eccentricity at Pot Base , e =

$e = 49 + 15 + \frac{40}{2} = 84$ mm

Moment at Pot Base, M =	
= 0.00 x 1000 x 84	= 6194.38 x 1000 x 84
= 0.00 N - mm	= 520327821.1 N - mm

Design Calculations of 5548 - 2755 KN Pin Bearing

Maximum Compressive stress in Bottom Plate =

$= \dfrac{0.00}{7302191634} \times (527.5 - 327.0771765)$	$= \dfrac{520327821.1}{7302191634} \times (527.5 - 327.0771765)$
$= 0 \times 200.42282$	$= 0.071256391 \times 200.42282$
= 0.00 MPa	= 14.28 MPa

Maximum Tensile stress in Extreme Bolts =

$= \dfrac{0.00}{7302191634} \times (455 + 327.0771765)$	$= \dfrac{520327821.1}{7302191634} \times (455 + 327.0771765)$
$= 0 \times 782.07718$	$= 0.071256391 \times 782.07718$
= 0.00 MPa	= 55.73 MPa

Check for the Thickness of Pot Base =

(a) At a distance of 127.5 mm from the Face

$M = \dfrac{0 \times 200.4228235}{2} \times \left(127.5 - \dfrac{200.42282}{3}\right)$	$M = \dfrac{14.29 \times 200.43}{2} \times \left(127.5 - \dfrac{200.42282}{3}\right)$
M = 0 N - mm	M = 86860.52166 N - mm
Permissible Compressive stress	
$= 0.66 \times 340 =$ 224.4 MPa	$= 0.66 \times 340 =$ 224.4 MPa
$Z\ req. = \dfrac{0}{224.4} = 0.00\ mm^3$	$Z\ req. = \dfrac{86860.52166}{224.4} = 387.08\ mm^3$
Thickness required,	
$= \dfrac{1}{6} \times d^2 = 0.00$	$= \dfrac{1}{6} \times d^2 = 387.08$
= d = 0.00 < 49 mm (Provided)	= d = 48.19 < 49 mm (Provided)
Hence O. K.	Hence O. K.

(4) **Pot Wall / Cylinder**

Hoop Tensile Stress

SLS	ULS
Axial Tension $= \dfrac{0.00 \times 1000}{2 \times 135 \times 115}$	$= \dfrac{6194.38 \times 1000}{2 \times 135 \times 115}$
= **0.00 MPa**	= **199.50 MPa**
= **0.00 < 204 Mpa** **(0.6 x 340 (fy) = 204 Mpa)** **(As per Cl - 926.2.2.1 of IRC:83 (Part III)**	= **199.50 < 204 Mpa** **(0.6 x 340 (fy) = 204 Mpa)** **(As per Cl - 926.2.2.1 of IRC:83 (Part III)**

SLS	ULS
Shear Stress $= \dfrac{1.5 \times 0.00 \times 1000}{530 \times 135}$	$= \dfrac{1.5 \times 6194.38 \times 1000}{530 \times 135}$
= 0.00 MPa < 153 MPa	= 129.86 MPa < 153 MPa
Hence O. K.	Hence O. K.

Eccentricity at base of Pot Wall, e =

$$e = 15 + \frac{40}{2} = 35\ mm$$

Bending Stress $= \dfrac{1.5 \times 1000 \times 0.00 \times 35 \times 6}{530 \times 135 \times 135}$	$= \dfrac{1.5 \times 1000 \times 6194.38 \times 35 \times 6}{530 \times 135 \times 135}$
= 0.00 MPa < 224.4 MPa	= 202.01 MPa < 224.4 MPa
Hence O. K.	Hence O. K.

Combined stresses

$= ((0)^2 + (3 \times (0)^2)^{1/2}$	$= ((202.01)^2 + (3 \times (129.87)^2)^{1/2}$
= 0 < 306 Mpa	= 302.33 < 306 Mpa
Hence O. K.	Hence O. K.

Design Calculations of 5548 - 2755 KN Pin Bearing

(5) **Bolts Connecting Top and Bottom Plates to Base Plates**

No of bolts used =	36	Nos.	Bolt Diameter =	M	36	mm
C. Sec. Area of one Bolt =	817	mm^2	Total C. Sec. Area of Bolts =		29412	mm^2
Shear Strength of the Bolt Gr. 10.9 =	238.00	MPa	Shear Strength in Seismic =		238.00	MPa
Tensile Strength of the Bolt Gr. 10.9 =	357.00	MPa	Tensile Strength in Seismic =		357.00	MPa

Maximum Shear Stress in the Bolts =

$= \frac{0 \times 1000}{29412} = 0.00$ MPa $\qquad = \frac{6194.38 \times 1000}{29412} = 210.61$ MPa

Maximum Shear Stress in the Bolts =

$= 0.00 < 238.00$ MPa $\qquad = 210.61 < 238.00$ MPa

Hence O. K. Hence O. K.

Tensile Strength of the Bolt Gr. 10.9 = 357.00 MPa Tensile Strength in Seismic = 357.00 MPa

As the tensile stress calculated earlier for extreme Bolts in Top Plate is greater than for Bottom Plate. Hence,

Max. Tensile Stress in Bolts =

$= 0.00 < 357.00$ MPa $\qquad = 162.54 < 357.00$ MPa

Hence O. K. Hence O. K.

Check for combined Shear & Tension =

$= \frac{0.00}{238.00} + \frac{0.00}{357.00} < 1.4 \qquad = \frac{210.61}{238.00} + \frac{162.54}{357.00} < 1.4$

$= 0.00 < 1.4 \qquad = 1.34 < 1.4$

Hence O. K. Hence O. K.

(6) **Contact Stress between Pot Wall and Piston (Vertical face of Piston) =**

SLS **ULS**

Taking Vertical face of Piston as 40 mm

$= 0.6 \sqrt{\frac{0 \times 1000 \times 2.0 \times 10^5}{40 \times 530} \times \left[1 - \frac{528.5}{530}\right]} \qquad = 0.6 \sqrt{\frac{6194.38 \times 1000 \times 2.0 \times 10^5}{40 \times 530} \times \left[1 - \frac{528.5}{530}\right]}$

$= 0.6 \times 0.00 \qquad = 0.6 \times 406.68$

$= 0.00 < 255$ MPa $\qquad = 244.01 < 255$ MPa

Hence O. K. Hence O. K.

(7) **Studs Embeded in Concrete =**

Size of Concrete Embedment Plate for Bottom (mm) = 1140 x 1140

Size of Concrete Embedment Plate for Top (mm) = 1140 x 1140

No. of Anchor Studs in each Plate = 100

Diameter of Anchor Studs (mm) = 30

As the Size of the Concrete Embedment Plates and No. of Studs to be provided in each Plate is same for both Top and Bottom, Hence, the N. A. thus calculated from the above inputs shall be same for both Top and Bottom Plates.

No. of Anchor Suds in each row = 10

Total No. of Rows = 10

Distance of 1st Row from the edge of the Plate	=	75		
Distance of 2nd Row from the edge of the Plate	=	185	Distance between adjacent Rows =	110
Distance of 3rd Row from the edge of the Plate	=	295	Clear Gap between Two studs =	80
Distance of 4th Row from the edge of the Plate	=	405	C/c distance between extreme studs =	990
Distance of 5th Row from the edge of the Plate	=	515		
Distance of 6th Row from the edge of the Plate	=	625		
Distance of 7th Row from the edge of the Plate	=	735		
Distance of 8th Row from the edge of the Plate	=	845		
Distance of 9th Row from the edge of the Plate	=	955		
Distance of 10th Row from the edge of the Plate	=	1065		

Design Calculations of 5548 - 2755 KN Pin Bearing

Area of Stud in One Row $= 10 \times \frac{\pi}{4} \times 30 \times 30 = 7068.58 \ mm^2$

For the Purpose of calculating the N. A., equating the moment of areas in Compression Zone to the moment of the areas in Tension Zone

Assuming the Neutral axis to be at a distance of y mm from th edge of the plate

$$\text{N. A.} = 1140 \ \frac{y^2}{2} - 7068.59\,(y - 75) - 7068.59\,(y - 185) = 7068.59\,(295 - y) + 7068.59\,(405 - y)$$
$$+ 7068.59\,(515 - y) + 7068.59\,(625 - y) + 7068.59\,(735 - y) + 7068.59\,(845 - y)$$
$$+ 7068.59\,(955 - y) + 7068.59\,(1065 - y)$$

$$\text{N. A.} = 570 \ y^2 - 7068.59\,y + 530143.76 - 7068.59\,y + 1307687.942 = 2085232.124 - 7068.59\,y +$$
$$2862776.306 - 7068.59\,y + 3640320.487 - 7068.59\,y + 4417864.669 - 7068.59\,y +$$
$$5195408.851 - 7068.59\,y + 5972953.033 - 7068.59\,y + 6750497.214 - 7068.59\,y +$$
$$7528041.396 - 7068.59\,y$$

$$\text{N. A.} = 570 \ y^2 + 1837831.72 = 38453094.08 - 42411.51\,y$$

$$\text{N. A.} = 570 \ y^2 - 42411.51\,y \ 36615262 = 0$$

$$\text{N. A.} = y^2 + 62.01 \ y - 64237.30 = 0$$

Solving the above quadretic equation using the formula =

$$y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$y = \frac{-62.01 \pm \sqrt{(62.01 \times 62.01) - (4 \times 1 \times -64237.31)}}{2 \times 1}$$

$$y = 224.34 \ mm$$

$$I_{N.A.} = \frac{1140 \times 224.34 \times 224.34 \times 224.34}{3} - \{7068.59 \times (224.34 - 75) \times (224.34 - 75)\} - \{7068.59 \times (224.34 - 185) \times (224.34 - 185)\}$$
$$+ \{7068.59 \times (295 - 224.34) \times (295 - 224.34)\} + \{7068.59 \times (405 - 224.34) \times (405 - 224.34)\}$$
$$+ \{7068.59 \times (515 - 224.34) \times (515 - 224.34)\} + \{7068.59 \times (625 - 224.34) \times (625 - 224.34)\}$$
$$+ \{7068.59 \times (735 - 224.34) \times (735 - 224.34)\} + \{7068.59 \times (845 - 224.34) \times (845 - 224.34)\}$$
$$+ \{7068.59 \times (955 - 224.34) \times (955 - 224.34)\} + \{7068.59 \times (1065 - 224.34) \times (1065 - 224.34)\}$$

$$I_{N.A.} = 4290182886 - 157636471.94 - 10936916.27 + 35297080.59 + 230716964.9 + 597196569.19 + 1134735893.48$$
$$+ 1843334937.75 + 2722993702 + 3773712186.\text{[illegible]} + 4995490390.49$$

$$I_{N.A.} = 19455087222.51 \ mm^4$$

	SLS			ULS	
Horizontal force, H =	0.00	kN	H =	6194.38	kN

As the Moment generated at the Interface of Top Embedment Plate shall be higher because of higher eccentricity,
Same shall be used in the calculation =

Eccentricity at Top Base , e =

$$e = 36 + 83 + 67 + 115 - \frac{40}{2} = 281 \ mm$$

Moment at Base of top Embedment Plate, M =

SLS	ULS
$= 0.00 \times 1000 \times 281$	$= 6194.38 \times 1000 \times 281$
$= 0.00$ N - mm	$= 1740620449$ N - mm

Maximum Tensile stress in Extreme Studs =

SLS	ULS
$= \frac{0.00}{19455087222.51} \times (1065 - 224.34)$	$= \frac{1740620449}{19455087222.51} \times (1065 - 224.34)$
$= 0 \times 840.66$	$= 0.089468653 \times 840.66$
$= 0.00$ MPa < 144 MPa	$= 75.21$ MPa < 144 MPa
Hence O. K.	Hence O. K.

Design Calculations of 5548 - 2755 KN Pin Bearing

Tensile Force in Extreme Studs / No. =

$= 0.00 \times \frac{\pi}{4} \times 30 \times 30$	$= 75.21 \times \frac{\pi}{4} \times 30 \times 30$
= 0.00 N or 0.00 kN	= 53165.04 N or 53.17 kN

Maximum Shear Stress in Studs =

Horizontal force, H = 0.00 kN	H = 6194.38 kN
$= \frac{0.00 \times 1000}{70685.83} = 0.00$ MPa < 108 MPa	$= \frac{6194.38 \times 1000}{70685.83} = 87.63$ MPa < 108 MPa
Hence O. K.	Hence O. K.

Check for Combined Bending and Shear Check =

$= \frac{0.00}{108} + \frac{0.00}{144} = 0.00 < 1.4$	$= \frac{87.63}{108} + \frac{75.21}{144} = 1.33 < 1.4$
Hence O. K.	Hence O. K.

(8) **Connection between embeded Studs and Plates =**

Diameter of Anchor Studs (mm) = 30

Providing Weld of Size = 14 mm Thk.

Outer edge dia. Of the weld = 30 + (2 x 14) = 58 mm

Area of weld = $\frac{\pi}{4} \times (58 \times 58) - (30 \times 30) = 1935.22$

Effective Area, Taking in Account throat thickness,

= 1935.22 x 0.7 = 1354.65 mm^2

Tensile Force / Stud = 0.00 kN	= 53.17 kN
Shear Force / Stud = $\frac{0.00}{100} = 0.00$ kN	$= \frac{6194.38}{100} = 61.94$ kN

Shear Stress in Weld due to Tensile Force =

$= \frac{0.00 \times 1000}{1354.65} = 0.00$ MPa	$= \frac{53.17 \times 1000}{1354.65} = 39.25$ MPa

Shear Stress in Weld due to Shear Force =

$= \frac{0.00 \times 1000}{1354.65} = 0.00$ MPa	$= \frac{61.94 \times 1000}{1354.65} = 45.73$ MPa

As Shear Stress in weld due to Tension and due to Shear are prependicular to each other, so Resultant Shear Stress =

= (0 x 0) + (0 x 0)	= (39.25 x 39.25) + (45.73 x 45.73)
= 0.00 MPa < 110 MPa	= 60.26 MPa < 110 MPa
Hence O. K.	Hence O. K.

Also, as per IS : 816, equivalent Stress =

= (0 x 0) + 1.8 (0 x 0)	= (39.25 x 39.25) + 1.8 (45.73 x 45.73)
= 0.00 MPa < 110 MPa	= 72.83 MPa < 110 MPa
Hence O. K.	Hence O. K.

(9) **Plate embeded in Concrete =**

Minimum embedment Length of Bolt required for M 36 Bolt is 36 mm

No. of Bolts Provided in each component = 36 Nos.

Thickness of embedment Plate Provided = = 36 mm

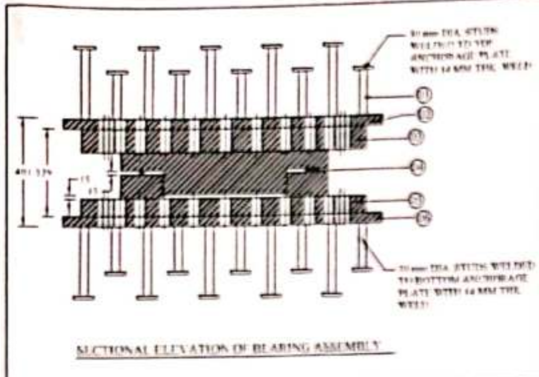
Plate thickness available below threading = 36 - 36 = 0 mm

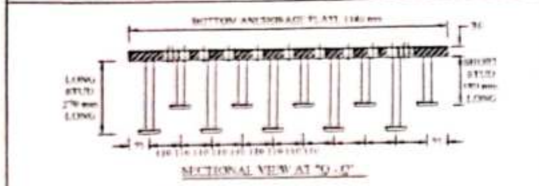
Bearing presure between Plate and Bolt =

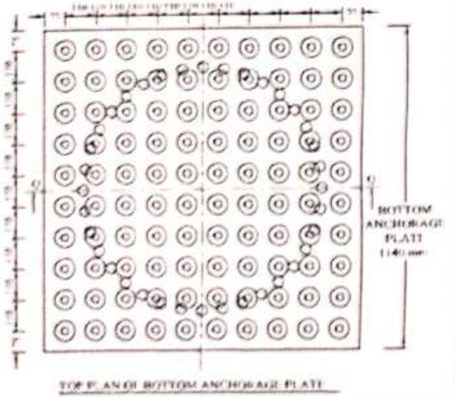
Horizontal force, H = 0.00 kN	H = 6194.38 kN

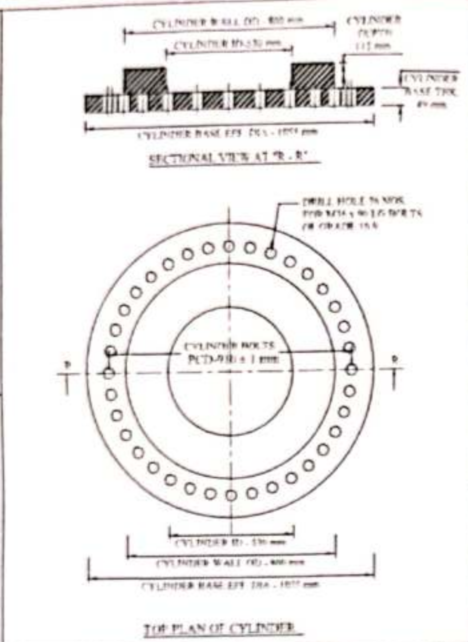
Bearing Stress,

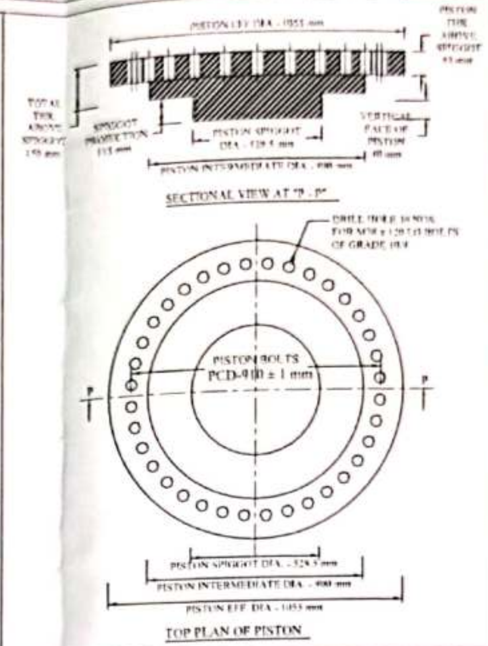
$= \frac{0.00 \times 1000}{36 \times (36 \times 36)}$	$= \frac{6194.38 \times 1000}{36 \times (36 \times 36)}$
= 0.00 MPa < 180 MPa	= 132.77 MPa < 180 MPa
Hence O. K.	Hence O. K.

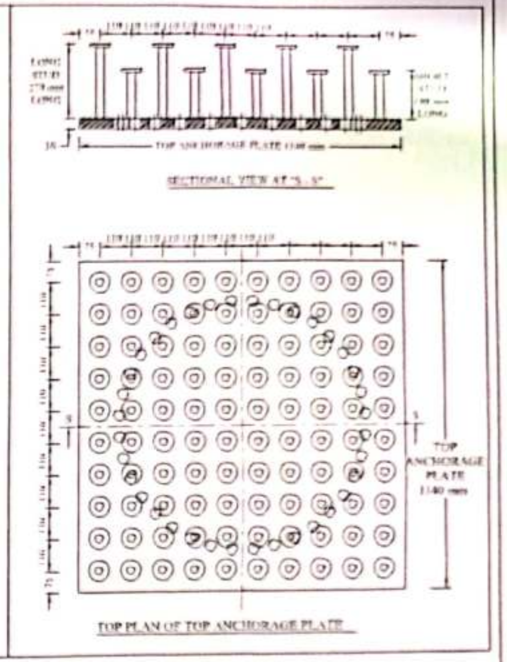












S. No.	DESCRIPTION	SPECIFICATION	QTY
09	TRANSPORT BRACKET	IS 2062 GRADE E 250	04
08	FLAT WASHER	STD	12
07	ANCHORING BOLTS M36 Gr 10.9	IS 1367	12
06	BOTTOM ANCHORAGE PLATE	IS 2062 GRADE E 250	01
05	CYLINDER	IS 1030 GRADE 340-570 W	01
04	DUST SEAL	BITUMEN IMPREGNATED	01
03	INTERMEDIATE COMPONENT (PISTON)	IS 1030 GRADE 340-570 W	01
02	TOP ANCHORAGE PLATE	IS 2062 GRADE E 250	01
01	SHEAR HEADED STUDS	IS 2062 GRADE E 250	208

Bearing Type	Case	Vertical Load (KN) Max	Vertical Load (KN) Min	Hor. Load (KN) Long	Hor. Load (KN) Trans	Movement T L (mm)
Pin Bearing	SLS	0.00	0.00	0.00	0.00	± 9 ± 9
	ULS	0.00	0.00	2348.00	2753.00	

NOTES

MATERIALS :
1. ANCHORES HSS BOLTS OF Gr. 10.9 & STUDS MATERIAL AS PER IS 2062, GR E 250.
2. ACESSORIES TO IS 2062, GR E 250.
3. CONCRETE GRADE FOR PEDESTAL IS M45.
4. CONCRETE GRADE FOR SUPERSTRUCTURE IS M50.

WELDING :
ALL WELDING WILL BE MANUAL INERT GAS PROCESS AND 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 EACH OF EPOXY INTERMEDIATE ANDFINISH PAINT. TOTAL DRY FILM THICKNESS = 160 MICRONS.

TESTS :
a) TESTS ON CASTING: TESTS SPECIFIED IN IS 1030 WILL BE PERFORMED. CASTINGS SHALL BE ULTRASONICALLY TESTED & CERTIFICATES SUBMITTED.
QUALITY LEVEL 1 AS PER IS 9565.

b) ACCEPTANCE TEST ON BEARINGS.

c) ALL TESTS ON BEARINGS WILL BE CARRIED OUT IN PRESENCE OF REPRESENTATIVE OF DPT. PMC. 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) ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE MENTIONED.
2) PCD = PITCH CIRCLE DIAMETER
3) TOLERANCES
   a) PLAN DIMENSIONS - 0 TO + 5mm
   b) OVERALL HEIGHT - 0 TO + 3mm
   c) HEIGHT OF ELASTOMER - 0 / + 5%
   d) HEIGHT OF ANY STEEL COMPONENT
      1) MACHINED - 0 TO + 1mm
      2) UNMACHINED CLASS 2 OF IS 4897

TYPE :- PIN BEARING
BEARING MARK : B5
CH. : 516+938

TRANSVERSE DIRECTION

TRAFFIC DIRECTION (LONGITUDINAL)

KARMA ENTERPRISE Guwahati

Project	[illegible]	Manufacturer & Supplier :- Karma Enterprise Guwahati
Client	[illegible]	
Authority Engineer	[illegible]	
Contractor	[illegible]	
Title	[illegible] Pin Bearing	