# Quality Assurance of PoT Bearing

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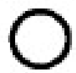
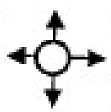
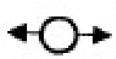
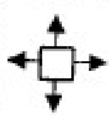
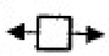
# Bearing Design Details

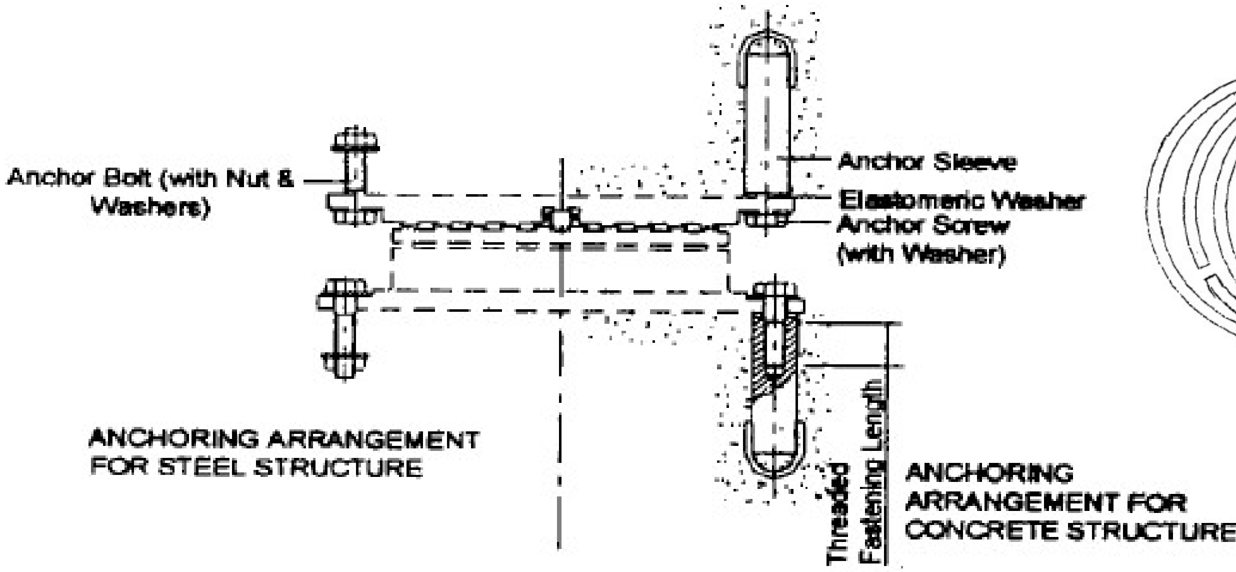
- IRC-83-1982 Metalic  Bearing

  Part-III

# 924. SYMBOLS AND NOTATIONS

## 924.1. Symbolic Representation of Bearing Function

| Symbol | Bearing Type | Resists Vertical Load | Resists Horizontal Force Along Direction (In The Horizontal Plane) | Permits Translation Along Direction (In The Horinzontal Plane) | Permits Rotation Axis (In The Horizontal Plane) |
|---|---|---|---|---|---|
|  | Fixed Pot | Yes | Any | No | Any |
|  | Free Sliding Pot-cum-PTFE | Yes | No | Any | Any |
|  | Guided Sliding Pot-cum-PTFE | Yes | Uni-directional | Uni-directional | Any |
|  | Free PTFE Sliding Assembly | Yes | No | Any | No |
|  | Guided PTFE Sliding Assembly | Yes | Uni-directional | Uni-directional | No |
|  | Pin | No | Any | No | Any |
|  | Metallic Guide | No | Uni-directional | Uni-directional | Uni-directional |




(a) Anchoring Arrangement with Bolt-Nut/Screw-Sleeve System

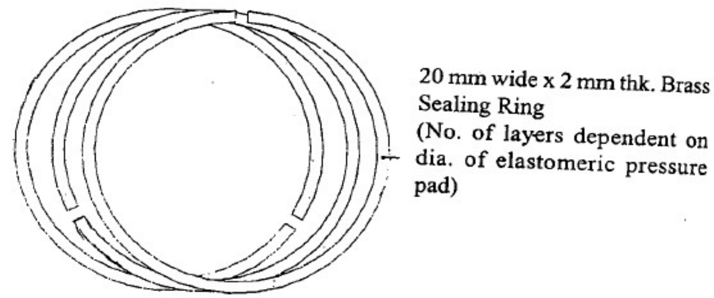
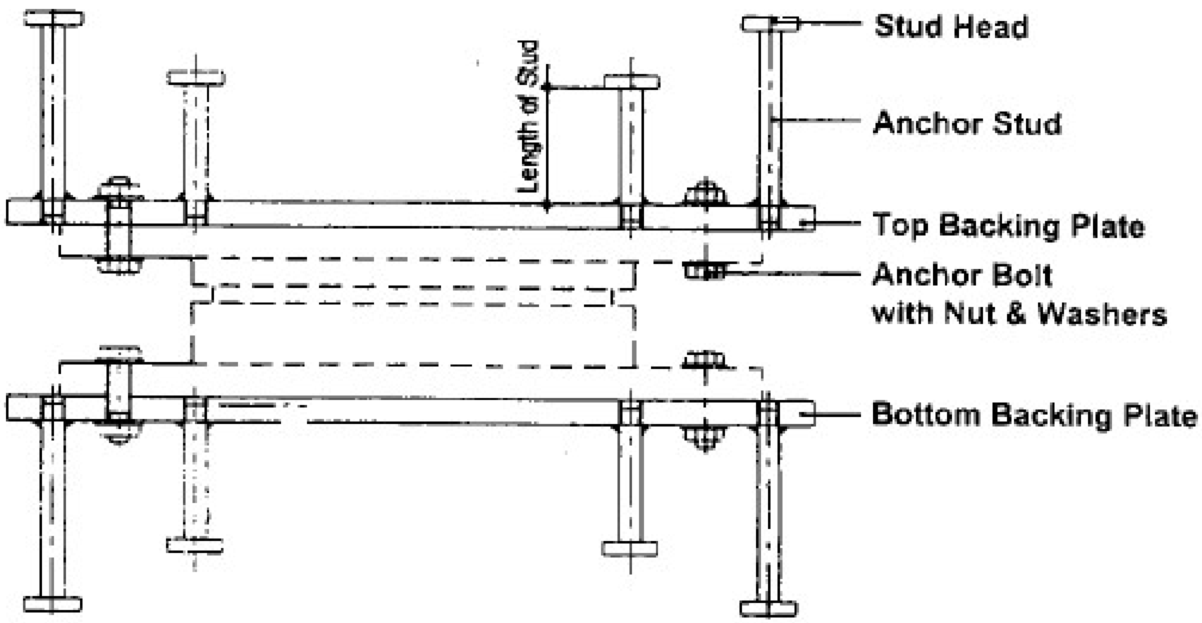



Fig. 23. Brass sealing ring

Internal Seal by 20x2mm thick Brass Ring, min. 2 No.




(b) Anchoring Arrangement with Backing Plates & Studs

**Fig. 20. Anchoring arrangement**

**For Fixed Pot Bearing**

Design of Elastomer
Design of  Anchor Arrangement
Design of Pot Cylinder

**For Guide Pot Bearing**

Design of Elastomer
Design of  Anchor Arrangement
Design of Pot Cylinder
Design of PTFE  and Guide

# Design of Elastomer

926.2.3. **Particular recommendations for confined elastomeric pressure pad**

926.2.3.1. Permissible limits for confined elastomeric pressure pad depend on the effectiveness of the internal seal preventing it from extruding between the piston and the cylinder wall and as such shall be verified by load testing of assembled bearing.

926.2.3.2. Average stress in confined elastomeric pressure pad of Pot bearing shall not exceed 35 MPa and extreme fibre pressure shall not exceed 40 MPa.

926.2.3.3. Minimum average stress in confined elastomeric pressure pad of Pot bearing, under any critical combination of loads and forces that can coexist, shall in no case be less than 5 MPa.

926.2.3.4. The dimension of the confined elastomeric pressure pad shall be such that at design rotation the deflection at the perimeter shall not exceed 15 per cent of the pad thickness below the internal seal, Fig. 26.

926.2.3.6. The minimum thickness of the confined elastomeric pressure pad shall not be less than 1/15th of its diameter or 16 mm, whichever is higher and the diameter shall not be less than 180 mm.

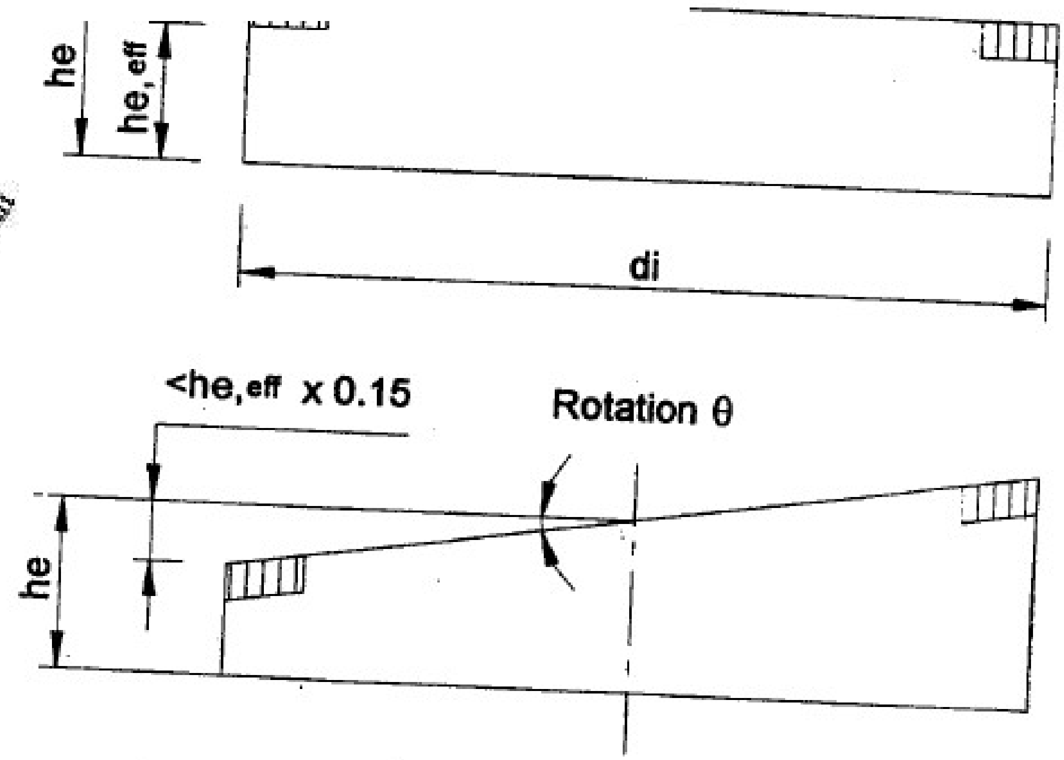



**Fig. 26. Allowable strain in elastomeric pressure pad**

926.2.3.5. No increase in permissible limits of stresses and strain is allowed for seismic, wind or any other load combinations.

# Design of Elastomer

926.1.5.1. Induced moment resulting from resistance to rotation due to the effect of tilting stiffness of elastomeric pressure pad shall be determined as follows:

$$M_{e,d} = di^3 \times (k_1.\theta p + k_2.\theta v),$$

Where,

di = diameter of elastomeric pressure pad in mm

he = thickness of confined elastomeric pressure pad in mm.

$k_1$ and $k_2$ shall be as per Table 3. Intermediate values may be obtained by linear interpolation.

θp = calculated value of resultant rotation angle due to permanent actions and long term effects, in radian

θv = calculated value of resultant rotation angle due to variable actions, in radian, and

$M_{e,d}$ = induced moment in N-mm.

**TABLE 3. VALUES OF CONSTANTS $k_1$ AND $k_2$**

| di/he | $k_1$ | $k_2$ |
|---|---|---|
| 15 | 2.2 | 101 |
| 12.5 | 1.8 | 58.8 |
| 10 | 1.5 | 30.5 |
| 7.5 | 1.1 | 13.2 |

926.1.5.2. Induced moment resulting from resistance to rotation due to friction at the piston-cylinder contact surface due to coexisting horizontal force shall be determined as follows:

$$M_{R,d} = 0.2 \times C \times H,$$

Where,

- C = the perpendicular distance from the point of action of horizontal force on cylinder wall to the axis of rotation in mm, Fig. 25.
- H = design horizontal force in N
- $M_{R,d}$ = induced moment in N-mm.

926.1.5.3. For Pot bearings total induced moment will be $M_{T,d} = M_{e,d} + M_{R,d}$ and for Pin bearings total induced moment will be $M_{T,d} = M_{R,d}$.

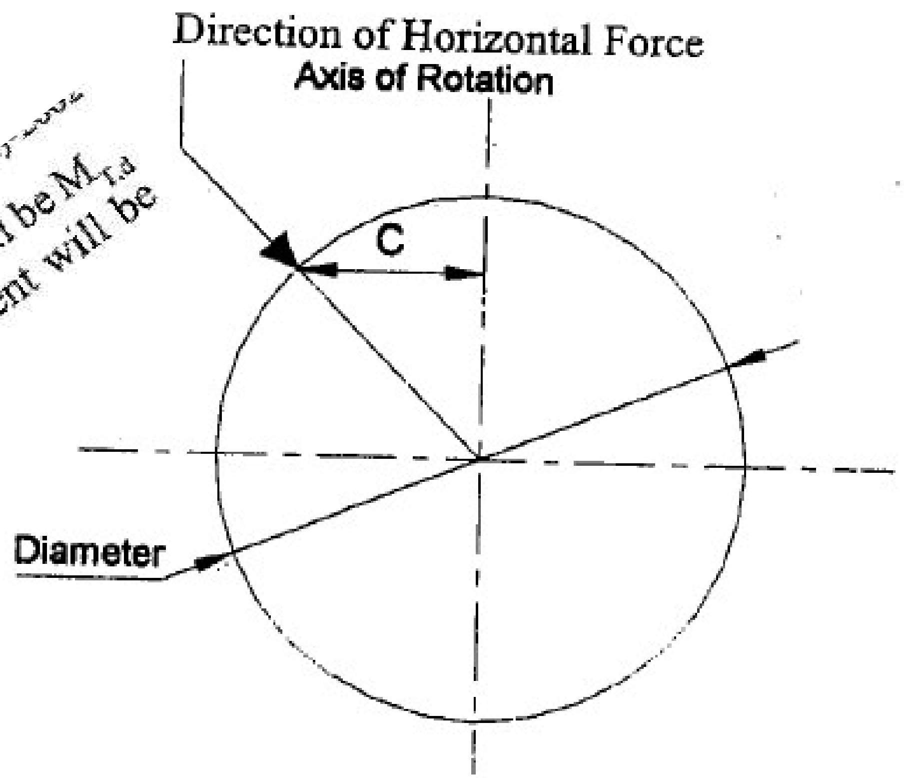



**Fig. 25. Moment arm for rotation resistance due to friction**

# Design of Elastomer

$$Extreme\_Comp.\_Stress = \frac{V\max}{(0.25\times\Pi\times d_i^2)} + \frac{M_{td}}{(\Pi\times\frac{d_i^3}{32})}$$

$$Average\_Stress = \frac{V\max}{(0.25\times\Pi\times d_i^2)}$$

$$Minimum\_Stress = \frac{V\min}{(0.25\times\Pi\times d_i^2)}$$

| | | |
|---|---|---|
| Dia. of Elastomeric pressure pad, mm (di) | 450 | Ok |
| Thickness of confined elastomeric pressure pad,mm (he) | 35 | Ok |
| Induced Moment, Mtd = Med+Mrd | 6.35E+07 | Nmm |
| Area,Ae | 159043 | $mm^2$ |
| Extreme Compressive Stress, Mpa | 28.91 | <40 Mpa,Ok |
| Average Stress | 21.82 | <35 Mpa,Ok |
| Min Stress | 13.46 | >5 Mpa,Ok |
| Max. Strain | 0.54 | <15%,Ok |

# Design of Anchor Arrangement

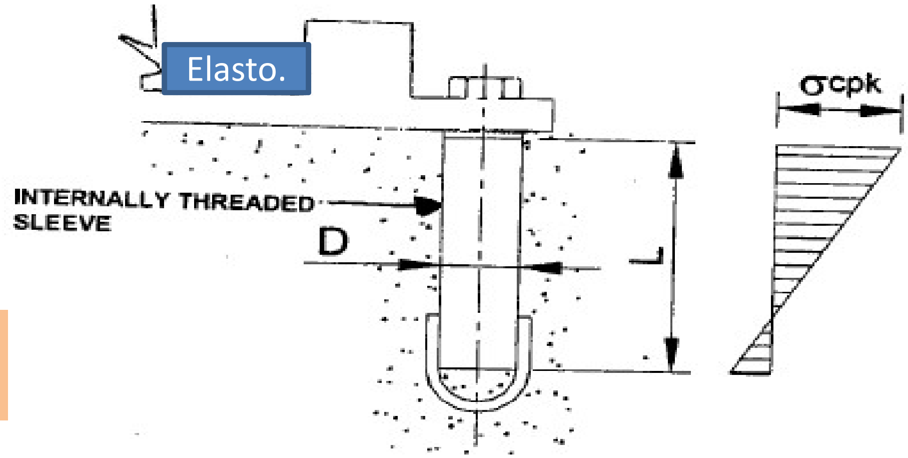



Fig. 34. Stress distribution in concrete adjacent to sleeve

H max < No. of Bolt x $R_v$

**Sleeve, D ≥ 2 . Bolt Dia.**

**L ≤ 5.D**

**Peak Stress in Concrete**

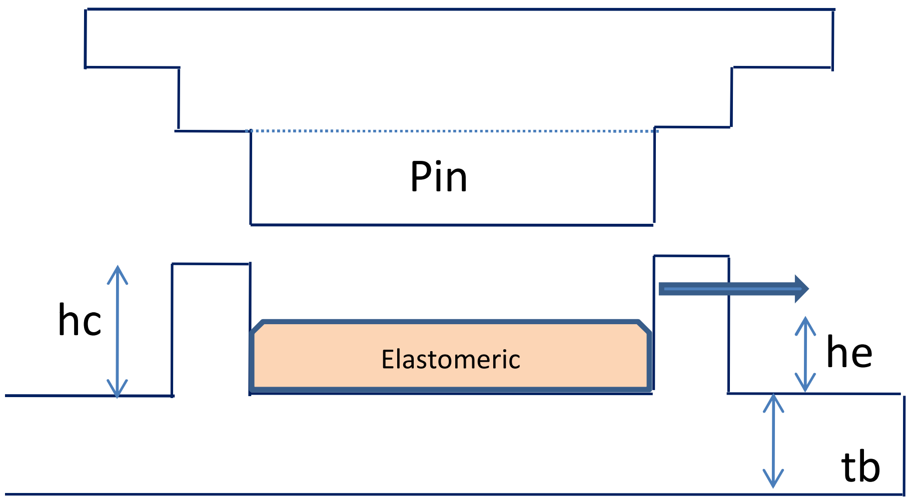
$$= \frac{3 \times Area_{bolt} \times \sigma_{tf}}{D \times L} < \sigma cbc$$

Fixed Pot Bearing

# Design of Anchor Arrangement

Resultant Co-existing moment =

Hmax . (he+0.5(hc-he)+tb)




$$< \frac{f_y \times 0.66 \times MoI_{bolt}}{\sum x_i}$$

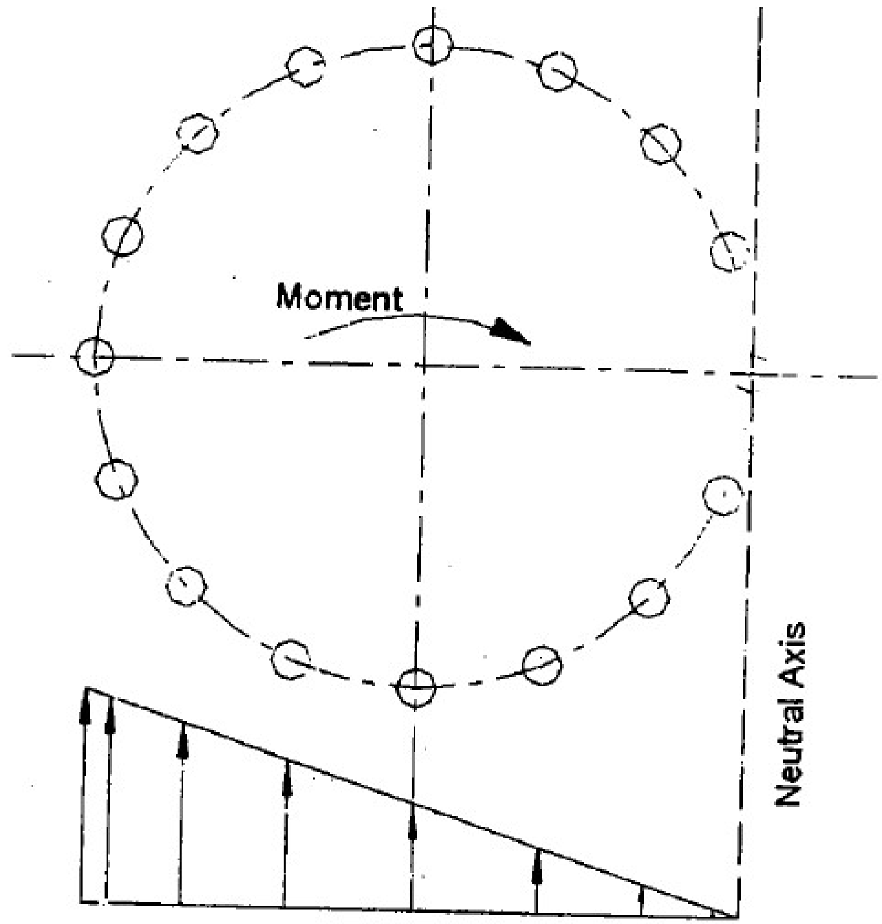
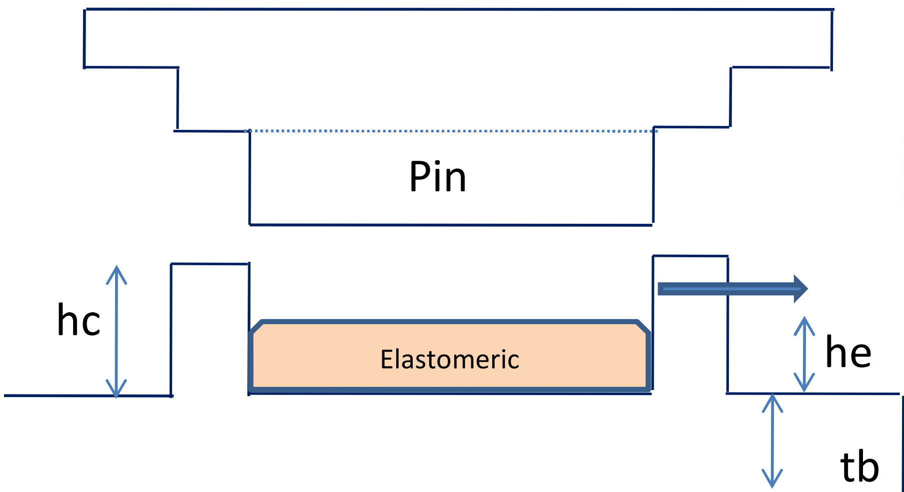



Fig. 32. Distribution of forces on bolt/screw/stud group

Fixed Pot Bearing

# Design of  Pot Cylinder

hc  ≥  he  +  pin depth  –  gap ( not less than 5mm)



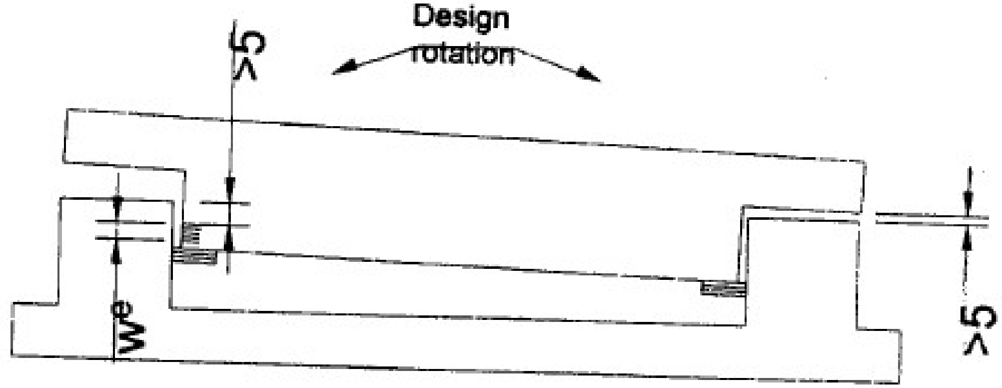
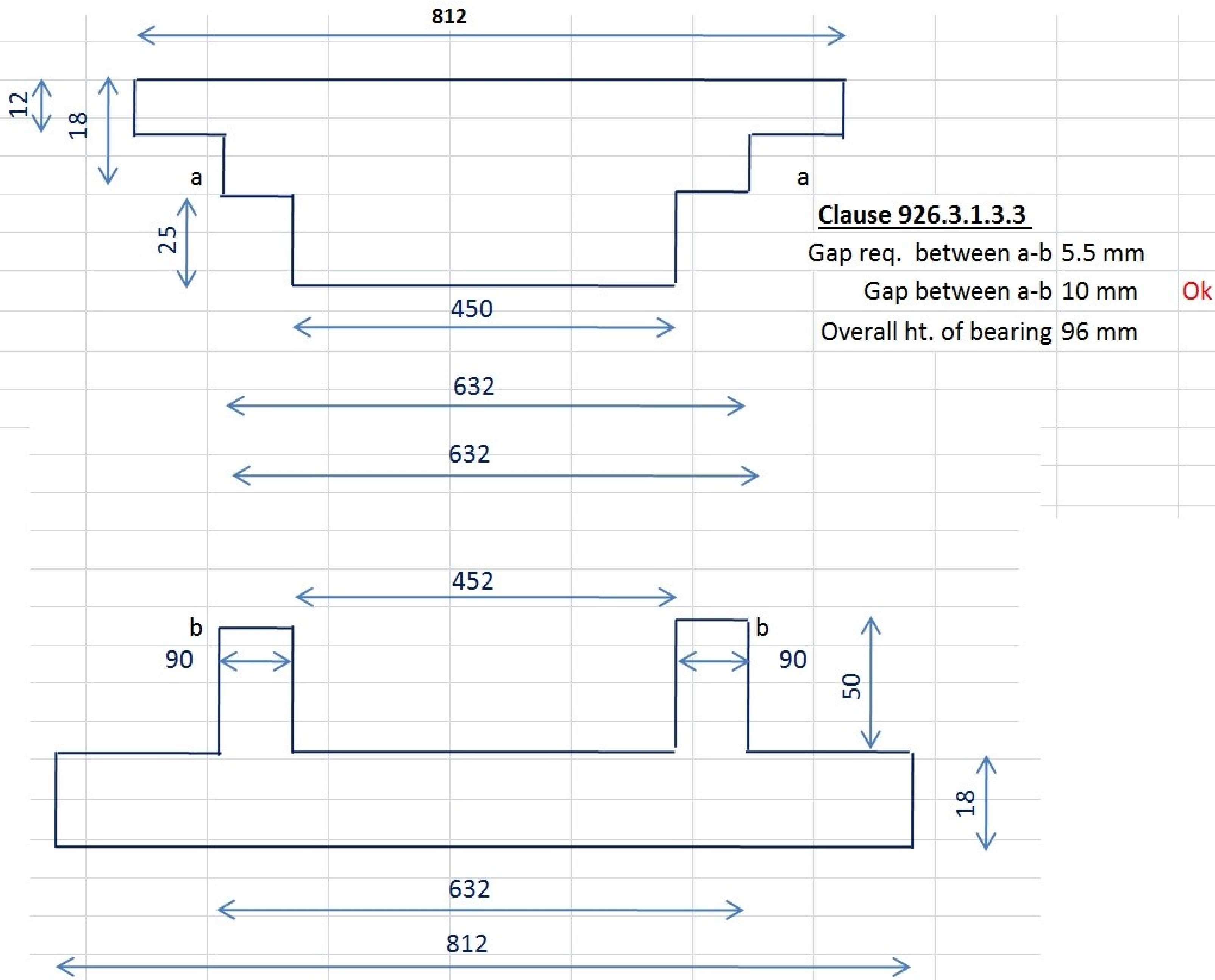




Fig. 30. Interconnection and clearance of components

**Check for**

**Tensile Stress in cylinder,Mpa**
**Hoop Tensile Stresss(Fluid Pressure+H-Force),Mpa**
**Shear stress at wall-base inerface,Mpa**
**Bending Stress  at wall-base inerface,Mpa**
**Combined Stress,Mpa**
**Hertz Stress, Mpa**
**Ave. permissible direct Bearing Stress (Concrete)**
**Actual direct bearing stress,Mpa**


812
12
18
a
a
25
450
Clause 926.3.1.3.3
Gap req. between a-b 5.5 mm
Gap between a-b 10 mm Ok
Overall ht. of bearing 96 mm
632
632
452
b
b
90
90
50
18
632
812

# Design of  Pot Cylinder

**Tensile Stress in cylinder,Mpa**

$$= \frac{H\max}{2\times hc\times bp} < 0.60\times f_y$$

**Hoop Tensile Stresss(Fluid Pressure+H-Force),Mpa**

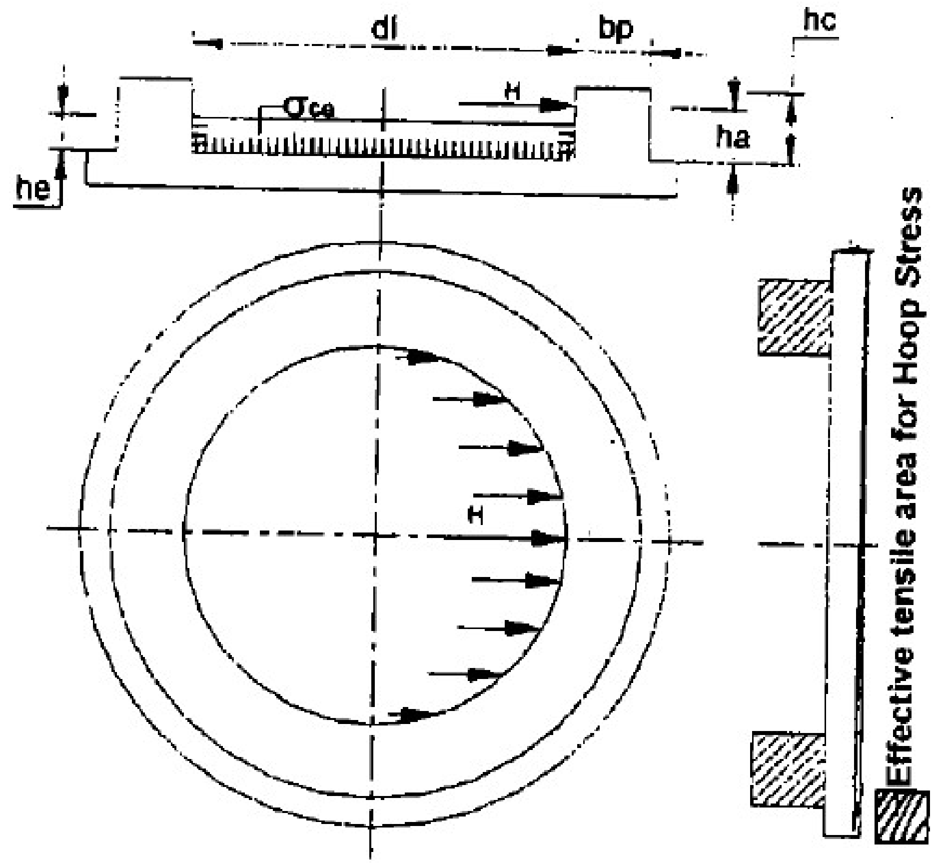



Fig. 28. Design principle of cylinder wall

# Design of  Pot Cylinder

**Hoop Tensile Stresss(Fluid Pressure+H-Force),Mpa**

926.3.1.1.7.1. Hoop tensile stress in the cross section of cylinder wall due to:

(i) Fluid pressure, $\sigma at_1 = (di \times he \times \sigma ce)/(2 \times bp \times hc)$

(ii) Horizontal force, $\sigma at_2 = H/(2 \times bp \times hc)$

Where,

| | | |
|---|---|---|
| di | = | diameter of confined elastomeric pressure pad in mm, |
| he | = | thickness of confined elastomeric pressure pad in mm, |
| $\sigma ce$ | = | fluid pressure in confined elastomeric pressure pad due to vertical load in MPa, |
| bp | = | thickness of cylinder wall in mm, |
| hc | = | height of cylinder wall in mm, |

# Design of Pot Cylinder

**Shear stress at wall-base interface,Mpa**

926.3.1.1.7.2. Shear stress at cylinder wall and base interface calculated considering 1mm radial slice of the cylinder due to:

(i) Fluid pressure, $\tau vm_1 = (he \times \sigma ce)/bp$

(ii) Horizontal force, $tvm_2 = 1.5 \times H/(di \times bp)$

Where,

Parabolic distribution factor is considered as 1.5.

**Bending Stress at wall-base interface,Mpa**

926.3.1.1.7.3. Bending stress at cylinder and base interface calculated considering 1mm radial slice of the cylinder due to:

(i) Fluid pressure, $\sigma bt1 = (6 \times \sigma ce \times he^2)/(2 \times bp^2)$

(ii) Horizontal force, $\sigma bt2 = 1.5 \times 6 \times H \times ha/(di \times bp^2)$

Where,

ha = height of line of application of design horizontal force from cylinder wall above base interface in mm,

H = design horizontal force in N,

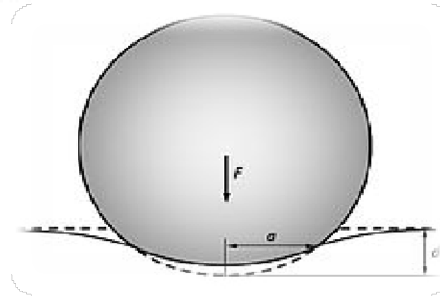
**Combined Stress,Mpa**

obtained from the following formula and shall not exceed 0.9 $fy$.

$$\sigma e,cal = \sqrt{(3 \times \tau vm,cal^2 + \sigma bt,cal^2)} \text{ or}$$

$$\sigma e,cal = \sqrt{(3 \times \tau vm,cal^2 + \sigma bc,cal^2)}$$

**Hertz Stress, Mpa**



**Hertz Stress Concept**

926.3.3.2.1. The effect of the Hertz stress ($\sigma$p,Hertz) at the mating interface shall be calculated using the following expression:

$$\sigma p,\ Hertz = 0.6 \sqrt{[\{(H \times Es)/(w_e \times dc)\} \times (1\text{-}dn/dc)]}$$

Where,

| | | |
|---|---|---|
| H | = | design horizontal force in N, |
| Es | = | static modulus of elasticity of steel in MPa. |
| $w_e$ | = | effective contact width of contact surface in mm, |
| dc | = | inner diameter of cylinder in mm. |
| dn | = | diameter of pin in mm. |

$\sigma$p, Hertz shall not exceed the value of permissible bearing stress as specified in Clause 926.2.2.

**Ave. permissible direct Bearing Stress (Concrete) > Actual direct bearing stress,**

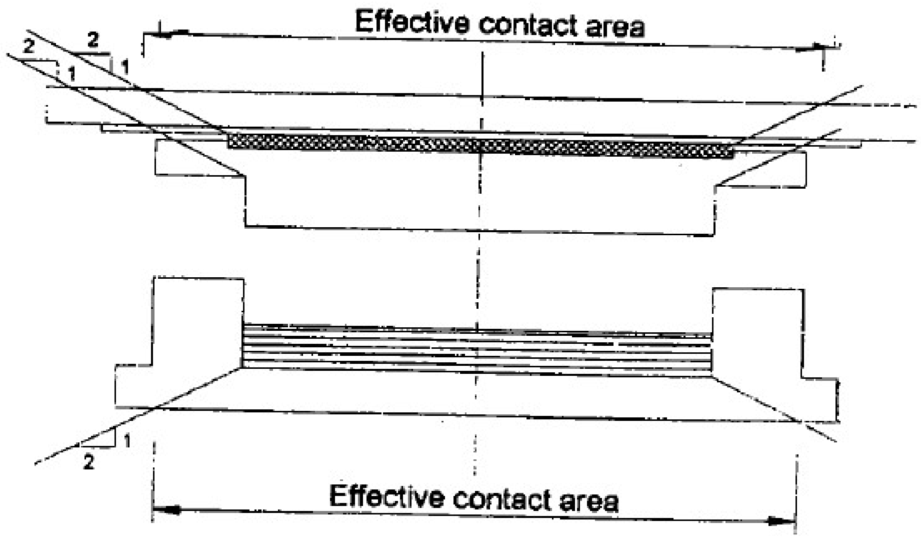



**Fig. 27. Load dispersion through bearing components**

$$\sigma cc = \sigma co \sqrt{(A_1/A_2)}$$

$\sigma co$ = permissible direct compressive stress in concrete = 0.25 $f$ck, where $f$ck is the characteristic compressive strength of concrete.

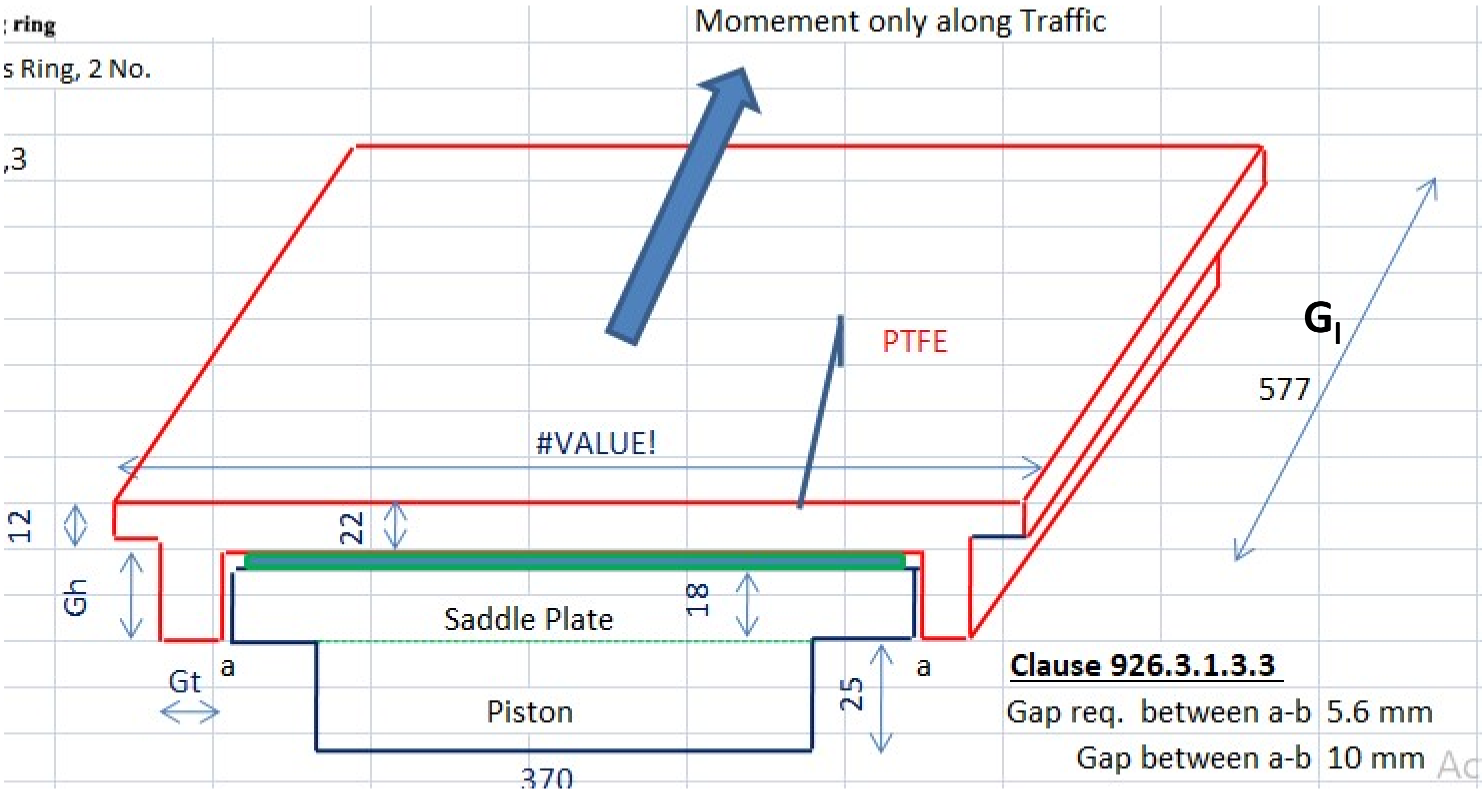
$A_1$ = dispersed concentric area, which is geometrically similar to the loaded area $A_2$ and also the largest area that can be contained in a plane of $A_1$ (maximum width of dispersion beyond the loaded area face shall be limited to twice the height).

$A_2$ = loaded area and,

$$\sqrt{(A_1/A_2)} \leq 2$$

The projection of the adjacent structure beyond the loaded area shall not be less than 150 mm. Adequate reinforcement for spalling and bursting tension shall be provided.

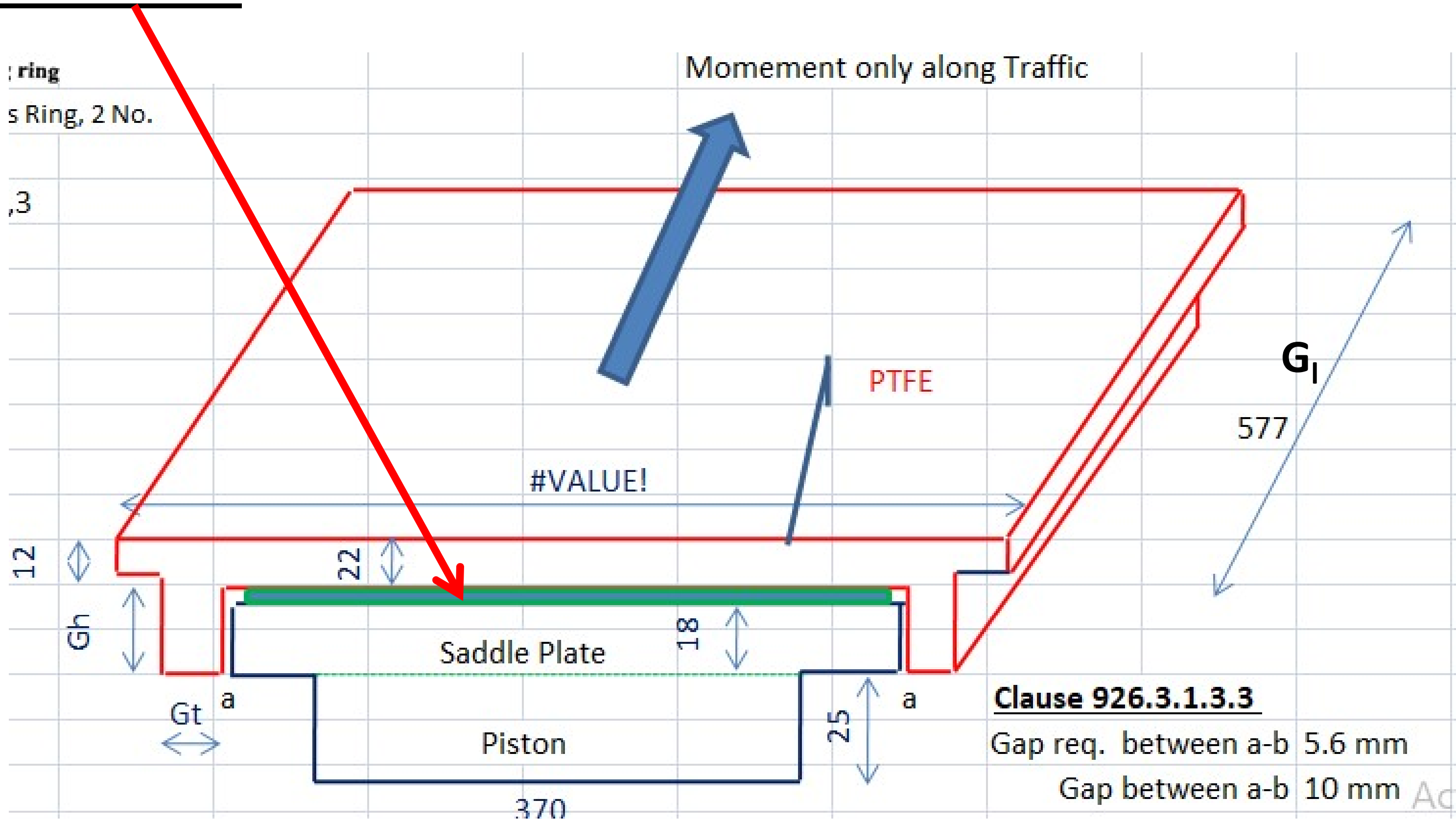
# Design of Guide




$$Shear\_Stress = \frac{H_{\max}}{Gt \times G_l}$$

$$Bending\_Stress = \frac{H_{\max} \times G_h / 2}{G_t \times G_h^2 / 6}$$

# Design of PTEF




$$Induced\_Moment = \frac{V_{max} \times \mu \times t}{2}$$

$$Bending\_Stress < 45\,MPa$$

## 2. BEARING LOADS & MOVEMENTS

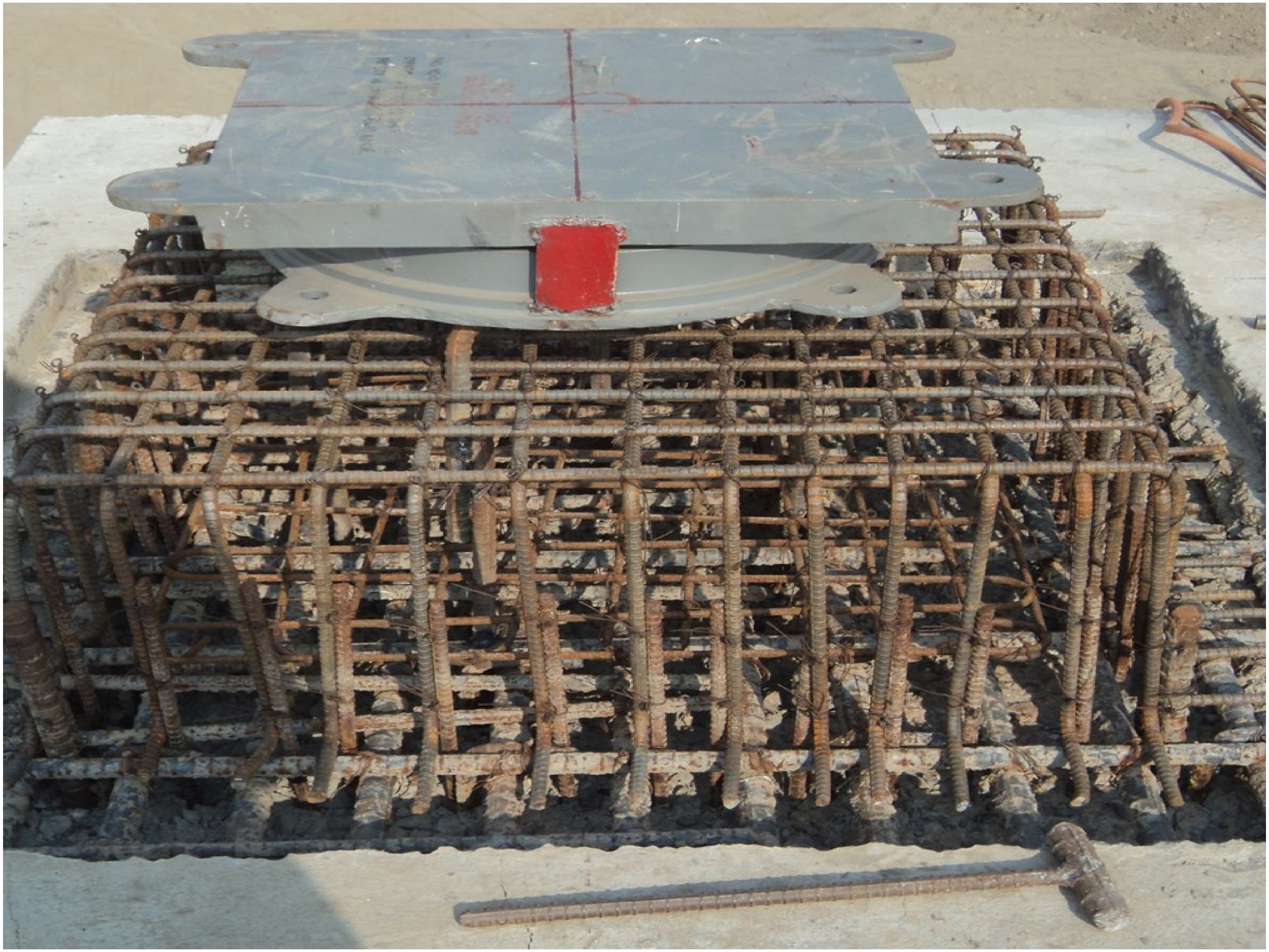
| | | NORMAL | SEISMIC Long: | SEISMIC Trans: | UNIT |
|---|---|---|---|---|---|
| A. | LOAD CAPACITY VERTICAL (MAX) | 2024 | 3028 | 2506 | KN |
| B. | LOAD CAPACITY VERTICAL (MIN) | 1332 | 1512 | 1512 | KN |
| C. | HORIZONTAL (MAX) LONGITUDINAL | 81 | 757 | 00 | KN |
| | HORIZONTAL (MAX)TRANSVERSE | 00 | 00 | 490 | KN |

| MOVEMENT | | |
|---|---|---|
| LONGITUDINAL | 0 | MM |
| LATERAL | 0 | MM |
| ROTATION | 0.0024 | RAD. |
| TOP/BOTTOM DISP. | 864/884 | MM |

## 3. MATERIAL

A. CONCRETE AT TOP BEARING SHALL BE OF M-45
CONCRETE AT BOTTOM BEARING SHALL BE OF M-45

B. CAST STEEL IN POT CYLINDER AND BASE PLATE, PISTON, SADDLE PLATE, TOP PLATE SHALL CONFIRM TO I.S.-1030 GRADE 340-570W



**Bearings**

**Bearings**


**Bearings**

Fixed/Free

## Bearings