8.3 Design of Base Plate for Thickness

8.3.1 Design of base plate for thickness (Elastic Design)

Upto this point, the chief concern has been about the concrete foundation, and methods of design have been proposed for arriving at a base plate area that will keep the permissible stress in the support within the specification. The base plate itself is subject to shear and moment. It is in effect an overhanging beam and must be analysed as such. Furthermore, since the load from an H-shaped Column is distributed differently along its two axes the base plate must be analysed in two directions.

8.3.1.1 Shear and bending moment about the X - axis:

Referring to the figure 8.4 is the upward load from the foundation is $P / H \text{ N/mm}$ along the Y axis. The share of the total load $P$ brought to the top of the base plate by each flange is assumed to be concentrate at the mid-thickness and hence the length of overhang or cantilever is $(H - d + t_f) / 2$. As may be noted from the shear diagram. The point of maximum shear is also at the mid-thickness of the column flange and is equal to load per mm multiplied by the overhang. Therefore the maximum total shear $V$ in the base plate along a line parallel with the axis and splitting the column flange is

$$V_x = \frac{P(H - d + t_f)}{2H}$$

In plotting that portion of the shear diagram beneath the column, the net upward pressure per mm must be used or $P/H - P_{tw}/A$, in which ' $A$ ' represents the cross sectional area of the column.
If there are no wind or other horizontal loads the maximum bending moment in this direction $M_x$ is at the mid thickness of the column flange and is equal to the area of the shear diagram between that point and that left end

$$M_x = \frac{P}{8H}(H - d + t_f)^2$$

Ordinates for plotting the remainder of the moment diagram and found by the usual method of taking the algebraic sum of the shear area to the left. To get the required thickness $t'$ as governed by bending moment about the X-axis the rectangular beam formula will apply

$$t_x = \sqrt{\frac{6M}{B\sigma_{bs}}}$$

$\sigma_{bs}$ - Permissible bending steal of the plate
Fig 8.4
8.3.2 Design of base plate for thickness (Limit State Method)

The required plate thickness, \( t_{req'd} \), is to be determined from the limit state of yield line formation along the most severely stressed section. A yield line develops when the cross section moment capacity is equal to its plastic moment capacity. Depending on the size of the column relative to the plate and magnitude of the factored axial load, yield line can form in various patterns on the plate. Figure 8.6 shows three model of plate failure in axially loaded plates. If the plate is large compared to the column, yield lines are assumed to form around the perimeter of the effective load bearing area (the cross-hatched area) as shown in the figure 8.6a. If the plate is small and the column factored load is light, yield lines are assumed to form around the inner perimeter of the I-shaped area as shown in figure 8.6b. If the plate is small and the column factor is heavy, yield lines are assumed to form around the inner edge of the column flanges and both side of the column web as shown in figure 8.6c.
The following equation can be used to calculate the required plate thickness:

\[ t_{req'd} = \sqrt[3]{\frac{2P_u}{0.90F_yBN}} \]
Where \( l \) is the larger of \( m, n \) and \( ln' \) given by

\[
m = \frac{(N - 0.95d)}{2}
\]
\[
n = \frac{(B - 0.80b_f)}{2}
\]
\[
n' = \frac{\sqrt{db_f}}{4}
\]

and

\[
\lambda = \frac{2\sqrt{X}}{1 + \sqrt{1 - X}} \leq 1
\]

in which

\[
X = \left( \frac{4db_f}{(d + b_f)^2} \right) \frac{p_a}{\phi \cdot P_p}
\]

### 8.3.3 Design base plate Thickness (IS: 800: Draft)

Column and base plate connections - Where the end of the column is connected directly to the base plate by means of full penetration butt welds, the connection shall be deemed to transmit to the base all the forces and moments to which the column is subjected.

Slab Bases - Columns with bases need not be provided with gussets, but sufficient fastenings shall be provided to retain the parts securely in place and to resist all moments and forces, other than direct compression, including those arising during transit, unloading and erection.
The minimum thickness, $t_s$, of the rectangular slab bases, supporting columns under axial compression shall be

$$t_s = \sqrt{2.5w(a^2 - 0.3b^2)\gamma_{m0}/f_y} > t_f$$

Where $w$ = uniform pressure from below on the slab base under the factored load axial compression

$a, b$ = larger and smaller projection of the slab base beyond the rectangle circumscribing the column, respectively

$t_f$ = flange thickness of compression member

When the slab does not distribute the column load uniformly, due to eccentricity of the load etc, special calculation shall be made to show that the base is adequate to resist the moment due to the non-uniform pressure from below.

The cap or base plate lateral dimension in any degree shall not be less than $1.5(d_o + 75)$ mm in width or diameter, where $d_o$ is the nominal diameter of the pipe column or the dimension of the column in that direction.

Bases for bearing upon concrete or masonry need not be machined on the underside.

In cases where the cap or base is fillet welded directly to the end of the column without boring and shouldering, the contact surfaces shall be machined to give a perfect bearing and the welding shall be sufficient to transmit the forces as required in slab bases. Where full strength butt welds are provided, machining of contact surfaces is not required.