Design of Base Plate Bearing on Concrete Subjected to Large Eccentricity, $e > N/2$

Loads

- Dead Load, $P_D =$ 21 kips
- Live Load, $P_L =$ 39 kips
- Moment from D.L., $M_D =$ 171 kip\cdot in
- Moment from L.L., $M_L =$ 309 kip\cdot in

Base Plate Material Properties

- Grade: $SEL("Material/ASTM"; NAME; ) =$ A36
- Yield stress, $f_{yp} =$ $TAB("Material/ASTM";F_y;NAME=Grade) =$ 36 ksi

Column, Base Plate and Pedestal Dimensions

- Concrete strength for pedestal ($f'_c$):
  $$f'_c = 3 \text{ ksi}$$
- Section: $SEL("AISC/W"; NAME; ) =$ W8X35
- Pedestal depth, $P_d =$ 28 in
- Pedestal width, $P_w =$ 28 in
- Base plate depth, $N =$ 14 in
- Base plate width, $B =$ 14 in
- Distance to bolt, $y =$ 1.50 in
- Depth of column, $d =$ $TAB("AISC/W";d; NAME=Sec.) =$ 8.1 in
- Flange of column, $b_f =$ $TAB("AISC/W";b_f;NAME=Sec.) =$ 8.0 in

Check Eccentricity Size

- $M_t =$ $M_D + M_L =$ 480 kip\cdot in
- $P_t =$ $P_D + P_L =$ 60 kips
- $e =$ $M_t/P_t =$ 8.00 in
- Check $e =$ IF($e >> N/2;"O.K.";"not O.K." ) = O.K.

(Note that: if this check was not O.K., this template will give a wrong solution)

The Ultimate Load and Moment

(Chapter 2 of ASCE/SEI 7)
$$P_u = 1.2*P_D + 1.6*P_L = 88 \text{ kips}$$
\[ M_u = 1.2M_D + 1.6M_L = 700 \text{ kip}\text{in} \]

**The Maximum Bearing Stress, \( F_b \)**

\[ \Phi_c = 0.60 \]

\[ A_1 = N\cdot B = 196.00 \text{ in}^2 \]

\[ A_2 = P_d \cdot P_w = 784.00 \text{ in}^2 \]

\[ F_{b1} = 0.85\Phi_c f'_c \sqrt[6]{(A_2/A_1)} = 3.06 \text{ ksi} \]

\[ F_{b2} = 1.7f'_c = 5.10 \text{ ksi} \]

\[ F_b = \text{MIN}(F_{b1};F_{b2}) = 3.06 \text{ ksi} \]

\[ N' = N-y = 12.50 \text{ in} \]

\[ F' = \frac{F_b \cdot B \cdot N'}{2} = 267.8 \text{ ksi} \]

Distance from the base to bolt centers (\( A' \)) is:

\[ A' = \frac{N}{2} - y = 5.50 \text{ in} \]

\[ M_1 = P_u \cdot A' + M_u = 1184 \text{ kip\text{in}} \]

\[ A_1 = \frac{F_b \cdot B}{3} \]

\[ A_2 = \frac{F_b \cdot B}{3} \]

\[ A = \text{MIN}(A_1;A_2) = 5.1 \text{ in} \]

\[ \text{Check}_A = \text{IF}(A < N;"O.K.";"not O.K." \}) = \text{O.K.} \]

(If this check was not O.K., increase plate dimensions to find a solution or check inputs)

**Tension in Bolts**

\[ T = \frac{F_b \cdot A \cdot B}{2 - P_u} = 21.2 \text{ kips} \]

**Base Plate Thickness**

The critical section is at distance (x) from the plate edge, where:

\[ x = \frac{N \cdot 0.95 \cdot d}{2} = 3.15 \text{ in} \]

The distance form the zero stress point to this section (\( x_1 \)) and the stress at this section (\( F_s \)) can be calculated as:
The factored moment for a 1-in strip at this section \( M_{s1} \) can be determined from the bearing stress distribution as follows:

\[
M_{s1} = \frac{F_s \cdot x^2}{2} + \frac{(F_b - F_s)^* \cdot x^* \cdot 0.67}{2} = 12.09 \text{ kip}\cdot\text{in}
\]

Also, the moment based on the critical section on the anchor bolt side is determined as follows (it is assumed that the critical plate width is based on the load spreading out at 45 degrees):

\[
M_{s2} = \frac{T}{2}(x-y)/(2(x-y)) = 5.30 \text{ kip}\cdot\text{in}
\]

So, the critical moment is the maximum from \( M_{s1} \) and \( M_{s2} \) as follows:

\[
M_s = \text{MAX}(M_{s1}, M_{s2}) = 12.09 \text{ kip}\cdot\text{in}
\]

\[
t_{p,\text{min}} = \sqrt{\frac{4 \cdot M_s}{0.9 \cdot f_{yp}}} = 1.22 \text{ in}
\]

Summary: Use Plate with the following Minimum Dimensions

| Plate length | N | = 14 in |
| Plate width  | B | = 14 in |
| Plate thickness | \( t_{p,\text{min}} \) | = 1.22 in |