Beam-Bearing Plates and Column Base Plates by ASD/LRFD Steel Construction Manual

An Online Continuing Education Course for Engineers

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Beam-bearing Plates and Column Base Plates by

ASD/LRFD Steel Construction Manual

13th Edition

Column Base Plates

When a steel column is supported by a footing, it is necessary for the column load to be spread over a sufficient area of the footing. We do this by a steel base plate. The base plate can be welded or by some type of welded or bolted lug angles. OSHA requires that you use no less than four anchor bolts for each column base plate. The lengths and widths of column base plates are usually selected in even inches, like 8″ X 10″. The thickness is in $^1/_8$″ increments up to 1.25 inches and $^1/_4$″ inch increments thereafter.

The design bearing strength, $\phi_c P_p$, and the allowable bearing strength, P_p/Ω_c for column bases and bearing on concrete are found in J8 of the specification.

$$\phi_c = 0.60 \text{ (LRFD)} \qquad \Omega_c = 2.50 \text{ (ASD)}$$

The nominal bearing strength, P_p, is determined as follows:

(a) On the full area of a concrete support:

$$P_p = 0.85 f'_c A_1 \qquad \text{(J8-1)}$$

(b) On less than the full area of a concrete support:

$$P_p = 0.85 f'_c A_1 \sqrt{A_2/A_1} \leq 1.7 f'_c A_1 \qquad \text{(J8-2)}$$

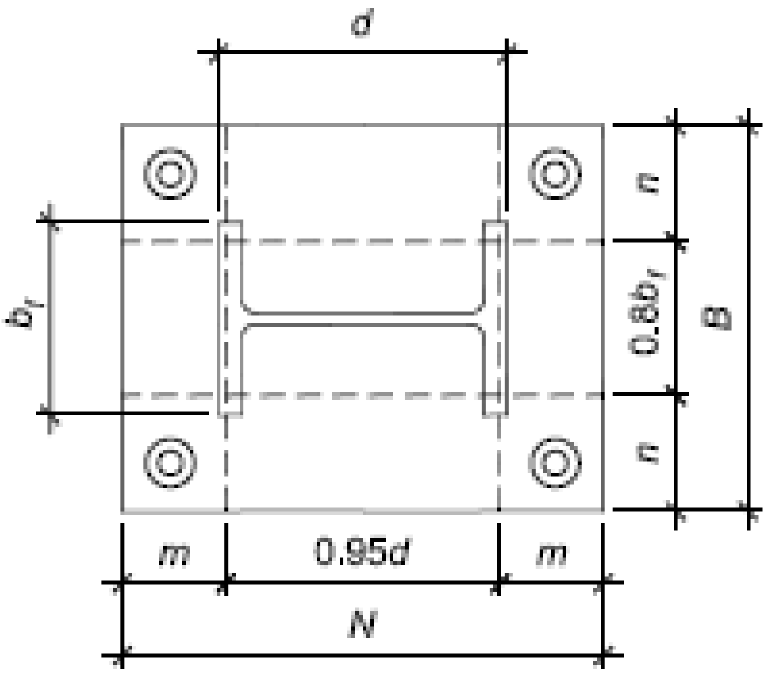
where

A_1 = area of steel concentrically bearing on a concrete support, in.^{2} (mm^2)

A_2 = maximum area of the portion of the supporting surface that is geometrically similar to and concentric with the loaded area, in.^{2} (mm^2)

Note: $\sqrt{A_2/A_1} \leq 2$

Geometry:



As you can see:

$B = 2n + 0.8b_f$ and $N = 2m + 0.95d$

Remember, B and N are usually in even inches. Also m and n should be about equal. Base plates should usually be designed with ASTM A36 material. For most wide-flange columns subject to axial compression only, a $^5/_{16}$ inch fillet weld on one side of each flange will provide adequate strength.

$$m = \frac{N - 0.95d}{2}$$

$$n = \frac{B - 0.8b_f}{2}$$

$$\lambda n' = \lambda \frac{\sqrt{db_f}}{4}$$

N = base plate length, in.

B = base plate width, in.

b_f = column flange width, in.

d = overall column depth, in.

n' = yield-line theory cantilever distance from column web or column flange, in.

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

$$X = \left\{ \frac{4db_f}{(d + b_f)^2} \right\} \frac{P_u}{\phi_c P_p} \text{ (LRFD)}$$

$$X = \left\{ \frac{4db_f}{(d + b_f)^2} \right\} \frac{\Omega_c P_a}{P_p} \text{ (ASD)}$$

where

P_u = the required axial compressive load (LRFD), kips

P_a = the required axial compressive load (ASD), kips

$$t_{min} = l\sqrt{\frac{2P_u}{\phi F_y BN}} \text{ (LRFD)}$$

$$t_{min} = l\sqrt{\frac{2\Omega P_a}{F_y BN}} \text{ (ASD)}$$

where

ϕ = resistance factor for flexure, 0.90

Ω = factor of safety for ASD, 1.67

F_y = specified minimum yield stress of base plate, ksi

Since l is the maximum value of m, n, and $\lambda n'$, the thinnest base plate can be found by minimizing m, n, and λ. This is usually accomplished by proportioning the base plate dimensions so that m and n are approximately equal.

AISC, Design Guide 1, 2nd edition mentions design procedures for three general cases of base plates subjected to axial compressive loads.

Case I:	$A_2 = A_1$
Case II:	$A_2 \geq 4A_1$
Case III:	$A_1 < A_2 < 4A_1$

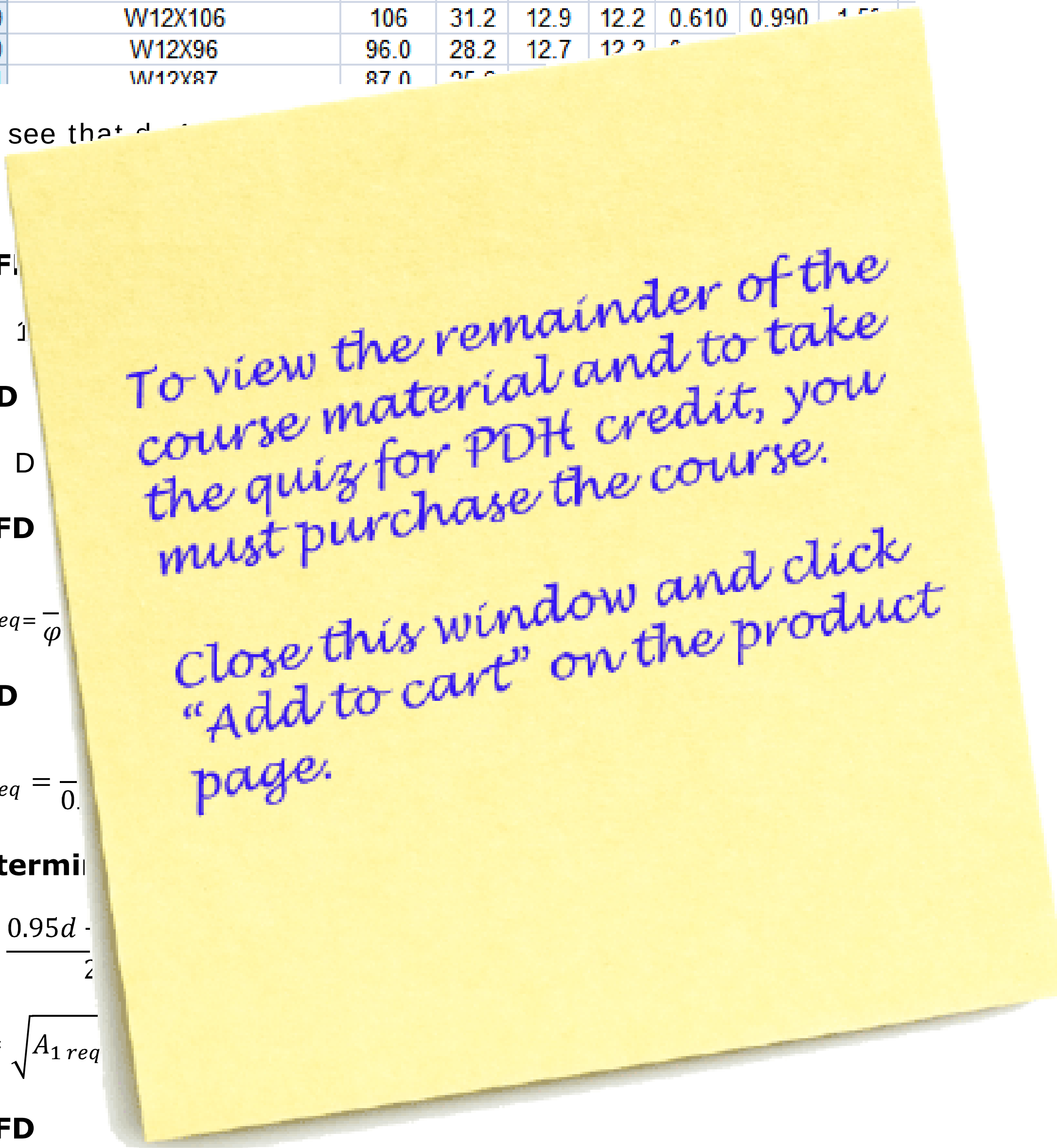
Example 1

Design a base plate for a W12 X 152 column (F_y=50 ksi) that supports a dead load of 220 kips and a live of 440 kips. Use and A36 plate (F_y=36 ksi) to cover the entire area of the 3 ksi concrete pedestal.

This would be Case I: A_2=A_1

1	Shape	Weight	Area	Depth	b_f	t_w	t_f	k_{des}
2		w	A	d				
3		lbs/ft	in^2	in	in	in	in	in
214	W12X190	190	55.8	14.4	12.7	1.06	1.74	2.33
215	W12X170	170	50.0	14.0	12.6	0.960	1.56	2.16
216	W12X152	152	44.7	13.7	12.5	0.870	1.40	2.00
217	W12X136	136	39.9	13.4	12.4	0.790	1.25	1.85
218	W12X120	120	35.3	13.1	12.3	0.710	1.11	1.70
219	W12X106	106	31.2	12.9	12.2	0.610	0.990	[illegible]
220	W12X96	96.0	28.2	12.7	[illegible]	[illegible]	[illegible]	[illegible]
221	W12X87	87.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

We see that d...



LRF

$P_u =$ 1

ASD

$P_a =$ D

LRFD

$A_{1\,req} = \frac{\ldots}{\varphi \ldots}$

ASD

$A_{1\,req} = \frac{\ldots}{0.\ldots}$

Determi

$\Delta = \frac{0.95d - \ldots}{2}$

$N \approx \sqrt{A_{1\,req} \ldots}$

LRFD

$$N = \sqrt{632.68\ in^2} + 1.508\ in = 26.66\ in\ \ now\ if\ we\ round\ up\ to\ even\ inches, N = 28\ in$$

$$B = \frac{A_1}{N} = \frac{632.68\ in^2}{28\ in} = 22.6\ in\ rounded\ up\ to\ even\ inches, B = 24\ in$$