

Example Problem 7.2

Given: In the building drawing set the column located the intersection of grids G & 12 supports some floor, roof, and exterior wall. See drawings BLDG S1 and S2.

Wanted: Select a Round HSS section that may be used at the first floor at this location.

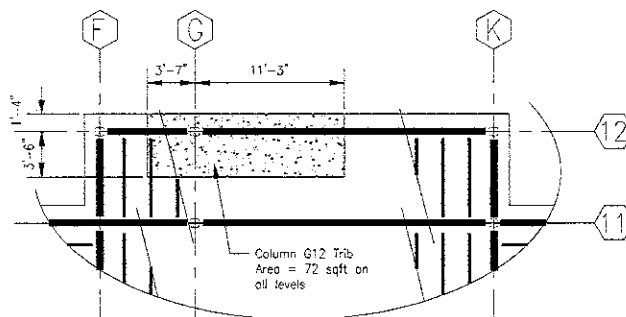
Solution:

THE COLUMN SUPPORTS
ROOF + 2 FLOORS PLUS
EXTERIOR WALL

TRIB AREA / LEVEL = 72 ϕ

LENGTH OF WALL = 14'-10"

HEIGHT OF WALL = 23'-0"



FIND UNIT LOADS FROM DRAWING

$$D = (14 + \frac{10}{12}) (23 \text{ FT}) (50 \text{ psf}) + 2 (72 \phi) (60 \text{ psf}) + (72 \phi) (150 \text{ psf}) = 29.3 \text{ K}$$

$$L = 2 (72 \phi) (40 \text{ psf}) = 5.76 \text{ K}$$

$$S = 72 \phi (50 \text{ psf}) = 3.60 \text{ K}$$

LRFD : LC-3 CONTROL (NEED TO VERIFY THIS!)

$$P_u = 1.2 D + 1.6 S + L = 1.2 (29.3) + 1.6 (3.60) + 5.76 \text{ K} = 46.7 \text{ K}$$

$$\text{REQ'D } P_n = P_u / \phi = 46.7 \text{ K} / .9 = 51.9 \text{ K}$$

ASD : LC-4

$$P_a = D + .75 (S + L) = 29.3 + .75 (3.6 + 5.76) = 36.3 \text{ K}$$

$$\text{REQ'D } P_n = \Omega P_a = 1.67 (36.3 \text{ K}) = 60.7 \text{ K}$$

STEEL: ASTM A500, GR. B, RWD

$$F_y = 42 \text{ KSI}$$

PROBLEM 7.2 (CONTINUED)

$$\text{ESTIMATE } F_{cr} \approx 30 \text{ ksi} \Rightarrow \text{REQ'D } A_g \approx \frac{51.9 \text{ k}}{30 \text{ ksi}} = 1.73 \text{ in}^2$$

- NOTE, WE ARE LOOKING FOR LRFD COLUMN 1ST, THEN WILL LOOK FOR ASD.

- IT IS HELPFUL TO SORT THE RND HSS SHAPE BY A_g USING THE DATABASE PROVIDED WITH THE SCM.

$$\rightarrow \text{TRY HSS } 3 \times 0.216, A_g = 1.77 \text{ in}^2, D/t = 14.9, r = .992 \text{ in}$$

COLUMN LENGTH $\approx 10.67'$; $K_x = K_y = 1.0$ (NO MOMENT CONNECTIONS TO BEAMS OR FOUNDATION)

CHECK COMPACT CRITERIA (CASE 15)

$$D/t = 14.9 \leq .11 \frac{29000}{42} = 75.95 \therefore \text{NOT SLENDER}$$

$$KL/r = \frac{(1)(10.67)(12)}{.992} = 129 \not\leq 4.71 \sqrt{\frac{29000}{42}} = 124 \therefore \text{EQ E3-3}$$

$$F_e = \frac{\pi^2 (29000 \text{ ksi})}{(129)^2} = 17.2 \text{ ksi}$$

$$F_{cr} = .877 (17.2 \text{ ksi}) = 15.1 \text{ ksi}$$

$$P_N = (15.1 \text{ ksi})(1.77 \text{ in}^2) = 26.7 \text{ k} \neq \text{REQ'D } P_N = 51.9 \text{ k} \therefore \text{NG}$$

TRY MOVING UP THE SORTED SIZE TABLE TO A MEMBER W/ LARGER DIAMETER:

$$\rightarrow \text{TRY HSS } 3.5 \times 0.203, A_g = 1.97, D/t = 18.5, r = 1.17$$

$$D/t = 18.5 \leq 76 \therefore \text{NOT SLENDER}$$

$$KL/r = \frac{10.67(12)}{1.17} = 109.4 \leq 124 \therefore \text{EQ E3-2}, F_e = 23.9$$

$$F_{cr} = (42 \text{ ksi}) \left[.658^{(43/23.9)} \right] = 20.1 \text{ ksi}$$

$$P_N = 20.1 \text{ ksi} (1.97 \text{ in}^2) = 39.7 \neq \text{REQ'D } P_N = 51.9 \text{ k} \therefore \text{NG}$$

PROBLEM 7.2 (CONTINUED)

JBO 3/4

→ TRY HSS 3.5 x .216, $A_g = 2.08 \text{ in}^2$, $D/t = 17.4$, $r = 1.17$

$D/t = 17.4 \leq 76 \therefore$ NOT SLENDER

$\frac{KL}{r} = 109.4 \leq 124 \therefore$ EQ E3-2 ; $F_e = 23.9 \text{ ksi}$

$F_{cr} = (42 \text{ ksi}) \left[.658^{(42/23.9)} \right] = 20.1 \text{ ksi}$

$P_n = (20.1 \text{ ksi})(2.08 \text{ in}^2) = 41.9 \text{ k}$

$\frac{\text{REQ'D } P_n}{P_n} = 1.24 \not\leq 1.0 \therefore$ NG

REQ'D P_n IS 24%
OVER CAPACITY
OF CURRENT SELECTION

→ TRY HSS 4 x 0.188, $A_g = 2.09 \text{ in}^2$, $D/t = 23.0$, $r = 1.35 \text{ in}$

$D/t = 23.0 \leq 76 \therefore$ NOT SLENDER

$\frac{KL}{r} = 94.8 \leq 124 \therefore$ EQ 3-2 ; $F_e = 31.8 \text{ ksi}$

$F_{cr} = (42 \text{ ksi}) \left[.658^{(42/31.8)} \right] = 24.2 \text{ ksi}$

$P_n = (24.2 \text{ ksi})(2.09 \text{ in}^2) = 50.5 \text{ ksi}$

LRFD $\frac{\text{REQ'D } P_n}{P_n} = \frac{51.9}{50.5} = 1.03$ { CAN BE CONSIDERED CLOSE
ENOUGH DUE TO CONSERVATIVE
ASSUMPTIONS IN LOAD CALCS
ASD $\frac{\text{REQ'D } P_n}{P_n} = \frac{60.7}{50.5} = 1.20 \not\leq 1.0 \therefore$ NG } COLUMN KL.

→ TRY HSS 5.563 x 0.134, $D/t = 44.9$, $A_g = 2.12 \text{ in}^2$, $r = 1.92 \text{ in}$

$D/t = 44.9 \leq 76 \therefore$ NOT SLENDER

$KL/r = 66.7 \leq 124 \therefore$ EQ E3-2 ; $F_e = 64.4 \text{ ksi}$

$F_{cr} = (42 \text{ ksi}) \left[.658^{(42/64.4)} \right] = 32.0 \text{ ksi}$

$P_n = 32.0 \text{ ksi}(2.12 \text{ in}^2) = 67.8 \text{ k}$

LRFD $\frac{\text{REQ'D } P_n}{P_n} = \frac{51.9}{67.8} = \underline{\underline{0.765 \leq 1.0 \therefore \text{OK}}}$ LOTS OF RESERVE
CAPACITY

PROBLEM 7.2 (CONTINUED)

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$$\frac{ASD \text{ REQ'D } P_u}{P_n} = \frac{60.7}{67.8} = .895 \leq 1.0 \text{ is GOOD!}$$

SOLUTION SUMMARY

LRFD: HSS 4 x 0.188 IS PROBABLY CLOSE ENOUGH
HOWEVER HSS 5.563 x 0.134 GETS SIGNIFICANTLY
MORE CAPACITY FOR A VERY SLIGHT INCREASE
IN WEIGHT

USE: HSS 5.563 x 0.134

ASD: THE HSS 4 x 0.188 DOES NOT WORK FOR ASD

USE: HSS 5.563 x 0.134

NOTE: THE INITIAL GUESS FOR F_{cr} WAS OFF, WHICH MADE
THE SEARCH A LITTLE LOWER THAN IT COULD HAVE BEEN!