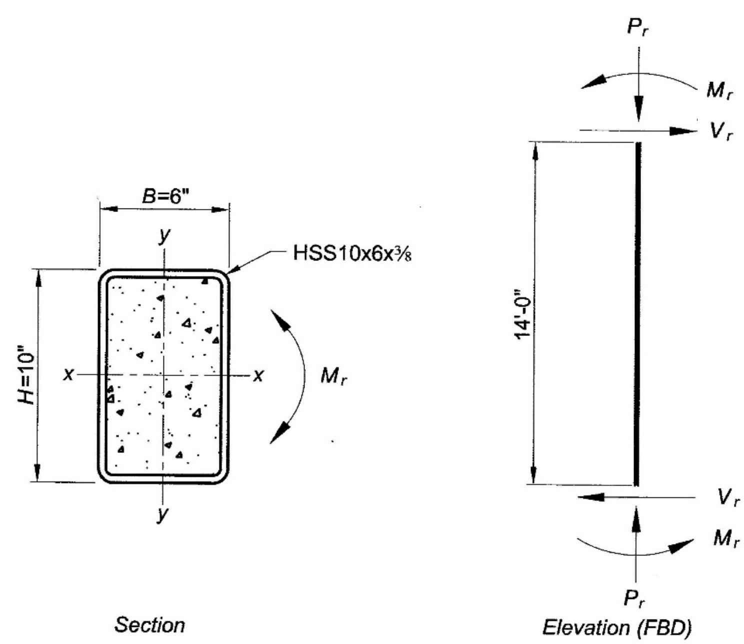
AISC-360-10 Example 003

COMPOSITE COLUMN DESIGN

EXAMPLE DESCRIPTION

Determine if the 14-ft.-long filled composite member illustrated below is adequate for the indicated axial forces, shears, and moments. The composite member consists of an ASTM A500 Grade B HSS with normal weight (145 lb/ft^3) concrete fill having a specified compressive strength, $f_c' = 5$ ksi.

GEOMETRY, PROPERTIES AND LOADING



Section
Elevation (FBD)

Member Properties	Loading	Geometry
HSS10x6 x⅜	P_r = 129.0 kips	Height, L = 14 ft
E = 29,000 ksi	M_r = 120.0 kip-ft	
F_y = 46 ksi	V_r = 17.1 kips	

TECHNICAL FEATURE OF ETABS TESTED

Tension capacity of composite column design.

RESULTS COMPARISON

Independent results are referenced from Example I.1 from the AISC Design Examples, Version 14.0.

Output Parameter	ETABS	Independent	Percent Difference
Required Strength, F_u (k)	129	129	0.00%
Available Strength, ΦP_n (kip)	342.9	354.78	-3.35%
Required Strength, M_u (k-ft)	120	120	0.00%
Available Strength, $\Phi_b M_n$ (k-ft)	130.58	130.5	0.06%
Interaction Equation H1-1a	1.19	1.18	0.85%

COMPUTER FILE: AISC-360-10 EXAMPLE 003.EDB

CONCLUSION

The ETABS results show an acceptable comparison with the independent results.

HAND CALCULATION

Properties:

Materials:

ASTM A500 Grade B Steel

E = 29,000 ksi, F_y = 46 ksi, F_u = 58 ksi

5000 psi normal weight concrete

E_c = 3,900 ksi, $f_c' = 5$ ksi, w_{concrete} = 145 pcf

Section dimensions and properties:

HSS10x6x⅜

H = 10.0 in, B= 6.00 in, t = 0.349 in

A_s = 10.4 in^2, I_{sx} = 137 in^4, Z_{sx}=33.8 in^3, I_{sy} = 61.8 in^4

Concrete area

h_t = 9.30 in., b_t = 5.30 in., A_c = 49.2 in.2, I_{cx} = 353 in^4, I_{cy} = 115 in^4

Compression capacity:

Nominal Compressive Strength:

$\Phi_c P_n$= 354.78 kips as computed in Example I.4

Bending capacity:

Maximum Nominal Bending Strength:

Z_{sx} = 33.8 in^3

$$Z_c = \frac{b_i \bullet h_i^2}{4} - 0.192 \bullet r_i^3 \text{ where } r_i = t$$

$$= \frac{5.30 \bullet (9.30)^2}{4} - 0.192 \bullet (0.349)^3 = 114.7 \text{ in.}^3$$

$$M_D = F_y \bullet Z_{sx} + \frac{0.85 \bullet f_c' \bullet Zc}{2}$$

$$= 46 \bullet 33.8 + \frac{0.85 \bullet 5 \bullet 115}{2} = \frac{1{,}798.5 \text{ kip-in.}}{12 \text{ in./ft}} = 149.9 \text{ kip-ft}$$

Available Bending Strength:

$$h_n = \frac{0.85 \bullet f_c' \bullet A_c}{2(0.85 \bullet f_c' \bullet b_i + 4 \bullet t \bullet F_y)} \le \frac{h_i}{2}$$

$$= \frac{0.85 \bullet 5 \bullet 49.2}{2(0.85 \bullet 5 \bullet 5.30 + 4 \bullet 0.349 \bullet 50)} \le \frac{9.30}{2}$$

$$= 1.205 \le 4.65$$

$$= 1.205 \text{ in.}$$

$$Z_{sn} = 2 \bullet t \bullet h_n^2 = 2 \bullet 0.349 \bullet (1.205)^2 = 1.01 \text{ in.}^3$$

$$Z_{cn} = b_i \bullet h_n^2 = 5.30 \bullet (1.205)^2 = 7.70 \text{ in.}^3$$

$$M_{nx} = M_D - F_y \bullet Z_{sn} - \frac{0.85 \bullet f_c' \bullet Z_{cn}}{2}$$

$$= 1,800 - 46 \bullet 1.02 - \frac{0.85 \bullet 5 \bullet 7.76}{2} = \frac{1,740 \text{ kip-in.}}{12 \text{ in./ft}} = 144.63 \text{ kip-ft}$$

$$\Phi_b M_{nx} = 0.9 \bullet 144.63 = 130.16 \text{ kip-ft}$$

Interaction Equation H1-1a:

$$\frac{P_u}{\Phi_c \bullet Pn} + \frac{8}{9}\left(\frac{M_u}{\Phi_b \bullet M_n}\right) \le 1.0$$

$$\frac{129}{354.78} + \frac{8}{9}\left(\frac{120}{130.16}\right) \le 1.0$$

1.18 > 1.0 **n.g.**