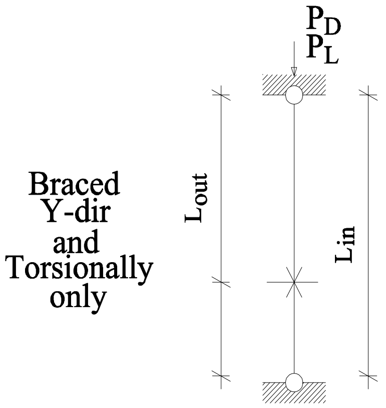
Design of W-Shapes Subjected to Axial Compression



Materials

Grade:	SEL("Material/ASTM"; NAME;)	=	A992
F_y=	TAB("Material/ASTM";F_y;NAME=Grade)	=	50.00
E=			29000 ksi

Buckling Lengths

kL_{in}=	30.00 ft
kL_{out}=	15.00 ft

(kL_{in} and kL_{out} are unbraced lengths for the strong- and weak-axes)

Axial Loads

Dead load, P_D=			140 kips
Live load, P_L=			420 kips

From Chapter 2 of ASCE/SEI 7, the required compressive strength is:

Ultimate load, P_u=	$1.2*P_D+1.6*P_L$	=	840 kips

Section Details

sec.:	SEL("AISC/W";NAME;)	=	W14X90
depth, d=	TAB("AISC/W";d;NAME=sec.)	=	14.00 in
Web th., t_w=	TAB("AISC/W";t_w;NAME=sec.)	=	0.44 in
Flange width, b_f=	TAB("AISC/W";b_f;NAME=sec.)	=	14.50 in
Flange th., t_f=	TAB("AISC/W";t_f;NAME=sec.)	=	0.71 in
Area, A=	TAB("AISC/W";A;NAME=sec.)	=	26.50 in^2
r_x=	TAB("AISC/W";r_x;NAME=sec.)	=	6.14 in
r_y=	TAB("AISC/W";r_y;NAME=sec.)	=	3.70 in

(r_x and r_y are the radius of gyration about x- and y-axes, respectively)

Element Classification (According to Table B4-1)

(1) Web:

h/t_w, λ_w= TAB("AISC/W";h/t_w;NAME=sec.) = 25.90

According to AISC Specification Table B4.1 Case 10, the limiting width-to-thickness ratio for non-compact web is:

Web_Class= IF($\lambda_w \le 1.49 * \sqrt{(E/F_y)}$;"Non-Compact";"Slender") = Non-Compact

(2) Flanges:

$b_f/2t_f$, λ_f= TAB("AISC/W";$b_f/2t_f$;NAME=sec.) = 10.20

According to AISC Specification Table B4.1 Case 4, the limiting width-to-thickness ratio for non-compact flange is:

k_c= MIN(MAX(4/$\sqrt{(\lambda_w)}$;0.35);0.76) = 0.76

λ_{rf}= $0.64*\sqrt{(k_c*E/F_y)}$ = 13

Fl_Class= IF($\lambda_f \le \lambda_{rf}$;"Non-Compact";"Slender") = Non-Compact

Slenderness Check (According to Section E2)

For members designed on the basis of compression, the slenderness ratio KL/r preferably should not exceed 200.

$\lambda_x = \frac{kL_{in}}{r_x}*12$ = 58.6

$\lambda_y = \frac{kL_{out}}{r_y}*12$ = 48.6

Then, the governed slenderness (λ_{max}):

λ_{max}= MAX(λ_x;λ_y) = 58.6

Critical Stresses

The available critical stresses may be interpolated from AISC Manual Table 4-22 or calculated directly as follows:

-Calculate the elastic critical buckling stress, F_e:

$F_e = \frac{\pi^2 * E}{\lambda_{max}^2}$ = 83.3 ksi

-Calculate the flexural buckling stress, F_{cr} (Eqns. E3-2 and E3-3):

λ_1= $4.71*\sqrt{(E/F_y)}$ = 113

F_{cr}= IF($\lambda_{max} \le \lambda_1$; $0.658^{(F_y/F_e)}*F_y$;$0.877*F_e$) = 38.9 ksi

Nominal Compressive Strength (Eqn. E3-1)

P_n= $F_{cr}*A$ = 1031 kips

Φ_v= 0.90

$\Phi_v P_n$= Φ_v*P_n = 928 kips

Compressive stress_safety (S_s):

S_s=	IF(Φ_v*P_n>Pu;"Safe";"Unsafe")	=	Safe
Stress_ratio=	P_u/(Φ_v*P_n)	=	0.91

Design Summary

Ultimate load, P_u=	1.2*P_D+1.6*P_L	=	840 kips
Design load, $\Phi_v P_n$=	Φ_v*P_n	=	928 kips
Stress_ratio=	P_u/(Φ_v*P_n)	=	0.91
S_s=	IF(Φ_v*P_n>Pu;"Safe";"Unsafe")	=	Safe