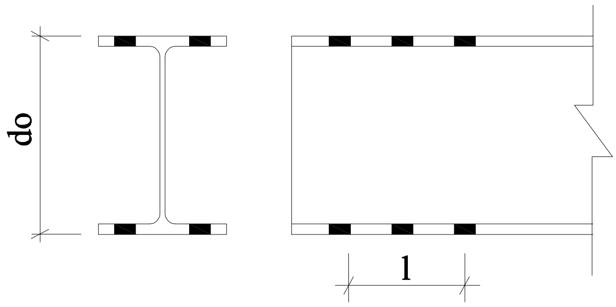
Design of W-Shapes Subjected to Tension Force in a Bolted Connection



Materials

Grade:	SEL("Material/ASTM"; NAME;)	=	A992
F_y=	TAB("Material/ASTM";F_y;NAME=Grade)	=	50 ksi
F_u=	TAB("Material/ASTM";F_u;NAME=Grade)	=	65 ksi

Buckling Lengths

Member length, L=			25.00 ft

Axial Loads

Axial dead load, P_D=			30 kips
Axial Live load, P_L=			90 kips

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

Ultimate load, P_u=	$1.2*P_D+1.6*P_L$	=	180 kips

Section and Connection Details

sec.:	SEL("AISC/W";NAME;)	=	W12X106
depth, d_o=	TAB("AISC/W";d;NAME=sec.)	=	12.90 in
Web th., t_w=	TAB("AISC/W";t_w;NAME=sec.)	=	0.61 in
Flange width, b_f=	TAB("AISC/W";b_f;NAME=sec.)	=	12.20 in
Flange th., t_f=	TAB("AISC/W";t_f;NAME=sec.)	=	0.99 in
Gross Area, A_g=	TAB("AISC/W";A;NAME=sec.)	=	31.20 in^2
r_x=	TAB("AISC/W";r_x;NAME=sec.)	=	5.47 in
r_y=	TAB("AISC/W";r_y;NAME=sec.)	=	3.11 in

(r_x and r_y are the radius of gyration about x- and y- axis)

Rounded depth, d_{WT}=	TAB("AISC/W";d_{WT};NAME=sec.)	=	13.00 in
WT=	TAB("AISC/WT";NAME;$d_{ro}=d_{WT}/2$)	=	WT6X53
y =	TAB("AISC/WT"; y;NAME=WT)	=	1.190 in
Bolt_diameter:	SEL("AISC/Bolt";Size;)	=	d3/4
d_b=	TAB("AISC/Bolt";dia;Size=Bolt_diameter)	=	0.750 in
hole diameter, d_h=	$d_b+1/16$	=	0.813 in

Connection length, l = 9.00 in

Check Tensile Yielding

From AISC Manual Table 5-1, the tensile yielding strength is:

Φ_{t1} = 0.90

P_{n1}= $\Phi_{t1} * F_y * A_g$ = 1404.0 kips

Yield_safety= IF($P_u \le P_{n1}$;"Safe";"Unsafe") = Safe

Check Tensile Rupture

Calculate the shear lag factor, U, as the larger of the values from AISC specification section D3, Table D3.1 case 2 and case 7. From AISC Specification Section D3, for open cross sections, U need not be less than the ratio of the gross area of the connected element(s) to the member gross area.

U_1= $\frac{2 * b_f * t_f}{A_g}$ = 0.774

Case 2: Check as two WT-shapes per AISC Specification Commentary Figure C-D3.1

U_2= $1 - \frac{y}{l}$ = 0.868

Case 7:

U_3= IF($b_f \ge 2/3 * d_o$; 0.90; 0.85) = 0.900

U = MAX(U_1;U_2;U_3) = 0.900

Effective Net Area

Calculate A_n using AISC Specification Section B4.3.

A_n= $A_g - 4 * (d_h + 1/16) * t_f$ = 27.73 in^2

Calculate A_e using AISC Specification Section D3

A_e= $A_n * U$ = 24.96 in^2

Available Tensile Rupture Strength

P_2= $F_u * A_e$ = 1622.4 kips

Φ_{t2}= 0.75

P_{n2}= $P_2 * \Phi_{t2}$ = 1216.8 kips

Rupture_safety= IF($P_u \le P_{n1}$;"Safe";"Unsafe") = Safe

Slenderness Check (According to section D1)

For members designed on the basis of compression, the slenderness ratio KL/r should not exceed 300.

λ_{max}= $\frac{L}{r_y} * 12$ = 96.5

Slenderness_limit= IF($\lambda_{max} \le 300$; "Safe"; "Unsafe") = Safe

Design Summary

Ultimate load, P_u=	$1.2*P_D+1.6*P_L$	=	180.0 kips
P_{n1}=	$\Phi_{t1} * F_y * A_g$	=	1404.0 kips
Yield_safety=	IF($P_u \le P_{n1}$;"Safe";"Unsafe")	=	Safe
P_{n2}=	$P_2 * \Phi_{t2}$	=	1216.8 kips
Rupture_safety=	IF($P_u \le P_{n1}$;"Safe";"Unsafe")	=	Safe
Slenderness_limit=	IF($\lambda_{max} \le 300$; "Safe"; "Unsafe")	=	Safe