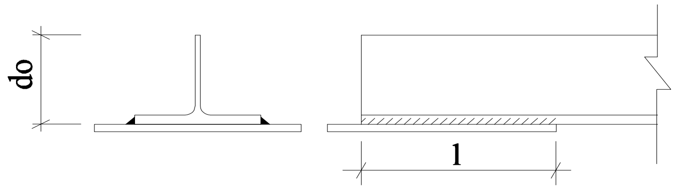
Design of WT-Shapes Subjected to Tension Force in Welded Connections



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 Length

Member length, L= 30.00 ft

Axial Loads

Axial dead load, P_D= 40 kips

Axial Live load, P_L= 120 kips

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

Ultimate load, P_u= $1.2*P_D+1.6*P_L$ = 240 kips

Section and Connection Details

sec.: SEL("AISC/WT";NAME;) = WT6X20

depth, d_o= TAB("AISC/WT";d;NAME=sec.) = 5.97 in

Web th., t_w= TAB("AISC/WT";t_w;NAME=sec.) = 0.29 in

Flange width, b_f= TAB("AISC/WT";b_f;NAME=sec.) = 8.01 in

Flange th., t_f= TAB("AISC/WT";t_f;NAME=sec.) = 0.515 in

Gross Area, A_g= TAB("AISC/WT";A;NAME=sec.) = 5.84 in^2

r_x= TAB("AISC/WT";r_x;NAME=sec.) = 1.57 in

r_y= TAB("AISC/WT";r_y;NAME=sec.) = 1.94 in

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

Distance to centroid, y = TAB("AISC/WT"; y;NAME=sec.) = 1.09 in

Connection length, l = 16.00 in

Check Tensile Yielding

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

Φ_{t1} = 0.90

P_{n1}= $\Phi_{t1} * F_y * A_g$ = 262.8 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.

$U_1 = \frac{b_f * t_f}{A_g}$ = 0.706

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

$U_2 = 1 - \frac{y}{l}$ = 0.932

Case 7:

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

U = MAX(U_1;U_2;U_3) = 0.932

Effective Net Area

Calculate A_n using AISC Specification Section B4.3.

$A_n = A_g$ = 5.8 in^2

Calculate A_e using AISC Specification Section D3

$A_e = A_n * U$ = 5.4 in^2

Available Tensile Rupture Strength

$P_2 = F_u * A_e$ = 351.0 kips

Φ_{t2}= 0.75

$P_{n2} = P_2 * \Phi_{t2}$ = 263.3 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.

r_{min}= MIN(r_x; r_y) = 1.57 in

$\lambda_{max} = \frac{L}{r_{min}} * 12$ = 229.3

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

Design Summary

Ultimate load, P_u= 1.2*P_D+1.6*P_L = 240.0 kips

P_{n1}= $\Phi_{t1} * F_y * A_g$ = 262.8 kips

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

P_{n2}= $P_2 * \Phi_{t2}$ = 263.3 kips

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

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