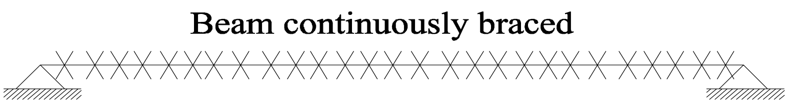
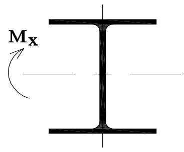
Mx Continuously Braced W-Shape	AISC Page: 1

Design of W-Shapes Subjected to Moment about Strong Axis and Continuously Braced





Materials

Grade:	SEL("Material/ASTM";NAME;)	=	A992
F_y=	TAB("Material/ASTM";F_y;NAME=Grade)	=	50 ksi
E=			29000 ksi

Beam Length and Cb

Total length, L= 35.00 ft

Design Moments and Uniform Live Load

Ultimate moment, M_u= 200.00 kip*ft

Ultimate moment due to live load case, M_L= 140.00 kip*ft

Ultimate shear, Q_u= 30.00 kips

Section Details

sec.:	SEL("AISC/W";NAME;)	=	W21X48
depth, d=	TAB("AISC/W";d;NAME=sec.)	=	20.60 in
Web th., t_w=	TAB("AISC/W";t_w;NAME=sec.)	=	0.35 in
Flange width, b_f=	TAB("AISC/W";b_f;NAME=sec.)	=	8.14 in
Flange th., t_f=	TAB("AISC/W";t_f;NAME=sec.)	=	0.43 in
Plastic sec. modulus, Z_x=	TAB("AISC/W";Z_x;NAME=sec.)	=	107.00 in^3
Elastic sec. modulus, S_x=	TAB("AISC/W";S_x;NAME=sec.)	=	93.00 in^3
Inertia about x-axis, I_x=	TAB("AISC/W";I_x;NAME=sec.)	=	959.00 in^4
r_y=	TAB("AISC/W";r_y;NAME=sec.)	=	1.66 in
r_{ts}=	TAB("AISC/W";r_{ts};NAME=sec.)	=	2.05 in

(r_y is radius of gyration about y-axis and r_{ts} : is effective radius of gyration for the L.T.B.)

Torsional constant, J=	TAB("AISC/W";J;NAME=sec.)	=	0.80 in^4
h_o=	TAB("AISC/W";h_o;NAME=sec.)	=	20.20 in

(h_o is the distance between C.L. of flanges)

AISC Specification Eqn. (F2-1):

Yielding Moment, M_p= Z_x*F_y*1/12 = 446 kip*ft

Element Classification

(1) Web:

h/t_w, λ_w= TAB("AISC/W";h/t_w;NAME=sec.) = 53.60

According to AISC Specification Table B4.1 Case 9, the limiting width-to-thickness ratio for the web is:

Web_Class= IF($\lambda_w \le 3.76*\sqrt{(E/F_y)}$;"Compact"; "Non-Compact") = Compact

(2) Comp. flange:

$b_f/2t_f$, λ_f= TAB("AISC/W";$b_f/2t_f$;NAME=sec.) = 9.47

According to AISC Specification Table B4.1 Case 1, the limiting width-to-thickness ratios for the compression flange are:

λ_{pf}= $0.38*\sqrt{(E/F_y)}$ = 9

λ_{rf}= $1.00*\sqrt{(E/F_y)}$ = 24

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

Because the beam is continuously braced, and therefore not subjected to lateral-torsional buckling, the available strength is governed by AISC Specification Sections F3.1 and F3.2. The nominal flexural moment is calculated as follows, satisfying the condition of compression Flange Local Buckling:

M_{n1a}= $M_p-0.7*F_y*S_x*1/12$ 174.75 kip*ft

M_{n1}= IF(Fl_Class="Compact"; M_p; $(M_p-(M_{n1a})*(\frac{\lambda_f-\lambda_{pf}}{\lambda_{rf}-\lambda_{pf}})))$ = 441 kip*ft

Check The Available Flexure Strength

ΦM_n= $0.90*MIN(M_p;M_{n1})$ = 397 kip*ft

Safety= IF($\Phi M_n \ge M_u$;"Safe";"Unsafe") = Safe

Moment_ratio= $M_u/\Phi M_n$ = 0.50

Check Shear Strength

h/t_w, λ_w= TAB("AISC/W";h/tw;NAME=sec.) = 53.6

λ_{w0}= $2.24*\sqrt{(E/Fy)}$ = 53.9

λ_{w1}= $1.10*\sqrt{(5*E/F_y)}$ = 59.2

λ_{w2}= $1.37*\sqrt{(5*E/F_y)}$ = 73.8

Except for very few sections, which are listed in the User Note, AISC Specification Section G2.1(a) is applicable to the I-shaped beams published in the AISC Manual for F_y = 50 ksi. C_v is calculated exactly according to Eqns. G2-2, G2-3, G2-4, and G2-5

C_v= IF($\lambda_w \le \lambda_{w0}$;1;IF(($\lambda_w > \lambda_{w1}$ AND $\lambda_w \le \lambda_{w2}$);$\lambda_{w1}/\lambda_w$;$1.51*5*E/(F_y*\lambda_w^2)$))= 1.00

From AISC Specification Section G2.1b,

A_w= $d*t_w$ = 7 in^2

From AISC Specification Section G2.1, the available shear strength is:

V_n= $0.6*F_y*A_w*C_v$ = 210 kips

Φ_v= 1.00

$\Phi_v V_n$= Φ_v*V_n = 210 kips

Shear_safety= IF(Φ_v*V_n>Qu;"Safe";"Unsafe") = Safe

Check Deflection

Δ_{all}=	12*L/360	=	1.17 in
W_{eq} (LL), W_L=	$\frac{8 * M_L}{L^2}$	=	0.91 kip/ft
Δ_{act}=	$\frac{5 * W_L * L^4}{384 * E * I_x} * 12^3$	=	1.10 in

Deflection safety (D_s):

Ds=	IF($\Delta_{all} \geq \Delta_{act}$;"Safe";"Unsafe, increase section")	=	Safe

Design Summary

ΦM_n=	0.90*MIN(M_p;M_{n1})	=	397 kip*ft
Safety=	IF($\Phi M_n \geq M_u$;"Safe";"Unsafe")	=	Safe
Moment_ratio=	$M_u/\Phi M_n$	=	0.50
Δ_{all}=	12*L/360	=	1.17 in
Δ_{act}=	$12 * \frac{5 * W_L * L^4}{384 * E * I_x}$	=	0.01 in
Ds=	IF($\Delta_{all} \geq \Delta_{act}$;"Safe";"Unsafe, increase section")	=	Safe