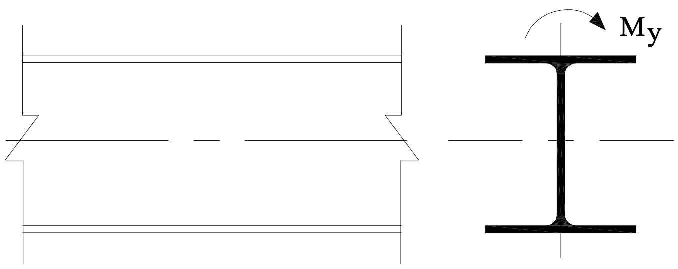
Design of W-shapes Subjected to Moment about Minor Axis



Materials

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

Beam Length

Total length, L=			35.00 ft

Design Moments and Uniform Live Load

Ultimate moment in minor-axis, M_{yu}=			266.00 kip*ft
Ultimate shear force, Q_{xu}=			20.00 kips

Section Details

sec.:	SEL("AISC/W";NAME;)	=	W24X131
depth, d=	TAB("AISC/W";d;NAME=sec.)	=	24.50 in
Web th., t_w=	TAB("AISC/W";t_w;NAME=sec.)	=	0.60 in
Flange width, b_f=	TAB("AISC/W";b_f;NAME=sec.)	=	12.90 in
Flange th., t_f=	TAB("AISC/W";t_f;NAME=sec.)	=	0.96 in
Plastic sec. modulus, Z_y=	TAB("AISC/W";Z_y;NAME=sec.)	=	81.50 in^3
Elastic sec. modulus, S_y=	TAB("AISC/W";S_y;NAME=sec.)	=	53.00 in^3

AISC Specification Eqn. (F6-1):

Yielding Moment, M_p=	MIN (Z_y*F_y*1/12;1.6/12*S_y*F_y)	=	340 kip*ft

Element Classification

Flanges:

$b_f/2t_f$, λ_f=	TAB("AISC/W";$b_f/2t_f$;NAME=sec.)	=	6.7

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

λ_{pf}=	0.38*$\sqrt{(E/F_y)}$	=	9.2
λ_{rf}=	1.0*$\sqrt{(E/F_y)}$	=	24.1
Fl_Class=	IF($\lambda_f \le \lambda_{pf}$;"Compact";"Non-Compact")	=	Compact

Because the beam bent about the minor-axis, the available strength is governed by AISC Specification

Sections F6.1 and F6.2. The nominal flexural moment is calculated as follows, satisfying the condition of compression Flange Local Buckling:

M_{n1}= IF(Fl_Class="Compact"; M_p; $(M_p-(M_p-0.7*F_y*S_y*1/12)*(\frac{\lambda_f-\lambda_{pf}}{\lambda_{rf}-\lambda_{pf}})))$ = 340 kip*ft

Check The Available Flexure Strength

ΦM_n=	0.90*MIN(M_p;M_{n1})	=	306 kip*ft
Safety=	IF($\Phi M_n \geq M_{yu}$;"Safe";"Unsafe")	=	Safe
Moment ratio=	$M_{yu}/\Phi M_n$	=	0.87

Check Shear Strength Section G (AISC Spec.)

Calculate A_w. (Multiply by 2 for both shear resisting elements.)

A_w=	$2*b_f*t_f$	=	24.77 in^2

Calculate Cv: (Eqns. G2-2, G2-3, G2-4 and G2-5)

$b_f/2t_f$, λ_f=	TAB("AISC/W";$b_f/2t_f$;NAME=sec.)	=	6.70
k_v=			1.20
ψ_{f1}=	$1.1*\sqrt{(k_v*E/F_y)}$	=	29.0
ψ_{f2}=	$1.37*\sqrt{(k_v*E/F_y)}$	=	36.1
C_v=	IF(λf≤ψf1;1; IF(λf>ψf1 AND λf≤ψf2;ψf1/λf;1.51*kv*E/(Fy*λf^2)))	=	1.0

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

Φ_v=			0.90
Nominal shear strength, V_n=	$0.6*F_y*A_w*C_v$	=	743 kips
Design shear, ΦV_n=	Φ_v*V_n	=	669 kips
Shear_safety=	IF($V_n>Q_{xu}$; "Safe"; "Unsafe")	=	Safe

Design Summary

ΦM_n=	0.90*MIN(M_p;M_{n1})	=	306 kip*ft
Safety=	IF($\Phi M_n \geq M_{yu}$;"Safe";"Unsafe")	=	Safe
Moment ratio=	$M_{yu}/\Phi M_n$	=	0.87
Design shear, ΦV_n=	Φ_v*V_n	=	669 kips
Shear_safety=	IF($V_n>Q_{xu}$; "Safe"; "Unsafe")	=	Safe