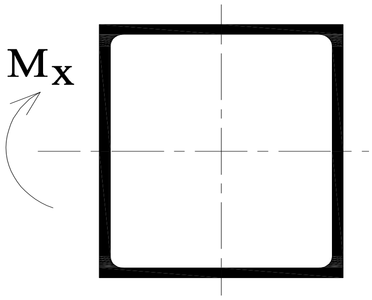
Design of HSS-Shapes Subjected to Moment about Strong Axis



Materials

Grade:	SEL("Material/ASTM"; NAME;)	=	A500
Fy=	TAB("Material/ASTM";F_y;NAME=Grade)	=	46 ksi
E=			29000 ksi

Beam Length and C_b

Total length, L=	50.00 ft

Design Moments and Uniform Live Load

Ultimate moment, M_u=	180.00 kip*ft
Ultimate moment due to live load case, M_L=	95.00 kip*ft
Ultimate Shear force, Q_u=	66 kips

Section Details

sec.:	SEL("AISC/HSS";NAME;)	=	HSS18X6X3/8
depth, H_t=	TAB("AISC/HSS";H_t;NAME=sec.)	=	18.00 in
HSS th., t_{des}=	TAB("AISC/HSS";t_{des};NAME=sec.)	=	0.349 in
HSS width, b=	TAB("AISC/HSS";B;NAME=sec.)	=	6.00 in
Plastic sec. modulus, Z_x=	TAB("AISC/HSS";Z_x;NAME=sec.)	=	86.40 in^3
Elastic sec. modulus, S_x=	TAB("AISC/HSS";S_x;NAME=sec.)	=	66.90 in^3
Inertia about x-axis, I_x=	TAB("AISC/HSS";I_x;NAME=sec.)	=	602.00 in^4
Yielding Moment, M_p=	Z_x*F_y*1/12	=	331 kip*ft

Element Classification

(1) Web:

h/t_{des}, λ_w=	TAB("AISC/HSS";h/t_{des};NAME=sec.)	=	48.70

Determine the limiting ratio for a compact HSS web in flexure from AISC Specification Table B4.1b Case 19.

λ_{wr}=	$2.42*\sqrt{(E/F_y)}$	=	60.8
Web_Class=	IF($\lambda_w \leq \lambda_{wr}$;"Compact"; "Non-Compact")	=	Compact

(2) Comp. flange:

b/t_{des}, λ_f=	TAB("AISC/HSS";b/t_{des};NAME=sec.)	=	14.20

Determine the limiting ratio for a slender HSS flange in flexure from AISC Specification Table B4.1b Case 17.

λ_{fr}=	$1.12*\sqrt{(E/F_y)}$	=	28.1
Fl_Class=	IF($\lambda_f \le \lambda_{fr}$;"Compact";"Non-Compact")	=	Compact
M_{n1a}=	M_p-F_y*S_x*1/12	=	74.55 kip*ft
λ_{fa}=	$3.57*\lambda_f*\sqrt{\frac{F_y}{E}}-4$	=	-1.98
M_{n1b}=	MIN(M_p ; M_p-M_{n1a}* λ_{fa})	=	331.0 kip*ft
M_{n1}=	IF(Fl_Class="Compact"; M_p; M_{n1b})	=	331.0 kip*ft

(Note that For HSS with noncompact flanges and compact webs, AISC Specification Section F7.2(b) applies)

Check The Available Flexure Strength

ΦM_n=	0.90*MIN(M_p;M_{n1})	=	298 kip*ft
Safety=	IF($\Phi M_n \ge M_u$;"Safe";"Unsafe")	=	Safe
Moment raio=	$M_u/\Phi M_n$	=	0.60

Check Shear Strength

From AISC Specification Section G5, if the exact radius is unknown, h shall be taken as the corresponding outside dimension minus three times the design thickness.

h=	H_t-3*t_{des}	=	17 in
λ_w=	TAB("AISC/HSS";h/t_{des};NAME=sec.)	=	48.70

For rectangular HSS in shear, use AISC Specification Section G2.1 with Aw = 2ht (per AISC Specification Section G5) and kv = 5.

k_v=			5
λ_{w1}=	$1.1*\sqrt{(k_v*E/F_y)}$	=	62
λ_{w2}=	$1.37*\sqrt{(k_v*E/F_y)}$	=	77
C_{va}=	1.51*5*E/(F_y*λ_w^2)	=	2.0
C_v=	IF($\lambda_w \le \lambda_{w1}$;1;IF(($\lambda_w > \lambda_{w1}$ AND $\lambda_w \le \lambda_{w2}$);$\lambda_{w1}/\lambda_w$;$C_{va}$))	=	1
A_w=	2*h*t_{des}	=	12 in^2

Nominal shear strength (V_n):

V_n=	0.6*F_y*A_w*C_v	=	331.20 kips

From AISC Specification Section G1, the available shear strength is:

Φ_v=			0.90
$\Phi_v V_n$=	Φ_v*V_n	=	298.08 kips
Shear_safety=	IF(Φ_v*V_n>Q_u;"Safe";"Unsafe")	=	Safe

Check Deflection

Δ_{all}=	L/240	=	0.21 ft
W_{eq} (LL), W_L=	$\frac{8 * M_L}{L^2}$	=	0.30 kip/ft
Δ_{act}=	$\frac{5 * W_L * L^4}{384 * E * Ix} * 12^2$	=	0.201 ft
Deflection safety, D_s=	IF($\Delta_{all} \geq \Delta_{act}$;"Safe";"Increase section")	=	Safe

Design Summary

ΦM_n=	0.90*MIN(M_p;M_{n1})	=	298 kip*ft
Safety=	IF($\Phi M_n \geq M_u$;"Safe";"Unsafe")	=	Safe
Moment raio=	$M_u/\Phi M_n$	=	0.60
$\Phi_v V_n$=	Φ_v*V_n	=	298 kips
Shear_safety=	IF(Φ_v*V_n>Q_u;"Safe";"Unsafe")	=	Safe
Δ_{act}=	$\frac{5 * WL * L^4}{384 * E * Ix}$	=	0.00 ft
Δ_{all}=	L/240	=	0.21 ft
Deflection safety, D_s=	IF($\Delta_{all} \geq \Delta_{act}$;"Safe";"Increase section")	=	Safe