

Steel Design Report

Element: **Untitled2 ()**
 Description:
 Date: **08/20/2010 01:06 PM**

Company:
 User:
 Software: **Digital Canal Steel Design 4.0**

GENERAL INFORMATION

Description	Value	Description	Value
Run Mode	Design Mode	K_y	1.00
Design Code	AISC 13th Edition LRFD	K_z	1.00
Beam-Column Length	12.00 ft	Total Load Deflection Limit	L / 240
Steel Yield Stress	50.00 ksi	Live Load Deflection Limit	L / 360
C_b Calculation	$12.5M_{max} / (2.5M_{max} + 3M_A + 4M_B + 3M_C)$	Lateral Torsional Braced (LTB) Length	
C_{mx} Calculation	Always use 1.0 (conservative)	Section Shape	HSS
C_{my} Calculation	Always use 1.0 (conservative)	Maximum Section Depth	20.00 in
L_x	12.00 ft	Minimum Section Depth	3.00 in
L_y	12.00 ft	Back-Back Distance (double angles only)	-
L_z	12.00 ft	Section Width (angles, double angles)	-
K_x	1.00	Check Section List	-
		Maximum Stress Ratio	1.000

LOAD INFORMATION

Ref. No.	Load Case	Load Type	Dir	Begin Value	Begin Position	End Value	End Position
1	Dead	Concen	Z	-190.000 (kips)	12.000 (ft)	-	-
2	Live	Linear	Y	-1.500 (kips / ft)	0.000 (ft)	-1.500 (kips / ft)	12.000 (ft)
3	Wind	Linear	X	-0.250 (kips / ft)	0.000 (ft)	-0.350 (kips / ft)	12.000 (ft)

SELECTED LOAD COMBINATIONS

Load Combination	Code Check	Total	Live	Dependent	Conditional
LC2: 1.40DL	x			-	-
LC3: 1.20DL+1.60LL+0.50SL	x			-	-
LC4: 1.20DL+LL+1.60SL	x			-	-
LC5: 1.20DL+0.80WL+1.60SL	x			-	-
LC6: 1.20DL+LL+1.60WL+0.50SL	x			-	-
LC7: 1.20DL+LL+0.20SL+EL	x			-	-
LC8: 0.90DL+1.60WL	x			-	-
LC9: 0.90DL+EL	x			-	-

CRITICAL STRESS SUMMARY

Ref. No.	Section Name	Opt. Mark	Governing Criteria	Stress Ratio	Load Combination	Distance (ft)
3	HSS7X9X1/2	-	Axial-Bending	0.8207	LC3: 1.20DL+1.60LL+0.50SL	6.0000
4	HSS8X8X3/8	-	Axial-Bending	0.9877	LC3: 1.20DL+1.60LL+0.50SL	6.0000
5	HSS9X9X5/16	-	Axial-Bending	0.9518	LC3: 1.20DL+1.60LL+0.50SL	6.0000

CRITICAL STRESS DETAILS

Section Name: HSS7X9X1/2

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	495.67	0.4600	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	51.748	127.50	0.4059	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	151.88	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.8207	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	-3.040	190.96	0.0159	LC8: 0.90DL+1.60WL	12
Shear-Y	kips	-14.400	140.74	0.1023	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.0000	0.6000	0.0000	-	0
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.0000	0.4000	0.0000	-	0

Section Name: HSS8X8X3/8

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	399.69	0.5704	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	51.748	110.25	0.4694	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	110.25	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.9877	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	-3.040	131.04	0.0232	LC8: 0.90DL+1.60WL	12
Shear-Y	kips	-14.400	131.04	0.1099	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.0000	0.6000	0.0000	-	0
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.0000	0.4000	0.0000	-	0

Section Name: HSS9X9X5/16

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	395.53	0.5764	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	49.839	118.01	0.4223	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	118.01	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.9518	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	-3.040	127.71	0.0238	LC8: 0.90DL+1.60WL	12
Shear-Y	kips	-14.400	127.71	0.1128	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.0000	0.6000	0.0000	-	0
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.0000	0.4000	0.0000	-	0

Design Procedure for HSS8X8X3/8

Designed according to AISC 13th Edition (LRFD)

Critical load effect at distance 6 feet under load combination LC3: 1.20DL+1.60LL+0.50SL

INPUT**PROPERTIES:**

A (in ²)	10.4	b _f (in)	8	K _x	1	S _x (in ³)	24.9
I _x (in ⁴)	100	t _f (in)	0.349	K _y	1	S _y (in ³)	24.9
I _y (in ⁴)	100	d (in)	8	K _z	1	Z _x (in ³)	29.4
r _x (in)	3.1	t _w (in)	0.349	L _x (in)	144	Z _y (in ³)	29.4
r _y (in)	3.1	k (in)	0.698	L _y (in)	144		
J (in ⁴)	160	x ₀ (in)	0	L _b (in)	0		
C _w (in ⁶)	0	y ₀ (in)	0	C _b	1		
α	0	x _{bar} (in)	4	C _{mx}	1	Welded	No
β	0	y _{bar} (in)	4	C _{my}	1	F _y (ksi)	50

LOAD EFFECTS:

P (kips)	M _x (ft-kips)	M _y (ft-kips)	V _x (kips)	V _y (kips)
228	43.2	0	0	0

SOLUTION**1. CHECK AXIAL STRENGTH**

(a). Flexural & Local Buckling

Description	Formula	Value	Code
KL / r	max(K _x L _x / r _x , K _y L _y / r _y)	46.45	
Q _s	for tubes and HSS Q _s = 1.0	1	
Q _a	Section is compact: Q _a = 1	1	E7.2
Q	Q _s Q _a	1	E7
F _c	F _c = E π ² / (KL / r) ²	132.6	E3-4
F _{cr} (ksi)	(for F _c >= 0.44 Q F _y) F _{cr} = Q 0.658 ^{Q_{Fy/Fe}} F _y	42.7	E7-2

Axial Capacity: P_n = F_{cr} A = 444.1 kips: P_c = φ P_n = 399.7 kips**2. CHECK FLEXURAL STRENGTH**

(a). X-Axis Yielding

Description	Formula	Value	Code
M _n (ft-kips)	M _{px} = F _y Z _x	122.5	F7-1

(b). X-Axis Flange Local Buckling

Description	Formula	Value	Code
λ	b _{flat} / t	19.92	Table B4.1
λ _p	1.12 (E / F _y) ^{0.5}	26.97	Table B4.1
λ _r	1.40 (E / F _y) ^{0.5}	33.72	Table B4.1
M _n	Flange is compact, M _n = M _p	122.5	F7.2.(a)

(c). X-Axis Web Local Buckling

Description	Formula	Value	Code
λ	h _{flat} / t	19.92	Table B4.1
λ _p	2.42 (E / F _y) ^{0.5}	58.28	Table B4.1
λ _r	5.70 (E / F _y) ^{0.5}	137.3	Table B4.1
M _n	Web is compact, M _n = M _p	122.5	F7.3.(a)

(d). Y-Axis Yielding

Description	Formula	Value	Code
M _n (ft-kips)	M _{py} = F _y Z _y	122.5	F7-1

(e). Y-Axis Flange Local Buckling

Description	Formula	Value	Code
λ	b _{flat} / t	19.92	Table B4.1
λ _p	1.12 (E / F _y) ^{0.5}	26.97	Table B4.1
λ _r	1.40 (E / F _y) ^{0.5}	33.72	Table B4.1
M _n	Flange is compact, M _n = M _p	122.5	

(c). Y-Axis Web Local Buckling

Description	Formula	Value	Code
λ	h_{flat} / t	19.92	Table B4.1
λ_p	$2.42 (E / F_y)^{0.5}$	58.28	Table B4.1
λ_r	$5.70 (E / F_y)^{0.5}$	137.3	Table B4.1
M_n	Web is compact, $M_n = M_p$	122.5	

Flexural Capacity - Strong Axis: $M_{nx} = 122.5$ ft-kips: $M_{cx} = \phi M_{nx} = 110.3$ ft-kipsFlexural Capacity - Weak Axis: $M_{ny} = 122.5$ ft-kips: $M_{cy} = \phi M_{ny} = 110.3$ ft-kips

3. CHECK AXIAL AND FLEXURAL INTERACTION

Description	Formula	Value	Code
P_{elx} (kips)	$P_{elx} = EI_x / L^2 / (\text{MIN}(1, K_x) L_x)^2$	1380	C2-5
B_{1x}	$B_{1x} = C_{mx} / (1 - \alpha P_r / P_{elx}) \geq 1.0$	1.198	C2-2
M_{rx} (ft-kips)	$B_{1x} M_{rx}$	51.75	C2-1a
P_{ely} (kips)	$P_{ely} = EI_y / L^2 / (\text{MIN}(1, K_y) L_y)^2$	1380	C2-5
B_{1y}	$B_{1y} = C_{my} / (1 - \alpha P_r / P_{ely}) \geq 1.0$	1.198	C2-2
M_{ry} (ft-kips)	$B_{1y} M_{ry}$	0	C2-1a

Axial and Flexural Interaction: for $P_r/P_c \geq 0.20$: $P_r/P_c + 8/9 (M_{rx}/M_{cx} + M_{ry}/M_{cy}) = 0.9877$ (H1-1a) Note:

- 1). Moment magnification factor B_1 is conservatively applied to overall moment
- 2). Moment magnification factor B_2 is assumed to have been taken care of by P-Delta Analysis
- 3). $\alpha = 1$

AXIAL-FLEXURAL INTERACTION STATUS: OK

4. CHECK SHEAR STRENGTH

Description	Formula	Value	Code
k_v	$k_v = 5.0$	5.0	G5
C_v	$C_v = 1$	1.00	G2-3
A_w	$A_w = 2 h_{flat} t$ where $h_{flat} = d - 3 t$	4.85	G5
V_{ny}	$V_{ny} = 0.6 F_y A_w C_v$	145.60	G2-1

Description	Formula	Value	Code
k_v	$k_v = 5.0$	5.0	G5
C_v	$C_v = 1$	1.00	G2-3
A_w	$A_w = 2 b_{flat} t$ where $b_{flat} = b - 3 t$	4.85	G5
V_{nx}	$V_{ny} = 0.6 F_y A_w C_v$	145.60	G2-1

$$V_{cy} = \phi V_{ny} = 131$$

$$V_{ry} = 0$$

$$V_{ry} / V_{cy} = 0$$

SHEAR-Y STATUS: OK

$$V_{cx} = \phi V_{nx} = 131$$

$$V_{rx} = 0$$

$$V_{rx} / V_{cx} = 0$$

SHEAR-X STATUS: OK

5. CHECK TOTAL LOAD DEFLECTIONS (Load Combination: Δ_x - Not Applicable, Δ_y - Not Applicable)

Description	Formula	Value	Code
Allowable Δ_x	$L/240$	0.60	Not Applicable
Allowable Δ_y	$L/240$	0.60	Not Applicable

Note:

$$\Delta_{x(\text{Act})} / \Delta_{x(\text{All})} = 0.00 / 0.60 = 0.00$$

TOTAL LOAD DEFLECTION-X STATUS: OK

$$\Delta_{y(\text{Act})} / \Delta_{y(\text{All})} = 0.00 / 0.60 = 0.00$$

TOTAL LOAD DEFLECTION-Y STATUS: OK

6. CHECK LIVE LOAD DEFLECTIONS (Load Combination: Δ_x - Not Applicable, Δ_y - Not Applicable)

Description	Formula	Value	Code
Allowable Δ_x	L/360	0.40	Not Applicable
Allowable Δ_y	L/360	0.40	Not Applicable

Note:

$$\Delta_{x(\text{Act.})} / \Delta_{x(\text{All.})} = 0.00 / 0.40 = 0.00$$

LIVE LOAD DEFLECTION-X STATUS: OK

$$\Delta_{y(\text{Act.})} / \Delta_{y(\text{All.})} = 0.00 / 0.40 = 0.00$$

LIVE LOAD DEFLECTION-Y STATUS: OK