Steel Design Report

Element: C:/DCC/steel6/Projects/Report.rtf
Description:
Date: 8/6/2020 5:27:20 PM

Company:
User:
Software: Digital Canal Steel Design 6.4

GENERAL INFORMATION

Description	Value	Description	Value
Run Mode	Design Mode	K_y	1.00
Design Code	AISC 14th 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	Y	-0.250 (kips / ft)	0.000 (ft)	-0.350 (kips / ft)	12.000 (ft)

ANALYSIS RESULT

Note: Deflections are calculated based on $I_x = I_y = 1.0$ in^4

LOAD COMBINATION LC3: 1.20DL+1.60LL+0.50SL

Distance (ft)	Shear Y (kips)	Shear X (kips)	Moment X (ft-kips)	Moment Y (ft-kips)	Deflection Y (in)	Deflection X (in)
0	14.4	0	0	0	0	0
0.6	12.96	0	8.208	0	-6.1476	0
1.2	11.52	0	15.552	0	-12.1209	0
1.8	10.08	0	22.032	0	-17.7621	0
2.4	8.64	0	27.648	0	-22.9322	0
3	7.2	0	32.4	0	-27.5108	0
3.6	5.76	0	36.288	0	-31.396	0
4.2	4.32	0	39.312	0	-34.5042	0
4.8	2.88	0	41.472	0	-36.7708	0
5.4	1.44	0	42.768	0	-38.1493	0
6	0	0	43.2	0	-38.6119	0
6.6	-1.44	0	42.768	0	-38.1493	0
7.2	-2.88	0	41.472	0	-36.7709	0
7.8	-4.32	0	39.312	0	-34.5045	0
8.4	-5.76	0	36.288	0	-31.3962	0
9	-7.2	0	32.4	0	-27.5112	0
9.6	-8.64	0	27.648	0	-22.9326	0
10.2	-10.08	0	22.032	0	-17.7626	0
10.8	-11.52	0	15.552	0	-12.1214	0
11.4	-12.96	0	8.208	0	-6.1482	0
12	-14.4	0	0	0	0	0

SELECTED LOAD COMBINATIONS

Load Combination	Code Check	Total	Live	Dependent	Conditional

LC2: 1.40DL	x	x	x	-	-
LC3: 1.20DL+1.60LL+0.50SL	x	x	x	-	-
LC4: 1.20DL+LL+1.60SL	x	x	x	-	-
LC5: 1.20DL+0.80WL+1.60SL	x	x	x	-	-
LC6: 1.20DL+LL+1.60WL+0.50SL	x	x	x	-	-
LC7: 1.20DL+LL+0.20SL+EL	x	x	x	-	-
LC8: 0.90DL+1.60WL	x	x	x	-	-
LC9: 0.90DL+EL	x	x	x	-	-

CRITICAL STRESS SUMMARY

Ref. No.	Section Name	Opt. Mark	Governing Criteria	Stress Ratio	Load Combination	Distance (ft)
1	HSS6X12X5/8	✔	Live Deflection Y	0.9021	LC3: 1.20DL+1.60LL+0.50SL	6.0000
2	HSS7X9X1/2	-	Live Deflection Y	0.9653	LC3: 1.20DL+1.60LL+0.50SL	6.0000
3	HSS8X6X5/8	-	Axial-Bending	0.8550	LC3: 1.20DL+1.60LL+0.50SL	6.0000
4	HSS9X5X5/8	-	Axial-Bending	0.8780	LC3: 1.20DL+1.60LL+0.50SL	6.0000
5	HSS10X4X5/8	-	Axial-Bending	0.9947	LC3: 1.20DL+1.60LL+0.50SL	6.0000
6	HSS12X4X1/2	-	Axial-Bending	0.9196	LC3: 1.20DL+1.60LL+0.50SL	6.0000
7	HSS14X4X3/8	-	Axial-Bending	0.9753	LC3: 1.20DL+1.60LL+0.50SL	6.0000

CRITICAL STRESS DETAILS

Section Name: HSS6X12X5/8 ✔

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	645.33	0.3533	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	57.371	157.88	0.3634	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	157.88	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.6763	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	252.45	0.0000	-	0
Shear-Y	kips	-14.400	252.45	0.0570	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.3609	0.6000	0.6014	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.3609	0.4000	0.9021	LC3: 1.20DL+1.60LL+0.50SL	6

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	58.719	127.50	0.4605	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	127.50	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.8693	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	182.25	0.0000	-	0
Shear-Y	kips	-14.400	182.25	0.0790	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.3861	0.6000	0.6435	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.3861	0.4000	0.9653	LC3: 1.20DL+1.60LL+0.50SL	6

Section Name: HSS8X6X5/8

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	469.41	0.4857	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	56.238	135.38	0.4154	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	135.38	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.8550	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	189.00	0.0000	-	0
Shear-Y	kips	-14.400	189.00	0.0762	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.3387	0.6000	0.5645	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.3387	0.4000	0.8468	LC3: 1.20DL+1.60LL+0.50SL	6

Section Name: HSS9X5X5/8

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)

Axial	kips	228.00	417.56	0.5460	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	53.913	144.38	0.3734	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	144.38	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.8780	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	189.00	0.0000	-	0
Shear-Y	kips	-14.400	189.00	0.0762	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.2903	0.6000	0.4839	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.2903	0.4000	0.7258	LC3: 1.20DL+1.60LL+0.50SL	6

Section Name: **HSS10X4X5/8**

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	332.43	0.6859	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	52.515	151.13	0.3475	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	151.13	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.9947	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	189.00	0.0000	-	0
Shear-Y	kips	-14.400	189.00	0.0762	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.2591	0.6000	0.4319	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.2591	0.4000	0.6479	LC3: 1.20DL+1.60LL+0.50SL	6

Section Name: **HSS12X4X1/2**

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	340.92	0.6688	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	49.420	175.13	0.2822	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	175.13	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.9196	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	182.25	0.0000	-	0
Shear-Y	kips	-14.400	182.25	0.0790	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.1839	0.6000	0.3064	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.1839	0.4000	0.4597	LC3: 1.20DL+1.60LL+0.50SL	6

Section Name: **HSS14X4X3/8**

	Unit	Load Effects	Resistance	Ratio	Load Combination	Distance (ft)
Axial	kips	228.00	312.28	0.7301	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-X	ft-kips	48.262	174.93	0.2759	LC3: 1.20DL+1.60LL+0.50SL	6
Bending-Y	ft-kips	0.0000	174.93	0.0000	LC3: 1.20DL+1.60LL+0.50SL	6
Interaction	-	-	-	0.9753	LC3: 1.20DL+1.60LL+0.50SL	6
Shear-X	kips	0.0000	159.30	0.0000	-	0
Shear-Y	kips	-14.400	159.30	0.0904	LC3: 1.20DL+1.60LL+0.50SL	12
Total Defl-X	in	0.0000	0.6000	0.0000	-	0
Total Defl-Y	in	0.1532	0.6000	0.2554	LC3: 1.20DL+1.60LL+0.50SL	6
Live Defl-X	in	0.0000	0.4000	0.0000	-	0
Live Defl-Y	in	0.1532	0.4000	0.3831	LC3: 1.20DL+1.60LL+0.50SL	6

Design Procedure for HSS8X6X5/8

Designed according to AISC 14th Edition (LRFD)

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

INPUT

PROPERTIES:

A (in^2)	14	b_f (in)	6	K_x	1	S_x(in^3)	28.5
I_x (in^4)	114	t_f (in)	0.58	K_y	1	S_y (in^3)	24.1
I_y (in^4)	72.3	d (in)	8	K_z	1	Z_x(in^3)	36.1
r_x (in)	2.85	t_w (in)	0.58	L_x (in)	144	Z_y(in^3)	29.5
r_y (in)	2.27	k (in)	1.16	L_y (in)	144		
J (in^4)	150	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)	3	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	$\max(K_xL_x / r_x, K_yL_y / r_y)$	63.44	
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_e	$F_e = E \pi^2 / (KL / r)^2$	71.13	E3-4
F_{cr} (ksi)	(for $F_e >= 0.44 Q F_y$) $F_{cr} = Q\ 0.658^{\ Q Fy/Fe} F_y$	37.26	E7-2

Axial Capacity: $P_n = F_{cr} A$ = 521.57 kips : $P_c = \varphi P_n$ = 469.41 kips

2. CHECK FLEXURAL STRENGTH

(a). X-Axis Yielding

Description	Formula	Value	Code
M_n (ft-kips)	$M_{px} = F_y Z_x$	150.42	F7-1

(b). X-Axis Flange Local Buckling

Description	Formula	Value	Code
λ	b_{flat} / t	7.34	Table B4.1b
λ_p	$1.12 (E / F_y)^{0.5}$	26.97	Table B4.1b
λ_r	$1.40 (E / F_y)^{0.5}$	33.72	Table B4.1b
M_n	Flange is compact, $M_n = M_p$	150.42	F7.2.(a)

(c). X-Axis Web Local Buckling

Description	Formula	Value	Code
λ	h_{flat} / t	10.79	Table B4.1b
λ_p	$2.42 (E / F_y)^{0.5}$	58.28	Table B4.1b
λ_r	$5.70 (E / F_y)^{0.5}$	137.27	Table B4.1b
M_n	Web is compact, $M_n = M_p$	150.42	F7.3.(a)

(d). Y-Axis Yielding

Description	Formula	Value	Code
M_n (ft-kips)	$M_{px} = F_y Z_x$	122.92	F7-1

(e). Y-Axis Flange Local Buckling

Description	Formula	Value	Code
λ	b_{flat} / t	10.79	Table B4.1b
λ_p	$1.12 (E / F_y)^{0.5}$	26.97	Table B4.1b
λ_r	$1.40 (E / F_y)^{0.5}$	33.72	Table B4.1b
M_n	Flange is compact, $M_n = M_p$	122.92	

(f). Y-Axis Web Local Buckling

Description	Formula	Value	Code
λ	h_{flat} / t	7.34	Table B4.1b
λ_p	$2.42 (E / F_y)^{0.5}$	58.28	Table B4.1b
λ_r	$5.70 (E / F_y)^{0.5}$	137.27	Table B4.1b
M_n	Web is compact, $M_n = M_p$	122.92	

Flexural Capacity - Strong Axis: M_{nx} = 150.42 ft-kips: $M_{cx} = \varphi M_{nx}$ = 135.38 ft-kips
Flexural Capacity - Weak Axis: M_{ny} = 122.92 ft-kips: $M_{cy} = \varphi M_{ny}$ = 110.63 ft-kips

3. CHECK AXIAL AND FLEXURAL INTERACTION

Description	Formula	Value	Code
P_{e1x} (kips)	$P_{e1x} = EI_x\pi^2 / (MIN(1, K_x)L_x)^2$	1573.54	C2-5
B_{1x}	$B_{1x} = C_{mx} / (1 - \alpha P_r / P_{e1x}) >= 1.0$	1.3	C2-2
M_{rx} (ft-kips)	$B_{1x}M_{rx}$	56.24	C2-1a
P_{e1y} (kips)	$P_{e1y} = EI_y\pi^2 / (MIN(1, K_y)L_y)^2$	997.96	C2-5
B_{1y}	$B_{1y} = C_{my} / (1 - \alpha P_r / P_{e1y}) >= 1.0$	1.58	C2-2
M_{ry} (ft-kips)	$B_{1y}M_{ry}$	0	C2-1a

Axial and Flexural Interaction: for $P_r/P_c >= 0.20$: $P_r/P_c + 8/9 (M_{rx}/M_{cx} + M_{ry}/M_{cy}) = 0.855$ (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). a = 1.6
AXIAL-FLEXURAL INTERACTION STATUS: OK

4. CHECK SHEAR STRENGTH

Description	Formula	Value	Code
k_v	$k_v = 5.0$	0:0.00	G5
C_v	$C_v = 1$	1.00	G2-3
A_w	$A_w = 2\ h_{flat}\ t$ where $h_{flat} = d - 3\ t$	7.26	G5
V_{ny}	$V_{ny} = 0.6\ F_y A_w C_v$	217.85	G2-1

Description	Formula	Value	Code
k_v	$k_v = 5.0$	0:0.00	G5
C_v	$C_v = 1$	1.00	G2-3
A_w	$A_w = 2\ b_{flat}\ t$ where $b_{flat} = b - 3\ t$	4.94	G5
V_{nx}	$V_{ny} = 0.6\ F_y A_w C_v$	148.25	G2-1

$V_{cy} = \varphi V_{ny}$ = 196.06
V_{ry} = 0
V_{ry} / V_{cy} = 0
SHEAR-Y STATUS: OK
$V_{cx} = \varphi V_{nx}$ = 133.42
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 - LC3: 1.20DL+1.60LL+0.50SL)

Description	Formula	Value	Code
Allowable δ_x	L/240	0.6	Not Applicable
Allowable δ_y	L/240	0.6	Not Applicable

Note:
$\delta_{x(Act.)} / \delta_{x(All.)} = 0 / 0.6 = 0$
TOTAL LOAD DEFLECTION-X STATUS: OK
$\delta_{y(Act.)} / \delta_{y(All.)} = 0.3387 / 0.6 = 0.5645$
TOTAL LOAD DEFLECTION-Y STATUS: OK

6. CHECK LIVE LOAD DEFLECTIONS (Load Combination: δ_x - Not Applicable, δ_y - LC3: 1.20DL+1.60LL+0.50SL)

Description	Formula	Value	Code
Allowable δ_x	L/360	0.4	Not Applicable
Allowable δ_y	L/360	0.4	Not Applicable

Note:
$\delta_{x(Act.)} / \delta_{x(All.)} = 0 / 0.4 = 0$

LIVE LOAD DEFLECTION-X STATUS: OK
$\delta_{y(Act.)} / \delta_{y(All.)} = 0.3387 / 0.4 = 0.8468$
LIVE LOAD DEFLECTION-Y STATUS: OK