

Steel Check Report

Project: Lesson2 (c:\dcc\Frame2012\projects\L2_Done)
 Description: Complete Lesson 2
 Date: 06/09/2011 10:56 AM

Company:
 User:
 Software: Digital Canal Frame Analysis & Design

Code Check Results (LRFD 13)

CRITICAL STRESS SUMMARY

ID	Section Name	Status	Governing Criteria	Stress Ratio	Load Combination	Distance (ft)
1	W12x40	OK	Axial-Bending	0.5482	Comb1	12.000
2	W18x50	OK	Live Deflection Y	0.5546	Comb1	10.024
3	W12x40	OK	Axial-Bending	0.5473	Comb2	0.0000
4	SC1	NG	Live Deflection Y	19.303	Comb1	11.662
5	SC1	NG	Live Deflection Y	19.302	Comb1	11.662
6	SC1	NG	Live Deflection Y	19.305	Comb1	11.664
7	SC1	NG	Live Deflection Y	19.299	Comb1	11.664
8	W12x40	OK	Axial-Bending	0.6324	Comb2	0.0000
9	W18x50	OK	Live Deflection X	0.5864	Comb1	12.069
10	W12x40	OK	Axial-Bending	0.4777	Comb1	12.000
11	W18x50	OK	Live Deflection X	0.1855	Comb1	10.536
12	W18x50	OK	Live Deflection X	0.6053	Comb1	12.542
13	W18x50	OK	Live Deflection X	0.7606	Comb1	2.5096
14	W18x50	OK	Axial-Bending	0.4618	Comb1	0.0000

SELECTED LOAD COMBINATIONS

Load Combination	Code Check	Total	Live	Dependent	Conditional
Comb1	x		x	-	-
Comb2	x	x		-	-

Design Procedure for Member 1: W12x40
Designed according to AISC LRFD 13th Edition (2005)
Critical load effect at distance 12 feet under load combination Comb1

INPUT**PROPERTIES:**

A (in ²)	11.8	b _f (in)	8.005	K _x	1.83	S _x (in ³)	51.9
I _x (in ⁴)	310	t _f (in)	0.515	K _y	1.69	S _y (in ³)	11
I _y (in ⁴)	44.1	d (in)	11.94	K _z	1	Z _x (in ³)	57.5
r _x (in)	5.13	t _w (in)	0.295	L _x (in)	144	Z _y (in ³)	16.8
r _y (in)	1.93	k (in)	1.25	L _y (in)	144		
J (in ⁴)	0.95	x ₀ (in)	0	L _b (in)	144		
C _w (in ⁶)	1440	y ₀ (in)	0	C _b	1		
α	0	x _{bar} (in)	4.003	C _{mx}	1	Welded	No
β	0	y _{bar} (in)	5.97	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)
36.66	-59.22	3.048	0.2535	-4.935

SOLUTION**1. CHECK AXIAL STRENGTH**

(a). Flexural & Local Buckling

Description	Formula	Value	Code
KL / r	$\max(K_x L_x / r_x, K_y L_y / r_y)$	126.1	
Q _s	for b / t ≤ 0.56 (E / F _y) ^{0.5} Q _s = 1.0	1	E7-4
Q _a	(for b / t < 1.49 (E / f) ^{0.5}) Q _a = 1.0	1	E7.2.(a)
Q	$Q_s Q_a$	1	E7
F _e	$F_e = E \pi^2 / (KL / r)^2$	18	E3-4
F _{cr} (ksi)	(for F _e < 0.44 Q F _y) F _{cr} = 0.877 F _e	15.79	E7-3

(b). Flexural-Torsional Buckling

Description	Formula	Value	Code
F _e (ksi)	$F_e = (\pi^2 EC_w / (K_z L_z)^2 + GJ) / (I_x + I_y)$	86.18	E4-4
F _{cr} (ksi)	(for F _e ≥ 0.44 Q F _y) F _{cr} = Q 0.658 ^{Q F_y/F_e} F _y	39.22	E7-2

Note:

- 1). Q_a is computed with f = 15.7875 ksi which is the smaller of F_{cr} for local buckling and flexural torsional buckling using a value of Q = 1.0

Axial Capacity: P_n = F_{cr} A = 186.3 kips: P_c = φ P_n = 167.7 kips**2. CHECK FLEXURAL STRENGTH**

(a). Strong Axis Yielding

Description	Formula	Value	Code
M _{px} (ft-kips)	M _{px} = F _y Z _x	239.6	F2-1

(b). Lateral-Torsional-Buckling (LTB)

Description	Formula	Value	Code
L _p (in)	$L_p = 1.76 r_y (E / F_y)^{0.5}$	81.81	F2-5
L _r (in)	$L_r = 1.95 r_{ts} (E / (0.7 F_y) (J c / (S_x h_o))^{0.5} (1 + (1 + 6.76 (0.7 F_y S_x h_o / (E J c))^{2.0.5})^{0.5})^{0.5}$	254.9	F2-6
M _n (ft-kips)	$M_n = C_b (M_p - (M_p - 0.7 F_y S_x) (L_b - L_p) / (L_r - L_p))$	207.9	F2-2

(c). Flange Local Buckling

Description	Formula	Value	Code
λ _f	b _f /2t _f	7.772	Table B4.1
λ _{pf}	0.38 (E / F _y) ^{0.5}	9.152	Table B4.1
λ _{rf}	1.0 (E / F _y) ^{0.5}	24.08	Table B4.1
M _n	M _{px} = F _y Z _x	239.6	F2.2.(a)

Note:

- 1). 0.35 < k_c = 4 / (h/t_w)^{0.5} < 0.76 => k_c = 0.64 (F3.2)

(d). Web Local Buckling

Description	Formula	Value	Code
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λ	$(d - 2k)/t_w$	32	Table B4.1
λ_p	$3.76 (E / F_y)^{0.5}$	90.55	Table B4.1
λ_r	$5.7 (E / F_y)^{0.5}$	137.3	Table B4.1
M_n	Web is compact	239.6	NA

(e). Weak Axis Yielding

Description	Formula	Value	Code
M_{ny} (ft-kips)	$M_{py} = F_y Z_y \leq 1.6 F_y S_y$	70	F6-1

(f). Weak Axis Flange Local Buckling

Description	Formula	Value	Code
λ_f	$b_f/2t_f$	7.772	Table B4.1
λ_{pf}	$0.38 (E / F_y)^{0.5}$	9.152	Table B4.1
λ_{rf}	$1.0 (E / F_y)^{0.5}$	24.08	Table B4.1
M_n	Flange is compact	70	NA

Flexural Capacity - Strong Axis: $M_{nx} = 207.9$ ft-kips: $M_{cx} = \phi M_{nx} = 187.1$ ft-kipsFlexural Capacity - Weak Axis: $M_{ny} = 70$ ft-kips: $M_{cy} = \phi M_{ny} = 63$ ft-kips

3. CHECK AXIAL AND FLEXURAL INTERACTION

Description	Formula	Value	Code
P_{elx} (kips)	$P_{elx} = EI_x/\pi^2 / (\text{MIN}(1, K_x)L_x)^2$	4279	C2-5
B_{1x}	$B_{1x} = C_{mx} / (1 - \alpha P_r / P_{elx}) \geq 1.0$	1.009	C2-2
M_{rx} (ft-kips)	$B_{1x}M_{rx}$	-59.73	C2-1a
P_{ely} (kips)	$P_{ely} = EI_y/\pi^2 / (\text{MIN}(1, K_y)L_y)^2$	608.7	C2-5
B_{1y}	$B_{1y} = C_{my} / (1 - \alpha P_r / P_{ely}) \geq 1.0$	1.064	C2-2
M_{ry} (ft-kips)	$B_{1y}M_{ry}$	3.243	C2-1a

Axial and Flexural Interaction: for $P_r/P_c \geq 0.20$: $P_r/P_c + 8/9 (M_{rx}/M_{cx} + M_{ry}/M_{cy}) = 0.5482$ (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	for $h/t_w < 260$, $k_v = 5$	5.0	G2.1.(b)
C_v	$C_v = 1$	1.00	G2-2
A_w	$A_w = d t_w$	3.52	G2.1
V_{ny}	$V_{ny} = 0.6 F_y A_w C_v$	105.67	G2-1

For webs of rolled members with $h/t_w \leq 2.24(E/F_y)^{0.5}$, $\phi_v = 1.0$ (G2-2)

Description	Formula	Value	Code
k_v	tee stems or flanges in shear	1.20	G2.1.(b) and G7
C_v	$C_v = 1$	1.00	G2-3
A_w	$A_w = 2 b_f t_f$	8.25	G7
V_{nx}	$V_{nx} = 0.6 F_y A_w C_v$	247.35	G2-1 and G7

$$V_{cy} = \phi V_{ny} = 105.7$$

$$V_{ry} = -4.935$$

$$V_{ry} / V_{cy} = 0.0467$$

SHEAR-Y STATUS: OK

$$V_{cx} = \phi V_{nx} = 222.6$$

$$V_{rx} = 0.2535$$

$$V_{rx} / V_{cx} = 0.001139$$

SHEAR-X STATUS: OK

5. CHECK TOTAL LOAD DEFLECTIONS (Load Combination: Δ_x - Comb2, Δ_y - Comb2)

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

Note:

$$\Delta_{x(\text{Act.})} / \Delta_{x(\text{All.})} = 0.03 / 0.60 = 0.05$$

TOTAL LOAD DEFLECTION-X STATUS: OK

$$\Delta_{y(\text{Act.})} / \Delta_{y(\text{All.})} = 0.07 / 0.60 = 0.11$$

TOTAL LOAD DEFLECTION-Y STATUS: OK

6. CHECK LIVE LOAD DEFLECTIONS (Load Combination: Δ_x - Comb1, Δ_y - Comb1)

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

Note:

$$\Delta_{x(\text{Act.})} / \Delta_{x(\text{All.})} = 0.04 / 0.40 = 0.10$$

LIVE LOAD DEFLECTION-X STATUS: OK

$$\Delta_{y(\text{Act.})} / \Delta_{y(\text{All.})} = 0.11 / 0.40 = 0.26$$

LIVE LOAD DEFLECTION-Y STATUS: OK