McCormac

As a result of the preceding information, the AISC Specification (D2) states that the nominal strength of a tension member, P_n, is to be the smaller of the values obtained by substituting into the following two expressions:

For the limit state of yielding in the gross section (which is intended to prevent excessive elongation of the member),

$$P_n = F_y A_g \qquad \text{(AISC Equation D2-1)}$$

$$\phi_t P_n = \phi_t F_y A_g = \text{design tensile strength by LRFD } (\phi_t = 0.9)$$

Tensile yielding

$$\boxed{\frac{P_n}{\Omega_t} = \frac{F_y A_g}{\Omega_t} = \text{allowable tensile strength for ASD } (\Omega_t = 1.67)}$$

For tensile rupture in the net section, as where bolt or rivet holes are present,

$$P_n = F_u A_e \qquad \text{(AISC Equation D2-2)}$$

$$\phi_t P_n = \phi_t F_u A_e = \text{design tensile rupture strength for LRFD } (\phi_t = 0.75)$$

Tensile rupture

$$\boxed{\frac{P_n}{\Omega_t} = \frac{F_u A_e}{\Omega_t} \text{ allowable tensile rupture strength for ASD } (\Omega_t = 2.00)}$$

Equations for the Limit State

Prepared by Eng.Maged Kamel.

EXAMPLE 4-4

Tension Member Analysis

Determine if the channel is adequate for the applied tension load shown in Figure 4-9. The channel is ASTM A36; it is connected with four ⅝-in. diameter bolts. Neglect block shear.

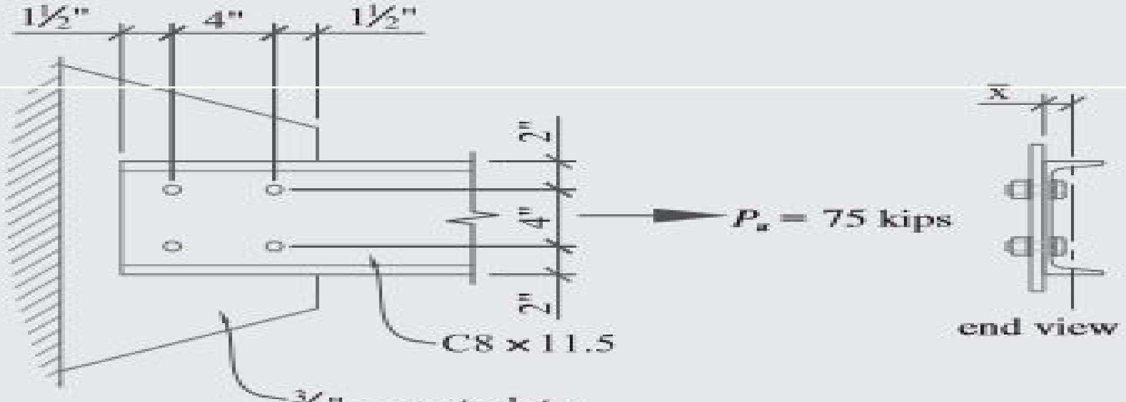


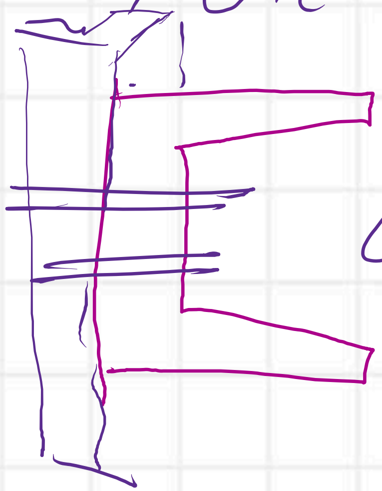
Figure 4-9 Details for Example 4-4.

(continued)

Remarks

Given

$P_{ult} \Rightarrow$ LRFD



Connected thru one side

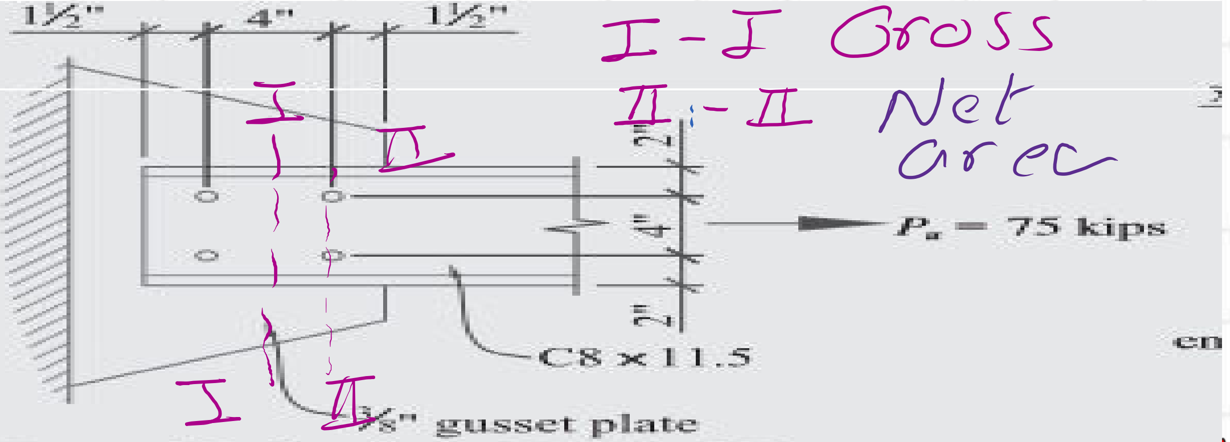


Figure 4-9 Details for Example 4-4.

I - I Gross

II - II Net area

by Eng.Maged Kamel.

Given A36 $\Rightarrow F_y = 36$ ksi

$F_u = 58$ ksi

$d_b = \frac{5''}{8} \Rightarrow d_h = \frac{6''}{8}$

Find U?

Case of yielding: $\phi_{ty} \cdot F_y A_g$

Case of rupture: $\phi_{tr} \cdot F_U \cdot A_e$

$U = 1 - \frac{\bar{x}}{L}$

$U = 1 - \left(\frac{0.572}{4}\right)$

$= 0.857$

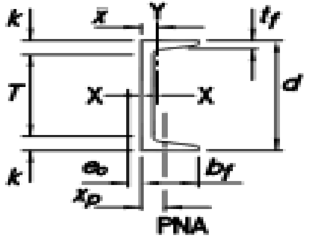
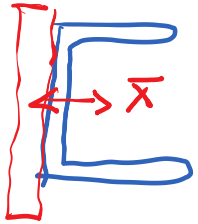
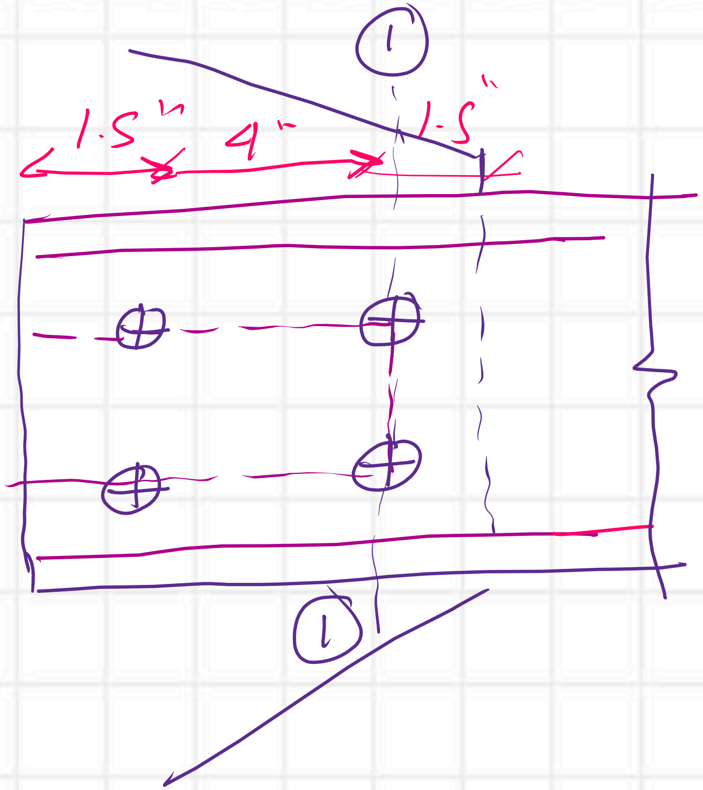


Table 1-5
C-Shapes
Dimensions



$\bar{x} = 0.572$

Shape	Area, A	Depth, d		Web Thickness, t_w		$\frac{t_w}{2}$	Flange Width, b_f		Flange Average Thickness, t_f		Distance k	Distance T	Distance Workable Gauge	r_{ts}	h_o	Nominal Wt.	Shear Ctr, e_o	Axis X-X I	Axis X-X S	Axis X-X r	Axis X-X Z	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r	Axis Y-Y $\bar{x}$	Axis Y-Y Z	Axis Y-Y x_p	Torsional J	Torsional C_w	Torsional $\bar{r}_o$	Torsional H
	in.^{2}	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.	lb/ft	in.	in.^{4}	in.^{3}	in.	in.^{3}	in.^{4}	in.^{3}	in.	in.	in.^{3}	in.	in.^{4}	in.^{6}	in.	
C15×50	14.7	15.0	15	0.716	11/16	3/8	3.72	3 3/4	0.650	5/8	1 7/16	12 1/8	2 1/4	1.17	14.4	50	0.583	404	53.8	5.24	68.5	11.0	3.77	0.865	0.799	8.14	0.490	2.65	492	5.49	0.937
×40	11.8	15.0	15	0.520	1/2	1/4	3.52	3 1/2	0.650	5/8	1 7/16	12 1/8	2	1.15	14.4	40	0.767	348	46.5	5.43	57.5	9.17	3.34	0.883	0.778	6.84	0.392	1.45	410	5.71	0.927
×33.9	10.0	15.0	15	0.400	3/8	3/16	3.40	3 3/8	0.650	5/8	1 7/16	12 1/8	2	1.13	14.4	33.9	0.896	315	42.0	5.61	50.8	8.07	3.09	0.901	0.788	6.19	0.332	1.01	358	5.94	0.920
C12×30	8.81	12.0	12	0.510	1/2	1/4	3.17	3 1/8	0.501	1/2	1 1/8	9 3/4	1 3/4[g]	1.01	11.5	30	0.618	162	27.0	4.29	33.8	5.12	2.05	0.762	0.674	4.32	0.367	0.861	151	4.54	0.919
×25	7.34	12.0	12	0.387	3/8	3/16	3.05	3	0.501	1/2	1 1/8	9 3/4	1 3/4[g]	1.00	11.5	25	0.746	144	24.0	4.43	29.4	4.45	1.87	0.779	0.674	3.82	0.306	0.538	130	4.72	0.909
×20.7	6.08	12.0	12	0.282	5/16	3/16	2.94	3	0.501	1/2	1 1/8	9 3/4	1 3/4[g]	0.983	11.5	20.7	0.870	129	21.5	4.61	25.6	3.86	1.72	0.797	0.698	3.47	0.253	0.369	112	4.93	0.899
C10×30	8.81	10.0	10	0.673	11/16	3/8	3.03	3	0.436	7/16	1	8	1 3/4[g]	0.924	9.56	30	0.368	103	20.7	3.43	26.7	3.93	1.65	0.668	0.649	3.78	0.441	1.22	79.5	3.63	0.921
×25	7.35	10.0	10	0.526	1/2	1/4	2.89	2 7/8	0.436	7/16	1	8	1 3/4[g]	0.911	9.56	25	0.494	91.1	18.2	3.52	23.1	3.34	1.47	0.675	0.617	3.18	0.367	0.687	68.3	3.76	0.912
×20	5.87	10.0	10	0.379	3/8	3/16	2.74	2 3/4	0.436	7/16	1	8	1 1/2[g]	0.894	9.56	20	0.636	78.9	15.8	3.67	19.4	2.80	1.31	0.690	0.606	2.70	0.294	0.368	56.9	3.93	0.900
×15.3	4.48	10.0	10	0.240	1/4	1/8	2.60	2 5/8	0.436	7/16	1	8	1 1/2[g]	0.868	9.56	15.3	0.796	67.3	13.5	3.88	15.9	2.27	1.15	0.711	0.634	2.34	0.224	0.209	45.5	4.19	0.884
C9×20	5.87	9.00	9	0.448	7/16	1/4	2.65	2 5/8	0.413	7/16	1	7	1 1/2[g]	0.850	8.59	20	0.515	60.9	13.5	3.22	16.9	2.41	1.17	0.640	0.583	2.46	0.326	0.427	39.4	3.46	0.899
×15	4.40	9.00	9	0.285	5/16	3/16	2.49	2 1/2	0.413	7/16	1	7	1 3/8[g]	0.825	8.59	15	0.681	51.0	11.3	3.40	13.6	1.91	1.01	0.659	0.586	2.04	0.245	0.208	31.0	3.69	0.882
×13.4	3.94	9.00	9	0.233	1/4	1/8	2.43	2 3/8	0.413	7/16	1	7	1 3/8[g]	0.814	8.59	13.4	0.742	47.8	10.6	3.48	12.6	1.75	0.954	0.666	0.601	1.94	0.219	0.168	28.2	3.79	0.875
C8×18.75	5.51	8.00	8	0.487	1/2	1/4	2.53	2 1/2	0.390	3/8	15/16	6 1/8	1 1/2[g]	0.800	7.61	18.75	0.431	43.9	11.0	2.82	13.9	1.97	1.01	0.598	0.565	2.17	0.344	0.434	25.1	3.05	0.894
×13.75	4.03	8.00	8	0.303	5/16	3/16	2.34	2 3/8	0.390	3/8	15/16	6 1/8	1 3/8[g]	0.774	7.61	13.75	0.604	36.1	9.02	2.99	11.0	1.52	0.848	0.613	0.554	1.73	0.252	0.186	19.2	3.26	0.874
×11.5	3.37	8.00	8	0.220	1/4	1/8	2.26	2 1/4	0.390	3/8	15/16	6 1/8	1 3/8[g]	0.756	7.61	11.5	0.697	32.5	8.14	3.11	9.63	1.31	0.775	0.623	0.572	1.57	0.211	0.130	16.5	3.41	0.862

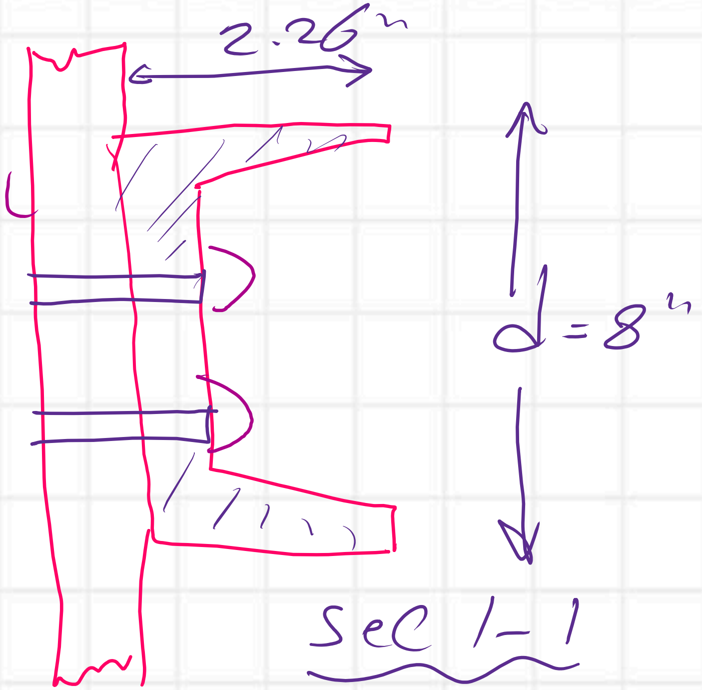


$t_f = 0.39"$

$d = 8" \Rightarrow$ Channel

$t_w = 0.22"$

$d_h = \frac{6}{8}"$



Sec 1-1

$t_w = 0.22"$

$A_g = 3.37 \text{ inch}^2$, $A_n = A_g - (n\, t_w\, d_h)$

$A_n = 3.37 - (2)0.22\left(\frac{6}{8}\right) = 3.04 \text{ inch}^2$

U value $= 0.857$ $\qquad A_e = U \cdot A_n$

$A_e = 0.857(3.04) = 2.61 \text{ inch}^2$

Neglecting Block Shear : A36 LRFD Design

$Ag = 3.37$ inch², $U = 0.857$, $An = 3.04$ inch²

$Fy = 36$ ksi, $FU = 58$ ksi

$Ae = 2.61$ inch²

Pn due to yielding : $Pn = Ag\,Fy$, $\phi = 0.90$

$Pn = 3.37(36) = 121.32$ kips

$\phi Pn = 0.9(121.32) = 109.188$ kips

Pn due to rupture $Pn = Ae\,FU$, $\phi = 0.75$

$Pn = 2.61(58) = 151.38$ kips

$\phi Pn = 0.75(151.38) = 113.535$ kips select min value

109.188 kips

Prepared by Eng.Maged Kamel.

Neglecting Block Shear : A36 LRFD Design

Given $P_{ult} = 75$ kips

$P_u \leq \phi P_n$

Design is governed by yielding

$\phi P_n = 109.188 \simeq 109.20$ kips

Since $P_{ult} < \phi P_n$ Section is adequate

Prepared by Eng.Maged Kamel.