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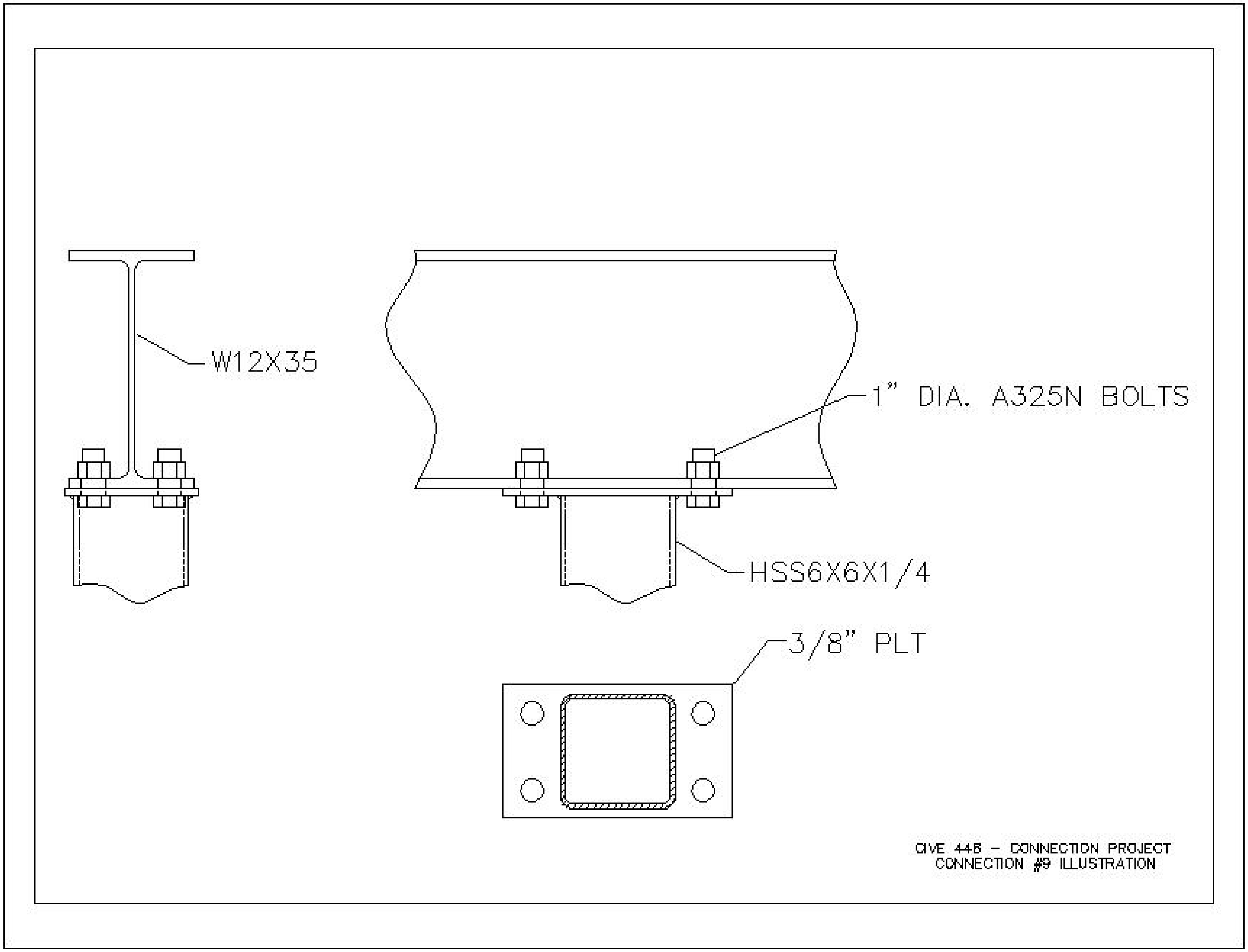
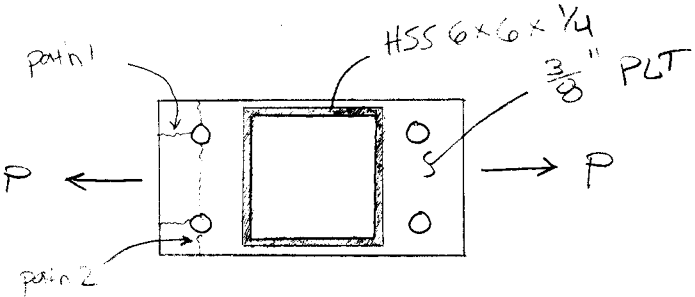
Sample Calculations - Connection 9



⇒ Limit state: Shear Rupture

$$R_n = 0.6 F_u A_{nv}$$



path 1:
$$A_{gv} = 2(1.5")(.375") = 1.125 \text{ in}^2$$
$$A_{nv} = 1.125 - 2(\tfrac{1}{2})(1.125")(.375) = 0.703 \text{ in}^2$$

$$R_n = 0.6(58 \text{ ksi})(0.703 \text{ in}^2) = \underline{\underline{24.5 \text{ k}}}$$ ←

⇒ Limit State: Shear Yielding

$$R_n = 0.60 F_y A_g$$
$$= 0.60(36 \text{ ksi})(7")(0.375") = \underline{\underline{56.7 \text{ k}}}$$ ←

⇒ Limit State: Weld Strength

$$\phi R_n = \min \begin{cases} \phi F_{Bm} A_{Bm} \\ \phi F_w A_w \end{cases} \geq P_u$$

* $t_w \cong \frac{1}{4}"$; ∴ $D_w = 0.35"$
* E70 electrodes

where: $\phi F_w A_w = 0.75 L_w t_w (0.6 F_{Exx})$

and: $$\phi F_{Bm} A_{Bm} = \min \begin{cases} 0.75 A_{nv}(0.6 F_u) = 0.75(t_{Bm} L_w)(0.6 F_u) \\ 0.75 F_u A_e = 0.75 F_u (U A_n) \\ 1.0 A_g (0.6 F_y) \end{cases}$$

$$\phi F_w A_w = 0.75(2)(6")(0.25")(0.6)(70 \text{ ksi}) = 94.5 \text{ k}$$

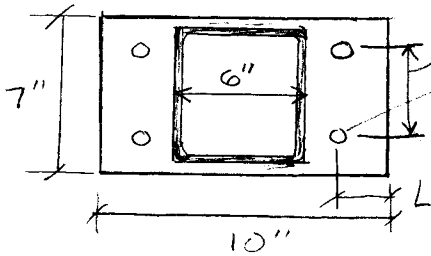
$$\phi F_{Bm} A_{Bm} = \min \begin{cases} 0.75(0.25")(6")(2 \text{ sides})(0.6)(58 \text{ ksi}) = 78.3 \text{ k} \\ 0.75(58 \text{ ksi})(1.0)(0.703 \text{ in}^2) = 30.6 \text{ k} \\ 1.0(7")(0.375")(0.6)(36 \text{ ksi}) = 56.7 \end{cases}$$

$$\phi R_n = \min(94.5, 78.3, 30.6, 56.7 \text{k})$$
$$= \underline{\underline{30.6 \text{ k}}}$$ ←

⇒ Limit State: Bolt bearing strength

$$R_n \text{ per bolt hole} = \min \begin{cases} 1.2 L_c t F_u \\ 2.4 d t F_u \end{cases}$$

* assumes deformation at the bolt hole at service load is not a design consideration



$d_h = 1" + \frac{1}{8}" = 1\frac{1}{8}"$

$$R_n \text{ per bolt} = \min \begin{cases} 1.2(1.5 - \frac{1}{2}(1.125"))(\frac{3}{8}")(58 \text{ ksi}) = 24.5 \text{ k} \\ 2.4(1")(\frac{3}{8}")(58 \text{ ksi}) = 52.2 \text{ k} \end{cases}$$

$$R_n = 0.75(24.5)(4 \text{ bolts}) = \underline{\underline{74 \text{ k}}}$$

⇒ Limit state: Bolt shear

$R_n \text{ per bolt} = F_{nv} A_b$ * refer to Table J3.2; assumed A325 bolts

$$= (48 \text{ ksi})(1")^2 \frac{\pi}{4} = 37.7 \text{ k}$$

$$R_n = 0.75(37.7 \text{ k})(4 \text{ bolts}) = \underline{\underline{113 \text{ k}}}$$

⇒ Limit state: Bolt tension

* refer to Table 7-2; for $d_b = 1"$, $A_b = 0.785 \text{ in}^2$, A325

$$\phi r_n = 53.0 \text{ k}$$

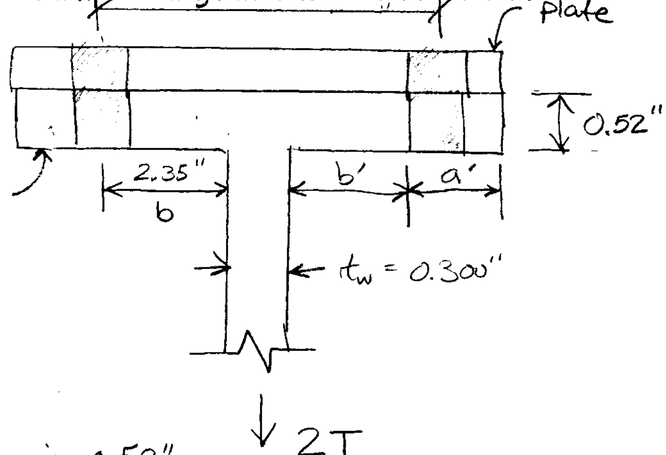
$$P_t = 53.0 \text{ k}(4 \text{ bolts}) = \underline{\underline{212 \text{ k}}}$$

⇒ Limit state: Prying action

$$t_{min} = \sqrt{\frac{4.44\,T\,b'}{p\,F_u}}$$

$$T \leq \frac{F_u t^2 p}{2.22\,b}$$

* where $p \geq g$



NOTE: the thickness of the flange, t_f is 0.52", while the plate thickness is 0.375". Also, the steel grade for the plate is lower (A36 vs A992), therefore, the base plate thickness controls.

NOTE 2: the tributary length per pair of bolts is 4.0" perpendicular to the plane shown in the figure above. Since g = 5.0" > 4.0", the value for g controls.

$$\therefore \frac{F_u t^2 p}{2.22\,b} = \frac{(58\text{ ksi})\left(\frac{3}{8}"\right)^2(5.0")}{2.22\,(2.35")} = 7.82\text{ k}$$

$$\Rightarrow 2T = 2(7.82) = \underline{\underline{15.6\text{ k}}} \leftarrow$$