Solution Hwk #7 - Prob # 1, Text Problem # 7.11 - 2

Structural Steel 2L 5 x 3 1/2 x 5/16 (LLBB)

$Ag := 5.12 \quad in^2$ $\quad Ae := 3.84 \quad in^2$ $\quad Fy := 36 \quad ksi$ $\quad F_u := 58 \quad ksi$

Yeild Strength $\phi_t P_n =$ $\quad \phi Pny := 0.9 Ag \cdot Fy$ $\quad \phi Pny = 165.888 \quad Kips$

$x := 0.829 \quad l := 5 \quad U := 1 - \frac{x}{l} \quad U = 0.834$

$A_e := U \cdot Ag \quad A_e = 4.271 \quad in^2$

Fracture strength of the section: $\phi P_n := 0.75 \cdot F_u \cdot A_e$ $\quad \phi P_n = 185.793 \quad Kips$

Gusset Plate 3/8 in thk

Fillet Weld 1/4" with E70 Electrodes $F_{exx} := 70 \quad ksi$

Step I: Check for limitations on weld geometry

$t_{min} := \frac{5}{16}$ in (double angle) $\quad t_{min} = 0.313 \quad in$

$t_{max} := \frac{3}{8}$ in (gusset plate) $\quad t_{max} = 0.375 \quad in$

$amax := t_{min} - \frac{1}{16}$ J2.2 $\quad amin := \frac{3}{16}$ Table J2.4 $\quad amax = 0.25 \quad in$

$a := \frac{1}{4}$ ok $\quad a = 0.25 \quad in$

$L_{wmin} := 4 \cdot a$ ok $\quad L_{wmin} = 1 \quad in$

Calculation for the weld strength:

(a) Longitudinal welds: $\phi R_{nl} := 0.75 \cdot 0.707 \cdot a \cdot 0.6 \cdot F_{exx}$ $\quad \phi R_{nl} = 5.568 \quad \frac{Kips}{in}$

Total Strength including for 2 L: $\phi R_n := 2 \cdot [\phi R_{nl} \cdot (5 + 5 + 5)]$ $\quad \phi R_n = 167.029 \quad Kips$

Base Strength of Metal

$Lw := 30 \quad in$

$\phi R_n := 0.9 \cdot 0.6 \cdot Fy \cdot t_{min} \cdot Lw$ $\quad \phi R_n = 182.25 \quad Kips$

Solution Hwk #13 - Prob # 2, Text Problem # 7.11 - 3

Tensile yeid strength	$F_y := 50$ Ksi	
Ultimate strength	$F_u := 70$ Ksi	
Tension member gross section:	$A_g := 0.75 \cdot 7$	$A_g = 5.25$ in^2
Yeild Strenght of the section	$\phi P_n := 0.9 \cdot F_y \cdot A_g$	$\phi P_n = 236.25$ kips
Effective member area	$A_e := A_g$ Assume	
Net section strength	$\phi P_n := 0.75 \cdot F_u \cdot A_e$	$\phi P_n = 275.625$ Kips
Thorat of the weld	$w := 0.5$ in	
$F_{EXX} := 70$	for a 70EXX electrode	
Weld strength	$\phi R_n := 0.75 \cdot 0.707 \cdot w \cdot 0.6 \cdot F_{EXX}$	$\phi R_n = 11.135$ $\frac{kips}{in}$
For a 7in length,	$\phi R_n \cdot 7 = 77.947$ Kips	
Base Metal Strength:	$\phi R_n := 0.9 \cdot .6 \cdot F_y \cdot 14 \cdot .75$	$\phi R_n = 283.5$ kips
Connection Strength	$2 \cdot (\phi R_n \cdot 7) = 3.969 \times 10^3$ Kips Controls	

PROBLEM 3 DESIGN A DOUBLE ANGLE TENSION MEMBER AND A WELDED CONNECTION SYSTEM TO CARRY A FACTORED LOAD OF 300 KIPS. ASSUME A36 MATERIAL FOR THE MEMBER AND THE GUSSET PLATE. ASSUME E70XX ELECTRODE. PROVIDE A FINAL DRAWING OF THE CONNECTION SYSTEM.

① FROM TABLE 3-7 IN AISC MANUAL,

	2L 4×4×3/4	WT/FT = 37
	2L5×3½×5/8	WT/FT = 33.5
	2L5×5×½	WT/FT = 32.6
SELECT →	2L6×4×1/2	WT/FT = 32.3 FT WITH YIELD ϕP_n = 306 kips, RUPTURE = 308 kips

② DESIGN WELDED CONNECTION

- FROM TABLE J2.4, SINCE $t_{MEMBER} = \frac{1}{2}$ in, $a_{min} = \frac{3}{16}$ in.
- FROM SPEC J2.2b, $a_{max} = t - \frac{1}{16}\text{in} = \frac{7}{16}$ in
- DESIGN $a = \frac{6}{16}\text{in} = \frac{3}{8}$ in

SHEAR STRENGTH OF WELD METAL = $\phi R_n = (0.75)(0.60)(\overset{(70)}{F_{EXX}})(0.707\,a)L_W$
$= 8.35\,L_W$ Kips

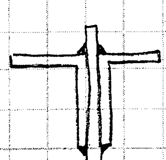
STRENGTH OF BASE METAL IN SHEAR = $\phi R_n = (0.9)(0.6)F_y\,t\,L_W$
$= (0.9)(0.6)(36\,\text{ksi})(\frac{1}{2}\text{in})L_W = 9.72\,L_W$ kips

- SHEAR STRENGTH OF WELD METAL GOVERNS, $\phi R_n = 8.35\,L_W$ kips
- $\phi R_n > 300$ kips

$$L_W = \frac{300\,\text{kips}}{8.35\,\text{kips/in}} = 35.92\text{ in}$$

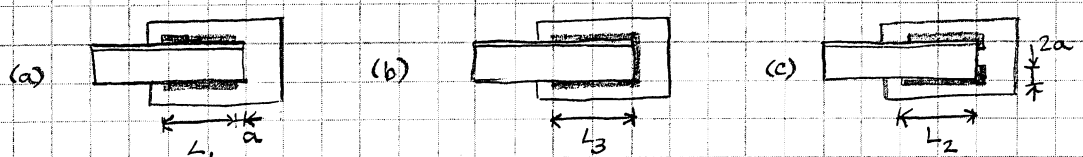
- DESIGN LENGTH OF 3/8" E70XX FILLET WELD = 36 in.
- SHEAR STRENGTH OF FILLET WELD = $\phi R_n = (8.35\,\text{kips/in})(36\,\text{in}) = 300.6$ kips

③ LAYOUT OF CONNECTION



welding on both sides of gusset

3 POSSIBLE SCENERIOS:



• SINCE THERE ARE 2 ANGLES TO BE WELDED TO THE GUSSET PLATE, TOTAL WELD FOR EACH ANGLE $= \frac{36 in}{2} = 18 in$

SELECT → • OPTION (a), FILLET WELD MUST TERMINATE AT LEAST $a - 3/8"$ FROM EDGE OF MEMBER so $L_1 = 9 in$.

• OPTION (b), SINCE TRAVERSE WELD WILL BE 6", $L_3 = \frac{18 in - 6 in}{2} = 6 in$

• OPTION (c), END RETURNS MUST BE AT LEAST $2a = 2(3/8 in) = 3/4 in$ EACH, so $L_2 = \frac{18 in - 2(3/4 in)}{2} = 8.25 in$

④ FRACTURE STRENGTH OF MEMBER (RECALL YIELD STRENGTH DOES NOT DEPEND ON WELD)

• $A_e = UA_g$
• FROM TABLE 1-7, $\bar{x} = 0.986 in$, $A_g = 2(4.72 in^2) = 9.44 in^2$

• $U = 1 - \frac{\bar{x}}{L} \leq 0.9$

• FOR OPTION (a) $L = 9 in$; $U = 1 - \frac{0.986 in}{9 in} = 0.89$

$$A_e = UA_g = (0.89)(9.44 in^2) = 8.41 in^2$$

• $\phi R_n = (0.75) A_e F_u = (0.75)(8.41 in^2)(58 ksi) = 365.7$ kips > 300 kips → OK

⑤ DESIGN GUSSET PLATE

• $\phi R_n > T_u$ = TENSION YIELDING LIMIT
• $(0.9) A_g F_y > 300 kips$ → SPEC J5-1 (pg. 16.1-68)
(36 ksi)

$$A_g > \frac{300 kips}{(0.9)(36 ksi)} = 9.26 in^2$$

• $\phi R_n > T_u$ = TENSION FRACTURE LIMIT STATE
• $(0.75) A_n F_u > 300 kips$; $A_n \leq 0.85 A_g$ → SPEC J5-2

$$A_g = \frac{(300 kips)}{(0.85)(0.75)(58 ksi)} = 8.11 in^2$$

- SELECT GUSSET $t = 3/4\,in$, $L = 13\,in \rightarrow A_g = 9.75\,in^2 > 9.26\,in^2$

(6) NOW RECHECK SIZE OF a

- FROM TABLE J2.4, $a_{min} = 1/4\,in < 3/8\,in \rightarrow OK$

- a_{max} is same, so OK

(7) DRAW CONNECTION (SEE NEXT PG)