Solutions to Homework 3

Solution Hwk # 3 - Prob. # 1 (Text 3.2-2)

Structural Steel: C8 x 11.5

$A_g := 3.37\ in^2$ $d := 8\ in$ $t_w := 0.220\ in$ $b_f := 2.26\ in$ $t_f := 0.390\ in$

$w := 11.5\ \frac{lb}{ft}$ $I_{xx} := 32.5\ in^4$ $I_{yy} := 1.31\ in^4$ Table 1-5, pg. 1-30

Material A572 Grade 50 Yeild Strength => $F_y := 50$ Ksi Ultimate Strength => $F_u := 65$ Ksi

Net Bolt dimension $d_h := \left(\frac{7}{8} + \frac{1}{16} + \frac{1}{16}\right)$ $d_h = 1$ in

Net Section Area $A_n := A_g - 2 \cdot d_h \cdot t_w$ $A_n = 2.93\ in^2$

Assumed that $A_e := 0.85 \cdot A_n$ $A_e = 2.49\ in^2$

Gross Yeilding design strength $F_{yd} := 0.9 \cdot F_y \cdot A_g$ $F_{yd} = 151.65$ Kips

Fracture design strength $F_{ud} := 0.75 \cdot F_u \cdot A_e$ $F_{ud} = 121.412$ Kips

Design Strength $F_d := if(F_{yd} > F_{ud}, F_{ud}, F_{yd})$ $F_d = 121.412$ Kips

We know factored load combinations is greater of 1.4 DL or 1.2 DL + 1.6 LL

Given that the ratio of live load to dead load is 3, therefore, LL = 3 DL, Subsituting in

1.2 DL + 1.6 LL = 6 DL

Hence, $DL := \frac{F_d}{6}$ $DL = 20.235$ Kips

$LL := 3 \cdot DL$ $LL = 60.706$ Kips

Total Service load resisted $SL := DL + LL$ $SL = 80.941$ Kips

Solution Hwk # 3, Prob # 2, Text Prob # 3.3-6

W 16 x 45 Grade A 992 steel (Table 3-1, pg. 3-18)

$A_g := 13.3 \ in^2$ $A_e := 9.98 \ in^2$ $F_y := 50 \ Ksi$ $F_u := 65 \ Ksi$

$d := 16.1 \ in$ $t_f := 0.565 \ in$ $b_f := 7.04 \ in$

Diameter of the bolts used $d_b := \frac{7}{8} \ in$

Nominal Yield Strength, $\phi_t P_{ny} =$ $F_{ny} := 599 \ Kip$

Fracture Strength, $\phi_t P_{nu} =$ $F_{nu} := 487 \ Kip$

Net Area = $A_n := A_g - 4 \cdot \left(d_b + \frac{1}{8} \right) \cdot t_f$ $A_n = 11.04 \ in^2$

From Comm. 3 of AISC codes $\frac{b_f}{d} = 0.437$ $< 2/3$ Therefore, $U := 0.85$

From Table 1-8, pg. 1-46 & 1-47, $x := 1.86 \ in$

From Figure, $l := 3(3)$ $l = 9 \ in$

$U := 1 - \frac{x}{l}$ $U = 0.793$

Effective Area = $A_e := U \cdot A_n$ $A_e = 8.758 \ in^2$

Fracture Strength : $F_{nu} := 0.75 \cdot A_e \cdot F_u$ $F_{nu} = 426.972 \ Kip$

Yield Strength : $F_{ny} := 0.9 \cdot A_g \cdot F_y$ $F_{ny} = 598.5 \ Kip$

Therefore, design strength = 427 kips

Solution Hwk # 3, Prob. # 3 (Text - 3.3-1)

Part (a): Two Bolts on L 4 x 3 x 1/4

(1) AISC Specification

$A_g := 1.69\ in^2$ $A_n := A_g - \left(\frac{3}{4} + \frac{1}{8}\right)\cdot\frac{1}{4}$ $A_n = 1.471\ in^2$

$x := 0.725\ in$ $l := 3\ in$ $U := 1 - \frac{x}{l}$ $U = 0.758$ < 0.9

$A_e := U\cdot A_n$ $A_e = 1.116\ in^2$

(2) Average value of U

$U := 0.75$ $A_e := A_n\cdot U$ $A_e = 1.103\ in^2$

Part (b): Welded Connection of L 5 x 5 x 3/8 - not a special case

(1) AISC Specification

$A_g := 5.9\ in^2$ $A_n := A_g$ $A_n = 5.9\ in^2$

$x := 1.47\ in$ $l := 5\ in$ $U := 1 - \frac{x}{l}$ $U = 0.706$ < 0.9

$A_e := U\cdot A_n$ $A_e = 4.165\ in^2$

(2) Average value of U

$U := 0.75$ 0.85 is also accepted due to confusion in the AISC code. However 0.75 was clear from Lecture notes

$A_e := A_n\cdot U$ $A_e = 4.425\ in^2$

Part (c): Flange Bolted Connection W 8 x 24

(1) AISC Specification

$A_g := 7.08\ in^2$ $A_n := A_g - 4\left(\frac{7}{8} + \frac{1}{8}\right)\cdot 0.4$ $A_n = 5.48\ in^2$

W8 x 24 $x := 0.695\ in$ $l := 9\ in$ $U := 1 - \frac{x}{l}$ $U = 0.923$ > 0.9

Using, $U := 0.9$ $A_e := U\cdot A_n$ $A_e = 4.932\ in^2$