CE 311 Celebration of Knowledge 4  
October 30, 2015  
50 minute time limit

You are allowed to use the AISC manual, pencils, and a calculator.

**Bonus Questions:**

1. (8 points). The steel (E=29000ksi, G=11200ksi) I-shape is subjected to end torques that cause a twist angle of 0.00714 radians over its length of 100 inches. Determine the applied torque, T (units: kip-in).

   ![Torque Diagram]

   \[ T = \frac{4L}{6J} \Rightarrow 4\pi J = T \]

   \[ J = \frac{1}{3} \left( 3(10)\left(\frac{1}{2}\right)^3 \right) = 1.25 \text{in}^4 \]

   \[ T = \frac{(0.00714)(11200)(1.25)}{100} = 1.00 \text{kip-in} \]

   \[ T = 1.00 \text{kip-in} \]

2. (0.1 points). Situation: The game features Team A vs. Team B. The Las Vegas line is Team A (-5.5). You instruct your bookie to “take the points.” Team A beats Team B by a score of 24 to 21. Did you win?

   **ANALYSIS:** Team A is a 5.5 point favorite. Team B is a 5.5 point underdog. You “took the points”, which means you are betting that Team B will not get beat by more than 5.5 points. Since Team B was not beat by more than 5.5, you won.

   (Circle One) **YES**  **NO**

3. (0.1 points). Situation: The game features Team C vs. Team D. The Las Vegas line is Team D (+6.5). You bet on Team D. Team C beats Team D by a score of 24 to 21. Did you win?

   **ANALYSIS:** Team D is a 6.5 point underdog. Since you bet on Team D, you won because they were not beat by more than 6.5.

   (Circle One) **YES**  **NO**

4. (0.1 points). From the All Hockey Hair Team 2013, what was the first name of the hockey player whose hair was compared with a tsunami and a hurricane?

   **HURRICANE WYATT**

5. (0.1 points). Who holds the record for having played in the greatest number of World Series games in his career?

   **YOGI BERRA**
6. (0.1 points). What two university’s football teams compete in the rivalry that is known as The Red River Rivalry?
   TEXAS VS OKLAHOMA

7. (0.1 points). Who was the first US president to die in office?
   WILLIAM HENRY HARRISON
1. (15 points). A “Steel Bridge Connection.”
A 1” square tube with a wall thickness of 0.0625” is sandwiched by two plates, connected by a ¼” bolt that goes through a drilled 9/32” hole (because the hole is not punched, no damage is associated with the hole). The tube has a yield strength $F_Y = 60$ ksi and an ultimate strength of $F_U = 70$ ksi. The ¼” diameter bolt has an ultimate tensile strength $F_U = 150$ksi. The bolt is tightened to a pretension of 0.5 kips. Assume the Shear Lag Factor is 0.6.

Determine the Nominal Fracture Strength $R_n$ of the tube.

$$A_g = l^2 - \left(\frac{d}{8}\right)^2 = 0.234\text{in}^2$$

$$A_n = 0.234\text{in}^2 - (2)(\frac{9}{32})(0.0625) = 0.199\text{in}^2$$

$$A_e = 0.6(0.199) = 0.119\text{in}^2$$

$$R_n = (70)(0.119) = 8.35\text{ kips}$$

2. (15 points). Using the information given in Problem 1, determine $R_n$ for the hole in the square tubing.

$$\ell_c = \frac{l}{2} - \frac{9}{64} = 0.3594\text{ kips}$$

$$1.2\ell_c t F_U = 1.2(0.3594)(2 * 0.0625)(70) = 3.77\text{ kips}$$

$$2.4d_b t F_U = 2.4(\frac{1}{4})(\frac{9}{32})(70) = 5.25\text{ kips}$$

$$R_n = 3.77\text{ kips}$$
3. (15 points) Using the information given in Problem 1, determine $R_n$ for two conditions:

a. The bolt fails
b. The connection slips

State any assumptions that are needed.

Assumption(s):

$\mu = 0.3$

4. (7 points) What magnitude of force will break a ¾” Group A Slip-Critical bolt if it is loaded in double shear on a Class A faying surface in standard holes with no filler shims?

ANSWER: Bolt Breaking Force

a). $R_n = 8.83$ kips

b). $R_n = 0.3$ kips
5. (30 points) Use ASD to select the lightest adequate Single L3x3 brace, along with the number of 5/8” bolts. Assure that it is adequate for:

- Yield
- Fracture
- Bolts

Given:

- A36 steel
- Group A 5/8” N bolts
- Applied load of 20 kips as shown

\[ P_{brace} = \frac{25}{2} \text{ kips} \]

Angle Selected: L3x3x 1/4”

No. 5/8” Bolts: 4

Fracture \( P_{n/\Omega} \): 29.1 or 33.0 kips
6. (18 points). You are a forensic structural engineering consultant, investigating the cause of a structural failure. An L4x4x1/4 angle had been welded to a plate, when it failed. Your job is to estimate how much axial load P was on the angle when it failed, knowing that a 2"x3" piece of the angle was torn out when it failed. State any assumptions needed.

Given: A36 steel

![Diagram of angle and plate with load](image)

**Answer:** Failure Force P

\[ P = 54.3 \text{ or } 60.9 \text{ kips} \]