SOLUTION

HOMEWORK - due Monday. Presentation does not count. Simply hand this sheet in, showing the answers in the units specified, only (please don’t cover the page in random scribbling. Do your work elsewhere)

1. A 3/8” diameter bolt was tested in tension, failing at a load of 6.63 kips. A single ½” diameter bolt from the same manufacturer, manufactured from the same steel (assume the strength is identical) will be used in a double shear application, as shown. Determine: \( P_n \), \( P_n/\Omega \), and \( \phi P_n \) for the bolted connection, assuming that bolt shear controls.

\[
\begin{align*}
P_n &= 14.1 \text{kips} \\
\frac{P_n}{\Omega} &= 7.07 \text{kips} \\
\phi P_n &= 10.6 \text{kips}
\end{align*}
\]

Solution:

3/8” Bolt Area, \( A = 0.1104 \text{ in}^2 \)
\( F_u = \frac{6.63 \text{kip}}{0.1104 \text{ in}^2} = 60.0 \text{ ksi} \)

Therefore, shear strength is:

\( F_{nv} = 0.6 \times 60 = 36 \text{ ksi} \)

½” Bolt Area, \( A = 0.1963 \text{ in}^2 \)

\[
\begin{align*}
P_n &= (2 \text{ shear planes})(0.1963 \text{ in}^2)(36 \text{ ksi}) = 14.14 \text{ kips} \\
\frac{P_n}{\Omega} &= 14.14/2 = 7.07 \text{ kips} \\
\phi P_n &= \frac{0.75}{14.14} = 10.6 \text{ kips}
\end{align*}
\]

2. Reading (Chapter J in AISC): TRUE or FALSE. An ASTM A490 bolt is considered to be a “Group B” bolt.

- **Group B:** ASTM A490, A490M, F2280, AND A354 (AISC pp. 16.1-118)

3. What is the minimum bolt pretension that is required for a 7/8” Group B bolt?

Answer:

Minimum bolt pretension = \( 49 \) kips per Table J3.1

Circle the Answer: SAFE

4. Would it be safe per ASD standards for a Group A bolt to be subjected to a tensile stress of 50 ksi?

\[
\text{The nominal strength } F_{nv} = 90 \text{ ksi. Therefore, the allowable strength, using } \Omega = 2 \text{ (fracture) is } 45 \text{ ksi. With the applied stress exceeding the allowable strength, this is not safe, per ASD.}
\]

5. The beam-to-column connection shown is called a double-angle all-bolted framed beam connection. Because it is a non-moment-resisting connection, it must only be designed for resisting vertical shear forces. It uses two angles (L shapes) that “sandwich the web of the beam, as shown. If the connection uses 1” Group A N bolts (threads not excluded from the shear planes), determine the ASD allowable shear force \( R_n/\Omega \) for the connection.

\[
R_n/\Omega = 127.2 \text{kips}
\]

Solution:

Non-moment-resisting connection: bolts act in shear, only
(6) bolts in single shear connect to the column, (3) bolts in double shear connect the angles to the beam.

\[
\begin{align*}
r_n/\Omega &= 21.2 \text{kips/bolt for 1” Group A N bolts in single shear, or} \\
r_n/\Omega &= 42.4 \text{kips/bolt for 1” Group A N bolts in double shear}
\end{align*}
\]

\[
R_n/\Omega = (3 \text{ bolts})(42.4 \text{kips}) = 127.2 \text{kips for the connection}
\]
6. Determine the number of Group A ¾" N bolts that are needed for the following problem, using ASD. The tension member is subjected to 80 kips tension due to wind load and 5 kips tension due to live load. Note: be sure to use the ASD load combinations, properly (the 80 kips wind is, indeed, an “ultimate wind” that will be reduced per ASD combinations).

![Diagram of a tension member with bolts and gusset plate]

\[ P_{\text{Wind}} = 80 \text{ kips} \]
\[ P_{\text{Live}} = 5 \text{ kips} \]

\[ P = 0.6W = 48 \text{ kips (controlling combo)} \]

Table 7-1: \[ 2 \times \frac{r_n}{\Omega} = 23.9 \text{ kips} \]
\[ = 47.8 \text{ kips} \]

Not quite adequate. Therefore, 3 bolts

Answer: 3 bolts

7. For all of the same given information as the previous problem, determine the number of ¾" Group A slip-critical (SC) bolts that are needed, assuming that a Class A faying surface exists and that the holes are standard (STD). There are no filler plates.

Table 7-3: \[ 4 \times \frac{r_n}{\Omega} = 12.7 \text{ kips} \]
\[ = 50.8 \text{ kips} \]

Exceeds \( P = 48 \text{ kips} \). Therefore, 4 bolts

Answer: 4 bolts

8. For all of the same given information as the previous problem, determine the number of ¾" Group A slip-critical (SC) bolts that are needed, assuming that a Class B faying surface exists and that the holes are long-slotted (LSLT). There are no filler plates.

Table 7-4:
\[ 4 \times \frac{r_n}{\Omega} (5/3) = 4 (8.87)(5/3) = 59.1 \text{ kips} \]

Exceeds \( P = 48 \text{ kips} \). Therefore, 4 bolts

Answer: 4 bolts

9. Reading question (Chapter J). Report the dimensions for a Standard (STD), Oversize (OVS), Short-Slot (SSLT), and Long-Slot (LSLT) hole for a ¾" diameter bolt:

Answers:

- STD: \( 13/16 \)
- OVS: \( 15/16 \)
- SSLT: \( 13/16 \times 1 \)
- LSLT: \( 13/16 \times 1-7/8 \)

10. What is the \( \Omega \) factor for a slip-critical bolt in a long-slotted hole?
Answer: 2.14 (see bottom of table 7-3 or pg. 16.1-126)

11. Bolts are usually subjected to shear, but here is a case in which a connection subjects bolts to tension. In this case, a “Tee” shape is bolted as shown and subjected to a force that puts tension on the bolts. If the bolts are ¾” diameter group A bolts, determine the ASD allowable tensile force for the connection (note: if you take an advanced steel
course, you will learn that this type of connection is also prone to a phenomenon known as “prying action.” However this is beyond the scope of CE311).

Table 7-2: \( r_n/\Omega = 19.9 \) kips

\[
(6)(19.9) = 119.4 \text{ kips}
\]

Answer:

\[
R_n/\Omega = 119 \text{ kips}
\]