LESSON OBJECTIVES
1. **Explain** why yielding must never be allowed along any structural member, but it is allowed (locally) on a connection (around bolt holes).
2. **Explain** why yielding is allowed at the connection, so that the limiting stress for connections is the ultimate (fracture) stress.
3. **Calculate** the controlling nominal strength $R_n$, considering yielding of the member, fracture of the connection, and bearing on the holes.

READING
- AISC Steel Manual Chapter D in the Specifications (the Specifications are under Part 16 of the manual)
- SEGUI: pp. 41 to 56 (the computation of the U factor will be covered in class on Friday), pp. 382 to 388.

STANDARD HOLES
- Circular. 1/16" larger diameter than the bolt.
- Assume an 1/16" of damage to the walls of the hole due to punching of the steel. Therefore, the hole deduction for TENSILE FRACTURE ON THE NET AREA is 1/16" + 1/16" = 1/8" larger than the bolt diameter. Note also that the assumption of damage is not applicable to end tearout.

HOMEWORK (Due Friday. Standard homework assignment. Presentation counts)
1. Given: A 6" x ½" A36 plate tension member, connected to a gusset plate with (6) ¾" diameter Group A N-bolts in standard holes.
   a. Determine $P_n/\Omega$ for the Yield Limit State.
   b. Determine $P_n/\Omega$ for the Fracture Limit State
   c. Determine $P_n/\Omega$ for the Holes (Bearing/Tearout)
   d. Determine $P_n/\Omega$ for the Bolts (Lesson 21)
   e. What is the maximum safe load that this connection & member can sustain?
   f. Determine the maximum safe load for this connection if the bolts are changed to (6) 1” Group A N-bolts and compare this result with 2e (do bigger bolts make the connection stronger?)

2. Given: A 6” x ½” A36 plate tension member, connected to a gusset plate with (6) ¾” diameter Group A N-bolts in standard holes.
   a. Determine $P_n/\Omega$, considering all limit states.
   b. Compare with the results of problem 1e (is this bolt arrangement stronger or weaker?)
3. Given: A 6” x ½” A36 plate tension member, connected to a gusset plate with (6) ¾” diameter Group A N-bolts in short-slotted holes (See AISC Table J3.3 on page 16.1-121, for dimensions).
   a. Determine $P_{n}/\Omega$, considering all limit states.
   b. Compare with the results of problem 1e (is this bolt arrangement stronger or weaker?)
   Note that the connection would be stronger in fracture if the slotted holes were aligned with the loading.

4. Steel Bridge Problem: The member is a ½” x ½” hollow, square tube, with a wall thickness of 1/16”. The tube material has $F_y=60$ ksi and $F_u=70$ ksi. The section has a 13/32” diameter hole drilled in it for a 3/8” bolt (assume no “damage”, as it is drilled, not punched). The center of the hole is 3/8” from the edge of the tube. The bolt is a Grade 8 bolt with an ultimate tensile strength of 150 ksi.
   a) Determine $r_{n}/\Omega$ for the limit state of bolt shear (Lesson 21)
   b) Determine $r_{n}/\Omega$ for the limit state of member yielding
   c) Determine $r_{n}/\Omega$ for the limit state of fracture (assume no “damage”, as it is drilled, not punched).
   d) Determine $r_{n}/\Omega$ for the limit state of the hole (bearing/tearout).
   e) Determine the maximum $P$ that can be safely applied, per ASD

0. (on your own. Do not hand in. Repeat the previous problem, but with a ¼” bolt in a hole that is oversized by 1/32”. Is this bolt size OK for all of your team’s needs?)