Connections

• needed to:
  – support beams by columns
  – connect truss members
  – splice beams or columns

• transfer load

• subjected to
  – tension or compression
  – shear
  – bending

Bolts

• bolted steel connections

Welds

• welded steel connections
Fasteners

- wood connections

Bolted Connection Design

- considerations
  - bearing stress
    - yielding
  - shear stress
    - single & double
  - member
    - rupture

Bolted Connection Design

- ASD steel
  - shear:
    \[ f_v \leq F_v \]
    - bolt strengths
    - single & double
  - bolt types
    - A325-SC, A490-SC
    - A325-N, A490-N
    - A325-X, A490-X

- ASD steel
  - bearing:
    - bolts rarely fail by bearing
    - other part fails first
**Tension Members**

- steel members can have holes
- reduced area
- increased stress

**Effective Net Area**

- likely path to “rip” across
- bolts divide transferred force too

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**ASD – Tension Members**

- non-pin connected members:
  - \( F_t = 0.60F_y \) on gross area
  - \( F_t = 0.50F_u \) on net area
- pin connected members:
  - \( F_t = 0.45F_y \) on net area
- threaded rods of approved steel:
  - \( F_t = 0.33F_u \) on major diameter
  - (for static loading only)

**LRFD - Tension Members**

- limit states for failure
  \[ P_u \leq \phi_t P_n \]
  1. yielding \( \phi_t = 0.9 \) \[ P_n = F_y A_g \]
  2. rupture* \( \phi_t = 0.75 \) \[ P_n = F_u A_e \]

\( A_g \) - gross area
\( A_e \) - effective net area
\( F_u \) - tensile strength of the steel (ultimate)
Welded Connection Design

- **considerations**
  - shear stress
  - yielding
  - rupture

Welded Connection Design

- **weld terms**
  - butt weld
  - fillet weld
  - plug weld
  - throat

- **weld materials**
  - E60XX
  - E70XX
  \( F_{EXX} = 70 \text{ ksi} \)

Welded Connection Design

- **ASD**
  - shear \( f_v \leq F_v \)
    - \( F_v = 0.30 F_{weld} \)
  - throat
    - \( T = 0.707 \times \text{weld size} \)
  - area
    - \( A = T \times \text{length of weld} \)
  - weld metal generally stronger than base metal (ex. \( F_y = 50 \text{ ksi} \))

Welded Connection Design

- **angles**
  - bolted
  - welded

Framed Beam Connections

- **connections**
  - bolted
  - welded
**Framed Beam Connections**

- **terms**
  - coping

**Beam Connections**

- **LRFD provisions**
  - shear yielding
  - shear rupture
  - block shear rupture
  - tension yielding
  - tension rupture
  - local web buckling
  - lateral torsional buckling

**Framed Beam Connections**

- **tables for standard bolt holes & spacings**
  - \( n = \) # bolts
  - angle leg thickness
  - length needed

**Beam Connections**

- **block shear rupture**
- **tension rupture**