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

- 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

Bolted Connection Design

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

Bolted Connection Design

- 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* $\phi_t = 0.75$ $P_n = F_u A_e$

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

- considerations
  - shear stress
  - yielding
  - rupture

Welded Connection Design

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

- weld materials
  - E60XX
  - E70XX
  - $F_{EXX} = 70$ ksi

Framed Beam Connections

- angles
  - bolted
  - welded

Welded Connection Design

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

Welded Connection Design

- shears $f_y \leq F_y$
- lengths $L = T \times$ length of weld
- areas $A = T \times$ length of weld
- moment connection
  - $M = 1.25 \times$ weld size
- shear connection
  - $V = 1.25 \times$ weld size

Connections 16
Lecture 26
Architectural Structures / ENOS 231
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Connections 17
Lecture 26
Architectural Structures / ENOS 231
S2004abn

Connections 18
Lecture 26
Architectural Structures / ENOS 231
S2004abn

Connections 19
Lecture 26
Architectural Structures / ENOS 231
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Connections 19
Lecture 26
Architectural Structures / ENOS 231
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**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**
  - $n = \# \text{ bolts}$
  - angle leg thickness
  - length needed

**Beam Connections**

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