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
Bolts

- types
  - materials
    - high strength
    - A307, A325, A490
- location of threads
  - included - N
  - excluded - X
- friction or bearing (SC)
  - always tightened

Bolted Connection Design

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

Bolts

- rarely fail in bearing
- holes considered 1/8” larger
- shear & tension
  \[ R_a \leq \frac{R_n}{\Omega} \]
  \[ R_u \leq \phi_v R_n \]
  - single shear or tension
    \[ \phi_v = 0.75 \]
  - double shear
    \[ R_n = F_n A_b \]
    \[ R_n = F_n 2A_b \]
Bolts

- **bearing**
  \[ R_a \leq \frac{R_n}{\Omega} \]
  \[ R_u \leq \phi R_n \]
  \[ \phi = 0.75 \]
  - deformation is concern
  \[ R_n = 1.2L_c t F_u \leq 2.4dt F_u \]
  - deformation isn’t concern
  \[ R_n = 1.5L_c t F_u \leq 3.0dt F_u \]
  - long slotted holes
  \[ R_n = 1.0L_c t F_u \leq 2.0dt F_u \]
  \( L_c \) – clear length to edge or next hole (ex. 1¼", 3")

Welded Connection Design

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

![Welded Connection Diagram](image-url)
Welded Connection Design

• weld process
  – melting of material
  – melted filler - electrode
  – shielding gas / flux
  – potential defects

• weld materials
  – E60XX
  – E70XX
  \( F_{\text{EXX}} = 70 \text{ ksi} \)

Welded Connection Design

• shear failure assumed
• 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

• minimum
  – table
• maximum
  – material thickness ( to \( \frac{1}{4}'' \))
  – 1/16” less
• min. length
  – 4 x size min.
  – \( \geq 1 \frac{1}{2}'' \)

Welded Connection Design

\[
R_n \leq \frac{R_u}{\Omega} \\
R_u \leq \phi R_n \\
\phi = 0.75
\]

\[
R_n = 0.6 F_{\text{EXX}} Tl = Sl
\]

– table for \( \phi \)S

**TABLE J2.4**

<table>
<thead>
<tr>
<th>Material Thickness of Thicker Part Joined, in. (mm)</th>
<th>Minimum Size of Fillet Weld(( d ), in. (mm))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{1}{32} ) (1.6)</td>
<td>( \frac{1}{8} (3.2) )</td>
</tr>
<tr>
<td>( \frac{1}{16} ) (3.2)</td>
<td>( \frac{1}{8} (3.2) )</td>
</tr>
</tbody>
</table>

(1) Leg diameter of fillet weld. Single pass welds may be used.
(2) Use section J2.2 for multiple size of fillet weld.
Framed Beam Connections

- angles
  - bolted
  - welded

Framed Beam Connections

- tables for standard
  bolt sizes & spacings
- # bolts
- bolt diameter, angle
  leg thickness
- bearing on
  beam web

Framed Beam Connections

- terms
  - coping

Framed Beam Connections

- welded example (shear)
Framed Beam Connections
• welded moment example

(AISC - Steel Structures of the Everyday)

Framed Beam Connections
• welded/bolted moment example

(AISC - Steel Structures of the Everyday)

Framed Beam Connections
• welded/bolted moment example

(AISC - Steel Structures of the Everyday)

Beam Connections
• LRFD provisions
  – shear yielding
  – shear rupture
  – block shear rupture
  – tension yielding
  – tension rupture
  – local web buckling
  – lateral torsional buckling
Beam Connections

\[ R_n = 0.6F_u A_{nv} + U_{bs} F_u A_{nt} \leq 0.6F_y A_{gv} + U_{bs} F_u A_{nt} \]

- where \( U_{bs} \) is 1 for uniform tensile stress

Other Connections

- seated beam
- continuous
  - beam to column
  - beam to beam

Other Connections

- splices
- rigid frame knees
- gussets & joints
Other Connections

- base plates
  - anchor bolts
  - bearing on steel
  - bending of plate

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