Review Bolts and Welds

Design bolt bearing strength \((L_o \geq 1.5d, s \geq 3d)\)
- \(\Phi R_b = \Phi (2.4dF_{tu})\)

Design bolt shear strength – threads excluded (X) in shear planes
- \(\Phi R_s = 0.75(0.50F_{th})mA_b\)

Design bolt shear strength – threads included (N) in shear planes
- \(\Phi R_s = 0.75(0.40F_{th})mA_b\)

Design bolt tensile strength
- \(\Phi R_t = 0.75(0.75F_{th})A_b\)

Design bolt Slip-Critical
- \(\Phi R_s = \mu D_hT_dT_r\)

Design strength of the weld
- \(\phi R_w = 0.707wL(\phi F_w) = 0.707wL(0.75[0.6F_{Exx}]) = 0.32wLF_{Exx}\)

Double-Angle Connection

For bolted connection (AISC Tables 10-1 or -2)
1. Manual Table 10-1 includes checks for the limit states of bearing, shear yielding, shear rupture, and block shear rupture on the angles, and shear on the bolts.
2. Check the beam web for bolt bearing. Block shear rupture, shear yielding and shear rupture will not control, since the beam is uncoped.
3. Check beam web for bolt bearing.
4. Check supporting member flange for bolt bearing.

For welded connection (AISC Table 10-3)
1a. Design the weld between the beam-web and the angle leg (welds A).
2a. Design the welds between support and the angle leg (welds B).
3a. Check minimum angle thickness.
Double-Angle Connection (coped)

Example II.A-4 All-Bolted Double-Angle Connection

1. Check bolt shear. Check angles for bolt bearing, shear yielding, shear rupture and block shear rupture
2. Check beam web for bolt bearing, block shear rupture, shear yielding and shear rupture
3. Check supporting member flange for bolt bearing
4. Check block shear rupture $U_{sh} = 1.0$
   \[ \phi R_e = \phi F_y A_{uu} U_{sh} = \min(0.6 F_y A_{uu}, \phi F_y A_{uu}) \]
5. Check flexural rupture on the coped section
   - Check local web buckling at the coped section
   - Check shear yielding on beam web

Unstiffened Seated Connection

Example II.A-12 All-Bolted Unstiffened Seated Connection (beam-to-column web)

1. Check beam web
   - For local web yielding:
     - For web crippling
2. Check shear yielding and flexural yielding of angle. Check local yielding and crippling of beam web
3. Check bolt bearing on the angle
4. Check supporting column

Stiffened Seated Connection

Example II.A-14 Stiffened Seated Connection (beam-to-column flange)

1. Determine stiffener width $W$ required
   - For web crippling:
     - For local web yielding
2. Determine stiffener length $L$ and stiffener to column flange weld size
3. Determine weld requirements for seat plate
4. Determine the seat plate dimensions
5. Check column web thickness
6. Select top angle, bolts, and welds

Example II.A-15 Stiffened Seated Connection (beam-to-column web)
Single-Plate Connection

For single-plate connection (AISC Table 10-9):

1. Check bolt shear. Check plate for shear yielding, shear rupture, and block shear rupture.
2. Check beam web for bolt bearing. Block shear rupture, shear yielding and shear rupture will not control for an uncoped section.

Example II.A-17 Single-Plate Connection (conventional -- beam-to-column flange)

Example II.A-19 Extended Single-Plate Connection (beam-to-column web)

For extended single-plate connection:

1. Determine the bearing strength of one bolt on the beam web.
2. Determine the strength of the bolt group.
3. Determine the maximum plate thickness.
4. Check flexural strength of the plate.
5. Check shear yielding of the plate.
6. Determine critical flexural stress in presence of shear stress, $f_s$.
7. Check shear rupture of the plate.
8. Check block shear rupture of the plate.

Example II.A-18 Single-Plate Connection (beam-to-girder web)

Example II.A-20 All-Bolted Single-Plate Shear Splice

For all bolted shear splice:

1. Design the bolt groups.
2. Design splice plate.
3. Check flexure of the plate.
4. Check shear yielding of the plate.
5. Check shear rupture of the plate.
6. Check block shear rupture of the plate.

Example II.A-21 Bolted/Welded Single-Plate Shear Splice

For welded shear splice:

1a. Design the weld group.
2a. Check shear rupture of beam web at the weld.
3a. Design the bolt group.
4a. Design splice plate.
5a. Check flexure of the plate.
6a. Check shear yielding of the plate.
7a. Check shear rupture of the plate.
8a. Check block shear rupture of the plate.
Bracket Plate Design

For bolt bracket plate
1. Design the bolt groups
2. Check bolt bearing
3. Check flexure in the bracket plate
4. Check local buckling of the bracket plate
5. Check shear yielding of the bracket plate
6. Check shear rupture of the bracket plate
7. Check block shear rupture of the bracket plate

Bracket Plate Design

For welded bracket plate
1a. Try a C-shaped weld
2a. Check flexure in the bracket plate
3a. Check local buckling of the bracket plate
4a. Check shear yielding of the bracket plate
5a. Check shear rupture of the bracket plate
6a. Check block shear rupture of the bracket plate

Eccentrically-Loaded Group

For bolt group
1. Direct shear force per bolt
2. Additional shear force due to eccentricity
3. Resultant shear force

Eccentrically-Loaded Group

For welded group
1a. Direct shear force per inch of weld
2a. Additional shear force due to eccentricity
3a. Resultant shear force
**Single-Angle Connection**

Example II.A-28  All-Bolted Single-Angle Connection (beam-to-girder web)

For all bolted single-angle connection
(AISC Table 10-10)

1. Design the bolts and angle
2. Check shear yielding of the angle
3. Check shear rupture of the angle
4. Check block shear rupture of the angle
5. Check failure of the support-leg of the angle
6. Check beam web for bolt bearing and block shear rupture.

**Tee Connection**

Example II.A-30  All-Bolted Tee Connection (beam-to-column flange)

For all bolted tee connection

1. Check limitation on tee stem thickness
2. Check limitation on bolt diameter for bolts through tee flange
3. Check bolt group through beam web for shear and bearing
4. Check shear yielding of the tee stem
5. Check block shear rupture of the tee stem
6. Check bolt group through support for shear and bearing combined with tension due to eccentricity
7. Check design strength of bolts for tension-shear interaction
8. Check bearing strength at bolt holes
9. Check beam web for bolt bearing, block shear rupture, shear yielding and shear rupture
10. Check supporting member web or flange for bolt bearing

**Single-Angle Connection**

Example II.A-29  Bolted/Welded Single-Angle Connection (beam-to-column flange)

For bolted/welded single-angle connection
(AISC Tables 10-10 or -11)

1a. Design single angle, bolts, and welds
2a. Check supported beam web
3a. Check support

**Tee Connection**

Example II.A-31  Bolted/Welded Tee Connection (beam-to-column flange)

For bolted/welded tee connection

1a. Check limitation on tee stem thickness
2a. Design the welds connecting the tee flange to the column flange
3a. Check the stem side of the connection
4a. Check bolt group through beam web for shear and bearing
5a. Check shear yielding of the tee stem
6a. Check block shear rupture of the tee stem
7a. Check bolt group through support for shear and bearing combined with tension due to eccentricity
8a. Check design strength of bolts for tension-shear interaction
9a. Check bearing strength at bolt holes
10a. Check beam web for bolt bearing, block shear rupture, shear yielding and shear rupture
11a. Check supporting member web or flange for bolt bearing