**Review Bolts and Welds**

**Design bolt bearing strength** ($L_u \geq 1.5d$, $s \geq 3d$)
- $\Phi R_u = \Phi(2.4dF_w)$

**Design bolt shear strength – no threads in shear planes**
- $\Phi R_u = 0.75(0.50F_w^b)mA_b$

**Design bolt shear strength – threads in shear planes**
- $\Phi R_u = 0.75(0.40F_w^b)mA_b$

**Design bolt tensile strength**
- $\Phi R_u = 0.75(0.75F_w^b)A_b$

**Design strength of the weld**
- $\phi R_n = 0.707W_L(\phi F_w) = 0.707W_L(0.75[0.6F_{\text{Exx}}]) = 0.32WLF_{\text{Exx}}$

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**Double-Angle Connection**

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 unnotched.
3. Check beam web for bolt bearing.
4. Check supporting member flange for bolt bearing.
Double-Angle Connection (coped)

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

1. Check bolt shear. Check angle 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.
5. Check flexural rupture on the copped section.
   - Check local web buckling at the copped section.
   - Check shear yielding on beam web.

Double-Angle Connection (coped)

Example II.A-5  Bolted/Welded Double-Angle Connection (beam-to-girder web)

For bolted/ welded connection (AISC Tables 10-2 or 31):
1. Design the web between the beam-web and the angle leg (weld A).
2. Check minimum angle thickness.

Unstiffened Seated Connection

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

For all bolted connection (AISC Table 10-5):
1. Check beam web.
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)

For all welded connection (AISC Tables 10-7 or 8):
1. Determine stiffener width W required.
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 weld.

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

For bolted/ welded connection (AISC Tables 10-5 & -6):
1a. Check minimum angle thickness.
Single-Plate Connection

Example II.A-17 Single-Plate Connection (conventional – beam-to-column flange)
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-18 Single-Plate Connection (beam-to-girder web)

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

Single-Plate Shear Splice

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

Example II.A-22  Bolted Bracket Plate Design

For bolt bracket plate

1. Torsion 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

Example II.A-23  Welded 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

Example II.A-24  Eccentrically-Loaded Bolt Group (IC method)
Example II.A-25  Eccentrically Loaded Bolt Group (elastic method)

Elastic Method

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

Example II.A-26  Eccentrically-Loaded Weld Group (IC method)
Example II.A-27  Eccentrically-Loaded Weld Group (elastic method)

Elastic Method

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 fixture of the support-leg of the angle
6. Check beam web for bolt bearing and block shear rupture.

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-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

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