Typical Steel Connections

Dr. Seshu Adluri
Introduction

Steel Connections

Many configurations are used for force transfer in connections. The configuration depends upon the type of connecting elements, nature and magnitude of the forces (and moments), available equipment, fabrication and erection considerations, cost, etc.
Rivets
Bolts
Connections

- Many types based on function
  - Beam-to-Beam Connections
  - Beam-to-Column Connections
  - Column-to-Column Connections
  - Column Base Plates
  - Pocket Beam
  - Gusset plate connections (truss type, frame type, bracings, …)
  - Splices (cover plates, …)
Cover plates

Figure 2 Transfer of axial forces through cover plates
Cover plates

Figure 3  Welded cover plate

Figure 4  Bolted cover plates
Bolted Column Splice
Moment Connection
Gusset plate connections

Bolted Connection

Figure 7  Connection of tension members to gusset plates
Gusset plate connections

Figure 10 Bolted connection between angles

Figure 12 Member with two angle sections
Gusset plate connections
Force dispersion to gusset plates

Figure 16 Spread and effective breadth in a welded and a bolted connection
Steel Framing Connections

- Framed Connections
  - Bolts only in web, not the flanges
  - Transmits only shear
  - Not bending moment
  - Accomplished with
    - clip angles & bolts/welds

- Moment Connections
  - Transmit shear & moment
  - Flanges must be connected
  - Bolt/Weld Flanges
  - May require column stiffeners
Framed connections

- Only shear transfer
  - Equivalent to pinned end for the beam
  - No moment at the beam end
  - Rotation is freely (?) allowed
Framed connections

- End reaction only
  - Web of the beam is connected
  - No connection for the flanges
Transfer of shear force in frames

(a) Bearing plate
(b) Flush end plate
(c) Web plate
(d) Angle cleat

Figure 17 Connections to transfer beam loading into column by means of shear
Beam-to-beam connections

Figure 20  Beam-to-beam connections

Figure 21  Possible critical sections at the ends of secondary beams
Beam-to-beam connections
Beam-to-column connections

1. Plastic failure of the column flange
2. Yield / rupture of the column web
3. Rupture of the welds

4. Rupture of the bolts
5. Plastic failure of the end plate, respectively angle cleat of T-section

Figure 2 Checking criteria for the tension zone of unstiffened connections

Figure 1 The tension zone of beam-to-column connections
Beam-to-column connections

Figure 6. All-bolted double angle shear connection.
- Bevel
- Full penetration groove weld
- Field welding
- Weld access hole
- back-up bar

Figure 7. Directly welded flange fully restrained moment conn.
- fillet welds
- shear tabs

Figure 3  Beam-to-column connections
Beam to column joints

Fig. 18.1. Types of beam-to-column connections. Note. The need for column stiffeners in any of these connections must be checked. (a) Flexible connections. (b) Semi-rigid connections. (c) Rigid connections.
Beam to column joints
Beam to column joints

Deformation of web angle connection

Deformation of seat angle connection

Fig. 18.3. Deformations of flexible beam-to-column connections.
Beam to column joints

Fig. 18.5. Angle in standard beam connections described in Fig. 18.4. (Courtesy of University of Illinois.)

Fig 18.6. Eccentric shear acting on bolt group
Beam-to-column connections

![Diagram of beam-to-column connections](image)

Figure 4  Flexibility and rotation capacity for simple end plates
Beam-to-column connections

Figure 5  Transfer of tensile force via bending of the column flange in a bolted connection
Beam-to-column connections

(a) Bolt fracture
(b) Bearing yielding
(c) Net-section fracture
(d) Edge distance fracture
(e) Plate yielding
(f) Weld fracture

Figure 5 Modes of failure for fin plates
Beam to Column Rigid Joints

Bending moment from the beam
Beam to Column Rigid Joints

- The bending moment of the beam is primarily taken by the flanges in the form of tension and compression forces.
Beam to Column Rigid Joints

Fig. 18.19. Deformation of column in moment resistant connection. (a) Distortion of unstiffened column. (b) Web crippling in beam-to-column connection. (Courtesy of British Steel Corp.)
Beam to Column
Rigid Joints

Figure 12  Strengthening the column flange with stiffening plates
Beam-to-column connections

Figure 4  Stiffening plates to strengthen the column flange
Stiffener plates are used to ‘shore up’ the column flanges against the forces transmitted by the beam flanges. The stiffeners may be full length or may extend only part of the column web depth.
Beam plate buckling

Beam flange local buckling

Beam web crippling
Beam plate buckling

Beam web local yielding

Beam web buckling (look closely)
Concentrated forces on webs

Figure 17 Tests for the determination of $b_{eff}$ in the compression zone
Beam to Column Rigid Joints

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Figure 3  Critical components in moment connection
Beam to Column Semi-Rigid Joints

Figure 4. Controlled yielding of end plate protects brittle components (bolts & welds) from overloading.
Beam to Column Rigid Joints

- Stiffener plates are used to ‘shore up’ the column flanges against the forces transmitted by the beam flanges. The stiffeners may be full length or may extend only part of the column web depth.

Figure 21  Strengthening of the column web in the shear zone
Beam to Column Rigid Joints

(a) Conventional horizontal stiffeners
(b) 'K' pattern
(c) 'Morris' stiffener (with compression stiffener)
(d) Supplementary web plates

Figure 4. Stiffening/strengthening possibilities
Beam to Column Rigid Joints

- The bending moment of the beam is primarily taken by the flanges in the form of tension and compression forces.
- The bending moment of the column is also resolved as a force couple.
Beam to Column Rigid Joints

- Stiffeners help in distributing the forces in the connection zone and in avoiding local rupture, crushing or buckling of the beam web.
Beam to Column Rigid Joints

Figure 2 Typical moment connections
Beam Splices

Figure 1 Types of splice arrangements
Beam Splices

(a) End plated

(b) Bolted cover plates

(c) Fully welded one sided cover plates

(d) Fully butt welded

Overlapped

F/2

F/2

(a)

Splice plated

Effect of eccentricity

(b)

Splice plated

Figure 5  Splices in beams

Figure 2  Bolted splices
Column Splices

Figure 6 Column splices
Column Splices

Figure 3  Column splices

Figure 4  Welded column splice for sections of differing serial size
Connections for Bents (Eves)

Figure 20  Shear panel of a T-connection

Figure 22  Schematization of the action in the shear zone with tension and compression

Figure 12  Types of eaves connection
Connections for Bents (Eves)

(a) Eaves connection

(b) Apex connection

Figure 6  Portal frame connections
Connections in frames

Figure 1  Simple frames
Bracing Connections in frames
Column Bases

(a) 
(b) 
(c) 
(d)

Figure 8  Column bases
Column Base Anchors

Figure 9  Anchorages of holding down bolts
Beam-to-wall connections

Figure 10  Beam-to-concrete wall connections
Beam-to-wall connections

Figure 11 Design model for connection of figure 10(e) subject to shear and moment
References

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