Predesigned Bolted Framing Angle Connections

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

The current AISC Specification provisions governing the use of mechanical fasteners in structural applications are largely based upon rational rules provided in *Guide to Design Criteria for Bolted and Riveted Joints* by Fisher and Struik.[1] This publication was sponsored by the Research Council on Structural Connections to evaluate and distill the results of voluminous research in this field that has been conducted since the late 1800's.

Unfortunately, adoption of rules which provide the designer with an improved basis for understanding and estimating the real strength of structural connections has made connection design more complex. There are several modes of failure, any one of which may control the strength of a connection, and each must be considered. Thus, the design or checking of a given connection has become more demanding than in the past, when Specification provisions masked the true performance of connections behind overly conservative rules which addressed only a few possible modes of failure. For a complete framing angle connection design, the following must be considered: bolt shear, bearing on connected material, edge distance, block shear, net section shear, connection length, bolt spacing, slip resistance, hole size and shape and, in some cases, other special factors.

Because many typical connections are used repeatedly, in the same project or in different projects, AISC has developed tables of predesigned framing angle connections to reduce the time and cost that would be required for design, review, and checking for approval if unique designs were prepared for each application.

PREDESIGNED CONNECTION CAPACITIES (TABLES 2, 3, 4, AND 5)

The typical connection is illustrated in Fig. 1. The following controlling variables were used in calculating the tabulated capacities, considering all potential factors affecting connection strength listed in the previous paragraph:

1. Minimum edge and end distance: $1\frac{1}{4}$ in.
2. Beams: 36 ksi and 50 ksi (F_u = 65 ksi) steel
3. Two connection angles: 36 ksi steel
4. Bolts: $\frac{3}{4}$-in. dia. and $\frac{7}{8}$-in. dia., A325
5. Bolt spacing: 3 in.
6. Uncoped and single-coped beams
7. W-shapes with nominal web thicknesses up to and including $\frac{15}{16}$-in.
8. Bearing connections with bolt threads included (N) or excluded (X) from the shear plane

Note that tables do not apply to friction-type connections, single-angle connections, double-coped beams, nor A307 and A490 bolts insofar as bolt shear capacities are concerned.

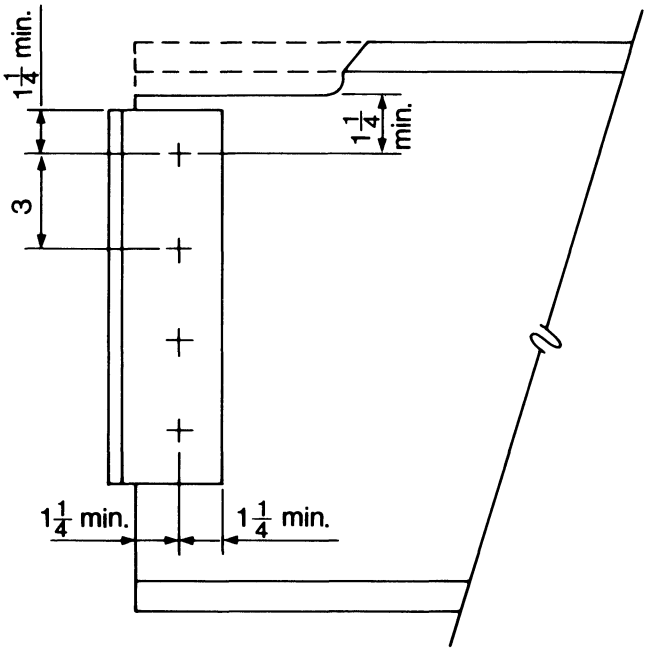

Fig. 1. Dimensions shown are basis for calculation of tabular values for double-angle predesigned connections.

Table 1. Coefficients for Computing Actual Web Shear Capacity

No. of Bolts	Uncoped Connections				Coped Connections			
	36 ksi Steel		50 ksi Steel		36 ksi Steel		50 ksi Steel	
	3/4" Bolts	7/8" Bolts	3/4" Bolts	7/8" Bolts	3/4" Bolts	7/8" Bolts	3/4" Bolts	7/8" Bolts
2	72.5	72.5	81.3	81.3	72.5	72.1	81.3	80.8
3	108.8	108.8	121.9	121.9	108.0	108.0	121.9	121.0
4	145.0	145.0	162.5	162.5	145.0	143.9	162.5	161.3
5	181.3	181.3	203.1	203.1	181.3	179.8	203.1	201.5
6	217.5	217.5	243.8	243.8	217.5	215.7	243.8	241.7
7	253.8	253.8	284.4	284.4	253.8	251.6	284.4	282.0
8	290.0	290.0	325.0	325.0	290.0	287.5	325.0	322.2
9	326.3	326.3	365.6	365.6	326.3	323.4	365.6	362.4
10	362.5	362.5	406.3	406.3	362.5	359.2	406.3	402.6

Notes: 1. Based on dimensions shown in Fig. 1, where coefficient times actual web thickness = connection capacity (where web shear controls).
2. Minimum connection angle thicknesses tabulated in Tables 2 through 5 may not be adequate when connection capacities are determined b use of coefficients.
3. Tabular values for 50 ksi steel are based on F_u = 65 ksi.

The predesigned connections covered by the tables in this paper are not to be construed as standard connections. They are connections for beam shapes which have been grouped to facilitate presentation in concise tabular form. The calculated capacities are based on the actual web thickness of the critical shape within each group. Thus, the capacities reflect less than the true allowable capacity for shapes in a group other than the critical shape. The tables should not preclude the use of higher capacities for these or similar connections, if supported by calculations in accordance with Specification provisions, using actual dimensions of the beam shapes, connection materials, and fasteners.

For the purposes of table organization, the shapes are grouped in columns according to nominal web thickness and number of fasteners. The connection angles have a length not less than one-half the beam depth nor more than the depth of the beam web clear of the flange-to-web fillets.

The tabulated connection capacities are based on the shape with the thinnest web in the group, indicated by an asterisk. Thus, for a connection using 3/4-in. dia. bolts for an A36 steel beam (Table 2) with a nominal web thickness of 3/16-in., the controlling shape for a 2 bolt group is a W8x10. The capacity for the group was calculated using the actual web thickness for this shape (0.170 in.) and is listed as 12.3 kips. The tabulated capacities, therefore, provide additional conservatism for beams in the groups which have actual web thickness greater than the critical shape.

For beam groups with thick webs, particularly those of 50 ksi steel, bolt shear may govern. For those cases, the capacities are listed with either an N or X prefix, and the shapes for connections which could be governed by bolt shear are included within a shaded area. Two different shadings have been used to distinguish between those cases which may be governed by either beam web thickness or bolt shear capacity if threads are included in the shear plan (N), and those cases where the capacity is independent o beam web thickness and is entirely dependent on bolt shea capacity (N) or (X). For example, a 2 bolt connection usin 3/4-in. dia. bolts with threads included in the shear plane A36 steel beam, and nominal web thickness greater tha 1/2-in. would have a capacity of 37.2 kips (Table 2). I threads are excluded from the shear plane, the web thick ness would control up to a nominal web thickness o 11/16-in., beyond which the maximum 2 bolt capacity would be limited to 53 kips, the maximum shear strength of th bolts.

The tabular capacities are applicable to both uncope and single-coped connections. In Tables 2 and 4 (3/4-in. dia bolts), all tabulated web capacities are governed by en distance and are identical for coped and uncoped connec tions. In Tables 3 and 5, tabulated web capacities are base on coped connections governed by block shear. In no cas are these values more than 1% less than the capacities fc equivalent uncoped connections.

COEFFICIENTS FOR EXACT CAPACITY CALCULATIONS

The user may encounter cases in which the tabulated c pacity (based on the thinnest web in the group) may b slightly less than required for a particular situation. T provide a convenient means for determining the fully ju tified capacity in accordance with Specification requir ments, Table 1 lists coefficients which can be multipli by the exact web thickness to yield the actual capacit Values are listed for both the uncoped and single-cop case. Since these slightly larger values may exceed the bc shear capacity, the capacity calculated using Table coefficients should be checked against the N or X capaciti in Tables 2, 3, 4 and 5, as appropriate.

CONNECTION ANGLE THICKNESSES

The minimum connection angle thicknesses shown at the top of each vertical column in Tables 2, 3, 4 and 5 are those which provide a net area shear strength equal to or greater than the corresponding web capacity tabulated for each group in that column. Thus, in some cases the tabulated minimum angle thickness may be larger than actually required for an individual group within a column. The listed angle thickness is always conservative for the tabulated capacities. However, if a higher capacity is calculated using Table 1 coefficients, the connection angle thickness should be checked.

Listed connection angle thicknesses are valid for the outstanding leg as long as each angle contains the same number of bolts as does the leg connected to the beam web. The detailer should be careful regarding tightening clearances if the gage is small. In such cases, it may be necessary to stagger the bolts in the two legs.

MINIMUM DIMENSIONS

The minimum dimensions shown in Fig. 1 are the dimensions used strictly for the purpose of calculating the tabulated capacities; they are not intended to restrict the use of larger end distances. For example, usual practice in dimensioning framing angle connections is to provide a setback from the back of the outstanding legs of angles to allow for possible overrun tolerance on the cut length of the beam. This setback normally results in an end distance greater than the $1\frac{1}{4}$ in. used in the calculations.

DISCLAIMER

REFERENCES

1. *Fisher, J. W. and J. H. A. Struik* Guide to Design Criteria for Bolted and Riveted Joints *John Wiley & Sons, New York, N.Y., 1974.*

Table 2. Predesigned Bolted Shear Connection Capacities (kips) for Single Coped and Uncoped W Shapes

Nominal Web Thickness, In.		3/16	1/4	5/16	3/8	7/16
Min. Connection Angle Thickness, In.		1/4	1/4	1/4	1/4	1/4
No. of Bolts	2	**12.3 kips** W8x10* W10x12 W12x14	**16.0 kips** W8x13–24 W10x15–26 W12x16*–30	**20.7 kips** W8x28*–35 W10x30–39, 49 W12x35–45	**25.4 kips** W8x40, 48 W10x45*, 54 W12x50–65	**30.5 kips** W10x60* W12x72
	3	**21.8 kips** W12x14	**23.9 kips** W12x16*–30 W14x22–30 W16x26, 31	**31.0 kips** W12x35–45 W14x34*–48 W16x36, 40 W18x35, 40	**37.5 kips** W12x50, 53*–65 W14x53, 61 W16x45*, 50, 67 W18x46, 50, 55	**45.1 kips** W12x72 W14x68*, 74, 90 W16x57, 77 W18x60*, 65, 76
	4		**36.3 kips** W16x26*, 31	**42.8 kips** W16x36*, 40 W18x35, 40	**50.0 kips** W16x45*, 50, 67 W18x46, 50, 55	**60.2 kips** W16x57, 77 W18x60*, 65, 76
	5			**54.4 kips** W18x35*, 40	**63.4 kips** W18x46, 50, 55 W21x44*–62 W24x55	**75.2 kips** W18x60*, 65, 76 W21x68, 73 W24x62*–76 W27x84
	6				**76.1 kips** W21x44*–62 W24x55	**90.3 kips** W21x68, 73 W24x62, 68*, 76 W27x84
	7				**100.2 kips** W24x55*	**105.3 kips** W24x62, 68*, 76 W27x84
	8					**133.4 kips** W27x84
	9					
	10					

Notes: 1. Tabulated connection capacities are based on the shape with the thinnest web in each group, except that capacities in shaded areas may be limited by bolt shear (N or X).

2. In Tables 2 and 4 (3/4-in. bolts), the connection capacities of coped and uncoped beams are identical.

3. Increased capacities may be computed using actual web thickness for shapes without asterisks, using the coefficients in Table 1.

Beam:	36 ksi
Angles:	36 ksi
Bolts:	A325, 3/4-in.

1/2	9/16	5/8	11/16	3/4	13/16–15/16
5/16	5/16	3/8	3/8	7/16	1/2
34.1 kips **N-37.2 kips** W8x58 W10x68*, 77 W12x79*, 87	**39.9 kips** **N-37.2 kips** W8x67 W12x96*	**43.9 kips** **N-37.2 kips** W10x88* W12x106	**49.3 kips** **N-37.2 kips** W10x100* W12x120	**N-37.2 kips** **X-53.0 kips** W10x112	**N-37.2 kips** **X-53.0 kips** W12x136–170
51.1 kips **N-55.8 kips** W12x79*, 87 W14x82, 99, 109 W16x89 W18x71.86	**58.2 kips** **N-55.8 kips** W12x96 W14x120 W16x100 W18x97*, 106	**66.3 kips** **N-55.8 kips** W12x106* W14x132 W18x119	**74.0 kips** **N-55.8 kips** W12x120 W14x145*	**N-55.8 kips** **X-79.5 kips** W14x159	**N-55.8 kips** **X-79.5 kips** W12x136–170 W14x176, 193
69.6 kips **N-74.4 kips** W16x89 W18x71, 86* W21x101, 83	**77.6 kips** **N-74.4 kips** W16x100 W18x97*, 106 W21x93, 111	**87.0 kips** **N-74.4 kips** W18x119 W21x122*, 132		**104.4 kips** **N- 74.4 kips** W21x147	
85.2 kips **N-93.0 kips** W18x71, 86 W21x101, 83 W24x84*, 104, 94 W27x94, 102	**97.0 kips** **N-93.0 kips** W18x97*, 106 W21x93, 111 W24x117 W27x114	**108.8 kips** **N- 93.0 kips** W18x119 W21x122*, 132 W24x131, 146 W27x146	**119.6 kips** **N- 93.0 kips** W24x162 W27x161*	**130.5 kips** **N- 93.0 kips** W21x147* W27x178	
102.2 kips **N-111.6 kips** W21x101, 83 W24x84*, 104, 94 W27x94, 102 W30x99	**118.5 kips** **N-111.6 kips** W21x93, 111 W24x117 W27x114 W30x108*–124 W33x118, 130	**130.5 kips** **N-111.6 kips** W21x122*, 132 W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135–160	**143.6 kips** **N-111.6 kips** W24x162 W27x161* W30x191 W33x201 W36x170	**156.6 kips** **N-111.6 kips** **X-159.0 kips** W21x147* W27x178 W30x211 W33x221 W36x182, 194, 230	**N-111.6 kips** **X-159.0 kips** W33x241 W36x210, 245–300
119.3 kips **N-130.2 kips** W24x84*, 104, 94 W27x94, 102 W30x99	**138.3 kips** **N-130.2 kips** W24x117 W27x114 W30x108*–124 W33x118, 130	**152.3 kips** **N-130.2 kips** W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x130*–160	**167.5 kips** **N-130.2 kips** W24x162 W27x161* W30x191 W33x201 W36x170	**184.0 kips** **N-130.2 kips** **X-185.5 kips** W27x178* W30x211 W33x221 W36x182*, 194, 230	**N-130.2 kips** **X-185.5 kips** W33x241 W36x210, 245–300
142.1 kips **N-148.8 kips** W27x94*, 102 W30x99	**158.1 kips** **N-148.8 kips** W27x114 W30x108*–124 W33x118, 130	**174.0 kips** **N-148.8 kips** W27x146 W30x132, 173 W33x141, 152 W36x135*–160	**191.4 kips** **N-148.8 kips** W27x161* W30x191 W33x201 W36x170	**210.3 kips** **N-148.8 kips** **X-212.0 kips** W27x178* W30x211 W33x221 W36x182*, 194, 230	**N-148.8 kips** **X-212.0 kips** W33x241 W36x210, 245–300
	179.4 kips **N-167.4 kips** W33x118*, 130	**195.8 kips** **N-167.4 kips** W33x141, 152 W36x135*–160	**221.9 kips** **N-167.4 kips** W33x201 W36x170*	**236.5 kips** **N-167.4 kips** **X-238.5 kips** W33x221 W36x182*, 194, 230	**N-167.4 kips** **X-238.5 kips** W33x241 W36x210, 245–300
		217.5 kips **N-186.0 kips** W36x135*–160	**246.5 kips** **N-186.0 kips** W36x170	**262.8 kips** **N-186.0 kips** **X-265.0 kips** W36x182*, 194, 230	**N-186.0 kips** **X-265.0 kips** W36x210, 245–300

* Indicates the shape with the least web thickness of all shapes within the group.

□ Connection capacity controlled by bolt shear if bolt threads included in shear plane.

■ Connection capacity controlled by bolt shear in all cases.

Table 3. Predesigned Bolted Shear Connection Capacities (kips) for Single Coped and Uncoped W Shapes

Nominal Web Thickness, In.		3/16	1/4	5/16	3/8	7/16
Min. Connection Angle Thickness, In.		1/4	1/4	1/4	1/4	1/4
No. of Bolts	2	**12.3 kips** W8x10* W10x12 W12x14	**15.9 kips** W8x13–24 W10x15–26 W12x16*–30	**20.5 kips** W8x28*–35 W10x30–39, 49 W12x35–45	**25.2 kips** W8x40, 48 W10x45*, 54 W12x50–65	**30.3 kips** W10x60* W12x72
	3	**21.6 kips** W12x14	**23.8 kips** W12x16*–30 W14x22–30 W16x26, 31	**30.8 kips** W12x35–45 W14x34*–48 W16x36, 40 W18x35, 40	**37.3 kips** W12x50, 53*–65 W14x53, 61 W16x45*, 50, 67 W18x46, 50, 55	**44.8 kips** W12x72 W14x68*, 74, 90 W16x57, 77 W18x60*, 65, 76
	4		**36.0 kips** W16x26*, 31	**42.5 kips** W16x36*, 40 W18x35, 40	**49.6 kips** W16x45*, 50, 67 W18x46, 50, 55	**59.7 kips** W16x57, 77 W18x60*, 65, 76
	5			**53.9 kips** W18x35*, 40	**62.9 kips** W18x46, 50, 55 W21x44*–62 W24x55	**74.6 kips** W18x60*, 65, 76 W21x68, 73 W24x62, 68*, 76 W27x84
	6				**75.5 kips** W21x44*–62 W24x55	**89.5 kips** W21x68, 73 W24x62, 68*, 76 W27x84
	7				**99.4 kips** W24x55	**104.4 kips** W24x62, 68*, 76 W27x84
	8					**132.3 kips** W27x84
	9					
	10					

Notes: 1. Tabulated connection capacities are based on the shape with the thinnest web in each group, except that capacities in shaded areas may be limite by bolt shear (N or X).

2. In Tables 3 and 5 (7/8-in. bolts), the connection capacities are based on coped beams. When used for uncoped beams, the values for the controllir shapes may be conservative by no more than 1%.

3. Increased capacities may be computed using actual web thickness for shapes without asterisks, using the coefficients in Table 1.

Beam:	36 ksi
Angles:	36 ksi
Bolts:	A325, 7/8-in.

1/2	9/16	5/8	11/16	3/4	13/16–15/16
5/16	3/8	3/8	7/16	7/16	1/2
33.9 kips	**39.7 kips**	**43.6 kips**	**49.0 kips** **N-50.6 kips**	**54.4 kips** **N-50.6 kips**	**57.0 kips** **N-50.6 kips**
W8x58 W10x68*, 77 W12x79*, 87	W8x67 W12x96*	W10x88* W12x106	W10x100* W12x120	W10x112	W12x136*-170
50.8 kips	**57.8 kips**	**65.9 kips**	**73.4 kips** **N-75.9 kips**	**80.5 kips** **N-75.9 kips**	**85.3 kips** **N-75.9 kips**
W12x79*, 87 W14x82, 99, 109 W16x89 W18x71, 86	W12x96 W14x120 W16x100 W18x97*, 106	W12x106* W14x132 W18x119	W12x120 W14x145*	W14x159	W12x136*-170
69.1 kips	**77.0 kips**	**86.3 kips**		**103.6 kips** **N-101.2 kips**	
W16x89 W18x71, 86* W21x83, 101	W16x100 W18x97*, 106 W21x93, 111	W18x119 W21x122*, 132		W21x147	
84.5 kips	**96.2 kips**	**107.9 kips**	**118.7 kips** **N-126.5 kips**	**129.5 kips** **N-126.5 kips**	
W18x71, 86 W21x83, 101 W24x84*-104 W27x94, 102	W18x97*, 106 W21x93, 111 W24x117 W27x114	W18x119 W21x122*, 132 W24x131, 146 W27x146	W24x162 W27x161*	W21x147* W27x178	
101.4 kips	**117.6 kips**	**129.4 kips**	**142.4 kips** **N-151.8 kips**	**155.3 kips** **N-151.8 kips**	**172.6 kips** **N-151.8 kips**
W21x83, 101 W24x84*-104 W27x94, 102 W30x99	W21x93, 111 W24x117 W27x114 W30x108*-124 W33x118, 130	W21x122*, 132 W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*-160	W24x162 W27x161* W30x191 W33x201 W36x170	W21x147* W27x178 W30x211 W33x221 W36x182, 194, 230	W33x241 W36x210, 245*-300
118.2 kips	**137.1 kips**	**151.0 kips**	**166.1 kips** **N-177.1 kips**	**182.4 kips** **N-177.1 kips**	**201.3 kips** **N-177.1 kips**
W24x84*-104 W27x94, 102 W30x99	W24x117 W27x114 W30x108*-124 W33x118, 130	W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*-160	W24x162 W27x161* W30x191 W33x201 W36x170	W27x178* W30x211 W33x221 W36x182*, 194, 230	W33x241 W36x210, 245*-300
140.9 kips	**156.7 kips**	**172.5 kips**	**189.8 kips** **N-202.4 kips**	**208.4 kips** **N-202.4 kips**	**230.0 kips** **N-202.4 kips**
W27x94*, 102 W30x99	W27x114 W30x108*-124 W33x118, 130	W27x146 W30x132, 173 W33x141, 152 W36x135*-160	W27x161* W30x191 W33x201 W36x170	W27x178* W30x211 W33x221 W36x182*, 194, 230	W33x241 W36x210, 245*-300
	177.9 kips	**194.0 kips**	**219.9 kips** **N-227.7 kips**	**234.5 kips** **N-227.7 kips**	**258.7 kips** **N-227.7 kips**
	W33x118*, 130	W33x141, 152 W36x135*-160	W33x201 W36x170*	W33x221 W36x182*	W33x241 W36x210, 245*-300
		215.5 kips	**244.3 kips**	**260.4 kips** **N-253.0 kips**	**287.4 kips** **N-253.0 kips**
		W36x135*-160	W36x170	W36x182	W36x210, 245*-300

* Indicates the shape with the least web thickness of all shapes within the group.

☐ Connection capacity controlled by bolt shear if bolt threads included in shear plane.

Table 4. Predesigned Bolted Shear Connection Capacities (kips) for Single Coped and Uncoped W Shapes

Nominal Web Thickness, In.		3/16	1/4	5/16	3/8	7/16
Min. Connection Angle Thickness, In.		1/4	1/4	1/4	1/4	5/16
No. of Bolts	2	**13.8 kips** W8x10* W10x12 W12x14	**17.9 kips** W8x13–24 W10x15–26 W12x16*–30	**23.2 kips** W8x28*–35 W10x30–39, 49 W12x35–45	**28.4 kips** W8x40, 48 W10x45*, 54 W12x50–65	**34.1 kips** W10x60* W12x72
	3	**24.4 kips** W12x14	**26.8 kips** W12x16*–30 W14x22–30 W16x26, 31	**34.7 kips** W12x35–45 W14x34*–48 W16x36, 40 W18x35, 40	**42.0 kips** W12x50, 53–65 W14x53, 61 W16x45*, 50, 67 W18x46, 50, 55	**50.6 kips** W12x72 W14x68*, 74, 90 W16x57, 77 W18x60*, 65, 76
	4		**40.6 kips** W16x26*, 31	**47.9 kips** W16x36*, 40 W18x35, 40	**56.1 kips** W16x45*, 50, 67 W18x46, 50, 55	**67.4 kips** W16x57, 77 W18x60*, 65, 76
	5			**60.9 kips** W18x35*, 40	**71.1 kips** W18x46, 50, 55 W21x44*–62 W24x55	**84.3 kips** **N-93.0 kips** W18x60*, 65, 76 W21x68, 73 W24x62, 68*, 76 W27x84
	6				**85.3 kips** W21x44*–62 W24x55	**101.2 kips** **N-111.6 kips** W21x68, 73 W24x62, 68*, 76 W27x84
	7				**112.3 kips** W24x55	**118.0 kips** **N-130.2 kips** W24x62, 68*, 76 W27x84
	8					**149.5 kips** **N-148.8 kips** W27x84
	9					
	10					

Notes: 1. Tabulated connection capacities are based on the shape with the thinnest web in each group, except that capacities in shaded areas may be limited by bolt shear (N or X).

2. In Tables 2 and 4 (3/4-in. bolts), the connection capacities of coped and uncoped beams are identical.

3. Increased capacities may be computed using actual web thickness for shapes without asterisks, using the coefficients in Table 1.

Beam:	50 ksi
Angles:	36 ksi
Bolts:	A325, 3/4-in.

1/2	9/16	5/8	11/16	3/4	13/16–15/16
5/16	3/8	7/16	7/16	7/16	7/16
38.2 kips **N-37.2 kips**	**44.7 kips** **N-37.2 kips**	**49.2 kips** **N-37.2 kips**	**N-37.2 kips** **X-53.0 kips**		
W8x58 W10x68*–77 W12x79*, 87	W8x67 W12x96*	W10x88* W12x106	W10x100 W12x136		
57.3 kips **N-55.8 kips**	**65.2 kips** **N-55.8 kips**	**74.3 kips** **N-55.8 kips** **X-79.5 kips**	**N-55.8 kips** **X-79.5 kips**	**N-55.8 kips** **X-79.5 kips**	
W12x79*, 87 W14x82, 99, 109 W16x89 W18x71, 86	W12x96 W14x120 W16x100 W18x97*, 106	W12x106* W14x132 W18x119	W12x120 W14x145	W14x159	
78.0 kips **N-74.4 kips**	**86.9 kips** **N-74.4 kips**	**97.5 kips** **N-74.4 kips** **X-106.0 kips**		**N-74.4 kips** **X-106.0 kips**	
W16x89 W18x71, 86* W21x83, 101	W16x100 W18x97*, 106 W21x93, 111	W18x119 W21x122*, 132		W21x147	
95.5 kips **N-93.0 kips**	**108.7 kips** **N- 93.0 kips**	**121.9 kips** **N- 93.0 kips**	**N- 93.0 kips** **X-132.5 kips**	**N- 93.0 kips** **X-132.5 kips**	
W18x71, 86 W21x83, 101 W24x84*–104 W27x94, 102	W18x97*, 106 W21x93, 111 W24x117 W27x114	W18x119 W21x122*, 132 W24x131, 146 W27x146	W24x162 W27x161	W21x147 W27x178	
114.6 kips **N-111.6 kips**	**132.8 kips** **N-111.6 kips**	**146.3 kips** **N-111.6 kips** **X-159.0 kips**	**N-111.6 kips** **X-159.0 kips**	**N-111.6 kips** **X-159.0 kips**	**N-111.6 kips** **X-159.0 kips**
W21x83, 101 W24x84*–104 W27x94, 102 W30x99	W21x93, 111 W24x117 W27x114 W30x108*–124 W33x118, 130	W21x122*, 132 W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*, 150, 160	W24x162 W27x161 W30x191 W33x201 W36x170	W21x147 W27x178 W30x211 W33x221 W36x182, 194, 230	W33x241 W36x210, 245–300
133.7 kips **N-130.2 kips**	**155.0 kips** **N-130.2 kips**	**170.6 kips** **N-130.2 kips** **X-185.5 kips**	**N-130.2 kips** **X-185.5 kips**	**N-130.2 kips** **X-185.5 kips**	**N-130.2 kips** **X-185.5 kips**
W24x84*–104 W27x94, 102 W30x99	W24x117 W27x114 W30x108*–124 W33x118, 130	W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*, 150, 160	W24x162 W27x161 W30x191 W33x201 W36x170	W27x178 W30x211 W33x221 W36x182, 194, 230	W33x241 W36x210, 245–300
159.3 kips **N-148.8 kips**	**177.1 kips** **N-148.8 kips**	**195.0 kips** **N-148.8 kips** **X-212.0 kips**	**N-148.8 kips** **X-212.0 kips**	**N-148.8 kips** **X-212.0 kips**	**N-148.8 kips** **X-212.0 kips**
W27x94*, 102 W30x99	W27x114 W30x108*–124 W33x118, 130	W27x146 W30x132, 173 W33x141, 152 W36x135*–160	W27x161 W30x191 W33x201 W36x170	W27x178 W30x211 W33x221 W36x182, 194, 230	W33x241 W36x210, 245–300
	201.1 kips **N-167.4 kips**	**219.4 kips** **N-167.4 kips**	**N-167.4 kips** **X-238.5 kips**	**N-167.4 kips** **X-238.5 kips**	**N-167.4 kips** **X-238.5 kips**
	W33x118*, 130	W33x141, 152 W36x135*–160	W33x201 W36x170	W33x221 W36x182	W33x241 W36x210, 245–300
		243.8 kips **N-186.0 kips**	**N-186.0 kips** **X-265.0 kips**	**N-186.0 kips** **X-265.0 kips**	**N-186.0 kips** **X-265.0 kips**
		W36x135*–160	W36x170	W36x182	W36x210, 245–300

* Indicates the shape with the least web thickness of all shapes within the group.

☐ Connection capacity controlled by bolt shear if bolt threads included in shear plane.

▨ Connection capacity controlled by bolt shear in all cases.

Table 5. Predesigned Bolted Shear Connection Capacities (kips) for Single Coped and Uncoped W Shapes

	Nominal Web Thickness, In.	3/16	1/4	5/16	3/8	7/16
	Min. Connection Angle Thickness, In.	1/4	1/4	1/4	1/4	5/16
No. of Bolts	2	**13.7 kips** W8x10* W10x12 W12x14	**17.8 kips** W8x13–24 W10x15–26 W12x16*–30	**23.0 kips** W8x28*–35 W10x30–39, 49 W12x35–45	**28.3 kips** W8x40, 48 W10x45*, 54 W12x50–65	**33.9 kips** W10x60* W12x72
	3	**24.2 kips** W12x14	**26.6 kips** W12x16*–30 W14x22–30 W16x26, 31	**34.5 kips** W12x35–45 W14x34*–48 W16x36, 40 W18x35, 40	**41.7 kips** W12x50, 53*, 58, 65 W14x53, 61 W16x45*, 50, 67 W18x46, 50, 55	**50.2 kips** W12x72 W14x68*, 74, 90 W16x57, 77 W18x60*, 65, 76
	4		**40.3 kips** W16x26*, 31	**47.6 kips** W16x36*, 40 W18x35, 40	**55.6 kips** W16x45*, 50, 67 W18x46, 50, 55	**66.9 kips** W16x57, 77 W18x60*, 65, 76
	5			**60.5 kips** W18x35*, 40	**70.5 kips** W18x46, 50, 55 W21x44*–62 W24x55	**83.6 kips** W18x60*, 65, 76 W21x68, 73 W24x62, 68*, 76 W27x84
	6				**84.6 kips** W21x44*–62 W24x55	**100.3 kips** W21x68, 73 W24x62, 68*, 76 W27x84
	7				**111.4 kips** W24x55	**117.0 kips** W24x62, 68*, 76 W27x84
	8					**148.2 kips** W27x84
	9					
	10					

Notes: 1. Tabulated connection capacities are based on the shape with the thinnest web in each group, except that capacities in shaded areas may be limited by bolt shear (N or X).

2. In Tables 3 and 5 (7/8-in. bolts), the connection capacities are based on coped beams. When used for uncoped beams, the values for the controlling shapes may be conservative by no more than 1%.

3. Increased capacities may be computed using actual web thickness for shapes without asterisks, using the coefficients in Table 1.

Beam:	50 ksi
Angles:	36 ksi
Bolts:	A325, 7/8-in.

1/2	9/16	5/8	11/16	3/4	13/16–15/16
5/16	3/8	7/16	7/16	1/2	1/2
38.0 kips	**44.4 kips**	**48.9 kips**	**54.9 kips** **N-50.6 kips**		
W8x58 W10x68*–77 W12x79*, 87	W8x67 W12x96*	W10x88* W12x106	W10x100* W12x136		
56.9 kips	**64.7 kips**	**73.8 kips** **N-75.9 kips**	**82.3 kips** **N-75.9 kips**	**90.1 kips** **N-75.9 kips**	
W12x79*, 87 W14x82, 99, 109 W16x89 W18x71, 86	W12x96 W14x120 W16x100 W18x97*, 106	W12x106* W14x132 W18x119	W12x120 W14x145*	W14x159	
77.4 kips	**86.3 kips**	**96.8 kips** **N-101.2 kips**		**116.1 kips** **N-101.2 kips**	
W16x89 W18x71, 86* W21x83, 101	W16x100 W18x97*, 106 W21x93, 111	W18x119 W21x122*, 132		W21x147	
94.7 kips	**107.8 kips**	**120.9 kips** **N-126.5 kips**	**133.0 kips** **N-126.5 kips**	**145.1 kips** **N-126.5 kips**	
W18x71, 86 W21x83, 101 W24x84*–104 W27x94, 102	W18x97*, 106 W21x93, 111 W24x117 W27x114	W18x119 W21x122*, 132 W24x131, 146 W27x146	W24x162 W27x161*	W21x147* W27x178	
113.6 kips	**131.7 kips**	**145.0 kips** **N-151.8 kips**	**159.5 kips** **N-151.8 kips**	**174.0 kips** **N-151.8 kips**	**193.4 kips** **N-151.8 kips**
W21x83, 101 W24x84*–104 W27x94, 102 W30x99	W21x93, 111 W24x117 W27x114 W30x108*–124 W33x118, 130	W21x122*, 132 W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*, 150, 160	W24x162 W27x161* W30x191 W33x201 W36x170	W21x147* W27x178 W30x211 W33x221 W36x182, 194, 230	W33x241 W36x210, 245*–300
132.5 kips	**153.7 kips**	**169.2 kips** **N-177.1 kips**	**186.1 kips** **N-177.1 kips**	**204.5 kips** **N-177.1 kips**	**225.6 kips** **N-177.1 kips**
W24x84*–104 W27x94, 102 W30x99	W24x117 W27x114 W30x108*–124 W33x118, 130	W24x131, 146 W27x146 W30x132, 173 W33x141, 152 W36x135*, 150, 160	W24x162 W27x161* W30x191 W33x201 W36x170	W27x178* W30x211 W33x221 W36x182*, 194, 230	W33x241 W36x210, 245*–300
157.9 kips	**175.6 kips**	**193.3 kips** **N-202.4 kips**	**212.7 kips** **N-202.4 kips**	**233.6 kips** **N-202.4 kips**	**257.8 kips** **N-202.4 kips**
W27x94*, 102 W30x99	W27x114 W30x108*–124 W33x118, 130	W27x146 W30x132, 173 W33x141, 152 W36x135*, 150, 160	W27x161* W30x191 W33x201 W36x170	W27x178* W30x211 W33x221 W36x182*, 194, 230	W33x241 W36x210, 245*–300
	199.3 kips	**217.4 kips** **N-227.7 kips**	**246.4 kips** **N-227.7 kips**	**262.7 kips** **N-227.7 kips**	**289.9 kips** **N-227.7 kips**
	W33x118*, 130	W33x141, 152 W36x135*, 150, 160	W33x201 W36x170*	W33x221 W36x182*	W33x241 W36x210, 245*–300
		241.6 kips **N-253.0 kips**	**273.8 kips** **N-253.0 kips**	**291.9 kips** **N-253.0 kips**	**322.1 kips** **N-253.0 kips**
		W36x135*, 150, 160	W36x170	W36x182	W36x210, 245*–300

* Indicates the shape with the least web thickness of all shapes within the group.

☐ Connection capacity controlled by bolt shear if bolt threads included in shear plane.