

Design Aids for Single Plate Framing Connections

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Recently completed research at the University of Arizona¹ has demonstrated that a properly designed single plate framing connection fabricated from A36 steel is safe and practical. To assist designers, detailers and estimators, the authors have developed tabular design aids which can significantly reduce the computation time required for the design of such connections.

DESIGN PROCEDURE

The design procedure presented in Ref. 1 is based on the results of experimental testing and finite element analysis. It considers both connection deformation and beam end rotation by means of "beam-lines" and connection moment rotation curves.

From Ref. 1, the equation for determining maximum moment in a single plate connection of A36 steel is (see Fig. 1):

$$M = R \times (e + a) \quad (1)$$

where

- M = maximum moment, kip-in.
- R = end reaction of beam, kips
- a = distance from bolt line to welded edge of plate, in.
- e = distance from bolt line to point of inflection of beam (eccentricity), in.
 $= h(e/h)_{ref} \times (n/N) \times (S_{ref}/S)^{0.4}$ (2)
- h = distance between center lines of top and bottom bolts, in.
- n = number of bolts
- N = coefficient based on bolt diameter
 $= 5$ for $3/4$ -in. and $7/8$ -in. bolts
 $= 7$ for 1-in. bolts
- l = span length of beam, in.
- d = depth of beam, in.
- S_{ref} = coefficient based on bolt diameter
 $= 100$ for $3/4$ -in. bolts
 $= 175$ for $7/8$ -in. bolts
 $= 450$ for 1-in. bolts
- S = section modulus of beam, in.³
- $(e/h)_{ref}$ = parameter based on l/d ratio of beam
 $= 0.06 (l/d) - 0.15$ when $l/d \geq 6$
 $= 0.035 (l/d)$ when $l/d < 6$

Equation (2) can be rewritten as:

$$e(S)^{0.4} = h(e/h)_{ref} \times n/N \times (S_{ref})^{0.4} \quad (3)$$

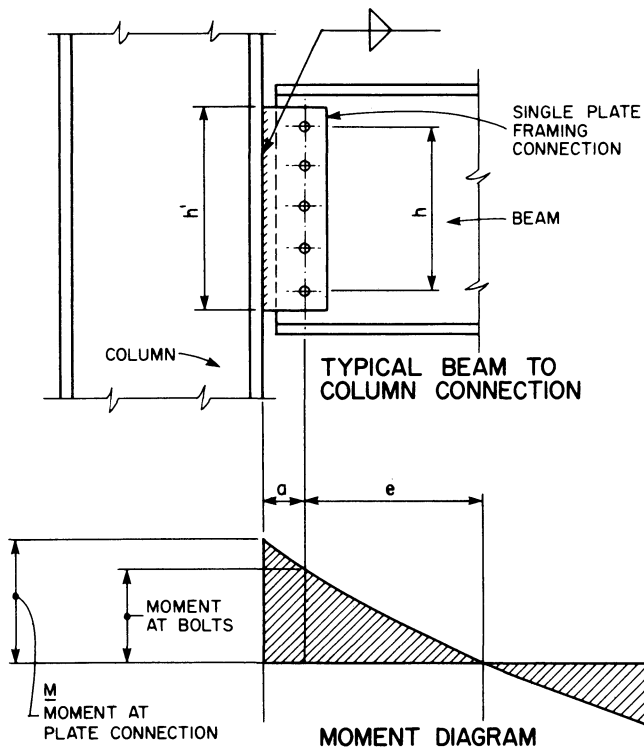


Figure 1

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Tables 1A, 1B, and 1C (for $\frac{3}{4}$ -in., $\frac{7}{8}$ -in. and 1-in. diameter bolts, respectively) tabulate values of $e(S)^{0.4}$ as a function of the number of bolts, n , and the l/d ratio of the beam. A 3-in. bolt spacing is assumed.

Tables 2A and 2B tabulate the following properties of various wide-flange shapes for $F_y = 36$ ksi and 50 ksi, respectively:

1. $S^{0.4}$
2. Web thickness, t_w , in.
3. $W_c/2$, kip-ft, where W_c is the Uniform Load Constant from the AISC *Manual of Steel Construction*, 8th Edition, p. 2-24. (To calculate maximum beam reaction of uniformly loaded beam, $R = W_c/2L$, where L is the span length in feet.)
4. Maximum allowable web shear, V , kips

Tables 1 and 2 permit easy computation of the value of e :

$$e = \frac{e(S)^{0.4} \text{ (from Table 1)}}{S^{0.4} \text{ (from Table 2)}}$$

and maximum moment M can then be determined from Eq. (1).

With moment M and reaction R known, the plate normal and shear stresses can be calculated as follows:

$$\text{Normal stress: } f_b = M/1/4t_p(h')^2$$

$$\text{Shear stress: } f_v = R/t_p h'$$

where

$$t_p = \text{plate thickness, in.}$$

$$h' = \text{depth of plate (} h + \text{edge distances), in.}$$

The maximum weld stress, f_r , is the resultant of these two stresses: $f_r = \sqrt{f_b^2 + f_v^2}$

It should be noted that the formula used to calculate the normal stress, f_b , is not a consequence of plastic plate action, but results from the fact that all outer bolts have force resultants that are nearly equal and normal to the bolt line (i.e., horizontal).

Tables 3A through 3I permit quick selection of *minimum* plate thickness and weld size for various end reactions on single plate connections with 2 to 10 bolts (A325 or A490) in a single row. The tables are based on:

- Steel: A36
- Welds: E70XX electrodes, fillet welds
- Allowable plate normal stress: 24.0 ksi
- Allowable shear stress: 14.5 ksi
- Allowable weld stress: 0.928 kips/in./ $\frac{1}{16}$ -in.
- Bolt spacing: 3 in. c. to c.
- Distance from bolt line to welded edge of plate: 3 in.
- Edge distance (top and bottom): $1\frac{1}{2}$ in.
- Holes: standard round, except where noted

Shown in Tables 3 (as an inset) is the *maximum* thickness for either the plate or web that may be used for various bolt sizes and types in standard round holes. This limitation is to avoid bolt shear.

The step-by-step design procedure that follows is applicable for an A36 steel beam under uniform load:

Given: Beam size and span

Solution:

1. Calculate l/d (see Fig. 1).
2. Determine number (n) of selected size and type of bolt:

From Table 2A or 2B, find $(W_c/2)$ for the given beam.

Compute beam reaction R :

$$R = (W_c/2)/L \text{ (for laterally supported beam)}$$

$$n = \frac{R}{\text{Allowable bolt shear}}$$

(for size and type of bolt selected)

3. Knowing l/d , n and bolt size, find $e(S)^{0.4}$ from Table 1A, 1B, or 1C.

Find $(S)^{0.4}$ for the given beam from Table 2A or 2B.

$$\text{Compute eccentricity } e: e = e(S)^{0.4}/(S)^{0.4}$$

4. Calculate moment M : $M = R(e + a)$
5. Enter the appropriate Table 3 for the number of bolts in the connection (n).

Knowing M and R , find the minimum plate thickness and weld size.

6. Knowing the type and size of the bolts, find the maximum plate thickness (A36 steel) from inset in Table 3.
7. For final design, plate and beam web end edge distances must be ≥ 2 times the bolt diameter.

Note:

Table 1 is based on beams of A36 steel and the normal pitch of 3 in. In the above procedure, if either or both of these conditions are not applicable, a modified eccentricity must be used in computing moment M in Step 4:

1. For a pitch other than 3 in.:

- a. $e_{mod} = [e(S)^{0.4}/(S)^{0.4}] \times (\text{pitch}/3)$ (Step 3)

- b. Compute M using e_{mod} instead of e . (Step 4)

- c. Select the appropriate Table 3 according to plate depth, rather than by number of bolts (n). (Step 5)

2. For a beam of F_y greater than 36 ksi:

- a. $e_{mod} = [e(S)^{0.4}/(S)^{0.4}] \times (36/F_y)$ (Step 3)

- b. Compute M using e_{mod} instead of e . (Step 4)

3. If cases 1 and 2 both apply:

a. $e_{mod} = [e(S)^{0.4}/(S)^{0.4}] \times (\text{pitch}/3) \times (36/F_y)$

b,c. Same as case 1

COMMENTS ON THE USE OF THE PROCEDURE

1. The moments resulting from this method are based on the assumption of a fixed support at the connection weld line. Most columns will have some flexibility; one-sided beam connections will have considerable flexibility. In those cases where rotation will occur at the support, the moment in the connections will be less than assumed as the basis of this method. Therefore, in many practical cases, additional conservatism is provided. In the case of a connection to a plate embedded in concrete, the assumption in this method is very close to actual conditions.
2. Tests on single plate framing connections have shown that, for bolts in *standard* holes, the plate and beam web end edge distances (to the edge normal to the beam axis) must be ≥ 2 times the bolt diameter, in order to permit some elongation of the hole without danger of breaking through the edge of the connected material. Step 7 of the design procedure reflects this requirement. Note that this is a greater minimum edge distance than required by the AISC Specification.
3. In further consideration of ductility, a *maximum* limit on web or plate thickness is required with *standard* holes to avoid bolt shear and to maintain ductile behavior. Maximum thickness values for A36 steel are tabulated in Table 3.
4. Research recently completed at the University of Arizona demonstrates that the design method is applicable to high-strength bolts in *slotted* holes *without* the maximum limit on plate or web thickness noted in paragraph 3 above. However, the clear (cover) distance from edge of hole to edge of plate must be equivalent to that provided by standard holes (see para. 2).
5. Note that the design procedure does not include a check of either net shear or bearing as a function of edge distance. Research at the University of Arizona on single plate framing connections of the proportions reported in Ref. 1, indicate that these failure modes do not occur. Additionally, research at the University of Texas on beam connections² indicates that performance of the connections is dependent on shear yielding on the gross section, because shear distortion through the bolt line is insignificant and ultimate strength through the net section is great enough to ensure yielding on the gross section.
6. Some research has been completed at the University of Arizona on A307 bolts. The results of these tests indicate that with standard holes the large D/t ratios

(bolt diameter/plate or web thickness) required to avoid bolt shear make their use impractical. For A307 bolts in slotted holes, the measured eccentricities were far below those predicted by the design curve for A325 and A490 bolts. Therefore, the D/t ratio requirements can be relaxed, because the resulting connection moments for A307 bolts in slotted holes will be significantly less than those for high-strength bolts.

7. For concentrated loads, the eccentricity (e or e_{mod}) as calculated in step 3 of the procedure must be multiplied by the appropriate Eccentricity Coefficient (Table 1).
8. The following restrictions should be placed on the use of this design method:
 - a. l/d limitations:
 - Noncomposite beams, $F_y = 36$ ksi: $l/d \leq 36$
 - Noncomposite beams, $F_y = 50$ ksi: $l/d \leq 24$
 - Beams that exceed these limits should be checked for excessive end rotation.
 - b. Plate material is to be ASTM A36.
 - c. Maximum pitch = 6.
9. Moment rotation response of a single plate framing connection is unaffected by the location of the neutral axis of the beam it supports.
10. Research and study is still underway at the University of Arizona on composite beams.

DESIGN EXAMPLES

Example 1

Given: Beam: W24x68, A36 steel
 Span: 24 ft (laterally supported)
 Design connection for maximum uniform load.

Solution:

1. $l/d = (24 \times 12)/24 = 12$
2. Assume $3/4$ -in. diam. A325N bolts (single shear value = 9.3 kips/bolt)
 - $R = (W_c/2)/L = 1230/24 = 51.25$ kips
 - $n = 51.25/9.3 = 5.5$ (use 6 bolts)

Note: Alternatively, n may be determined by entering Table 1A in the row for Max. R (A325N bolts) and finding that 55.7 kips, in the column headed "6", is the closest value higher than R of 51.25 kips. Therefore, use 6 bolts.
3. Enter Table 1A:
 - For 6 bolts and $l/d = 12$: $e(S)^{0.4} = 64.7$
 - Enter Table 2A for 24-in. beams:
 - For W24x68: $(S)^{0.4} = 7.50$
 - $e = [e(S)^{0.4}]/(S)^{0.4} = 64.7/7.50 = 8.627$ in.

4. $M = R(e + a) = 51.25 (8.627 + 3) = 595.9$ kip-in.
5. Enter Table 3E (6 bolts):
 In "Moment" column, find the closest value higher than 595.9 kip-in.
 $\frac{5}{16}$ -in. plate:
 Max. $M = 608$ kip-in. > 595.9 kip-in. **o.k.**
 $\frac{5}{16}$ -in. weld:
 Max. $R = 81$ kips > 51.25 kips **o.k.**
 Beam web thickness (W24x68) = $\frac{7}{16}$ -in. $> \frac{5}{16}$ -in. **o.k.**
6. Check maximum plate thickness:
 From Table 3E, for $\frac{3}{4}$ -in. diam. A325 bolts:
 Max $t = \frac{3}{8}$ -in. $> \frac{7}{16}$ -in. or $\frac{5}{16}$ -in. **o.k.**
 Note that only the plate thickness *or* the web thickness, not both, must be limited to the maximum thickness.
7. End edge distance = $2 \times D = 2 \times \frac{3}{4} = 1\frac{1}{2}$ in.
Use: $\frac{5}{16}$ -in. plate, $\frac{5}{16}$ -in. weld, six $\frac{3}{4}$ -in. diam. A325N bolts, $1\frac{1}{2}$ -in. end edge distance.

Example 2

Given: Same as Example 1, except use 4 bolts at 5-in. pitch.

Solution:

- Same as Example 1.
- Find $R = 51.25$ kips, as in Example 1.
 If A325N bolts are to be used, check the appropriate "Max. R " row in Tables 1A, 1B and 1C, and find that for 4 bolts, 1-in. diam. bolts (Table 1C) have a max. R of 66.0 kips > 51.25 kips **o.k.**
 Use 1-in. diam. A325N bolts.

- Enter Table 1C:
 For 4 bolts and $l/d = 12$: $e(S)^{0.4} = 33.8$
 Enter Table 2:
 For W24x68: $(S)^{0.4} = 7.50$
 Because pitch is 5 in. instead of normal 3 in., compute e_{mod} (see note 2 to step-by-step procedure):
 $e_{mod} = (33.8/7.50) \times (5/3) = 7.51$ in.
- $M = 51.25 (7.51 + 3.0) = 538.6$ kip-in.
- Depth of plate = $(3 \times 5) + (2 \times 1.5) = 18$ in.
 Enter Table 3E (plate depth = 18 in.):
 $\frac{5}{16}$ -in. plate:
 Max. $M = 546$ kip-in. > 538.6 kip-in. **o.k.**
 $\frac{1}{4}$ -in. weld:
 Max. $R = 55$ kips > 51.25 kips **o.k.**
 Beam web thickness (W24x68) = $\frac{7}{16}$ -in. $> \frac{5}{16}$ -in. **o.k.**
- Same as Example 1.
- End edge distance = $2 \times D = 2 \times 1 = 2$ in.
Use: $\frac{5}{16}$ -in. plate, $\frac{1}{4}$ -in. weld, four 1-in. diam. A325N bolts, 2-in. end edge distance.

REFERENCES

- Richard, Ralph M., James D. Kriegh, and Brett A. Lewis The Analysis and Design of Single Plate Framing Connections *AISC Engineering Journal, American Institute of Steel Construction, Chicago, Second Quarter 1980, pp. 38-52.*
- Ricles, J. M. and J. A. Yura The Behavior and Analysis of Double Row Bolted Shear Web Connections *The University of Texas PMFSEL Thesis No. 80-1, Austin, Texas, Sept. 1980.*

Table 1A. Values of $e(S)^{0.4}$ for $\frac{3}{4}$ -in. Diam. Bolts

l/d	No. of Bolts—One Vertical Line (n)								
	2	3	4	5	6	7	8	9	10
1	0.27	0.80	1.59	2.65	3.98	5.57	7.42	9.54	11.9
2	0.53	1.59	3.18	5.30	7.95	11.1	14.8	19.1	23.9
3	0.80	2.39	4.77	7.95	11.9	16.7	22.3	28.6	35.8
4	1.06	3.18	6.36	10.6	15.9	22.3	29.7	38.2	47.7
5	1.33	3.98	7.95	13.3	19.9	27.8	37.1	47.7	59.6
6	1.59	4.77	9.54	15.9	23.9	33.4	44.5	57.2	71.2
7	2.04	6.13	12.3	20.4	30.7	42.9	57.2	73.6	92.0
8	2.50	7.50	15.0	25.0	37.5	52.5	70.0	89.9	112.
9	2.95	8.86	17.7	29.5	44.3	62.0	82.7	106.	133.
10	3.41	10.2	20.4	34.1	51.1	71.6	95.4	123.	153.
11	3.86	11.6	23.2	38.6	57.9	81.1	108.	139.	174.
12	4.32	12.9	25.9	43.2	64.7	90.6	121.	155.	194.
13	4.77	14.3	28.6	47.7	71.6	100.	134.	172.	215.
14	5.22	15.7	31.3	52.2	78.4	110.	146.	188.	235.
15	5.68	17.0	34.1	56.8	85.2	119.	159.	204.	256.
16	6.13	18.4	36.8	61.3	92.0	129.	172.	221.	276.
17	6.59	19.8	39.5	65.9	98.8	138.	184.	237.	296.
18	7.04	21.1	42.2	70.4	106.	148.	197.	253.	317.
19	7.50	22.5	45.0	75.0	112.	157.	210.	270.	337.
20	7.95	23.9	47.7	79.5	119.	167.	223.	286.	358.
21	8.40	25.2	50.4	84.0	126.	176.	235.	303.	378.
22	8.86	26.6	53.2	88.6	133.	186.	248.	319.	399.
23	9.31	27.9	55.9	93.1	140.	196.	261.	335.	419.
24	9.77	29.3	58.6	97.7	147.	205.	273.	352.	440.
25	10.2	30.7	61.3	102.	153.	215.	286.	368.	460.
26	10.7	32.0	64.1	107.	160.	224.	299.	384.	480.
27	11.1	33.4	66.8	111.	167.	234.	312.	401.	501.
28	11.6	34.8	69.5	116.	174.	243.	324.	417.	521.
29	12.0	36.1	72.2	120.	181.	253.	337.	433.	542.
30	12.5	37.5	75.0	125.	187.	262.	350.	450.	562.
31	12.9	38.8	77.7	129.	194.	272.	363.	466.	583.
32	13.4	40.2	80.4	134.	201.	281.	375.	482.	603.
33	13.9	41.6	83.1	139.	208.	291.	388.	499.	624.
34	14.3	42.9	85.9	143.	215.	301.	401.	515.	644.
35	14.7	44.3	88.6	148.	221.	310.	413.	532.	664.

Maximum Reactions (R), kips

A325N	18.6	27.8	37.1	46.4	55.7	64.9	74.2	83.5	92.8
X	26.5	39.8	53.0	66.3	79.5	92.8	106.	119.	133.
A440N	24.7	37.1	49.5	61.9	74.2	86.6	99.0	111.	124.
X	35.3	53.0	70.7	88.4	106.	124.	141.	159.	177.

Note: Pitch = 3 in.

Table 1B. Values of $e(S)^{0.4}$ for $\frac{7}{8}$ -in. Diam. Bolts

l/d	No. of Bolts—One Vertical Line (n)								
	2	3	4	5	6	7	8	9	10
1	0.33	0.99	1.99	3.31	4.97	6.96	9.28	11.9	14.9
2	0.66	1.99	3.98	6.63	9.94	13.9	18.6	23.9	29.8
3	0.99	2.98	5.97	9.94	14.9	20.9	27.8	35.8	44.8
4	1.33	3.98	7.96	13.3	19.9	27.8	37.1	47.7	59.7
5	1.66	4.97	9.94	16.6	24.9	34.8	46.4	59.7	74.6
6	1.99	5.97	11.9	19.9	29.8	41.8	55.7	71.6	89.5
7	2.56	7.67	15.3	25.6	38.4	53.7	71.6	92.1	115.
8	3.13	9.38	18.8	31.3	46.9	65.6	87.5	113.	141.
9	3.69	11.1	22.2	36.9	55.4	77.6	103.	133.	166.
10	4.26	12.8	25.6	42.6	63.9	89.5	119.	153.	192.
11	4.83	14.5	29.0	48.3	72.5	101.	135.	174.	217.
12	5.40	16.2	32.4	54.0	81.0	113.	151.	194.	243.
13	5.97	17.9	35.8	59.7	89.5	125.	167.	215.	269.
14	6.54	19.6	39.2	65.4	98.0	137.	183.	235.	294.
15	7.10	21.3	42.6	71.0	107.	149.	199.	256.	320.
16	7.67	23.0	46.0	76.7	115.	161.	215.	276.	345.
17	8.24	24.7	49.4	82.4	124.	173.	231.	297.	371.
18	8.81	26.4	52.8	88.1	132.	185.	247.	317.	396.
19	9.38	28.1	56.3	93.8	141.	197.	263.	338.	422.
20	9.94	29.8	59.7	99.4	149.	209.	278.	358.	448.
21	10.5	31.5	63.1	105.	158.	221.	294.	378.	473.
22	11.1	33.2	66.5	111.	166.	233.	310.	399.	499.
23	11.6	34.9	69.9	116.	175.	245.	326.	419.	524.
24	12.2	36.7	73.3	122.	183.	257.	342.	440.	550.
25	12.8	38.4	76.7	128.	192.	269.	358.	460.	575.
26	13.4	40.1	80.1	134.	200.	280.	374.	481.	601.
27	13.9	41.8	83.5	139.	209.	292.	390.	501.	627.
28	14.5	43.5	87.0	145.	217.	304.	406.	522.	652.
29	15.1	45.2	90.4	151.	226.	316.	422.	542.	678.
30	15.6	46.9	93.8	156.	234.	328.	438.	563.	703.
31	16.	48.6	97.2	162.	243.	340.	453.	583.	729.
32	16.8	50.3	101.	168.	251.	352.	469.	603.	754.
33	17.3	52.0	104.	173.	260.	364.	485.	624.	780.
34	17.9	53.7	107.	179.	269.	376.	501.	644.	806.
35	18.5	55.4	111.	185.	277.	388.	517.	665.	831.

Maximum Reactions (R), kips

A325N	25.3	37.9	50.5	63.1	75.8	88.4	101.	114.	126.
X	36.1	54.1	72.2	90.2	108.	126.	144.	162.	180.
A490N	33.7	50.5	67.3	84.2	101.	118.	135.	152.	168.
X	48.1	72.2	96.2	120.	144.	168.	192.	217.	241.

Table 1C. Values of $e(S)^{0.4}$ for 1-in. Diam. Bolts

l/d	No. of Bolts—One Vertical Line								
	2	3	4	5	6	7	8	9	10
1	0.35	1.04	2.07	3.45	5.18	7.25	9.67	12.4	15.5
2	0.69	2.07	4.15	6.91	10.4	14.5	19.3	24.9	31.1
3	1.04	3.11	6.22	10.4	15.5	21.8	29.0	37.3	46.6
4	1.38	4.15	8.29	13.8	20.7	29.0	38.7	49.7	62.2
5	1.73	5.18	10.4	17.3	25.9	36.3	48.4	62.2	77.7
6	2.07	6.22	12.4	20.7	31.1	43.5	58.0	74.6	93.3
7	2.67	8.00	16.0	26.7	40.0	56.0	74.6	95.9	120.
8	3.26	9.77	19.5	32.6	48.9	68.4	91.2	117.	147.
9	3.85	11.5	23.1	38.5	57.7	80.8	108.	139.	173.
10	4.44	13.3	26.7	44.4	66.6	93.3	124.	160.	200.
11	5.03	15.1	30.2	50.3	75.5	106.	141.	181.	227.
12	5.63	16.9	33.8	56.3	84.4	118.	158.	203.	253.
13	6.22	18.7	37.3	62.2	93.3	131.	174.	224.	280.
14	6.81	20.4	40.9	68.1	102.	143.	191.	245.	306.
15	7.40	22.2	44.4	74.0	111.	155.	207.	267.	333.
16	8.00	24.0	48.0	80.0	120.	168.	224.	288.	360.
17	8.59	25.8	51.5	85.9	129.	180.	240.	309.	386.
18	9.18	27.5	55.1	91.8	138.	193.	257.	330.	413.
19	9.77	29.3	58.6	97.7	147.	205.	274.	352.	440.
20	10.4	31.1	62.2	104.	155.	218.	290.	373.	466.
21	11.0	32.9	65.7	110.	164.	230.	307.	394.	493.
22	11.5	34.6	69.3	115.	173.	243.	323.	416.	520.
23	12.1	36.4	72.8	121.	182.	255.	340.	437.	546.
24	12.7	38.2	76.4	127.	191.	267.	357.	458.	573.
25	13.3	40.0	80.0	133.	200.	280.	373.	480.	600.
26	13.9	41.8	83.5	139.	209.	292.	390.	501.	626.
27	14.5	43.5	87.1	145.	218.	305.	406.	522.	653.
28	15.1	45.3	90.6	151.	227.	317.	423.	544.	680.
29	15.7	47.1	94.2	157.	235.	330.	439.	565.	706.
30	16.3	48.9	97.7	163.	244.	342.	456.	586.	733.
31	16.9	50.6	101.	169.	253.	354.	473.	608.	760.
32	17.5	52.4	105.	175.	262.	367.	489.	629.	786.
33	18.1	54.2	108.	181.	271.	379.	506.	650.	813.
34	18.7	56.0	112.	187.	280.	392.	522.	672.	839.
35	19.2	57.7	115.	192.	289.	404.	539.	693.	866.

Maximum Reactions (R), kips

A325N	33.0	49.5	66.0	82.5	99.0	116.	132.	148.	165.
X	47.1	70.7	94.2	118.	141.	165.	189.	212.	236.
A490N	44.0	66.0	88.0	110.	132.	154.	176.	198.	220.
X	62.8	94.2	126.	157.	189.	220.	251.	282.	314.

**Table 2A. Beam Data for W Shapes ($F_y = 36$ ksi)
(Uniformly Loaded, Laterally Supported)**

Section	(S) ^{0.4}	t _w	W _c /2	V	Section	(S) ^{0.4}	t _w	W _c /2	V
W8 x 10	2.28	3/16	62.5	19.4	W14 x 22	3.85	1/4	232	45.8
x 13	2.50	1/4	79.5	26.6	x 26	4.16	1/4	282.5	51.4
x 15	2.68	1/4	94.5	28.8	x 30	4.46	1/4	336	54.2
x 18	2.97	1/4	121.5	27.1	x 34	4.73	5/16	389	57.8
x 21	3.19	1/4	145.5	30.0	x 38	4.95	5/16	437	63.4
x 24	3.37	1/4	167	28.2	x 43	5.23	5/16	500	60.4
x 28	3.58	5/16	194.5	33.3	x 48	5.48	5/16	560	68.0
x 31	3.76	5/16	220	33.1	x 53	5.71	3/8	620	74.7
x 35	3.96	5/16	249.5	36.5	x 61	6.11	3/8	740	75.5
x 40	4.17	3/8	284	43.1	x 68	6.38	7/16	825	84.5
x 48	4.51	3/8	346.5	49.3	x 74	6.60	7/16	895	92.5
x 58	4.86	1/2	416	64.7	x 82	6.85	1/2	985	106
x 67	5.16	9/16	483	74.4	x 90	7.28	7/16	1145	89.4
					x 99	7.56	1/2	1255	99.6
					x 109	7.86	1/2	1385	109
					x 120	8.16	9/16	1520	124
					x 132	8.47	5/8	1670	137
W10 x 12	2.60	3/16	87	27.2	W16 x 26	4.30	1/4	307	56.9
x 15	2.86	1/4	110.5	33.3	x 31	4.67	1/4	377.5	63.3
x 17	3.05	1/4	129.5	35.2	x 36	5.02	5/16	452	67.8
x 19	3.23	1/4	150.5	37.1	x 40	5.30	5/16	520	70.8
x 22	3.52	1/4	185.5	35.4	x 45	5.55	3/8	580	80.7
x 26	3.79	1/4	223	38.9	x 50	5.80	3/8	650	89.6
x 30	4.02	5/16	259	45.5	x 57	6.11	7/16	740	102
x 33	4.15	5/16	280	40.9	x 67	6.72	3/8	935	93.5
x 39	4.46	5/16	337	45.3	x 77	7.09	7/16	1070	109
x 45	4.75	3/8	393	51.3	x 89	7.52	1/2	1240	128
x 49	4.95	5/16	437	49.2	x 100	7.89	9/16	1400	144
x 54	5.14	3/8	480	54.1					
x 60	5.37	7/16	535	62.2	W18 x 35	5.06	5/16	461	77.0
x 68	5.64	1/2	605	70.9	x 40	5.42	5/16	545	81.8
x 77	5.94	1/2	685	81.5	x 46	5.74	3/8	630	94.3
x 88	6.27	5/8	780	95.1	x 50	6.02	3/8	710	92.6
x 100	6.60	11/16	895	109	x 55	6.27	3/8	785	102
x 112	6.92	3/4	1010	124	x 60	6.51	7/16	865	110
					x 65	6.72	7/16	935	120
					x 71	6.94	1/2	1015	133
					x 76	7.34	7/16	1170	112
					x 86	7.73	1/2	1330	128
					x 97	8.12	9/16	1505	144
					x 106	8.39	9/16	1630	160
					x 119	8.82	5/8	1850	180
W12 x 14	2.95	3/16	119	34.5					
x 16	3.11	1/4	137	38.2					
x 19	3.40	1/4	170.5	41.4					
x 22	3.65	1/4	203	46.4					
x 26	4.07	1/4	267	40.8					
x 30	4.31	1/4	309	46.5					
x 35	4.61	5/16	365	54.4					
x 40	4.85	5/16	415	51.1					
x 45	5.08	5/16	465	58.6					
x 50	5.30	3/8	520	65.4					
x 53	5.49	3/8	565	60.3					
x 58	5.71	3/8	625	63.6					
x 65	5.99	3/8	705	68.5					
x 72	6.24	7/16	780	76.4					
x 79	6.48	1/2	855	84.4					
x 87	6.74	1/2	945	93.6					

Notes: V = Max. web shear, kips
 Max. R = (W_c/2)/L, kips
 L = Span length, ft

**Table 2A. Beam Data for W Shapes ($F_y = 36$ ksi)
(Uniformly Loaded, Laterally Supported)**

Section	(S) ^{0.4}	t_w	$W_c/2$	V	Section	(S) ^{0.4}	t_w	$W_c/2$	V
W21 x 44	5.82	$\frac{3}{8}$	655	105	W30 x 99	9.37	$\frac{1}{2}$	2150	224
x 50	6.17	$\frac{3}{8}$	755	115	x 108	9.78	$\frac{9}{16}$	2390	236
x 57	6.58	$\frac{3}{8}$	890	124	x 116	10.2	$\frac{9}{16}$	2630	246
x 62	6.94	$\frac{3}{8}$	1015	122	x 124	10.5	$\frac{9}{16}$	2840	256
x 68	7.22	$\frac{7}{16}$	1120	132	x 132	10.8	$\frac{5}{8}$	3040	270
x 73	7.44	$\frac{7}{16}$	1210	140	x 173	12.4	$\frac{5}{8}$	4310	289
x 83	7.82	$\frac{1}{2}$	1370	160	x 191	12.9	$\frac{11}{16}$	4785	316
x 93	8.19	$\frac{9}{16}$	1535	182	x 211	13.4	$\frac{3}{4}$	5300	348
x 101	8.76	$\frac{1}{2}$	1315	155					
x 111	9.09	$\frac{9}{16}$	1990	172	W33 x 118	10.5	$\frac{9}{16}$	2870	262
x 122	9.43	$\frac{5}{8}$	2185	189	x 130	11.1	$\frac{9}{16}$	3250	278
x 132	9.73	$\frac{5}{8}$	2360	206	x 141	11.5	$\frac{5}{8}$	3585	292
x 147	10.2	$\frac{3}{4}$	2630	230	x 152	11.9	$\frac{5}{8}$	3895	308
					x 201	13.6	$\frac{11}{16}$	5450	349
					x 221	14.2	$\frac{3}{4}$	6050	381
					x 241	14.7	$\frac{13}{16}$	6650	411
W24 x 55	6.65	$\frac{3}{8}$	910	135	W36 x 135	11.4	$\frac{5}{8}$	3510	309
x 62	7.03	$\frac{7}{16}$	1050	148	x 150	12.0	$\frac{5}{8}$	4030	325
x 68	7.50	$\frac{7}{16}$	1230	143	x 160	12.4	$\frac{5}{8}$	4335	339
x 76	7.91	$\frac{7}{16}$	1410	153	x 170	12.7	$\frac{11}{16}$	4640	357
x 84	8.26	$\frac{1}{2}$	1570	164	x 182	13.1	$\frac{3}{4}$	4985	382
x 94	8.68	$\frac{1}{2}$	1775	182	x 194	13.5	$\frac{3}{4}$	5300	405
x 104	9.22	$\frac{1}{2}$	2065	174	x 210	13.9	$\frac{13}{16}$	5750	442
x 117	9.67	$\frac{9}{16}$	2330	193	x 230	14.8	$\frac{3}{4}$	6700	396
x 131	10.2	$\frac{5}{8}$	2630	215	x 245	15.2	$\frac{13}{16}$	7150	419
x 146	10.7	$\frac{5}{8}$	2970	233	x 260	15.5	$\frac{13}{16}$	7600	442
x 162	11.1	$\frac{11}{16}$	3310	256	x 280	16.0	$\frac{7}{8}$	8250	469
					x 300	16.5	$\frac{15}{16}$	8900	503
W27 x 84	8.54	$\frac{7}{16}$	1705	178					
x 94	9.00	$\frac{1}{2}$	1945	191					
x 102	9.35	$\frac{1}{2}$	2135	202					
x 114	9.78	$\frac{9}{16}$	2390	226					
x 146	11.1	$\frac{5}{8}$	3290	240					
x 161	11.6	$\frac{11}{16}$	3640	264					
x 178	12.0	$\frac{3}{4}$	4015	292					

Notes: V = Max. web shear, kips
 Max. R = $(W_c/2)/L$, kips
 L = Span length, ft

**Table 2B. Beam Data for W Shapes ($F_y = 50$ ksi)
(Uniformly Loaded, Laterally Supported)**

Section	(S) ^{0.4}	t_w	$W_c/2$	V	Section	(S) ^{0.4}	t_w	$W_c/2$	V
W8 x 10	2.28	3/16	85	26.8	W14 x 22	3.85	1/4	319	63.2
x 13	2.50	1/4	109	36.8	x 26	4.16	1/4	388.5	70.9
x 15	2.68	1/4	130	39.7	x 30	4.46	1/4	462	74.7
x 18	2.97	1/4	167	37.4	x 34	4.73	5/16	535	79.7
x 21	3.19	1/4	200	41.4	x 38	4.95	5/16	600	87.4
x 24	3.37	1/4	230	38.9	x 43	5.23	5/16	690	83.3
x 28	3.58	5/16	267.5	45.9	x 48	5.48	5/16	775	93.8
x 31	3.76	5/16	302.5	45.6	x 53	5.71	3/8	855	103
x 35	3.96	5/16	343	50.3	x 61	6.11	3/8	1015	104
x 40	4.17	3/8	390.5	59.4	x 68	6.38	7/16	1135	117
x 48	4.51	3/8	476.5	68.0	x 74	6.60	7/16	1230	128
x 58	4.86	1/2	570	89.3	x 82	6.85	1/2	1355	146
x 67	5.16	9/16	665	103	x 90	7.28	7/16	1540	123
					x 99	7.56	1/2	1725	137
					x 109	7.86	1/2	1905	150
					x 120	8.16	9/16	2090	171
					x 132	8.47	5/8	2400	189
W10 x 12	2.60	3/16	119.5	37.5	W16 x 26	4.30	1/4	422.5	78.5
x 15	2.86	1/4	152	46.0	x 31	4.67	1/4	520	87.3
x 17	3.05	1/4	178	48.5	x 36	5.02	5/16	620	93.6
x 19	3.23	1/4	207	51.2	x 40	5.30	5/16	710	97.7
x 22	3.52	1/4	225	48.8	x 45	5.55	3/8	800	111
x 26	3.79	1/4	307	53.7	x 50	5.80	3/8	890	124
x 30	4.02	5/16	356.5	62.8	x 57	6.11	7/16	1015	141
x 33	4.15	5/16	385	56.4	x 67	6.72	3/8	1285	129
x 39	4.46	5/16	463	62.5	x 77	7.09	7/16	1475	150
x 45	4.75	3/8	540	70.7	x 89	7.52	1/2	1705	176
x 49	4.95	5/16	600	67.9	x 100	7.89	9/16	1925	199
x 54	5.14	3/8	660	74.7					
x 60	5.37	7/16	785	85.8	W18 x 35	5.06	5/16	635	106
x 68	5.64	1/2	835	97.8	x 40	5.42	5/16	750	113
x 77	5.94	1/2	945	112	x 46	5.74	3/8	865	130
x 88	6.27	5/8	1085	131	x 50	6.02	3/8	980	128
x 100	6.60	11/16	1230	151	x 55	6.27	3/8	1080	141
x 112	6.92	3/4	1385	172	x 60	6.51	7/16	1190	151
					x 65	6.72	7/16	1285	165
					x 71	6.94	1/2	1395	183
					x 76	7.34	7/16	1605	155
					x 86	7.73	1/2	1825	177
					x 97	8.12	9/16	2070	199
					x 106	8.39	9/16	2245	221
					x 119	8.82	5/8	2540	249
W12 x 14	2.95	3/16	164	47.6					
x 16	3.11	1/4	188	52.8					
x 19	3.40	1/4	234.5	57.2					
x 22	3.65	1/4	279.5	64.0					
x 26	4.07	1/4	367.5	56.2					
x 30	4.31	1/4	424.5	64.2					
x 35	4.61	5/16	500	75.0					
x 40	4.85	5/16	570	70.4					
x 45	5.08	5/16	640	80.8					
x 50	5.30	3/8	710	90.2					
x 53	5.49	3/8	775	83.2					
x 58	5.71	3/8	860	87.8					
x 65	5.99	3/8	950	94.5					
x 72	6.24	7/16	1070	105					
x 79	6.48	1/2	1175	116					
x 87	6.74	1/2	1300	129					

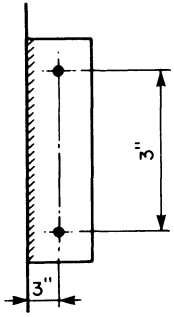
Notes: V = Max. web shear, kips
 Max. $R = (W_c/2)/L$, kips
 L = Span length, ft

**Table 2B. Beam Data for W Shapes ($F_y = 50$ ksi)
(Uniformly Loaded, Laterally Supported)**

Section	(S) ^{0.4}	t_w	$W_c/2$	V	Section	(S) ^{0.4}	t_w	$W_c/2$	V
W21 x 44	5.82	3/8	900	145	W30 x 99	9.37	1/2	2960	308
x 50	6.17	3/8	1040	158	x 108	9.78	9/16	3290	325
x 57	6.58	3/8	1220	171	x 116	10.2	9/16	3620	339
x 62	6.94	3/8	1385	168	x 124	10.5	9/16	3905	353
x 68	7.22	7/16	1540	182	x 132	10.8	5/8	4180	373
x 73	7.44	7/16	1660	193	x 173	12.4	5/8	5950	399
x 83	7.82	1/2	1880	221	x 191	12.9	11/16	6600	436
x 93	8.19	9/16	2110	251	x 211	13.4	3/4	7300	480
x 101	8.76	1/2	2495	214					
x 111	9.09	9/16	2740	237	W33 x 118	10.5	9/16	3950	361
x 122	9.43	5/8	3005	260	xt 130	11.1	9/16	4465	384
x 132	9.73	5/8	3245	284	x 141	11.5	5/8	4930	403
x 147	10.2	3/4	3620	318	x 152	11.9	5/8	5350	425
					x 201	13.6	11/16	7500	482
W24 x 55	6.65	3/8	1255	186	x 221	14.2	3/4	8350	526
x 62	7.03	7/16	1440	204	x 241	14.7	13/16	9100	567
x 68	7.50	7/16	1695	197					
x 76	7.91	7/16	1935	210	W36 x 135	11.4	5/8	4830	427
x 84	8.26	1/2	2155	227	x 150	12.0	5/8	5550	448
x 94	8.68	1/2	2440	250	x 160	12.4	5/8	5950	468
x 104	9.22	1/2	2840	241	x 170	12.7	11/16	6400	492
x 117	9.67	9/16	3200	267	x 182	13.1	3/4	6850	527
x 131	10.2	5/8	3620	296	x 194	13.5	3/4	7300	558
x 146	10.7	5/8	4080	322	x 210	13.9	13/16	7900	609
x 162	11.1	11/16	4555	353	x 230	14.8	3/4	9200	546
					x 245	15.2	13/16	9850	577
W27 x 84	8.54	7/16	2345	246	x 260	15.5	13/16	10,500	609
x 94	9.00	1/2	2675	264	x 280	16.0	7/8	11,350	646
x 102	9.35	1/2	2935	279	x 300	16.5	15/16	12,200	694
x 114	9.78	9/16	3290	311					
x 146	11.1	5/8	4520	331					
x 161	11.6	11/16	5000	364					
x 178	12.0	3/4	5500	403					

Notes: V = Max. web shear, kips
 Max. R = ($W_c/2$)/L, kips
 L = span length, ft

Table 3A. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 2
Plate Depth: 6 in.

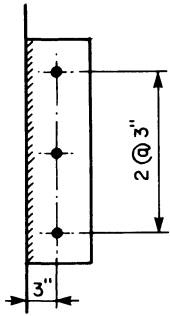
Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.											
		$1/8$	$3/16$	$1/4$	$5/16$	$3/8$	$7/16$	$1/2$	$9/16$	$5/8$	$11/16$		
$3/16$	30	9	16										
	33	3	16										
	37		16										
	41		16										
$1/4$	43		17	21									
	47		11	21									
	50		2	21									
	54			21									
$5/16$	57			23	27								
	60			19	27								
	64			12	27								
	68				27								
$3/8$	70				30	32							
	74				25	32							
	77				21	32							
	81				13	32							
$7/16$	84					36	37						
	87					33	37						
	90					29	37						
	95					22	37						
$1/2$	97					16	43	43					
	100					4	40	43					
	104						35	43					
	108						29	43					
$9/16$	111						24	48	48				
	115						14	45	48				
	118							41	48				
	122							37	48				
$5/8$	124							33	54	54			
	128							25	52	54			
	131							17	49	54			
	135								44	54			
$11/16$	139								38	59	59		
	142								32	59	59		
	145								26	55	59		
	149								15	50	59		

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$3/4$	$3/8$
	$7/8$	$7/16$
	1	$9/16$
A490	$3/4$	$1/2$
	$7/8$	$5/8$
	1	$11/16$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

Table 3B. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 3
Plate Depth: 9 in.

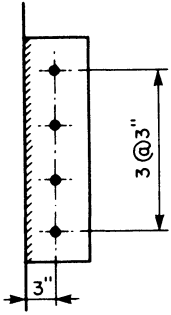
Min. Plate t , in.	Max Moment M , kip-in.	Fillet Weld Size (E70XX), in.											
		1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16		
3/16	68	14	24										
	75	2	24										
	82		24										
	91		24										
1/4	100		23	32									
	107		15	32									
	114			32									
	122			32									
5/16	130			33	40								
	137			27	40								
	144			19	40								
	152				40								
3/8	160				43	48							
	167				38	48							
	174				31	48							
	182				20	48							
7/16	190					53	56						
	197					48	56						
	204					42	56						
	213					33	56						
1/2	220					22	64	64					
	227						59	64					
	234						53	64					
	243						44	64					
9/16	250						36	72	72				
	257						25	69	72				
	264							63	72				
	273							55	72				
5/8	280							48	81	81			
	288							38	78	81			
	296							23	72	81			
	304								66	81			
11/16	310								60	89	89		
	318								51	89	89		
	326								40	83	89		
	334								23	76	89		

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	3/4	3/8
	7/8	7/16
	1	9/16
A490	3/4	1/2
	7/8	5/8
	1	11/16

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

Table 3C. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 4
Plate Depth: 12 in.

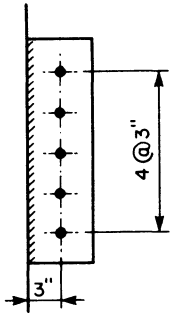
Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.											
		$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$		
$\frac{3}{16}$	122	32											
	135	32											
	149	32											
	162	32											
$\frac{1}{4}$	175	32	43										
	189	22	43										
	202		43										
	216		43										
$\frac{5}{16}$	229		45	54									
	243		37	54									
	256		25	54									
	270			54									
$\frac{3}{8}$	283			59	64								
	297			50	64								
	310			41	64								
	324			27	64								
$\frac{7}{16}$	337				72	75							
	351				64	75							
	364				55	75							
	378				44	75							
$\frac{1}{2}$	391				29	85	86						
	405					77	86						
	418					69	86						
	432					59	86						
$\frac{9}{16}$	445					47	97	97					
	459					29	91	97					
	472						83	97					
	486						74	97					
$\frac{5}{8}$	499						63	108	108				
	513						50	104	108				
	526						31	97	108				
	540							88	108				
$\frac{11}{16}$	553							78	118	118			
	567							66	117	118			
	590							38	104	118			
	594							31	101	118			
$\frac{3}{4}$	607								93	129	129		
	621								82	129	129		
	634								70	123	129	129	
	648								54	115	129	129	

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$\frac{3}{4}$	$\frac{3}{8}$
	$\frac{7}{8}$	$\frac{7}{16}$
	1	$\frac{9}{16}$
A490	$\frac{3}{4}$	$\frac{1}{2}$
	$\frac{7}{8}$	$\frac{5}{8}$
	1	$\frac{11}{16}$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

Table 3D. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 5
Plate Depth: 15 in.

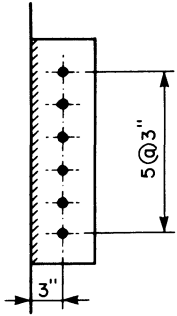
Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.										
		$3/16$	$1/4$	$5/16$	$3/8$	$7/16$	$1/2$	$9/16$	$5/8$	$11/16$	$3/4$	
$1/4$	275	39	54									
	295	28	54									
	315		54									
	338		54									
$5/16$	360		56	67								
	380		46	67								
	400		31	67								
	422			67								
$3/8$	440			74	81							
	460			65	81							
	480			54	81							
	506			33	81							
$7/16$	530				89	94						
	550				79	94						
	570				69	94						
	591				55	94						
$1/2$	610				37	107	108					
	630					98	108					
	650					89	108					
	675					74	108					
$9/16$	695					60	121					
	715					40	115	121				
	735						105	121				
	759						92	121				
$5/8$	780						79	135				
	800						63	131	135			
	820						42	122	135			
	844							110	135			
$11/16$	865							97	148			
	885							84	147	148		
	905							67	138	148		
	928							39	127	148		
$3/4$	950								115	162		
	970								102	162		
	990								88	155	162	
	1010								67	144	162	
$13/16$	1040									36	132	175
	1060										120	175
	1080										107	171
	1110										90	161

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$3/4$	$3/8$
	$7/8$	$7/16$
	1	$9/16$
A490	$3/4$	$1/2$
	$7/8$	$5/8$
	1	$11/16$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

Table 3E. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 6
Plate Depth: 18 in.

Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.																		
		$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$1\frac{1}{16}$	$\frac{3}{4}$									
$\frac{1}{4}$	396	47	64																	
	426	32	64																	
	456		64																	
	486		64																	
$\frac{5}{16}$	516		68	81																
	546		53	81																
	576		38	81																
	608			81																
$\frac{3}{8}$	638			88	97															
	668			76	97															
	698			61	97															
	729			40	97															
$\frac{7}{16}$	760				107	113														
	790				96	113														
	820				83	113														
	851				66	113														
$\frac{1}{2}$	880				44	128	129													
	910					117	129													
	940					105	129													
	972					89	129													
$\frac{9}{16}$	1000					71	145	145												
	1030					45	137	145												
	1060						125	145												
	1090						111	145												
$\frac{5}{8}$	1120						95	162	162											
	1150						75	156	162											
	1180						46	145	162											
	1220							132	162											
$1\frac{1}{16}$	1250							117	178	178										
	1280							99	176	178										
	1310							78	165	178										
	1340							46	152	178										
$\frac{3}{4}$	1370								138	194	194									
	1400								122	194	194									
	1430								104	185	194	194								
	1460								81	173	194	194								
$1\frac{3}{16}$	1490										160	210	210							
	1520										145	210	210							
	1550										129	205	205							
	1580										108	193	193							

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$\frac{3}{4}$	$\frac{3}{8}$
	$\frac{7}{8}$	$\frac{7}{16}$
	1	$\frac{9}{16}$
A490	$\frac{3}{4}$	$\frac{1}{2}$
	$\frac{7}{8}$	$\frac{5}{8}$
	1	$1\frac{1}{16}$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

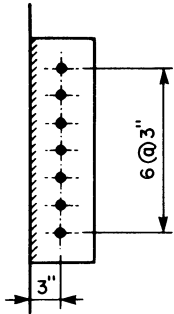


Table 3F. Maximum Permissible Beam End Reaction (kips)

No. of Bolts: 7
Plate Depth: 21 in.

Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.										
		$3/16$	$1/4$	$5/16$	$3/8$	$7/16$	$1/2$	$9/16$	$5/8$	$11/16$	$3/4$	
$1/4$	540	55	75									
	580	38	75									
	620		75									
	662		75									
$5/16$	700		80	94								
	740		66	94								
	780		47	94								
	827			94								
$3/8$	870			102	113							
	910			89	113							
	950			72	113							
	992			47	113							
$7/16$	1040				124	132						
	1080				111	132						
	1120				95	132						
	1160				77	132						
$1/2$	1200				49	148	151					
	1240					136	151					
	1280					122	151					
	1320					104	151					
$9/16$	1370					79	170					
	1410					48	158	170				
	1450						144	170				
	1490						129	170				
$5/8$	1530						110	189				
	1570						88	183	189			
	1610						56	170	189			
	1650							154	189			
$11/16$	1700							134	207			
	1740							114	205	207		
	1780							89	192	207		
	1820							54	178	207		
$3/4$	1860								162	226		
	1900								144	226		
	1940								123	217	226	
	1985								95	202	226	
$13/16$	2030								49	185	245	
	2070									168	245	
	2110									149	239	
	2150									126	225	
$7/8$	2190									99	211	
	2230									58	195	
	2270										178	
	2320										155	

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$3/4$	$3/8$
	$7/8$	$7/16$
	1	$9/16$
A490	$3/4$	$1/2$
	$7/8$	$5/8$
	1	$11/16$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

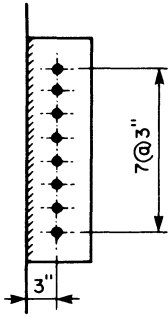


Table 3G. Maximum Permissible Beam End Reaction (kips)

No. of bolts: 8
Plate Depth: 24 in.

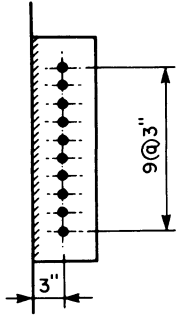
Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.											
		$5/16$	$3/8$	$7/16$	$1/2$	$9/16$	$5/8$	$11/16$	$3/4$	$13/16$	$7/8$		
$3/8$	1130	117	129										
	1190	101	129										
	1240	82	129										
	1300	54	129										
$7/16$	1350		144	151									
	1400		129	151									
	1460		111	151									
	1510		89	151									
$1/2$	1570		57	170	172								
	1620			155	172								
	1670			139	172								
	1730			119	172								
$9/16$	1780			94	194								
	1840			59	182	194							
	1890				167	194							
	1940				148	194							
$5/8$	2000				126	216							
	2050				100	209	216						
	2110				61	193	216						
	2160					176	216						
$11/16$	2210					156	237						
	2270					133	235	237					
	2320					104	220	237					
	2380					62	203	237					
$3/4$	2430						185	259					
	2480						164	259					
	2540						139	247	259				
	2590						108	231	259				
$13/16$	2650						62	213	280				
	2700							193	280				
	2750							171	273	280			
	2810							145	258	280			
$7/8$	2860							112	241	302			
	2920							62	222	302			
	2970								201	300	302		
	3020								178	285	302		
$15/16$	3080								150	268	324		
	3130								115	250	324		
	3190								61	231	324		
	3240									209	311		
1	3290									184	295		
	3350									154	278		
	3400									117	259		
	3460									59	238		

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$3/4$	$3/8$
	$7/8$	$7/16$
	1	$9/16$
A490	$3/4$	$1/2$
	$7/8$	$5/8$
	1	$11/16$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

Table 3H. Maximum Permissible Beam End Reaction (kips)



No. of Bolts: 9
Plate Depth: 27 in.

Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.																			
		$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$										
$\frac{3}{8}$	1440	132	145																		
	1510	113	145																		
	1580	90	145																		
	1640	61	145																		
$\frac{7}{16}$	1700		163	170																	
	1770		146	170																	
	1840		125	170																	
	1910		100	170																	
$\frac{1}{2}$	1980		67	193	194																
	2050			176	194																
	2120			157	194																
	2190			134	194																
$\frac{9}{16}$	2260			106	218																
	2330			64	204	218															
	2400				186	218															
	2460				166	218															
$\frac{5}{8}$	2520				144	243															
	2590				114	236	243														
	2660				70	218	243	243													
	2730					198	243														
$\frac{11}{16}$	2800					178	267														
	2870					151	265	267													
	2940					118	248	267	267												
	3010					70	229	267													
$\frac{3}{4}$	3070						210	291													
	3140						185	291													
	3210						157	278	291												
	3280						122	260	291												
$\frac{13}{16}$	3340						75	241	315												
	3410							219	315												
	3480							193	308												
	3550							163	290	315											
$\frac{7}{8}$	3620							129	272	340											
	3690							74	251	340											
	3760								227	338											
	3830								200	320											
$\frac{15}{16}$	3890								171	303											
	3960								131	282											
	4030								70	260											
	4100									235											
1	4160										209										
	4230										175										
	4300										133										
	4370										67										

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$\frac{3}{4}$	$\frac{3}{8}$
	$\frac{7}{8}$	$\frac{7}{16}$
	1	$\frac{9}{16}$
A490	$\frac{3}{4}$	$\frac{1}{2}$
	$\frac{7}{8}$	$\frac{5}{8}$
	1	$\frac{11}{16}$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.

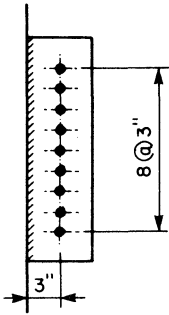


Table 3I. Maximum Permissible Beam End Reaction (kips)

No. of Bolts: 10
Plate Depth: 30 in.

Min. Plate t , in.	Max. Moment M , kip-in.	Fillet Weld Size (E70XX), in.																		
		$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$									
$\frac{3}{8}$	1770	147	162																	
	1860	127	162																	
	1940	102	162																	
	2030	67	162																	
$\frac{7}{16}$	2110		180	189																
	2200		161	189																
	2280		138	189																
	2360		111	189																
$\frac{1}{2}$	2450		73	213	216															
	2530			195	216															
	2620			174	216															
	2700			149	216															
$\frac{9}{16}$	2790			118	243															
	2870			74	227	243														
	2960				207	243														
	3040				185	243														
$\frac{5}{8}$	3120				159	270														
	3210				125	261	270													
	3290				77	242	270													
	3380					220	270													
$\frac{11}{16}$	3460					195	297													
	3550					166	294	297												
	3630					129	275	297												
	3710					78	254	297												
$\frac{3}{4}$	3800						232	324												
	3880						205	324												
	3970						174	309	324											
	4050						135	289	324											
$\frac{13}{16}$	4140						77	266	351											
	4220							241	351											
	4310							213	341	351										
	4390							181	322	351										
$\frac{7}{8}$	4470							141	302	378										
	4560							79	278	378										
	4640								252	375	378									
	4730								222	356	378									
$\frac{15}{16}$	4810								187	335	405									
	4900								143	313	405									
	4980								74	288	405									
	5060									261	389									
1	5150										230	370								
	5230										194	348								
	5320										147	324								
	5400										74	298								

Max. Permissible Plate Thickness, in.		
Bolt		Plate Max. t
Type	Diam.	
A325	$\frac{3}{4}$	$\frac{3}{8}$
	$\frac{7}{8}$	$\frac{7}{16}$
	1	$\frac{9}{16}$
A490	$\frac{3}{4}$	$\frac{1}{2}$
	$\frac{7}{8}$	$\frac{5}{8}$
	1	$\frac{11}{16}$

Note: For standard holes only; restriction does not apply for bolts in slotted holes.

Note: 1. Where no maximum permissible beam end reaction is tabulated, the connection is invalid.
2. Plate material: A36 steel.