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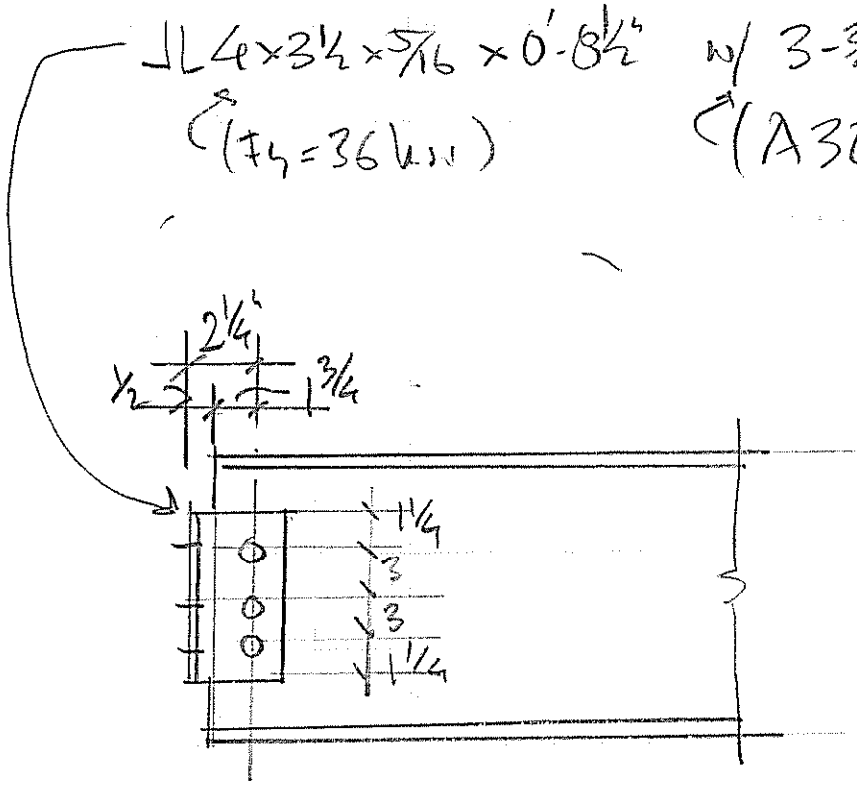
STANDARD DBL ANGLE BOLTED CONN.

- Based on typ. beam W16×31 (t_w = 0.275)
  STL grade 50ksi



CONCLUSION (see p. 2 & 3)

AISC Ref.	BEAM / ANGLE CAPACITY
LFRD, 3rd Ed. 1999	92.3 k
LFRD - 13th Ed. 2005	92.3 k — NO CHANGES

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Connection check based on AISC-LRFD, 3rd Ed. (1999)

from Table 10-1 (p. 2a):

$\phi R_n = 95,4\ k$ ← DBL L

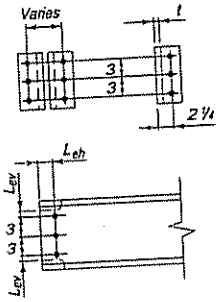
- Beam web:

$\phi R_n = (263\ k/in) \times 0,275 = 72,3\ k$ ← governs

Angle	F_y = 36 ksi F_u = 58 ksi	F_y = 50 ksi F_u = 65 ksi	Beam

Table 10-1 (cont.)
All-Bolted Double-Angle Connections
$\phi = 0.75$

$^3/_4$-in. Bolts 3 Rows W18, 16, 14, 12, 10* *Limited to W10×12, 15, 17, 19, 22, 26, 30	Bolt and Angle Design Strength, kips					
	ASTM Desig.	Thread Cond.	Hole Type	Angle Thickness		
				$^1/_4$	$^5/_{16}$	$^3/_8$	$^1/_2$
	A325/ F1852	N	–	76.7	95.4	95.4	95.4
		X	–	76.7	95.8	115	119
		SC Class A	STD	62.6	62.6	62.6	62.6
			OVS	53.3	53.3	53.3	53.3
			SSLT	53.3	53.3	53.3	53.3
		SC Class B	STD	76.7	94.9	94.9	94.9
			OVS	71.8	80.7	80.7	80.7
			SSLT	76.7	80.7	80.7	80.7
	A490	N	–	76.7	95.8	115	119
		X	–	76.7	95.8	115	149
		SC Class A	STD	76.7	78.3	78.3	78.3
			OVS	66.6	66.6	66.6	66.6
			SSLT	66.6	66.6	66.6	66.6
		SC Class B	STD	76.7	95.8	115	119
			OVS	71.8	89.7	101	101
			SSLT	76.7	95.8	101	101



Beam Web Design Strength per Inch Thickness, kips/in.													
Hole Type	L_{eh},* in.	Uncoped	Coped at Top Flange Only, L_{ev}, in.						Coped at Both Flanges, L_{ev}, in.					
			1 1/4	1 3/8	1 1/2	1 5/8	2	3	1 1/4	1 3/8	1 1/2	1 5/8	2	3
STD	1 1/2	263	188	191	195	199	210	239	172	179	186	194	210	239
	1 3/4	263	200	204	207	211	222	251	172	179	186	194	216	251
OVS	1 1/2	263	176	179	183	186	197	227	161	168	176	183	197	227
	1 3/4	263	188	191	195	199	210	239	161	168	176	183	205	239
SSLT	1 1/2	263	183	187	190	194	205	234	172	179	186	194	205	234
	1 3/4	263	195	199	203	206	217	246	172	179	186	194	216	246

Support Design Strength per Inch Thickness, kips/in.
526

Notes:
STD = Standard holes
OVS = Oversized holes
SSLT = Short-slotted holes oriented transverse to direction of load
N = Threads included
X = Threads excluded
SC = Slip critical

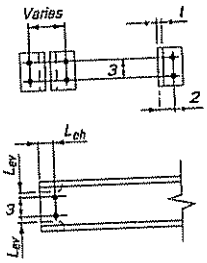
*Tabulated values include $^1/_4$-in reduction in end distance L_{eh} to account for possible underrun in beam length.

AISC-LRFD, 3rd Ed.

Beam	F_y = 50 ksi F_u = 65 ksi

All

$^3/_4$-in. Bolts
2 Rows
W12, 10, 8



Hole Type	L_{eh},* in.	Uncoped	
STD	1 1/2	175	12
	1 3/4	175	13
OVS	1 1/2	175	11
	1 3/4	175	12
SSLT	1 1/2	175	12
	1 3/4	175	13

Support Design Strength per Inch Thickness, kips/in
351

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Connection check based on AISC - 13th Ed.
(LFRD)

From Table 10.1 (p. 3a):

$\phi R_n = 95.4k$ ← DBL L

- beam web:

$\phi R_n = (263\ k/in) \times 0.295 = \underline{92.3k}$ ← govern

Beam F_y = 50 ksi, F_u = 65 ksi
Angle F_y = 36 ksi, F_u = 58 ksi

Table 10–1 (continued)
All-Bolted Double-Angle Connections

3/4-in. Bolts

Bolt and Angle Available Strength, kips

3 Rows
W18, 16, 14, 12, 10*
*Ltd. to W10x12, 15, 17, 19, 22, 26, 30

ASTM Desig.	Thread Cond.	Hole Type	Angle Thickness 1/4 ASD	1/4 LRFD	5/16 ASD	5/16 LRFD	3/8 ASD	3/8 LRFD	1/2 ASD	1/2 LRFD
A325/F1852	N	—	50.9	76.4	63.6	95.4	63.6	95.4	63.6	95.4
	X	—	50.9	76.4	63.7	95.5	76.4	115	79.5	119
	SC Class A	STD	44.3	66.4	44.3	66.4	44.3	66.4	44.3	66.4
		OVS	32.0	48.0	32.0	48.0	32.0	48.0	32.0	48.0
		SSLT	37.7	56.5	37.7	56.5	37.7	56.5	37.7	56.5
	SC Class B	STD	50.9	76.4	63.3	94.9	63.3	94.9	63.3	94.9
		OVS	45.7	68.6	45.7	68.6	45.7	68.6	45.7	68.6
		SSLT	49.6	74.4	53.8	80.7	53.8	80.7	53.8	80.7
A490	N	—	50.9	76.4	63.7	95.5	76.4	115	79.5	119
	X	—	50.9	76.4	63.7	95.5	76.4	115	99.4	149
	SC Class A	STD	50.9	76.4	55.4	83.1	55.4	83.1	55.4	83.1
		OVS	40.0	60.0	40.0	60.0	40.0	60.0	40.0	60.0
		SSLT	47.1	70.6	47.1	70.6	47.1	70.6	47.1	70.6
	SC Class B	STD	50.9	76.4	63.7	95.5	76.4	115	79.1	119
		OVS	47.9	71.8	57.1	85.7	57.1	85.7	57.1	85.7
		SSLT	49.6	74.4	62.0	92.9	67.2	101	67.2	101

Beam Web Available Strength per Inch Thickness, kips/in.

Hole Type	L_{ev} in.	STD L_{eh}* 1 1/2 ASD	1 1/2 LRFD	STD 1 3/4 ASD	1 3/4 LRFD	OVS 1 1/2 ASD	1 1/2 LRFD	OVS 1 3/4 ASD	1 3/4 LRFD	SSLT 1 1/2 ASD	1 1/2 LRFD	SSLT 1 3/4 ASD	1 3/4 LRFD
Coped at Top Flange Only	1 1/4	125	188	133	200	117	176	125	188	122	183	130	195
	1 3/8	128	191	136	204	119	179	128	191	125	187	133	199
	1 1/2	130	195	138	207	122	183	130	195	127	190	135	203
	1 5/8	132	199	141	211	124	186	132	199	129	194	138	206
	2	140	210	148	222	132	197	140	210	137	205	145	217
	3	159	239	167	251	151	227	159	239	156	234	164	246
Coped at Both Flanges	1 1/4	115	172	115	172	107	161	107	161	115	172	115	172
	1 3/8	119	179	119	179	112	168	112	168	119	179	119	179
	1 1/2	124	186	124	186	117	176	117	176	124	186	124	186
	1 5/8	129	194	129	194	122	183	122	183	129	194	129	194
	2	140	210	144	216	132	197	137	205	137	205	144	216
	3	159	239	167	251	151	227	159	239	156	234	164	246
Uncoped		175	263	175	263	175	263	175	263	175	263	175	263

Support Available Strength per Inch Thickness, kips/in.

Hole Type	ASD	LRFD
STD/OVS/SSLT	351	526

Notes:
STD = Standard holes
OVS = Oversized holes
SSLT = Short-slotted holes transverse to direction of load
N = Threads included
X = Threads excluded
SC = Slip critical

* Tabulated values include 1/4-in reduction in end distance L_{eh} to account for possible underrun in beam length.

AISC - 13th ED.

p. 30a

Beam F_y = 50 ksi, F_u = 65 ksi
Angle F_y = 36 ksi, F_u = 58 ksi

All-

2 Rows
W12, 10, 8

ASTM Desig	Thread Cond
A325/F1852	N
	X
	SC Class A
	SC Class B
A490	N
	X
	SC Class
	SC Class

Beam Web

Hole Type	L_{ev} in.	1 1/2 ASD	L
Coped at Top Flange Only	1 1/4	83.7	
	1 3/8	86.1	
	1 1/2	88.6	
	1 5/8	91.0	
	2	98.3	
	3	116	
Coped at Both Flanges	1 1/4	73.1	
	1 3/8	78.0	
	1 1/2	82.9	
	1 5/8	87.8	
	2	98.3	
	3	116	
Uncoped		117	

Support Available Strength per Inch Thickness, kips/in.

Hole Type	ASD	LRFD
STD/OVS/SSLT	234	351

Notes:
STD = S
OVS = C
SSLT = S

* Tabulat
underm

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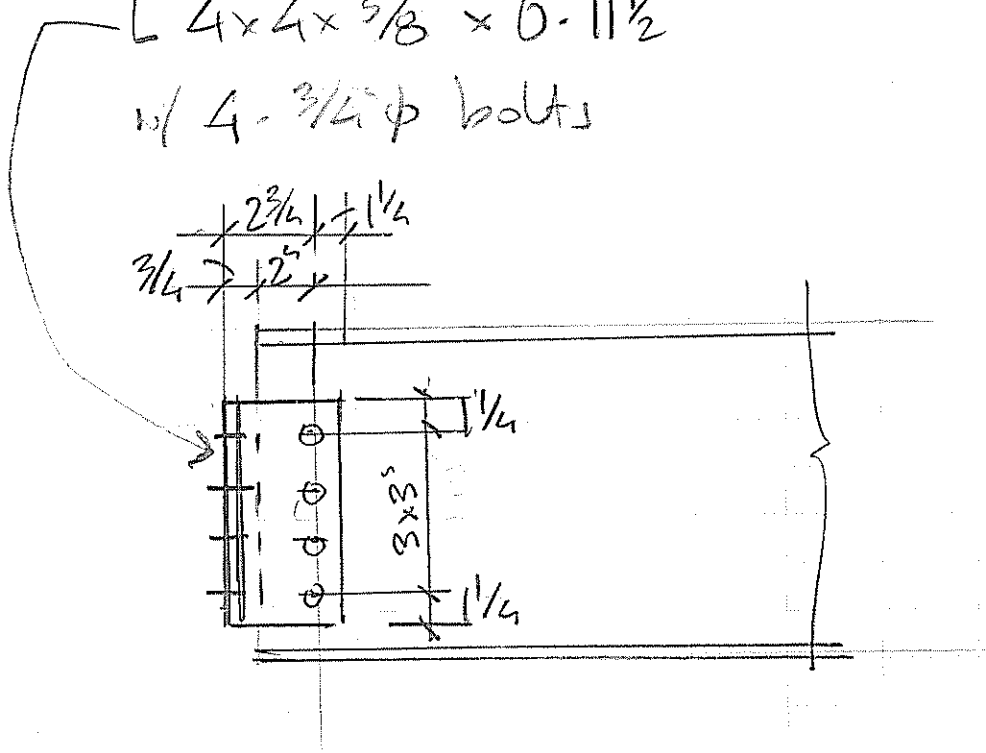
STANDARD SINGLE ANGLE BOLTED CONN.

- based on typ. beam W16×31 ($t_w = 0.275$)
  (steel grade 50 ksi)

L 4×4×5/8 × 0'-11½"
w/ 4 - 3/4" ϕ bolts



CONCLUSION (see p. 5 & 6)

AISC Ref.	SINGLE ANGLE BOLT CAP.
LFRD - 3rd ED., 1999	46.8k
- 13th ED, 2005	46.8k → NO CHANGES

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Connection check based on AISC-LRFD, 3rd Ed, 1999

- see p. 4 for conn. det.

$\phi R_n = C \times \phi r_n$

from Table 7-10 (see p. 5a) $\rightarrow \phi r_n = 15.9$ k/bolt

from Table 10-10 (see p. 5b) $\rightarrow C = 3.07$

$\phi R_n = 3.07 \times 15.9 = 48.8$ k

DBL JL

SINGLE L

Non-High-Strength Fasteners
Table 7-7

ominal Bolt Diameter d_b, in.					
3/8	3/4	7/8	1	1 1/8	1 1/4
3.4	3 5	5 5	8 0	12 2	16.3
0	11 6	17 2	23 2	32 1	41.2
6	7 6	10 7	14 2	18 9	24.3
4	0 2	0 5	−0 2	−0 1	−1.7
0	3 3	5 0	8 2	12 3	18.0
0	8 3	12 2	15 0	19 8	23.2
6	4 3	5 7	6 0	6 6	6.3
3	11 3	16 5	20 7	27 0	33.6
9	7 3	10 0	11 7	13 8	16.7

stitute (IFI)

gth Bolts
in., pounds

iameter d_b, in.						
2 3/4	3	3 1/4	3 1/2	3 3/4	4	
–	–	–	–	–		
680	900	1120	1390	1730	2130	
720	950	–	–	–		
168	200	235	272	313	355	
147	178	210	246	284	325	
–	–	–	–	–		
–	–	–	–	–		
738	950	1190	1530	1810	2160	

ute (IFI).

STRUCTION

$\phi = 0.75$

Table 7-10.
Design Shear Strength of One Bolt, kips

ASTM Desig	Thread Cond	ϕF_v (ksi)	Loading	Nominal Bolt Diameter d_b, in.							
				5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
				Nominal Bolt Area, in.^{2}							
				0.307	0.442	0.601	0.785	0.994	1 23	1.48	1.77
A325 F1852	N	36.0	S	11.0	15.9	21.6	28 3	35 8	44 2	53 5	63.6
			D	22.1	31.8	43.3	56.5	71.6	88.4	107	127
	X	45.0	S	13 8	19 9	27 1	35 3	44 7	55.2	66 8	79 5
			D	27.6	39.8	54.1	70.7	89.5	110	134	159
A490	N	45.0	S	13 8	19 9	27 1	35 3	44 7	55 2	66 8	79 5
			D	27.6	39.8	54.1	70.7	89.5	110	134	159
	X	56.3	S	17 3	24 9	33 8	44 2	55 9	69 0	83 5	99 4
			D	34.5	49.7	67.6	88.4	112	138	167	199
A307	–	18.0	S	5 52	7 95	10 8	14 1	17 9	22 1	26 7	31 8
			D	11.0	15.9	21.6	28.3	35.8	44.2	53.5	63.6

N = Threads included in shear plane
X = Threads excluded from shear plane
S = Single shear
D = Double shear.

$\phi = 0.75$

Table 7-11.
Design Shear Strength of *n* Bolts, kips

n	ASTM A325 & F1852											
	N						X					
	3/4		7/8		1		3/4		7/8		1	
	S	D	S	D	S	D	S	D	S	D	S	D
12	191	382	260	520	339	679	239	477	325	649	424	848
11	175	350	238	476	311	622	219	437	298	595	389	778
10	159	318	216	433	283	565	199	398	271	541	353	707
9	143	286	195	390	254	509	179	358	244	487	318	636
8	127	254	173	346	226	452	159	318	216	433	283	565
7	111	223	152	303	198	396	139	278	189	379	247	495
6	95.4	191	130	260	170	339	119	239	162	325	212	424
5	79.5	159	108	216	141	283	99 4	199	135	271	177	353
4	63.6	127	86 6	173	113	226	79 5	159	108	216	141	283
3	47 7	95.4	64 9	130	84 8	170	59.6	119	81 2	162	106	212
2	31.8	63 6	43 3	86 6	56 5	113	39 8	79 5	54 1	108	70.7	141
1	15.9	31.8	21.6	43.3	28.3	56.5	19.9	39.8	27.1	54.1	35.3	70.7

n	ASTM A490											
	N						X					
	3/4		7/8		1		3/4		7/8		1	
	S	D	S	D	S	D	S	D	S	D	S	D
12	239	477	325	649	424	848	298	596	406	812	530	1060
11	219	437	298	595	389	778	273	547	372	744	486	972
10	199	398	271	541	353	707	249	497	338	676	442	884
9	179	358	244	487	318	636	224	447	304	609	398	795
8	159	318	216	433	283	565	199	398	271	541	353	707
7	139	278	189	379	247	495	174	348	237	474	309	619
6	119	239	162	325	212	424	149	298	203	406	265	530
5	99 4	199	135	271	177	353	124	249	169	338	221	442
4	79 5	159	108	216	141	283	99 4	199	135	271	177	353
3	59.6	119	81.2	162	106	212	74 6	149	101	203	133	265
2	39.8	79.5	54 1	108	70.7	141	49.7	99 4	67 6	135	88 4	177
1	19.9	39.8	27.1	54.1	35.3	70.7	24.9	49.7	33.8	67.6	44.2	88.4

N = Threads included in shear plane.
X = Threads excluded from shear plane
S = Single shear
D = Double shear.

AISC-LRFD, 3rd. Ed.

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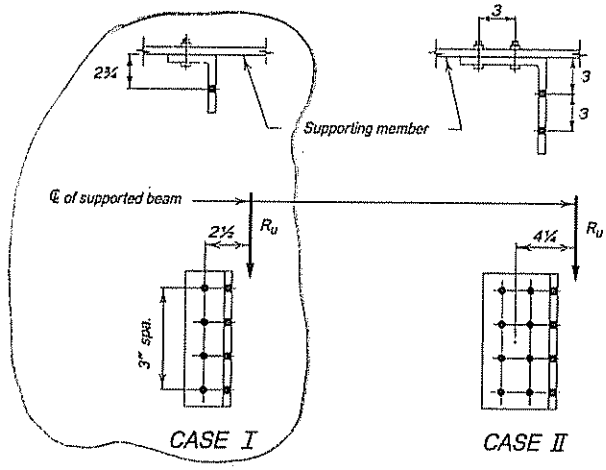
SHEAR FMC MOM. BRACE COMP. WELDS CONN.

SINGLE L

AISC-LRFD, 3rd Ed.

Table 10-10.
All-Bolted Single-Angle Connections



Note: standard holes in support leg of angle

Eccentrically Loaded Bolt Group Coefficients, C		
Number of Bolts in One Vertical Row, *n*	Case I	Case II
12	11 4	21 5
11	10 4	19 4
10	9 37	17 3
9	8 34	15 2
8	7 31	13 0
7	6 27	10 9
6	5 22	8 70
5	4 15	6 63
4	3.07	4 70
3	1 99	2 94
2	1 03	1 61
1	–	0.518

$\phi R_n = C \times \phi r_n$

where

C = coefficient from Table above
ϕr_n = design strength of one bolt in shear or bearing, kips/bolt

Notes:
For eccentricities less than or equal to those shown above, tabulated values may be conservatively used.
For greater eccentricities, coefficient C should be recalculated from Table 7-17 or Table 7-18.
Connection may be bearing-type or slip-critical.

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Number of Bolts in One Vertical Row	A325 Shear k
	¾ in.
12	191
11	175
10	159
9	143
8	127
7	111
6	95 4
5	79 5
4	63 6
3	47 7
2	31 8

Notes:
Gage in angle leg attachec
decreased
Tabulated weld design stre
these values being conser
half web or recalculated.
When the beam web thickı
back, either stagger the an
minimum thickness to dete

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Connection check based on AISC - 13th Ed. (LRFD)

See p. 4 for conn. det.

$\phi R_n = C \times \phi v_n$

from Table 7-1 → $\phi_v v_n = 15.9$ k
(see p. 6a)

from Table 10-10 → $C = 3.07$
(see p. 6b)

$\phi R_n = 3.07 \times 15.9 = 48.8$ k

Table 7–1
Available Shear Strength of Bolts, kips

Nominal Bolt Diameter d_b, in.					5/8		3/4		7/8		1	
Nominal Bolt Area, in.^{2}					0.307		0.442		0.601		0.785	
ASTM Desig.	Thread Cond.	F_{nv}/Ω (ksi)	ϕF_{nv} (ksi)	Loading	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
A325 F1852	N	24.0	36.0	S	7.36	11.0	10.6	15.9	14.4	21.6	18.8	28.3
				D	14.7	22.1	21.2	31.8	28.9	43.3	37.7	56.5
	X	30.0	45.0	S	9.20	13.8	13.3	19.9	18.0	27.1	23.6	35.3
				D	18.4	27.6	26.5	39.8	36.1	54.1	47.1	70.7
A490	N	30.0	45.0	S	9.20	13.8	13.3	19.9	18.0	27.1	23.6	35.3
				D	18.4	27.6	26.5	39.8	36.1	54.1	47.1	70.7
	X	37.5	56.3	S	11.5	17.3	16.6	24.9	22.5	33.8	29.5	44.2
				D	23.0	34.5	33.1	49.7	45.1	67.6	58.9	88.4
A307	–	12.0	18.0	S	3.68	5.52	5.30	7.95	7.22	10.8	9.42	14.1
				D	7.36	11.0	10.6	15.9	14.4	21.6	18.8	28.3

Nominal Bolt Diameter d_b, in.					1 1/8		1 1/4		1 3/8		1 1/2	
Nominal Bolt Area, in.^{2}					0.994		1.23		1.48		1.77	
ASTM Desig.	Thread Cond.	F_{nv}/Ω (ksi)	ϕF_{nv} (ksi)	Loading	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
A325 F1852	N	24.0	36.0	S	23.9	35.8	29.5	44.2	35.6	53.5	42.4	63.6
				D	47.7	71.6	58.9	88.4	71.3	107	84.8	127
	X	30.0	45.0	S	29.8	44.7	36.8	55.2	44.5	66.8	53.0	79.5
				D	59.6	89.5	73.6	110	89.1	134	106	159
A490	N	30.0	45.0	S	29.8	44.7	36.8	55.2	44.5	66.8	53.0	79.5
				D	59.6	89.5	73.6	110	89.1	134	106	159
	X	37.5	56.3	S	37.3	55.9	46.0	69.0	55.7	83.5	66.3	99.4
				D	74.6	112	92.0	138	111	167	133	199
A307	–	12.0	18.0	S	11.9	17.9	14.7	22.1	17.8	26.7	21.2	31.8
				D	23.9	35.8	29.5	44.2	35.6	53.5	42.4	63.6

ASD	LRFD
$\Omega_v = 2.00$	$\phi_v = 0.75$

AISC-13th ED.

P. 6a

Avai
Strengt

Nominal Bolt Diameter d_b, in.				
Nominal Bolt Area, in.^{2}				
ASTM Desig.	F_{nt}/Ω (ksi)	ϕF_{nt} (ksi)	r_n/Ω	
	ASD	LRFD	ASD	
A325 & F1852	45.0	67.5	13.	
A490	56.5	84.8	17	
A307	22.5	33.8	6.9	

Nominal Bolt Diameter d_b, in.			
Nominal Bolt Area, in.^{2}			
ASTM Desig.	F_{nt}/Ω (ksi)	ϕF_{nt} (ksi)	r_n
	ASD	LRFD	A
A325 & F1852	45.0	67.5	4
A490	56.5	84.8	5
A307	22.5	33.8	2

ASD	LRFD
$\Omega_v = 2.00$	$\phi_v = 0.75$

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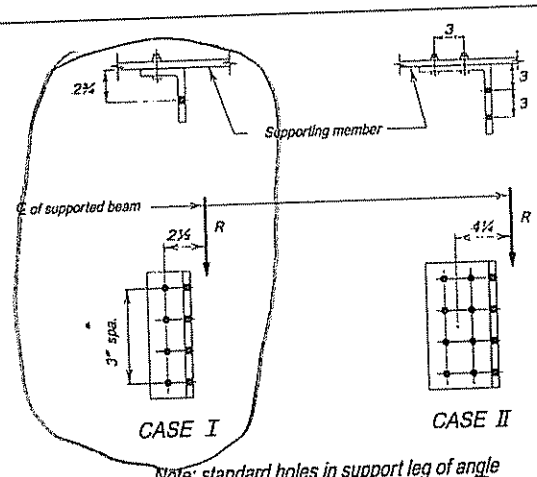
Table 10–10
All-Bolted Single-Angle Connections



Note: standard holes in support leg of angle

Eccentrically Loaded Bolt Group Coefficients, *C*

Number of Bolts in One Vertical Row, *n*	Case I	Case II
12	11.4	21.5
11	10.4	19.4
10	9.37	17.3
9	8.34	15.2
8	7.31	13.0
7	6.27	10.9
6	5.22	8.70
5	4.15	6.63
4	3.07	4.70
3	1.99	2.94
2	1.03	1.61
1	—	0.518

LRFD

$\phi R_n = C \times \phi r_n$ or $R_n/\Omega = C \times r_n/\Omega$

where

C = coefficient from Table above

ϕr_n = design strength of one bolt in shear or bearing, kips/bolt

r_n/Ω = allowable strength of one bolt in shear or bearing, kips/bolt

Notes:

For eccentricities less than or equal to those shown above, tabulated values may be used.

For greater eccentricities, coefficient C should be recalculated from Part 7.

Connection may be bearing-type or slip-critical.

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