# STEEL CONSTRUCTION



## AMERICAN INSTITUTE OF STEEL CONSTRUCTION

FOURTEENTH EDITION

#### **PART 10**

#### **DESIGN OF SIMPLE SHEAR CONNECTIONS**

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#### SCOPE

The specification requirements and other design considerations summarized in this Part apply to the design of simple shear connections. For the design of partially restrained moment connections, see Part 11. For the design of fully restrained (FR) moment connections, see Part 12.

#### **FORCE TRANSFER**

The required strength (end reaction),  $R_n$  or  $R_a$ , is determined by analysis as indicated in AISC *Specification* Section B3.6a. Per AISC *Specification* Section J1.2, the ends of members with simple shear connections are normally assumed to be free to rotate under load. While simple shear connections do actually possess some rotational restraint (see curve A in Figure 10-1), this small amount can be neglected and the connection idealized as completely flexible. The simple shear connections shown in this Manual are suitable to accommodate the end rotations required per AISC *Specification* Section J1.2.

Support rotation is acceptably limited for most framing details involving simple shear connections without explicit consideration. The case of a bare spandrel girder supporting infill beams, however, may require consideration to verify that an acceptable level of support rotational stiffness is present. Sumner (2003) showed that a nominal interconnection between

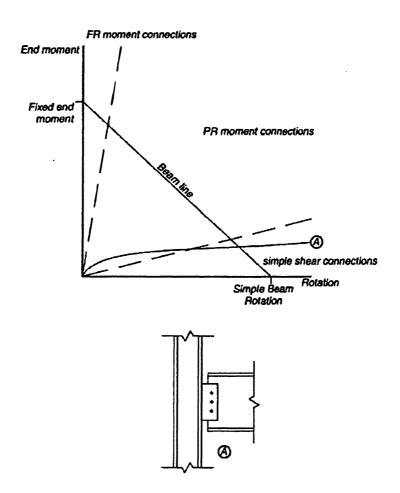


Fig. 10-1. Illustration of typical moment rotation curve for simple shear connection.

the top flange of the girder and the top flange of the framing beam is sufficient to limit support rotation.

#### **COMPARING CONNECTION ALTERNATIVES**

#### **Two-Sided Connections**

Two-sided connections, such as double-angle and shear end-plate connections, offer the following advantages:

- 1. suitability for use when the end reaction is large;
- 2. compact connections (usually, the entire connection is contained within the flanges of the supported beam); and,
- 3. eccentricity perpendicular to the beam axis need not be considered for workable gages (see Table 1-7A).

Note that two-sided connections may require additional consideration for erectability, as discussed in "Constructability Considerations" below.

#### **Seated Connections**

Unstiffened and stiffened seated connections offer the following advantages:

- 1. seats can be shop attached to the support, simplifying erection;
- 2. ample erection clearance is provided;
- 3. excellent safety during erection since double connections often can be eliminated; and,
- 4. the bay length of the structure is easily maintained (seated connections may be preferable when maintaining bay length is a concern for repetitive bays of framing).

#### **One-Sided Connections**

One-sided connections such as single-plate, single-angle and tee connections offer the following advantages:

- 1. shop attachment of connection elements to the support, simplifying shop fabrication and erection;
- 2. reduced material and shop labor requirements;
- 3. ample erection clearance is provided; and,
- 4. excellent safety during erection since double connections often can be eliminated.

#### CONSTRUCTABILITY CONSIDERATIONS

#### **Double Connections**

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A double connection occurs in field-bolted construction when beams or girders frame opposite each other. Double connections are a safety concern when they occur in the web of a column (see Figure 10-2) or the web of a beam that frames continuously over the top of a column<sup>1</sup> and all field bolts take the same open holes. A positive connection must be made

<sup>&</sup>lt;sup>1</sup>This requirement applies only at the location of the column, not at locations away from the column.

and maintained for the first member to be erected while the second member to be erected is brought into its final position. Conditions requiring the connector to hang one beam temporarily on a partially inserted bolt or drift pin are not allowed by OSHA.

Framing details can be configured using staggered angles or other similar details to provide a means to make a positive connection for the first member while the second member is brought into its final position. Alternatively, a temporary erection seat, as shown in Figure 10-2, can be provided. The erection seat, usually an angle, is sized and attached to the column web to support the dead weight of the member, unless additional loading is indicated in the contract documents. It is located to clear the bottom flange of the supported member by approximately <sup>3</sup>/<sub>8</sub> in. to accommodate mill, fabrication and erection tolerances.

The sequence of erection is most important in determining the need for erection seats. If the erection sequence is known, the erection seat is provided on the side needing the support. If the erection sequence is not known, a seat can be provided on both sides of the column web. Temporary erection seats may be reused at other locations after the connection(s) are made, but need not be removed unless they create an interference or removal is required in the contract documents.

See also the discussion under "Special Considerations for Simple Shear Connections."

#### **Accessibility in Column Webs**

Because of bolting and welding clearances, double-angle, shear end-plate, single-plate, single-angle, and tee shear connections may not be suitable for connections to the webs of W-shape and similar columns, particularly for W8 columns, unless gages are reduced. Such connections may be impossible for W6, W5 and W4 columns.

There is also an accessibility concern for entering and tightening the field bolts when the connection material is shop-attached to the supporting column web and contained within the column flanges.

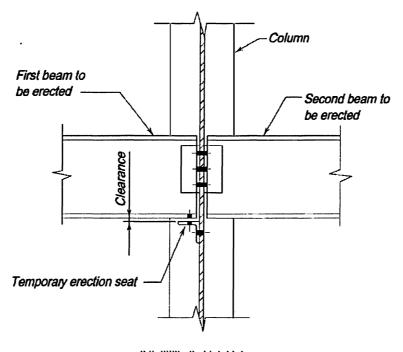


Fig. 10-2. Erection seat.

#### **Field-Welded Connections**

In field-welded connections, temporary erection bolts are usually provided to support the member until final welding is performed. A minimum of two bolts (one bolt in bracing members) must be placed for erection safety per OSHA requirements. Additional erection bolts may be required for loads during erection, to assist in pulling the connection angles up tightly against the web of the supporting beam prior to welding or for other reasons. Temporary erection bolts may be reused at other locations after final welding, but need not be removed unless they create an interference or removal is required in the contract documents.

#### **Riding the Fillet**

The detailed dimensions of connection elements must be compatible with the *T*-dimension of an uncoped beam and the remaining web depth of a coped beam. Note that the element may encroach upon the fillet(s), as given in Figure 10-3.

#### **DOUBLE-ANGLE CONNECTIONS**

A double-angle connection is made with two angles, one on each side of the web of the beam to be supported, as illustrated in Figure 10-4. These angles may be bolted or welded to the supported beam as well as to the supporting member.

When the angles are welded to the support, adequate flexibility must be provided in the connection. As illustrated in Figure 10-4(c), line welds are placed along the toes of the angles with a return at the top per AISC Specification Section J2.2b. Note that welding across the entire top of the angles must be avoided as it inhibits the flexibility and, therefore, the necessary end rotation of the connection. The performance of the resulting connection would not be as intended for simple shear connections.

#### **Available Strength**

The available strength of a double-angle connection is determined from the applicable limit states for bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n$ .

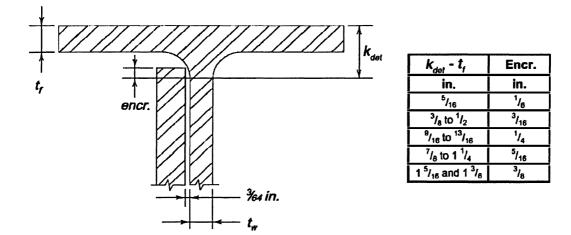
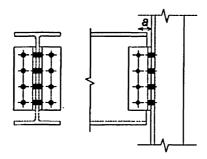
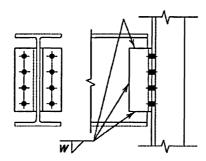


Fig. 10-3. Fillet encroachment (riding the fillet).

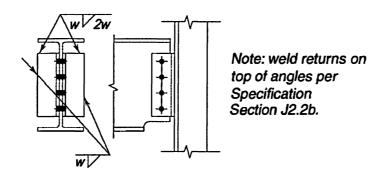
For standard or short-slotted holes, eccentricity on the supported side of double angle connections may be neglected for gages [distance from the face of the outstanding angle legs to the centerline of the vertical bolt row, shown as dimension a in Figure 10-4(a)] not exceeding 3 in., except in the case of a double vertical row of bolts through the web of the supported beam. Eccentricity should always be considered in the design of welds for double-angle connections.



#### (a) All-bolted



(b) Bolted/welded, angles welded to support beam



(c) Bolted/welded, angles welded to support

Fig. 10-4. Double-angle connections.

#### **Recommended Angle Length and Thickness**

To provide for stability during erection, it is recommended that the minimum angle length be one-half the *T*-dimension of the beam to be supported. The maximum length of the connection angles must be compatible with the *T*-dimension of an uncoped beam and the remaining web depth of a coped beam. Note that the element may encroach upon the fillet(s), as given in Figure 10-3.

To provide for flexibility, the maximum angle thickness for use with workable gages should be limited to <sup>5</sup>/<sub>8</sub> in. Alternatively, the shear-connection ductility checks illustrated in Part 9 can be used to justify other combinations of gage and angle thickness.

#### **Shop and Field Practices**

When framing to a girder web, both angles are usually shop-attached to the web of the supported beam. When framing to a column web, both angles should be shop-attached to the supported beam, when possible, and the associated constructability considerations should be addressed (see the preceding discussion under "Constructability Considerations").

When framing to a column flange, both angles can be shop-attached to the column flange or the supported beam. In the former case, this is a knifed connection, as illustrated in Figure 10-4(c), which requires an erection clearance, as illustrated in Figure 10-5(a), and that the bottom flange be coped. Also, provision must be made for possible mill variation in the depth of the columns, particularly in fairly long runs (i.e., six or more bays of framing). If both angles are shop-attached to the beam web, the beam length can be shortened to provide for mill overrun with shims furnished at the appropriate intervals to fill the resulting gaps or to provide for mill underrun. If both angles are shop-attached to the column flange, the erected beam is knifed into place and play in the open holes is normally sufficient to provide for the necessary adjustment. Alternatively, short-slotted holes can also be used.

When special requirements preclude the use of any of the foregoing practices, one angle could be shop-attached to the support and the other shipped loose. In this case, the spread between the outstanding legs should equal the decimal beam web thickness plus a clearance that will produce an opening to the next higher \(^{1}/16\)-in. increment, as illustrated in Figure 10-5(b). Alternatively, short-slotted holes in the support leg of the angle eliminate the need to provide for variations in web thickness. Note that the practice of shipping one angle loose is not desirable because it requires additional material handling as well as added erection costs and complexity.

#### **DESIGN TABLE DISCUSSION (TABLES 10-1, 10-2 AND 10-3)**

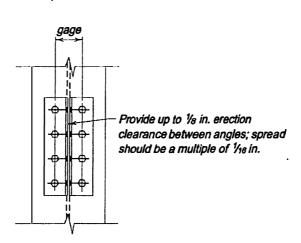
#### **Table 10-1. All-Bolted Double-Angle Connections**

Table 10-1 is a design aid for all-bolted double-angle connections. Available strengths are tabulated for supported and supporting member material with  $F_v = 50$  ksi and  $F_u = 65$  ksi and angle material with  $F_v = 36$  ksi and  $F_u = 58$  ksi. Eccentricity effects on the supported (beam) side of the connections are neglected, as discussed previously for gages not exceeding 3 in. All values, including slip-critical bolt available strengths, are for comparison with the governing LRFD or ASD load combination.

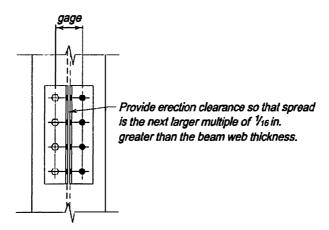
Tabulated bolt and angle available strengths consider the limit states of bolt shear, bolt bearing on the angles, shear yielding of the angles, shear rupture of the angles, and block

shear rupture of the angles. Values are tabulated for 2 through 12 rows of  $^{3}$ /4-in.-,  $^{7}$ /8-in.- and 1-in.-diameter Group A and Group B bolts (as defined in AISC *Specification Section J3.1*) at 3-in. spacing. For calculation purposes, angle edge distances,  $L_{ev}$  and  $L_{eh}$ , are assumed to be  $1^{1}$ /4 in.

Tabulated beam web available strengths, per in. of web thickness, consider the limit state of bolt bearing on the beam web. For beams coped at the top flange only, the limit state of block shear rupture is also considered. Additionally, for beams coped at both the top and bottom flanges, the tabulated values consider the limit states of shear yielding and shear rupture of the beam web. Values are tabulated for beam web edge distances,  $L_{ev}$ , from  $1^1/4$  in. to 3 in. and for beam end distances,  $L_{eh}$ , of  $1^1/2$  in. and  $1^3/4$  in. For calculation purposes, these end distances have been reduced to  $1^1/4$  in. and  $1^1/2$  in., respectively, to account for possible underrun in beam length. For coped members, the limit states of flexural yielding and local buckling must be checked independently per Part 9. When required, web reinforcement of coped members is treated as in Part 9.



(a) Both angles shop attached to the column flunge (beam knifed into place)



(b) One shop attached to the column flange, other shipped loose

Fig. 10-5. Erection clearances for double-angle connections.

Tabulated supporting member available strengths, per in. of flange or web thickness, consider the limit state of bolt bearing on the support. Note that resistance and safety factors are not noted in these tables, as they vary by limit state.

### Table 10-2. Available Weld Strength of Bolted/Welded Double-Angle Connections

Table 10-2 is a design aid arranged to permit substitution of welds for bolts in connections designed with Table 10-1. Electrode strength is assumed to be 70 ksi. Holes for erection bolts may be placed as required in angle legs that are to be field-welded.

Welds A may be used in place of bolts through the supported-beam web legs of the double angles or welds B may be used in place of bolts through the support legs of the double angles. Although it is permissible to use welds A and B from Table 10-2 in combination to obtain all-welded connections, it is recommended that such connections be selected from Table 10-3. This table will allow increased flexibility in the selection of angle lengths and connection strengths because Table 10-2 conforms to the bolt spacing and edge distance requirements for the all-bolted double-angle connections of Table 10-1.

Weld available strengths are tabulated for the limit state of weld shear. Available strengths for welds A are determined by the instantaneous center of rotation method using Table 8-8 with  $\theta = 0^{\circ}$ . Available strengths for welds B are determined by the elastic method. With the neutral axis assumed at one-sixth the depth of the angles measured downward and the tops of the angles in compression against each other through the beam web, the available strength,  $\phi R_{II}$  or  $R_{II}/\Omega$ , of these welds is determined by

LRFD	ASD
$\phi R_n = 2 \left( \frac{1.392DL}{\sqrt{1 + \frac{12.96e^2}{L^2}}} \right) $ (10-1a)	$\frac{R_n}{\Omega} = 2 \left( \frac{0.928DL}{\sqrt{1 + \frac{12.96e^2}{L^2}}} \right) $ (10-1b)

where

D = number of sixteenths-of-an-inch in the weld size

L = length of the connection angles, in.

e =width of the leg of the connection angle attached to the support, in.

Note that  $\phi = 0.75$  is included in the right hand side of Equation 10-1a and  $\Omega = 2.00$  is included in the right hand side of Equation 10-1b.

The tabulated minimum thicknesses of the supported beam web for welds A and the support for welds B match the shear rupture strength of these elements with the strength of the weld metal. As derived in Part 9, the minimum supported beam web thickness for welds A (two lines of weld) is

$$t_{min} = \frac{6.19D}{F_u} \tag{9-3}$$

and the minimum supporting flange or web thickness for welds B (one line of weld) is

$$t_{min} = \frac{3.09D}{F_u} \tag{9-2}$$

When welds B line up on opposite sides of the support, the minimum thickness is the sum of the thicknesses required for each weld. In either case, when less than the minimum material thickness is present, the tabulated weld available strength must be reduced by the ratio of the thickness provided to the minimum thickness.

When Table 10-2 is used, the minimum angle thickness is the weld size plus  $^{1}/_{16}$  in., but not less than the angle thickness determined from Table 10-1. The angle length, L, must be as tabulated in Table 10-2. In general,  $2L4\times3^{1}/_{2}$  will accommodate workable gages, with the 4-in. leg attached to the supporting member. The width of web legs in Case I (web legs welded and outstanding legs bolted) may be optionally reduced from  $3^{1}/_{2}$  in. to 3 in. The width of outstanding legs in Case II (web legs bolted and outstanding legs welded) may be optionally reduced from 4 in. to 3 in. for values of L from  $5^{1}/_{2}$  through  $17^{1}/_{2}$  in.

### Table 10-3. Available Weld Strength of All-Welded Double-Angle Connections

Table 10-3 is a design aid for all-welded double-angle connections. Electrode strength is assumed to be 70 ksi. Holes for erection bolts may be placed as required in angle legs that are to be field-welded.

Weld available strengths are tabulated for the limit state of weld shear. Available strengths for welds A are determined by the instantaneous center of rotation method using Table 8-8 with  $\theta = 0^{\circ}$ . Available strengths for welds B are determined by the elastic method as discussed previously for bolted/welded double-angle connections.

The tabulated minimum thicknesses of the supported beam web for welds A and the support for welds B match the shear rupture strength of these elements with the strength of the weld metal and are determined as discussed previously for Table 10-2. When welds B line up on opposite sides of the support, the minimum thickness is the sum of the thicknesses required for each weld. When less than the minimum material thickness is present, the tabulated weld available strength must be reduced by the ratio of the thickness provided to the minimum thickness.

When Table 10-3 is used, the minimum angle thickness must be equal to the weld size plus  $^{1}/_{16}$  in. The angle length, L, must be as tabulated in Table 10-3.  $2L4\times3^{1}/_{2}$  should be used for angle lengths equal to or greater than 18 in. For angle length less than 18 in., the 4-in. leg can be reduced to 3 in.

Angle Beam	$F_y = 50$ $F_u = 65$ $F_y = 36$ $F_u = 58$	ksi ksi		AI	I-B		ed		0-1 ubl		Ang	jle	,	3/4 Bo	,-in. Its
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	W44							ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
!	Varies	<b>'</b>			N	1	TD	197	295	246	369	286	430	286	430
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4	,	ĺ			N	S	TD	197	295	246	369	295	443	361	541
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٦ ا	oped at Top	.	1 <sup>3</sup> /8 1 <sup>1</sup> / <sub>2</sub>	501 503	751 754	509 511	763 767	470	706 709	479 481	718 722	497 500	746 750	506 508	758 762
	Flange Only	- P-		505	758	514		473 475	713		725	502	753	510	766
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			1 <sup>3</sup> /8	492	739	492	739	463	695	463	695	492	739	492	739
Co	oped at Botl	h	11/2	497	746	497	746	468	702	468	702	497	746	497	746
	Flanges	ſ	1 <sup>5</sup> /8	502	753	502	753	473	709	473 <sub>2</sub>	709	502	753	502	753
			2	513	769	517	775	483	724	488	731	510	764	517	775
			3	532	798	540	810	502.	753	510	765	529	794	537	806
	Uncope	d		702	1050	702	1050	702	1050	702	1050	702	1050	702	1050
	Support Ava Strength Inch Thick kips/in	per ness,		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											
STE OVS SSL	)/ S/ 1400		RFD 110	underrun in beam length.  Note: Slin-critical both values assume no more than one filler has been provided or both						ave					

Angle Beam	F <sub>u</sub> F <sub>y</sub>				Al		olte Ce	ed onr	1 (c Do iec	ubl tio	e- <i>l</i> ns	Ang		•	3/4 Bol	-in. Its	
4	ľ	- 50	J KJI				В	olt and	Angle A	Availab	le Stre	ngth, k	ips				
	11	Rows	;	Bolt	The	read	ш	ole			An	gle Thi	ckness	, in.			
<u> </u>				Group	1	nd.		/pe	1	/4	5,	16	3	/B	1	/2	
	W	44, 40		uroup	00	iiu.	''	pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
	Varios					N	S	TD	181	271	226	338	263	394	263	394	
		_	<u> </u>			X	STD		181	271	226	338	271	406	331	496	
li			]		و ا	SC	1	TD	139	209	139	209	139	209	139	209	
	<u> </u>	8		Group	l	ss A	1	VS	119	178	119	178	119	178	119	178	
l	! !!	0 <b>@ = 30</b> 0		A				SLT	139	209	139	209	139	209	139	209	
	1    1				9	SC		TD	1,81	271	226	338	232	348	232	348	
ا		_ !_	₩.		1	ss B	1	VS	180	269	198	296	198	296	198	296	
_	.,	l	MAG.		ļ			SLT	179	269	224	336	232	348	232	348	
1	Ц_		<b>⊣</b>		l	N		TD	181	271	226	338	271	406	331	496	
l	T					<u>X</u>		TD	181	271	226	338	271	406	361	542	
8				C	8	SC		TD	174	261	174	261	174	261	174	261	
1003 = 30			- -	Group B	Cla	ss A		VS SLT	148 174	222	148 174	222	148	222	148 174	222	
ā	•			D					181	261 271	226	261 338	174 271	261 406	290	261 435	
	<u> </u>				SC STD OVS				180	269	225	337			247	370	
Ě					Cla	ss B	SSLT		179	269	224	336	Professional Confession Confessio		290	435	
				Da	18fe	h Assail	•		per in					1400	Z3U :	400	
<u> </u>				DE	alli 110			uengu	hei III			KI PO/ II	SSLT				
		Hole T	уре			5	TD			O\ L <sub>eh</sub> *		ļ		SS	LI		
<u> </u>					41	1/2	1:	3/4	11/2		13/4		11/2		13	1/4	
		<i>L<sub>ev</sub></i> , i	in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
<u> </u>				1 <sup>1</sup> /4	457	685	465	697	429	644	437	656	454	680	462	693	
				1 <sup>3</sup> / <sub>8</sub>	459	689	467	701	431	647	440	659	456	684	464	696	
	`ono	d at To	n ا	1 <sup>1</sup> / <sub>2</sub>	462	692	470	704	434	651	442	663	458	688	467	700	
		ge Onl		1 <sup>5</sup> /8	464	696	472	708	436	654	444	667	461	691	469	704	
		go o	'	2	471	707	479	719	444	665	452	678	468	702	476	714	
				3	491	736	499	748	463	695	471	707	488	732	496	744	
				11/4	446	669	446	669	419	629	419	629	446	669	446	669	
				1 <sup>3</sup> /8	451	676	451	676	424	636	424	636	451	676	451	676	
C	opeo	d at Bo	oth	11/2	456	684	456	684	429	644	429	644	456	684	456	684	
	•	anges	ľ	15/8	461	691	461	691	434	651	434	651	461	691	461	691	
		-		2	471	707	475	713	444	665	449	673	468	702	475	713	
				3	491	736	499	748	463	695	471	707	488	732	496	744	
		Uncop	oed		644	965	644	965	644	965	644	965	644	965	644	965	
Ho	S	trengti h Thic kips/	kness, in.		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												
STI OV: SSI	<b>pe</b> D/ S/	1290		RFD 1930	under Note: S	rrun in b Slip-critic	eam lenç al bolt v	gth. alues as:		more th				nt for pos ovided or		ave	

DESIGN TABLES

$ \widetilde{\mathbf{g}}  _{F_u} =  \widetilde{\mathbf{g}}  _{F_y} =  \widetilde{\mathbf{g}}  _{F_y}$	50 ksi 65 ksi 36 ksi		Al		olt	ed	Do	onti ubl tio	e-A	•	jle	,	3/4 Bol	-in. Its	
<del> </del>   Fu =	58 ksi				В	olt and	Angle	Availab	le Stre	ngth, k	ips			***********	
10 Ro	we	l	_				T			gle Thic	•	, in.			
10 110	<del></del>	Bolt Group	1	read nd.	í	ole	1	/4	5/	16	3	/8	1	/2	
W44, 40	0, 36	ասար	CU	iiu.	,,	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			İ	N	S	TD	164	246	205	308	239	358	239	358	
Varies	<del></del>			X	<del></del>	TD	164	246	205	308	246	370	301	451	
	-		8	C	STD		127	190	127	190	127	190	127	190	
i z	ij	Group	Cla	ss A	OVS SSLT		108 127	161 190	108″ 127	161 190	108	161	108 127	161	
2. s		Α			STD		164	246	205	308	127 211	190 316	211	190 316	
	<u> i</u>		1	SC _		VS	163	245	180	269	180	269	180	269	
,	11.3		Cla	ss B		SLT	163	244	204	306	211	316	211	316	
3 1			j 1	N	STD		:164	246	205	308	246	370	301	451	
			,	X		TD	164	246	205	308	246	370	329	493	
			l s	C	3	TD	158	237	158	237	158	237	158	237	
963° Z	<b>†</b>	Group B	Class A			VS	135	202	135	202	135	202	135	202	
		D				slt TD	158 164	237 246	158 205	237 308	158 246	237 370	158 264	237 396	
3				C	3	VS	163	245	204	306	225	336	225	336	
			Clas	ss B	1	SLT	163	244	204 306		244 367		264	396	
	•	Be	am We	b Avail	able S	trength	h per Inch Thickness, kips/in.								
	_			S	TD .		Ī	0/	ovs				SSLT		
Hol	e Type						<i>L<sub>eh</sub></i> *, in.								
			11	1/2	1:	3/4	11		13	/4	11	/2	13	/4	
L <sub>6</sub>	<sub>r</sub> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	· ASD	LRFD	
		11/4	415	623	423	635	390	585	398	597	412	618	420	630	
		1 <sup>3</sup> /8	418	626	426	639	392	589	401	601	<b>3415</b>	622	423	634	
Coped at	• ;	1 <sup>1</sup> /2	420	630	428	642	395	592	403	605	417	626	425	638	
Flange (	Only	1 <sup>5</sup> /8	423	634	431	646	397	596	405	608	419	629	428	641	
		2	430	645	438	57	405	607	413	619	427	640	435	652	
		3	449	674	ે457 -405∂	686	424	636	432	648	446	669	454	682	
		1 <sup>1</sup> /4 1 <sup>3</sup> /8	405 410	607 614	405 410	607 614	380 385	570 578	380 385	570 578	405 410	607 614	405 410	607 614	
Coped at	Both	1º/8 1¹/2	414	622	414	622	390	585	390	585	414	622	414	622	
Flange	,	1 <sup>5</sup> /8	419	629	419	629	395	592	395	592	419	629	419	629	
		2	430	645	434	651	405	607	410	614	427	640	434	651	
		3	449:	674	457	686	424	636	432	648	446	669	454	682	
Und	coped		585	878	585	878	585	878	585	878	585	878	585	878	
Stren Inch Ti kip	t Availabl ngth per hickness, os/in.	'	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												
Type STD/		RFD 1760	under Note: S	run in b lip-critic	eam lenç al bolt v	gth. alues as:		on in end more that ers.				•		ave	

le Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$		Al		olt	10- ed onr	Do	ubl	e-A	-	gle		3/4 Bol	-in. Its
Angle	1 *	1				<b></b>								
A	<i>F<sub>u</sub> =</i> 58 ksi			-	В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	9 Rows	D-14	-			-1-			Ang	gle Thi	ckness	, in.		
		Bolt  Group	1	read ond.	1	ole /pe	1	/4	5/	16	3	/ <sub>8</sub>	1	/2
W	144, 40, 36, 33	dioup	00	niu.	''	he	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			1	N		TD	148	222	185	278	215	322	215	322
	Varies 1			X	STD		148	222	185	278	222	333	271	406
		Croun	8	SC		TD VS	114 97.1	171 145	114 97.1	171 145	114	171	114 97.1	171
		Group A	Cla	ss A	1	SLT	114	171	114	171	97.1 114	145 171	114	145 171
	₩	^				TD	148	222	185	278	190	285	190	285
			SC Class B		•	VS	147	221	162	242	162	242	162	.242
	13		Ula	SS B	SSLT		147	220	183	275	190	285	190	285
.5			1	N	ı	TD	148	222	185	278	222	333	271	406
			<u> </u>	<u> </u>		TD	148	222	185	278	222	333	296	444
2		Group	S	C		TD VS	142 121	214 182	142 121 -	214 182	142 121	214 182	142 121	214 182
8693-24	1	В	Cla	ss A		SLT	142	214	142	214	142	214	142	214
	L				-	TD	148	222	185	278	222	333	237	356
1.	,		l .	SC ss B	1		147	221	184	276	202	303	202	303
<u> </u>			Ula	55 D	SS	SLT	147	220 <b>183</b> 275		275	<b>220</b> 330		237	356
	<u>.</u>	Be	am We	b Avail	able S	trength	per In	ch Thic	kness,	kips/i	n.			
	Hole Type			S	TD			01				SS	LT	
	<u> </u>		4	1,	ا ا	2,	. م	L <sub>eh</sub> *		•	4		49	14
	L <sub>ev</sub> , in.			1/2		3/4	11/2 ASD   LRFD		13/4 RFD <b>ASD</b> LRF		1 <sup>1</sup> / <sub>2</sub> ASD LRFD		13	
ļ	<u>:'</u> ?	11/4	<b>ASD</b> 374	<b>LRFD</b> 561	<b>ASD</b> 382	LRFD 573	351	527	359	LRFD 539	371	556	<b>ASD</b> 379	LRFD 568
	į	1 <sup>3</sup> / <sub>8</sub>	376	564	384	576	353	530	362	542	373	560	381	572
C	: Coped at Top	11/2	379	568	387	580	356	534	364	546	376	563	384	576
1	Flange Only	1 <sup>5</sup> /8	381	572	389	584	358	537	366	550	378	567	386	579
		2	388	583	397	595	366	548	374	561	385	578	393	590
		3	408	612	416	624	385	578	<b>393</b>	590	405	607	413	619
		11/4	363	545	363	545	341	512	341,	512	363	545	363	545
	aned at Bath	1 <sup>3</sup> /8	368	552 550	368	552	346	519	346	519 527	368	552	368	552
U	oped at Both Flanges	1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub>	373	559	373	559 567	351 356	527	351	527	373	559	373	559
	1 iuiig00	2	378 . 388	567 583	378 392	589	,356 366	534 548	356 371	534 556	378 385	567 578	378 392	567 589
		3	408	612	416	624	385	578	393	590	405	607	413	619
	Unco ed		527	790	527	790	527	790	527	790	527	790	527	790
	Support Availabl Stren ther Inch Thickness kips/in.		OVS =											
STI OVS SSI	oe <b>ASD</b> 1 0/ S/ <b>1050</b>	LRFD 1580	under Note: S	run in b lip-critic	eam lenç al bolt v	ide <sup>1</sup> /4-in gth. alues ass e loads ii	sume no	more th						ave

Beam	$F_y = 50 \text{ ks}$ $F_u = 65 \text{ ks}$		Table 10-1 (continued) All-Bolted Double-Angle Connections												
Angle	$F_y = 36 \text{ ks}$	i			C	onr	ec	tio	ns				Bol	Its	
A	$F_u = 58 \text{ ks}$	i			В	olt and	Angle A	Availab	le Stre	ngth, k	ips				
1	7 Rows	D-14			<u> </u>		T	· <del></del>			ckness	, in.			
W44	l, 40, 36, 33, <b>3</b> 0	Bolt Group	I	read Ind.		ole /pe	1	/4	5/	16	3	/8	1	/2	
	27, 24						ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			1	N X	1	TD TD	116 116	174 174	145 145	217 217	167 174	251 260	167 210	251 316	
	'arios ,				-	STD STD		133	88.6	133	88.6	133	88.6	133	
Ĺ		Group	1	SC A		VS	88.6 75.5	113	75.5	113	75.5	113	75.5		
	9	Α	Lia	ISS A	-	SLT	88.6	133	88.6	133	88.6		88.6		
	693=18		9	SC		TD	116	174	145	217	148	221	148	221	
Ţ			1	ss B		VS Slt	115 114	172 172	126 143	188	126 148	188 221	126 148	188	
 14	17-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	-	<b> </b>	N	<del></del>	TD	116	174	145	214 217	174	260	210	221 316	
2	<u>.</u>		ı	X	ı	TD	116	174	145	217	174	260	231	347	
91 •	1	I				TD	1113	166	111	166	711	166	111	166	
863 - 16	7	Group	l .	SC ss A		VS	94.4	141	94,4	141	94.4	141	94,4	141	
ŧ		В	Ula	33 A	<del></del>	SSLT		166	111	166	111	166	111	166	
-,			5	SC	•	TD	116	174	145	217	174	260	185	277	
			Cla	Clace B UVS			115 114	172 172	144 143	215 214	.3 5	157   235   157   23 1 <b>72</b>   257   185   27			
		Re	eam Web Available Strength												
					TD		<b>PO. 11.</b>	0\		- Inport		SS	LT		
	Hole Type							L <sub>eh</sub> *	L <sub>eh</sub> *, in.						
	L <sub>ev</sub> , in.		1	1/2	15	3/4	11	11/2		13/4		11/2		1/4	
	-gy;		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
		11/4	291	436	299	449	273	410	281	422	288	432	296	444	
_		13/8	293	440	301	452	275	413	284	425	290	435	298	448	
	Soped at Top	11/2	296	444	304	456	278	417	286	429	293	439	301	451	
	Flange Only	1 <sup>5</sup> /8	298 306	447 458	306 314	459 470	280 288	420 431	288 296	433 444	295 302	443 454	303 311	455 466	
		3	325	488	333	500	307	461	315 d	473	322	483	330	495	
		11/4	280	420	280	420	263	395	263	395	280	420	280	420	
		13/8	285	428	285	428	268	402	268	402	285	428	285	428	
Co	oped at Both	11/2	290	435	290	435	273	410	273	410	290	435	290	435	
	Flanges	1 <sup>5</sup> /8	295	442	295	442	278	417	278	417	295	442	295	442	
		2	306	458	310	464	288	431	293	439	302	454	310	464	
	llnaanad	3	325	488	333	500	307	461	315	473	322	483	330	495	
;	Uncoped Support Availa Strength per Inch Thicknes kips/in.	•	0VS =	Standar Oversizes Short-s	ed holes	les trans	410	614		eads increads ex	cluded	614	410	614	
Hol Typ STI	oe ASU	LRFD	under Note: S	ated valu	ues inclue eam leng	ide <sup>1</sup> /4-in gth. alues as	sume no	more th				nt for pos		ave	

$\begin{array}{c c} E & F_y = 50 \text{ ksi} \\ \hline \Theta & F_u = 65 \text{ ksi} \end{array}$		Al		olt	10- ed	Do	ubl	e-A	-	gle		<sup>3</sup> / <sub>4</sub>	-in.
$ F_y  = 36 \text{ ksi}$ $ F_u  = 58 \text{ ksi}$	l			C	onr	ec	tio	ns				Bol	its
$ F_u  = 58 \text{ ksi}$				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
6 Rows	Bolt	Th	read	н	ole			An	gle Thi	ckness	, in.	r	
W40, 36, 33, 30, 27,	Group	1	nd.	1	/pe	1	/4	5/	16	3	/8	1	/2
24, 21	<u> </u>					ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		1	N	•	TD	99.5	149	124	187	143	215	143	215
		X			TD	99.5	149	124	187	149	224	180	271
Varios ,	Croup	SC		1	TD IVS	75.9 64.7	114 96.8	75.9 64.7	114	75,9 64.7	114	75.9 64.7	
	Group A	Class A		1	SLT	75.9	114	75.9	96.8	1000000	96.8 114	75.9	96.8
# # H	^				TD	99.5	149	124	187	127	190	127	190
26 Se 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1		SC Class D		1	VS	98.6	148	108	161	108	161	108	161
113		Cla	ss B	1	SLT	98.2	147	123	184	127	190	127	190
3			N		TD	99.5	149	124	187	149	224	180	271
			Χ	<del></del>	TD	99.5		124	187	149	224	199	299
51.08		9	SC .	1	TD	94.9	142	94.9	142	94,9	142	94.9	142 121
*	Group	1		1	VS	80.9	121	80.9	121	80.9	121	80.9 94.9	
4	В		Class A		SLT	94.9 99.5	142	94.9	142	94.9	142	94.9	
		S	C		STD OVS		149	124 123	187	149	224	158	237
		Cla	ss B	SSLT		98.6 98.2	148 147	123	185 184	135 147	202 221	135 158	202 237
	l Re	ı am We	h Avail	•		•	•				LL 1	130	1201
		eam Web Available Strength per Inch Thickness, kips/in.  STD OVS								SS	SLT		
Hole Type							L <sub>eh</sub> *	, in.					
/ in		1	1/2	13/4		11	1/2	13	13/4		1/2	13	7/4
<i>L<sub>ev</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
·····	11/4	249	374	258	386	234	351	242	363	246	370	255	382
	1 <sup>3</sup> /8	252	378	260	390	236	355	245	367	249	373	257 :	385
Coped at Top	11/2	254	381	262	394	239	358	247	371	251	377	259	389
Flange Only	1 <sup>5</sup> /8	257	385	265	397	241	362	249	374	254	381	262	393
	2	264	396	272	408	249	373	257	385	261	392	269	404
	3	284	425	292	438	268	402	276	414	281	421	289	433
	11/4	239	358	239	358	224	336	224	336	239	358	239	358
Coped at Both	1 <sup>3</sup> /8 1 <sup>1</sup> / <sub>2</sub>	244 249	366 373	244 249	366 373	229 234	344 351	229 234	344 351	244 249	366 373	244 249	366 373
Flanges	15/8	254		254				239				254	
· lunges	1 9/8	254 264	380 396	254 268	380 402	239 249	358 373	259 254	358 380	254 261	380 392	268	380 402
	3	284	425	292	438	268	402	276	414	281	421	289	433
Uncoped	ı <u> </u>	351	527	351	527	351	527	351	527	351	527	351	527
Support Availab Strength per Inch Thickness kips/in.		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											
Hole Type ASD STD/ OVS/ SSLT TO2	LRFD 1050	under Note: S	run in b Slip-critic	eam leng al boit v	gth.	sume no	more th				nt for pos		ave

Beam	$F_y = 50 \text{ k}$ $F_u = 65 \text{ l}$		Al				•	onti		-	, le		<sup>3</sup> /4	-in.	
Angle	$F_y = 36 \text{ k}$							tio					Bol	lts	
A	$F_u = 58 $	(Sİ ——			В	olt and	Angle	Availab	le Stre	ngth, k	ips				
	5 Rows	Bolt	The	read	н	ole			Ang	gle Thi	ckness	, in.			
1410	0 07 04 04	Groun		nd.	1	/pe	<u> </u>	/4	5/16		<u>.                                      </u>	/8	<u> </u>	/2	
W	0, 27, 24, 21,	16	   N				ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			1	N X	STD STD		83.3	125 125	104 104	156 156	119 125	179 187	119 . 150	179 225	
						TD	63.3	94.9	63.3	94.9	63.3	94.9	63.3	-	
1	/anes (	Group	SC Class A		1	VS	53.9	80.7	53.9	80.7	53.9	80.7	53.9	80.7	
ď		A	Cla	SS A		SLT	63.3	94.9	63.3		63.3			<del></del>	
	463-12			SC		TD	83.3	125	104	156	105	158	105	158	
[]		. 1	1	ss B	1	VS	82.4	124	89.9	134	89.9	1	89.9		
<del></del>	Lan nis	Z.	1	N		<u>slt</u> TD	82.0 83.3	123 125	102 104	154 156	105 125	158 187	105 150	158 225	
3			ł	X	1	TD	83.3	125	104	156	125	187	167	250	
463-12	<b> </b>					TD	79.1	119	79,1	119	79.1	119		119	
,  -		Group	1 <b>I</b> .	SC A	1	VS	67.4	101	67.4	101	67,4	101		101	
J	'	В	Cla	ss A		SLT	79.1 83.3	119	79.1	119	79.1	119		119	
			9	sc		STD		125	104	156	125	187	132	198	
			1	ss B	OVS		82.4	124	103	155	112	168	112	168	
					SSLT		<b>82.0   123</b>   <b>per inch Th</b>		102   154		123 184		132	198	
	•	В(	eam we			tren tn	per in			ips/i	T				
	Hole Typ	e		S	TD		<u> </u>	0			SSLT				
			ļ				1		L <sub>eh</sub> *, in.						
	<i>L<sub>ev</sub>,</i> in.			1/2		3/4	2 - 1-20 20-	1/2	13/4		11/2			/4	
		- 1 -4 4	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
		11/4	208	312	216	324	195	293	203	305	205	307	213	320	
	oned at Ton	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub>	210 213	316 319	219 221	328 332	197 200	296 300	206 208	308 312	207 -210	311 315	216 218	323 327	
	Soped at Top Flange Only	15/8	215	323	223	335	202	303	210	316	212	318	220	331	
	i lange only	2	223	334	231	346	210	314	218	327	220	329	228	342	
		3	242	363	250	375	229	344	237	356	239	359	247	371	
		11/4	197	296	197°	296	185	278	185	278	197	296	197	296	
		1 <sup>3</sup> /8	202	303	202	303	190	285	190	285	202	303	202	303	
C	oped at Both		207	311	207	311	195	293	195	293	207	311	207	311	
	<b>Flanges</b>	1 <sup>5</sup> /8	212	318	212	318	200	300	200	300	212	318	212	318	
		2	223	334	227	340	210	314	215	322	220	329	227	340	
	Uncoped	3	242 293	363	250	375	229	344	237	356 439	239 293	359	247 293	371	
	Support Avai Strength p Inch Thickn ips/in.	lable er ess,	293   439   293   293   293   293   293   293   293   293   293   293   293   293   293   293   293   293   293											439	
STI OV:	<b>De ASD</b> O/  S/ <b>585</b>	LRFD 878	unde Note: S	rrun in b Slip-critic	eam leng al bolt v	gth.	sume no	on in end more the				-		ave	

Beam	$F_y = 50 \text{ ksi}$	I				10-	-			-			2,		
Be	$F_u = 65 \text{ ksi}$		Al	I-B	olto	ed	Do	ubl	e-A	\nc	ale	,	<sup>3</sup> /4	-in،	
Angle	$F_y = 36 \text{ ksi}$				_	onr							Bol	lts	
An	$F_u = 58 \text{ ksi}$				В	olt and	Angle	Availab	le Stre	ngth, k	ips				
	4 Rows	Boit	The	ead		ole			An	gle Thi	ckness	, in.			
•		Group		eau nd.	1	/pe	1	/4	5,	16	3	/8	1	/2	
W	24, 21, 18, 16	<u> </u>					ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			N X		STD STD		67.1 67.1	101 101	83.9 83.9	126 126	95.5 101	143 151	95.5 120	143 180	
					-	TD	50.6	75.9	50.6	75.9	50.6	75.9		75.9	
		Group	SC Class A		1	VS	43.1	64.5	43.1	64.5	43.1	64.5	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	64.5	
	Varies	Α	Class A			SLT	50.6	75.9	50.6	75.9	50.6		1	•	
	à li		SC			TD	67.1	101	83.9	126	84.4	127	84.4		
B	<u> </u>	l	1	ss B	ı	VS Slt	65.3 65.8	97.9 98.7	71.9 82.2	108 123	71.9 84.4	108 127	71.9 84.4		
<b>.</b>	L <sub>dh</sub>			N		TD	67.1	101	83.9	126	101	151	120	180	
5				X		TD	67.1	101	83.9	126	101	151		201	
30.5	<u> </u>			SC .	1	TD	63,3	94.9	63.3	94.9	63.3	94.9	63,3	1	
Ė		Group	l	ss A	3	VS	53.9	80.7	53.9	80.7	53,9	80.7	53.9	80.7	
		В			-	SLT	63.3 67.1	94.9 101	63.3 83.9	94.9 126	63.3 101	94.9 151	63.3 105	94.9 158	
				C	STD OVS		65.3	97.9	81.6	122	89.9	134	89.9	1	
			Cla	ss B	SSLT		65.8	98.7	1 + 5 m 2 m21		98.7 148		105	158	
		Be	am We	b Avail	lable S	trength	per in	ch Thic	kness,	kips/ii	n.				
	Hole Type			S	TD			0\			SSLT				
÷					·		·	L <sub>eh</sub> *					T		
	<i>L<sub>ev</sub></i> , In.			//2	13/4			/2	13/4		11/2			/4	
		41/	ASD	LRFD		LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
		1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	167 169	250 254	175   177	262 266	156 158	234 238	164 167	246 250	164 166	245 249	172 . 174	257 261	
C	oped at Top	11/2	171	257	180	269	161	241	169	254	168	253	177	265	
	Flange Only	15/8	174	261	182	273	163	245	171	257	171	256	179	268	
		2	181	272	189	284	171	256	179	268	178	267	186	279	
		3	201	301	209	313	190	285	198	297	198	296	206	309	
		11/4	156	234	156	234	146	219	146	219	156	234	156	234	
C.	oped at Both	1 <sup>3</sup> /8 1 <sup>1</sup> /2	161 166	241	161 · 166 ·	241	151	227	151	227	161	241	161 166	241	
U	Flanges	15/8	171	249 256	171	249 256	156 161	234 241	156 161	234 241	166 171	249 256	171	249 256	
		2	181	272	185	278	171	256	176	263	178	267	185	278	
		3	201	301	209	313	190	285	198	297	198	296	206	309	
	Uncoped		234.	351	234	351	234	351	234	351	234	351	234	351	
	Support Available Strength per Inch Thickness kips/in.		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												
Hol Typ STI OVS SSI	<b>ne ASU '</b> D/ S/ <b>468</b>	.RFD 702	* Tabulated values include 1/4-in. reduction in end distance, L <sub>ah</sub> , to account for possible underrun in beam length.  Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.								ave				

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Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$	1	All		olt	10- e <b>d</b>	Do	ubl	e-A	-	jle	,	<sup>3</sup> /4	-in.
Angle	$F_y = 36 \text{ ksi}$	ı			C	onr	ec	tio	ns				Bol	ts
A	$F_u = 58$ ksi				В	olt and	Angle A	Availab	le Stre	ngth, k	ips			
	3 Rows	Bolt	The	ead	Н	ole			An	gle Thi	ckness	, in.		
	, 16, 14, 12, 10 <sup>+</sup> . to W10x12, 15, 17,	Group	''-	nd.	1	/pe	1	/4	5/	16	3/8		1,	/2
	19, 22, 26, 30						ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			!	N	1	TD TD	50.9	76.4	63.7	95.5 95.5	71.6	107	71.6	1
				X		TD	50.9 38.0	76.4 57.0	63.7	95.5 57.0	76.4	115 57.0	90.2	135 57.0
		Group	1	C	1	VS	32.4	48.4	32.4	48.4	32.4	48.4	32.4	48.4
Va	wine (	A	Cla	ss A	SSLT		38.0	57.0	38.0	57.0	38.0	57.0	38.0	57.0
	]] <del> </del>    +			·c	STD		50.9	76.4	63.3	94.9	63.3	94.9	63.3	94.9
•	31		1	SC Class B		VS	47.9	71.8	53.9	80.7	53.9	80.7	53.9	80.7
	Las man					SLT	49.6	74.4	62.0	92.9	63.3	94.9	63.3	94.9
3			•	N	1	TD	50.9	76.4	63.7	95.5	76,4	115	90.2	1
3	# -			X	-	TD TD	50.9 47.5	76.4 71.2	63.7- 47.5	95.5 71.2	-76.4 47.5	115 71.2	102 47.5	153 71.2
3	<del>*</del>	Group	S	SC		STD OVS		60.5	40.4	60.5	40.4	60.5	40.4	60.5
7		В	Cla	Class A		OVS SSLT		71.2	47.5	71.2	47.5	71.2	1 10 10 10 10	71.2
			_		STD		47.5 50.9	76.4	63.7	95.5	76.4	115	79.1	
			l	C P	ovs		47.9	71.8	59.8	89.7	67.4	101	67.4	1
			Clas	ss B	SSLT		49.6 74.4 62.			92.9	74.4	112	79.1	119
		Be	am We	b Avail				per Inch Thickness, kips/in.						
	Hele Time		STD OVS SSLT										LT	
	Hole Type		<i>L<sub>eh</sub>*</i> , In.								JOLI			
	, in		11	11/2 13/4 11/2 13/4 11/2							//2	13	/4	
	<i>L<sub>ev</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	'ASD'	LRFD	ASD	LRFD
		11/4	125	188	133	200	117	176	125	188	122	183	130	195
		1 <sup>3</sup> /8	128	191	136	204	119	179	128	191	125	187	133	199
	oped at Top	11/2	130	195	138	207	-122	183	130	195	127	190	135	203
I	Flange Only	1 <sup>5</sup> /8	132	199	1410	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
		11/4	115	172	115	172	107	161	107	161	115	172	115	172
C.	oped at Both	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub>	119 124	179 186	119 124	179 186	112 117	168 176	112 117	168 176	119 124	179 186	119 124	179 186
U	Flanges	15/8	129	194	129	194	122	183	122	183	129	194	129	194
		2	140	210	129   144	216	132	197	137	205	137	205	144	216
	•	3	159	239	167	251	151	227	159	239	156	234	164	246
	Uncoped		176 263 176 263 176 263 176 263 176 263 263 263 263 263 263 263 263 263 26											
	Support Availab Strength per Inch Thickness kips/in.		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											
Hol Typ STD OVS	<b>ASU</b> 100 100 100 100 100 100 100 100 100 10	LRFD 526	under Note: S	run in b	eam leng al bolt v	alues as	sume no	more th				-		ave

Angle Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$		AI		olt	ed	1 (c Do	ubl	le-/	-	gle	,	3/4 Bo	-in. Its
Ā	$F_u = 58 \text{ ksi}$				В	olt and	Angle	Availat	le Stre	ngth, k	ips			
	2 Rows	İ	Ι		Ι				An	gle Thi	ckness	, in.		
<u> </u>	2 110113	Bolt Group		read Ind.	j .	ole	1	/4	5	/16	3	/8	1	/2
	W12, 10, 8	arvup	Ι ω	iiu.	ני	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			1	N	S	TD	32.6	48.9	40.8	61.2	47.7	71.6	47.7	71.6
				X	S	TD	32.6	48.9	40.8	61.2	48.9	73.4	60.1	90.2
			,	SC	1	TD	25.3	38.0	25.3	38.0	25.3	38.0	25.3	38.0
		Group	1	iss A		VS	21.6	32.3	21.6	32.3	21.6	32.3	21.6	32.3
, v	aries 1	A				SLT	25.3	38.0	25.3	38.0	25.3	38.0	25.3	38.0
	31 1		9	SC	STD OVS		32.6 30.5	48.9	40.8	61.2 53.8	42.2	63.3	42.2	63.3
<u> </u>	-31		· Cla	ss B			32.6	45.7 48.9	36.0 40.8	61.2	36.0 42.2	53.8 63.3	36.0. 42.2	53.8 63.3
	Lah man.			N	SSLT STD		32.6	48.9	40.8	61.2	48.9	73.4	60.1	90.2
5			1	X	STD		32.6	48.9	40.8	61.2	48.9	73.4	65.3	97.9
3	<b>I</b>					STD		47.5	31.6	47.5	31.6	47.5	31.6	47.5
-51	1	Group		SC Clase A		ovs		40.3	27.0	40.3	27.0	40.3	27.0	40.3
		В	Cla	Class A		SSLT		47.5	31.6	47.5	31.6	47.5	31.6	47.5
				6C	STD		32.6	48.9	40.8	61.2	48.9	73.4	52.7	79.1
				ss B	OVS		30.5	45.7	38.1	57.1	44.9	67.2	44.9	67.2
					•	SLT	32.6 48.9 40.8 61.2 4					73.4	52.7	79.1
	•	Ве	am We	b Avall	able Strength per Inch T				kness,	kips/i				
	Hole Type			S	TD			0	VS			SS	LT	
	noie Type					L <sub>e</sub>			L <sub>eh</sub> *, in.					
	1 1-		1	1/2	1 <sup>3</sup> /4		11/2		13/4		11/2		13/4	
	<i>L<sub>er</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD.	LRFD	ASD.	LRFD	ASD	LRFD	ASD	LRFD
	· · · · · · · · · · · · · · · · · · ·	11/4	83.7	126	91.4	137	78.0	117	86.1	129	80.6	121	88.8	133
		1 <sup>3</sup> /8	86.1	129	94.3	141	80.4	121	88.6	133	83,1	125	91.2	137
C	oped at Top	11/2	88.6	133	96.7	145	82.9	124	91.0	137	85.5	128	93.6	140
1	Flange Only	1 <sup>5</sup> /8	91.0		≥99.1	149	85.3	128	93.4	140	88.0	132	96.1	144
		2	98.3	1	106	160	92.6	139	101	151	95.3		103	155
		3	116	175	117	176	112 🕏	168	117	176	113	170	117	176
		1 <sup>1</sup> / <sub>4</sub>	73.1	110	73.1	110	68.3	102	68.3	102	73.1		73.1	110
c	oped at Both	1 <sup>3</sup> /8 1 <sup>1</sup> / <sub>2</sub>	78.0 82.9	117 124	78.0 82.9	117	73.1	110	73.1	110	78.0	117	78.0 82.9	117
:	Flanges	15/8	87.8		87.8	124	78.0	117	78.0	117	82.9	124	-	124
	lunges	2	98.3	132 147	102	132 154	82.9 92.6	124 139	82.9 97.5	124 146	87.8 95.3	132 143	\$7.8 102	132 154
:	:	3	90.3 116	175	117	176	112	168	97.5 117	176	ະສວ.ລ 113	170	117	176
:	Uncoped		117:	176	117	176	117	176	117	176	117	176	117	176
:	Support Available Strength per Inch Thickness kips/in.		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											
STE OVS SSE	oe   <b>ASU</b>   1 0/ 5/ <b>234</b>	.RFD 351	* Tabulated values include <sup>1</sup> / <sub>4</sub> -in. reduction in end distance, L <sub>eh</sub> , to account for possible underrun in beam length.  Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.										ave	

$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		Al		olt	ed	Do	onti ubl	e-A	-	jle	•	7/8 Bol	-in. Its
$ \vec{\xi} F_u = 58 \text{ ksi}$				<u> </u>									
<b>         </b>	<u> </u>	1		В	olt and	Angle	Availab		•		· In		
12 Rows	Bolt	Thi	read	H	ole	<u> </u>			gle Thic		-	1 1	,
W44	Group	Co	nd.	(ד	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	/2 LRFD
Varies /	<u> </u>		N	S	TD	196	294	245	367	294	441	389	584
		1	X	STD		196	294	245	367	294	441	392	587
		ç	SC	STD		196	294	212	317	212	317	212	317
	Group		ss A	OVS SSLT		180	270	180	270	180	270	180	270
1183 - 33	A					194 196	292	212 245	317 367	212 294	317 441	212 353	317 529
		5	SC		STD		287	239	359	287	431	300	450
		Cla	ss B	OVS SSLT		191 194	292	243	365	292	438	353	529
			N		TD	196	294	245	367	294	441	392	587
1			Χ	STD		196	294	245	367	294	441	392	587
_     •		9	SC		STD		294	245	367	266	399	266	399
\ \ \	Group		Class A		ovs		287	227	339	227	339	227	339
	В		1		SLT	194	292	243	365	266	399	266	399
		S	SC	STD OVS		196   191	294 287	245 239	367 359	294 287	441 431	392 378	587 565
<b>3</b> = 3 = 3 = 3 = 3 = 3 = 3 = 3 = 3 = 3 =		Cla	ss B	SSLT		194	292	243	365	292	438	_389 .	583
	Be	am We	b Avail	•			•					1,2,00	
		am Web Available Strength per Inch Thickness, kips/in.  STD								SS	SLT		
Hole Type				<u>.                                    </u>	1			L <sub>eh</sub> *, in.					
		1	1/2	13/4		11/2		13/4		11/2		13	1/4
<i>L<sub>ev</sub>,</i> in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	11/4	468	702	476	714	438	657	446	669	465	697	473	710
	1 <sup>3</sup> /8	470	706	479	718	440	661	449	673	467	701	476	713
<b>Coped at Top</b>	11/2	473	709	481	722	443	664	451	676	470	705	478	717
Flange Only	1 <sup>5</sup> /8	475	713	483	725	445	668	453	680	472	708	480	721
	2	483	724	491	736	453	679	461	691	480	719	488	732
	3	502	753	510	765	472	708	480	720	499	749	507	761
	1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	458 463	687 695	458 463	687	429 434	644	429 434	644 651	458 463	687 695	458 463	687 695
Coped at Both	11/2	468	702	468	695 702	439	651 658	439	658	468	702	468	702
Flanges	15/8	473	709	473	709	444	665	444	665	472	708	473	709
3 Jan <b>3</b> G	2	483	724	488	731	453	679	458	687	480	719	488	731
	3	502	753	510	765	472	708	480	720	499	749	507	761
Uncoped		819	1230	819	1230	819	1230	819	1230	819	1230	819	1230
Support Availab Strength per Inch Thickness kips/in.		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											
STD/	.RFD 2460	underrun in beam length.  Note: Slin-critical holt values assume no more than one filler has been provided or holts have											

DESIGN TABLES 10-25

Angle Beam	$F_y = 50 \text{ ks}$ $F_u = 65 \text{ ks}$ $F_y = 36 \text{ ks}$	i   i	AI		olt	ed	Do	onti ubl	e-/	d) <b>An</b> g	jle	•	7/8 Bol	-in. Its
Ā	$F_u = 58 \text{ ks}$	1			В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	11 Rows	İ	Γ_		Ι	_	T		An	gle Thi	ckness	in.		
	II UOM2	Bolt	1	read	1	ole	1	/4		/16	T	<u>.</u> Ив	1	<u></u>
ĺ	W44, 40	Group	G	nd.	1,7	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	Mari sa	1		N	S	TD	180	269	225	337	269	404	357	535
	Varius .		L	X	S	TD	180	269	225	337	269	404	359	539
				SC		TD	180	269	194	291	194	291	194	291
	8	Group	1	iss A		VS	165	247	165	247	165	247	165	247
	8.89	A				SLT	178	267	194	291	194	291	194	291
			5	SC		TD	180	269	225	337	269	404	323	485
l [I	₩.			ss B	1	VS	175	263	219	328	263	394	275	412
		ļ				SLT	178	267	-223	334	267	401	323	485
-	<u></u>	1		N X	STD STD		180 180	269 269	225 225	337 337	269 269	404	359 359	539
			<u> </u>	^			180	269	225	337	244	404 365	244	539 365
B		Group	ı	SC	STD OVS		175	263	208	311	208	311	208	311
06 = 30	<b>!</b>	В	Cla	Class A		SSLT		267	223	334	244	365	244	365
			SC			TD	178 180	269	225	337	269	404	359	539
3	<u> </u>		3		OVS		175	263	219	328	263	394	346	518
7:	ſ		Cia	ss B	SSLT		178	267	223	334	267	401	357	535
		Be	am We	b Avail	lable S	trength	per Inch Thickness, k			kips/ir	1.			
											SS	SLT		
	Hole Type						L <sub>eh</sub> *		*, in.					
	/ in		1	1/2	13/4		1	<sup>1</sup> /2	13/4		1	1/2	13	/4
	<i>L<sub>ev</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		11/4	429	644	437	656	401	602	410	614	426	639	434	651
		13/8	431	647	440	659	404	606	412	618	428	643	437	655
C	oped at Top	11/2	434	651	442	663	406	609	414	622	431	646	439	658
1	Flange Only	1 <sup>5</sup> /8	436	654	444	667	409	613	417	625	433	650	441	662
		2	444	665	452	678	416	624	424	636	441	661	449	673
		3	463	695	471	707	436	653	444	665	460	690	468	702
		11/4	419	629	419	629	392	589	392	589	419	629	419	629
•	d -4 D-46	13/8	424	636	424	636	397	596	397	596	424	636	424	636
G	oped at Both	11/2	429	644	429	644	402	603	402	603	429	644	429	644
	<b>Flanges</b>	15/8	434	651	434	651	407	611	407	611	433	650	434	651
		2	444 463	665 695	449	673	416	624	422 444	633 665	441 460	661 690	449	673
	Uncoped	3	751	1130	471 751	707 1130	436 751	653 1130	751	1130	751	1130	468 751	702 1130
Hol	Support Availat Strength per Inch Thickness kips/in.	5,	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								1100			
Typ STI OVS SSI	oe ASU 0/ 5/ 1500	underrun in beam length.  Note: Slin-critical bolt values assume no more than one filler has been provided or bolts have										ave		

Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$
ıgle	$F_y = 36 \text{ ksi}$

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

7/8-in. Bolts

**SSLT** 

$ F_u  = 58 \text{ ks}$			Bolt and	Angle .	Availab	le Stre	ngth, k	ips			
10 Rows	Bolt	Throad	Holo			An	gle Thic	kness	, In.		
	Group	Thread Cond.	Hole Type	1	/4	5,	16	3	/8	1	/2
W44, 40, 36	a.oup	oona.	, iypc	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	163	245	204	306	245	368	325	487
Varios /	] ]	X	STD	163	245	204	306	245	368	327	490
( <del>4.)</del> (( <del>4.)</del>		00	STD	163	245	176	264	-176	264	176	264
	Group	SC Class A	ovs	150	225	150	225	150	225	150	225
## ## ## ## ## ## ## ## ## ## ## ## ##	A	Class A	SSLT	162	243	176	264	176	264	176	264
	А	00	STD	163	245	204	306	245	368	294	441
		SC Class R	ovs	159	238	198	298	238	357	250	375
113		Class B	SSLT	162	243	203	304	243	365	294	441
		N	STD	163	245	204	306	245	368	327	490
-		X	STD	163*	245	204	306	245	368	327	490
			STD	163	245	204	306	221	332	221	332
//- CB6	Group	SC Oleve A	ovs	159	238	189	282	189	282	189	282
<b>9</b>	В	Class A	SSLT	162	243	203	304	221	332	221	332
1		00	STD	163	245	204	306	245-	368	327	490
		SC Oleve P	ovs	159	238	198	298	238	357	315	471
		Class B	SSLT	162	243	203	304	243	365	324	486

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

OVS

STD

Hole Type			5	עו			U	VS		ļ	55	LI	
Hole Type							L <sub>eh</sub> '	', in.					
<i>L<sub>ev</sub></i> , in.		1	1/2	1	3/4	1	1/2	1	3/4	1	1/2	1	3/4
Lev, III.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	111/4	390	585	398	597	∜365	547	373	559	387	580	395	593
	1 <sup>3</sup> /8	392	589	401	601	367	551	375	563	389	584	398	596
Coped at Top	11/2	395	592	403	605	370	555	378	567	392	588	400	600
Flange Only	15/8	397	596	405	608	372	558	380	570	394	591	402	604
	2	405	607	413	619	379	569	388	581	402	602	410	615
	3_	424	636	432	648	399	598	407	611	421	632	429	644
	11/4	<b>380</b> ⋅	570	380	570	356	534	356	534	380	570	380	570
	1 <sup>3</sup> /8	385	578	385	578	361	541	361	541	385	578	385	578
Coped at Both	11/2	390	585	390	585	366	548	366	548	390	585	390	585
<b>Flanges</b>	1 <sup>5</sup> /8	395	592	<b>395</b>	592	371	556	371	556	394	591	395	592
	2	405	607	410	614	379	569	385	578	402	602	410	614
	3	424	636	432	648	399	598	407	611	·421	632	429	644
Uncoped			1020	683	1020	683	1020	683	1020	683	1020	683	1020

Support Available
Strength per
Inch Thickness,
kips/in.

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

Hole Type ASD LRFD

STD/
OVS/
SSLT 2050

\* Tabulated values include 1/4-in. reduction in end distance, Leh, to account for possible underrun in beam length.

Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.

DESIGN TABLES 10-27

eg F <sub>u</sub> :	= 50 ksi = 65 ksi = 36 ksi		Al		olte	be	1 (c Do nec	ubl	e-A	-	jle		7/8 Bol	-in. ts
<del> </del>   Fu =	= 58 ksi				Вс	lt and	Angle A	Availab	le Stre	ngth, k	ips			
Q R	lows	0-14			l	- • -	I		Ang	gle Thi	ckness	, in.		
		Bolt Group	1	ead nd.	1	ole pe	1	/4	5/	16	3	/8	1,	/2
W44, 40	0, 36, 33	aivap	00	ııu.	, יי	he	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
				N	1	TD	147	221	√184	276	221	331	292	438
Varies	<u></u>			<u>X</u>		TD	147	221	184	276	221	331	294	442
<b>—</b>	<del></del>		8	C	1	TD	147	221	159	238	159	238	159 ·	238
		Group	Cla	ss A	1	VS	135 146	202 219	135 159	202 238	135 159	202 238	135	202 238
	N = 120	Α	<b></b>			<u>slt</u> TD	147	221	184	276	221	331	159 264	397
<b>             </b>	*		8	C		VS	142	214	178	267	214	321	225	337
<u> </u>	1 2		Cla	ss B	1	SLT	146	219	182	273	219	328	264	397
4 77	mer.			N		TD	≟147⊚	221	184	276	221	331	294	442
1				X		TD	147	221	184	276	221	331	294	442
				 iC	S	<b>T</b> D	147	221	184	276	199	299	199	299
22 - NB8		Group	1		OVS		142 146	214	170	254	170	254	170	254
8		В	Ula	Class A		SSLT		219	182	273	199	299	199	299
3			S	C	STD		1,47	221	184	276	221	331	294	442
			1	ss B		VS	142	214	178	267	214	321	283	424
			L		<u> </u>	LT	146	219	182	273	219	328	292	438
		Re	am we	D AVAII	able St	rengtn	per inc			ness, kips/in.				
н	lole Type			S	<u>rd</u>		<u> </u>	01			SS		LT	
					I		<del>,</del>	L <sub>eh</sub> *						
	L <sub>ev</sub> , in.			//2		1 <sup>3</sup> / <sub>4</sub>		/2	13		CONTROL OF THE	/2		/4
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		11/4	351	527	359	539	328	492	336	505	348	522	356	534
١.,		1 <sup>3</sup> /8	353	530	362	542	331	496	339	508	350	526	359	538
I	at Top	11/2	356	534	364	546	333	500	341	512	353	529	361	541
Flange	e Only	1 <sup>5</sup> /8	358	537	366	550	336	503	344	516	355	533	363	545
		2	366 385	548 578	374 393	561 590	343 362	514 544	351 371.⁴	527 556	363 382	544 573	371 390	556 585
		1 <sup>1</sup> /4	341	512	341	512	319	479	319	479	341	512	341	512
		1 <sup>3</sup> /8	346	512	346	512	324	486	324	486	346	512	346	512
Coped	at Both	11/2	351	527	351	527	329	494	329	494	351	527	351	527
	nges	1 <sup>5</sup> /8	356	534	356	534	334	501	334	501	355	533	356	534
	-	2	366	548	371	556	343	514	349	523	363	544	371	556
		3	385	578	393	590	362	544	371	556	382	573	390	585
U	<b>Jncoped</b>		614	921	-614	921	614	921	614	921	614	921	614	921
Str Inch	ort Available rength per Thickness, kips/in.		0VS =	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										
Hole Type STD/ OVS/ SSLT	1000 p kij (100 	<ul> <li>* Tabulated values include ¹/₄-in. reduction in end distance, Leh, to account for possible underrun in beam length.</li> <li>Note: Slip-critical bolt values assume no more than one filler has been provided or bolt been added to distribute loads in the fillers.</li> </ul>											ave	

Angle Beam	F <sub>u</sub> =	50 ksi 65 ksi 36 ksi		AI		olt	10- ed onr	Do	ubl	e-A	-	jle	•	7/8 Bol	;-in. Its
A	$F_{u} =$	58 ksi		····	·	R	olt and	Angle	Availah	la Stra	nath k	inc			
$\vdash$			<u> </u>	ł			oit ailu	Allyle	Availan		gle Thic	•	in :		
<u> </u>	8 Ro	WS	Bolt		read	1	ole	1	/4		/ <sub>16</sub>		)/8	<u> </u>	/2
W4	4, 40, 3	6, 33, 30	Group	Co	nd.	T)	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
				1	N		TD	131%	197	164	246	197	295	260	389
	/aries	,			X		TD TD	131	197 197	164 141	246 212	197 141	295 212	262 141	393 212
			Group	8	SC	1	VS	120	180	120	180	120	180	120	180
		<b>†    ‡</b>	A	Cla	ss A		SLT	130	194	141	212	141	212	141	212
	763-21				SC		TD	131	197	164	246	197	295	235	353
		<u>                                     </u>		I .	ss B	OVS		126	189	158	237	189	284	200	300
	Lah	-11-3		<u> </u>		SSLT		130	194	162	243	194	292	235	353
3				ı	N	STD STD		131	197	164	246	197	295	262	393
	Ī				X	STD		131   131	197 197	164 164	246 246	197 177	295 266	262 177	393 266
763-21	•	ļ	Group	1	SC .	OVS		126	189	151	226	151	226	151	226
1 1	1		В	Cla	ss A		SSLT		194	162	243	177	266	177	266
1	<u> </u>				SC	STD		131	197	164	246	197	295	262	393
				1	ss B	OVS		126	189	ុ158	237	189	284	252	377
						SSLT		130	194	162	243	194   292		259	389
·			Be	am We			trength	per In	ch Thic	kness,	kips/ir	٦.			
	Но	le Type			S	TD			<u> </u>			SS		LT	
				41	1/2	13/4		11/2		13/4		11/2		13/4	
	L	<sub>ev</sub> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			11/4	312	468	320	480	292	438	300	450	309	463	317	476
			13/8	314	472	323	484	294	441	302	453	- 311	467	320	479
C	oped a	t Top	11/2	317	475	325	488	297	445	305	457	314	471	322	483
1	Flange	Only	1 <sup>5</sup> /8	319	479	327	491	299	449	307	461	316	474	324	487
			2	327	490	335	502	306	459	314	472	324	485	332	498
			3	346	519	354	531	326	489	334	501	343	515	351	527
			11/4	302	453	302	453	283	424	283	424	302	453	302	453
C	oped at	t Roth	1 <sup>3</sup> /8 1 <sup>1</sup> /2	307 312	461 468	307 312	461 468	288 293	431 439	288 293	431 439	307 312	461 468	307 312	461 468
"	<b>Flang</b>		1 <sup>5</sup> /8	317	475	317	475	297	446	297	446	316	474	317	475
			2	327	490	332	497	306	459	237	468	324	485	332	497
			3	346	519	354	531	326	489	334	501	343	515	351	527
	Un	coped		546	819	546	819	546	819	546	819	546	819	546	819
	Stre Inch T ki	rt Available ngth per l'hickness, ps/in.		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											
Hol Typ Sti Ovs SSi	)/ S/		RFD 1640	under Note: S	Tun in b lip-critic	eam leng al bolt v	gth.	sume no	more tha				nt for pos ovided or		ave

DESIGN TABLES 10–29

Angle Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		Al		olt	ed	1 (c Do iec	ubl	e-A	•	jle	•	7/8 Bol	;-in. Its
4	<i>Fu</i> = 30 K31				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	7 Rows		-		١	_ • -			An	gle Thi	ckness	, in.		
W44	1, 40, 36, 33, 30,	Bolt		read	1	ole	1	/4	5,	/16	3	/8	1	/2
	27, 24	Group	60	ond.	ני	/pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
l		<b> </b>	<del> </del>	N	S	TD	115	172	144	215	172	258	227	341
		<b>J</b>		X	S	TD	115	172	144	215	172	258	230	344
ļ	farios t			SC	S	TD	115	172	123	185	123	185	123	185
		Group	ı	iss A		VS	105	157	105	157	105	157	105	157
		Α	Ula ————————————————————————————————————	199 H	SSLT		113	170	123	185	123	185	123	185
	83 = C&B		وا	SC	STD		115	172	144	215	172	258	206	308
Į			1	ss B	1	VS	110	165	137	206	165	247	175	262
	L <sub>ph</sub>	<b></b>				SLT	113	170	142	213	170	255	206	308
1			1	N X	1	TD	115	172	144	215	172	258	230	344
91	T I			^		TD TD	115 115	172 172	144 144	215 215	172 155	258 233	230 155	233
863 = 16		Group	SC		3		110	165	132	198	132	198	132	198
-		В	Cla	ss A	OVS SSLT		113	170	142	213	155	233	155	233
3		"	20			TD	115	172	144	215	172	258	230	344
			1	SC _	ovs		110	165	137	206	165	247	220	329
			Cla	ss B	1	SLT	113 170 142 213					255	227	340
		Be	am We	b Avail	able S	trength	per Inc	ch Thic	kness,	kips/ir	1.	1,		
	Hala Tima			S	TD .			01	/S	1			LT	
	Hole Type		ĺ		<u>I</u>				, in.					
:			1	1/2	13/4		11	/2	13	/4	11/2		13	/4
	<i>L<sub>ev</sub></i> , in.		ASD LRFD		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Ť		11/4	273	410	281	422	255	383	263	395	270	405	278	417
÷		13/8	275	413	284	425	258	386	266	399	272	409	281	421
C	oped at Top	11/2	278	417	286	429	260	390	268	402	275	412	283	424
- { 1	Flange Only	1 <sup>5</sup> /8	280	420	288	433	262	394	271	406	277	416	285	428
		2	288	431	296	444	270	405	278	417	285	427	293	439
:		3	307	461	315	473	289	434	297	446	304	456	312	468
		11/4	263	395	263	395	246	369	246	369	263	395	263	395
_		1 <sup>3</sup> /8	268	402	268	402	251	377	251	377	268	402	268	402
C	oped at Both	11/2	273	410	273	410	256	384	256	384	273	410	273	410
	<b>Flanges</b>	15/8	278	417	278	417	261	391	261	391	277	416	278	417
		2	288	431	293	439	270	405	275	413	285	427	293	439
	Uncoped	3	307	461	315	473	289	434	297	446	304	456	312	468
	•		478	717	478	717	478	717	478	717	478	717	478	717
	Support Availab Strength per Inch Thickness kips/in.		0VS =	Standar Oversize Short-sl to direc	ed holes	les trans	sverse	;	X = Th	reads inc reads exc o critical				
Hol Typ STI OVS SSI	9e   ASU   1 0/ 5/ 958	LRFD 1430	under Note: S	run in b lip-critic	eam lenç al bolt va	gth. alues as:		more th				nt for pos		ave

$F_y = 50$ $F_u = 65$ $F_y = 36$	ksi		Table 10-1 (continued) All-Bolted Double-Angle Connections												
$\begin{array}{c c} \text{Pull} & F_y = 36 \\ F_u = 58 \end{array}$	- 1		Bolt and Angle Available Strength, kips												
<u> </u>	ИЭІ				В	olt and	Angle	Availab			•				
6 Rows		Bolt	Thread		Н	Hole			, <b>in.</b>						
W40, 36, 33, 30,	, 27,	Group	Cond.			Туре		/4	ļ	16	3/8		<del> </del>	/2	
24, 21							ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			1	N	1	TD	98.6	148	123	185	148	222	195	292	
				Х		TD TD	98.6 98.6	148	123 106	185 159	148 106	159	197 106	296 159	
Varies 1	. [	Group	1	SC	1	VS	90.1	135	90.1	135	90.1	135	90.1	135	
		А	Class A			SSLT		146	106	159	106	159	106	159	
51 = (\$\theta_0^2) = 15		••				TD	97.3 98.6	148	123	185	148	222	176	264	
\$			SC Class B			VS	93.5	140	117	175	140	210	150	225	
	.9		Ula	SS B	SSLT		97.3	146	122	182	146	219	176	264	
31 - 1255				N	1	TD	98.6	148	123	185	148	222	197	296	
			X		STD		98.6	148	123	185	148	222	197	296	
		_	SC Class A		STD OVS SSLT		98.6	148	123	185	133	199	133	199	
		Group B					93.5	1	113	169	113	169	113	169	
<b>.</b>		В				TD	97.3 98.6	146 148	122 123	182 185	133 148	199 222	133 197	199 296	
			S	C	1	VS	93.5	140	117	175	140	210	187	281	
		Cla	ss B	1	SLT	97.3	146	122	182	146	219	195	292		
	<u> </u>	Re	am We	h Avail	•	trength	•	•				1 2.0	100,55	1 202	
						u ongui				мроги	I .		17		
Hole Ty <sub>l</sub>	pe			3	TD				VS			SS	LI		
							<i>L<sub>eh</sub>*</i> , in.						421		
<i>L<sub>ev</sub></i> , in				//2		13/4		11/2		13/4		1/2	13/4		
		-111	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
		11/4	234	351	242	363	219	328	227	340	231	346	239	359	
Consider Ton	.	1 <sup>3</sup> /8 1 <sup>1</sup> /2	236 239	355 358	245 247	367 371	221 223	332 335	229 232	344 347	233 236	350 354	242 244	362 366	
Coped at Top Flange Only	-	15/8	241	362	249	374	226	339	234	351	238		246		
r lange only		2	249	373	257	385	233	350	234. 241	362	246	357 368	254	370 381	
		3	268	402	276	414	253	379	261	391	265	398	273	410	
		11/4	224	336	224	336	210	314	210	314	224	336	224	336	
		13/8	229	344	229	344	215	322	215	322	229	344	229	344	
Coped at Both	h	1 <sup>1</sup> / <sub>2</sub>	234	351	234	351	219	329	219	329	234	351	234	351	
Flanges	Γ	1 <sup>5</sup> /8	239	358	239	358	224	336	224	336	238	357	239	358	
	1	2	249	373	254	380	233	350	239	358	246	368	254	380	
		3	268	402	276	414	253	379	261	391	265	398	273	410	
Uncope	:d		410	614	410	614	410	614	410	614	410	614	410	614	
Support Ava Strength Inch Thicki kips/in	per ness,		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												
Hole ACD	.H	RFD	_	Tabulated values include $^{1}$ /4-in. reduction in end distance, $L_{ah}$ , to account for possible underrun in beam length. Note: Slip-critical bolt values assume no more than one filler has been provided or bolt poeen added to distribute loads in the fillers.											

Beam	_	50 ks		Al			10- ed	-			-	ale	•	<sup>7</sup> /8	j-in.		
Angle	•	36 ks	i				onr							Bo			
A	$F_{u} =$	58 ks	\$ <b>i</b>			В	olt and	Angle	Availab	le Stre	ngth, k	ips		<del></del>			
<u> </u>	5 Ro	ws	Dall	Th				Angle Thickness, in.									
			Bolt Group	1	Thread Cond.		Hole Type		/4	5/16		3/8		1	/2		
W3(	0, 27, 2	4, 21, 18	3	<u> </u>				ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
				1	N	1	TD	82.4	124	103	155	124	185	162	243		
				X SC		•	STD STD	82.4 82.4	124	103 88.1	155 132	124 88.1	185	165 88.1	132		
ļ,	/aries		Group			1	IVS	75.1	112	75.1	112	75.1	112	75.1	112		
		A	Class A			SLT	81.1	122	88.1	132	88.1	132	88.1	132			
2 - 292					SC		TD	82.4	124	103	155	124	185	147	220		
				1	ss B	OVS		77.2	116	96.5	145	116	174	125	187		
- 1-3 - 1-4		<u> </u>				SLT	81.1	122	101:	152	122	182	147	220			
3			1	N X	•	TD TD	82.4 82.4	124 124	103 103	155 155	124 124	185 185	165 165	247 247			
2:89						TD	82.4	124	103	155	111	166	111	166			
1			Group	SC Class A		OVS		77.2	116	94.4	141	94.4	141	94,4	141		
7	ļ		В	Ula	UldSS A		SLT	81.1	122	101	152	111	166	111	166		
:				9	C		TD	82.4	124	103	155	124	185	165	247		
	<u> </u>			1	ss B		VS	77.2	116	96.5	145	116	174	154	232		
	<u>;                                    </u>		<u> </u>	11/2	h Aresi	•	SLT	81.1	122	101	152	122	182	162	243		
·	<u> </u>		Dt	anı we	am Web Available Strength per Inch Thickness, kips/in.  STD OVS SSLT												
	Hol	le Type			3	טו				', in.			33	LI			
				11/2 13/4			11/2 13/4				1	1/2	13/4				
	L	<sub>ev</sub> , in.		ASD LRFD		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
			11/4	195	293	203	305	182	273	190	285	192	288	200	300		
			13/8	197	296	206	308	184	277	193	289	194	292	203	304		
	oped a	•	11/2	200	300	208	312	187;	280	195	293	197	295	205	307		
	Flange	Uniy	15/8	202	303	210	316	189	284	197	296	199	299	207	311		
			2 3	210 229	314 344	218 237	327 356	197 216	295 324	205 224	307 336	207 226	310 339	215 234	322 351		
			11/4	185	278	185	278	173	260	173	260	185	278	185	278		
			13/8	190	285	190.	285	178	267	178	267	190	285	190	285		
C	oped at	Both	11/2	195	293	195*	293	183	274	183	274	195	293	195	293		
	Flang	es	1 <sup>5</sup> /8	200	300	-200	300	188	282	188	282	199	299	200	300		
			2	210	314	215	322	197	295	202	303	207	310	215	322		
		20204	3	229	344	237	356	216	324	224	336	226	339	234	351		
		coped	bla.	341	512	341	512	341	512	341	512	341	512	341	512		
i	Strei Inch T	t Availa ngth pei hicknes ps/in.	•	0VS =	Short-s	ed holes	oles trans	N = Threads included X = Threads excluded sverse SC = Slip critical									
Hol Typ Sti OVS SSI	ne '	ASD 683	LRFD 1020	Underrun in beam length.  Note: Slip-critical bolt values assume no more than one filler has been provided or bolt											ave		

gle	$F_u = \frac{F_u}{F_y} = \frac{F_u}{F_y}$	50 ksi 65 ksi 36 ksi		Table 10-1 (continued)  All-Bolted Double-Angle  Connections  Bolt and Angle Available Strength, kips													
A	$F_u =$	58 ksi	ļ	<del>-</del>	-	В	olt and	Angle	Availab	le Stre	ngth, k	ips	<b>,,,,,</b>				
	4 Rov	ws.	D-M			١	-1-	Angle Thickness, in.									
<del> </del>			Bolt Group	i i	Thread Cond.		Hole Type		1/4		5/16		3/8		/2		
W	24, 21,	18, 16	агоар	00	iiu.		, pc	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
				1	N	1	TD	65.3	97.9	81.6	122	97,9	147	130	195		
				ļ	X		TD_	65.3	97.9	81.6	122	97.9	147	131	196		
			Croup	5	SC .		TD VS	65.3 60.1	97.9 89.9	70.5 60.1	106 89.9	70.5 60.1	106 89.9	70.5 60.1	106 89.9		
×	arios	t	Group A	Cla	Class A		SLT	64.9	97.3	70.5	106	70.5	106	70.5	ı		
	<del>}  </del>	<del>-  •</del>					TD	65.3	97.9	81.6	122	97.9	147	118	176		
	3	<b> </b> [i]			SC Class B		VS	60.9	91.4	76.1	114	91.4	137	100.	150		
	1 2					SSLT		64.9	97.3	81.1	122	97.3	146	118	176		
4				I	N	1	TD	65.3	97.9	81.6	122	97.9	147	131	196		
30.50%		Group B	Х			TD	65.3	97.9	81.6	122	97.9	147	131	196			
			SC Class A SC		STD OVS SSLT		65.3 60.9	97.9 91.4	81.6 75.5	122 113	88.6 75.5	133 113	88.6 75.5	r e			
							64.9	97.3	73.3 81.1∠	122	88.6	133	-88.6 -				
						TD	65.3	97.9	81.6	122	97.9	147	131	196			
				i			VS	60.9	91.4	76.1	114	91.4	137	122 ,	183		
			Clas	ss B	SS	SLT	64.9	97.3	81.1	122	97.3	146	130.	195			
			Be	am We	b Avail	lable S	trength	per In	ch Thic	kness,	kips/i	n.					
	llat	- T			S	TD			0\	/S			SS	LT			
	поі	е Туре						<i>L<sub>eh</sub></i> *, in.									
	,	<b>:</b> _		11	//2	1:	3/4	11/2		13/4		11/2		13	/4		
	L	,, in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	'ASD	LRFD	ASD	LRFD	ASD	LRFD		
			11/4	156	234	164	246	145	218	154	230	153	229	161	242		
			1 <sup>3</sup> /8	158	238	167	250	148	222	156	234	155	233	164	245		
C	oped at	t Top	11/2	161	241	169	254	150	225	158	238	158	237	166	249		
F	lange (	Only	1 <sup>5</sup> /8	163	245	171	257	153	229	161	241	160	240	168	253		
			2	171	256	179	268	160	240	168	252	168	251	176	264		
			3 41/.	190	285	198	297	180	269	188	282	187	281	195	293		
			1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	146 151	219 227	146 151	219 227	137	205 212	137 141	205 212	146 151	219 227	146 151	219 227		
Co	ped at	Both	11/2	156	234	156	234	141 146	212	146	212	156	234	156	234		
	Flange		1 <sup>5</sup> /8	161	241	161	241	151	227	151	227	160	240	161	241		
	·		2	-171	256	176	263	160	240	166	249	168	251	176	263		
			3	190	285	198	297	180	269	188	282	187	281	195	293		
	Un	coped		273	410	273	410	273	410	273	410	273	410	273	410		
	Strer inch T	t Availabl ngth per hickness, os/in.		0VS =	Short-s	ed holes	les trans	N == Threads included X == Threads excluded									
STD OVS SSL	e   '		* Tabulated values include ¹/4-in. reduction in end distance, L <sub>eh</sub> , to account for possible underrun in beam length.  Note: Slip-critical bott values assume no more than one filler has been provided or bolts.										ave				

DESIGN TABLES 10-33

Angle Beam	<i>F<sub>u</sub></i> =	50 ksi 65 ksi 36 ksi		Table 10-1 (continued)  All-Bolted Double-Angle  Connections  Bolt and Angle Available Strength, kips											;-in. Its	
A	$F_u =$	58 ksi				В	olt and	Anale	Availab	le Stre	nath. k	ips				
<del>                                     </del>	3 Ro	ws				1		Tg.c			gle Thi		in.			
W18		4, 12, 10 <sup>+</sup>	Bolt	Thread		Hole		<u></u>	/4	T	/ <sub>16</sub>	T	/8	1/2		
*Ltd		x12, 15, 17,	Group	Co	Cond.		ype	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
<del>                                     </del>	19, 22, 2	20, 30	<del>                                     </del>	<del> </del>	N	5	STD	47.9	71.8	59.8	89.7	71.8	108	95.7	144	
					X		STD	47.9	71.8	59.8	89.7	71.8	108	95.7	144	
l			ĺ			<del></del>	TD	47.9	71.8	52.9	79.3	52.9	79.3	52.9	79.3	
Varios		Group	1	SC		VS	44.6	66.9	45.1	67.4	45.1	67.4	45.1	67.4		
		Α	Ula	ss A	SSLT		47.9	71.8	52.9	79.3	52.9	79.3	52.9	79.3		
	111 3	<del>,     </del>			SC SC		TD	47.9 44.6	71.8	59.8	89.7	71.8	108	88.1	132	
	3 3 ma			[	Class B		OVS		66.9	55.7	83.6	66.9	100	************	112	
l						SSLT		47.9	71.8	59.8	89.7	71.8	108	88.1	132	
3					N	1	TD	47.9	71.8	59.8	89.7	71.8	108	95.7	144	
3				Х			TD_	47.9	71.8	59.8	89.7	71.8	108	95.7 66.4	144	
			Group	SC		STD OVS		47.9 44.6	71.8 66.9	59,8 55.7	89.7 83.6	66.4 56.6	99.7 84.7	56.6	99.7 84.7	
7"			B	Class A			SLT	47.9	71.8	59.8	89.7	66.4	99.7	66.4	99.7	
							TD	47.9	71.8	59.8	89.7	71.8	108	95.7	144	
					SC _	1	VS	44.6	66.9	55.7	83.6	66.9	100	89.2	134	
				Cla	ss B	1	SLT	47.9	71.8	59.8	89.7	71.8	108	95.7	144	
			Be	am We	b Avai	iable S	trength	per in	ch Thic	kness,	kips/i	n.	•			
					S	TD		l	01	vs.			SS	SLT		
	Но	ie Type						<u> </u>	L <sub>eh</sub> *, in.							
				11	1/2	1:	3/4	11/2 13/4				1	1/2	13/4		
	L	. <sub>ev</sub> , in.		ASD LRFD		ASD"	<del>.                                      </del>	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
			11/4	117	176	125	188	109	163	117	176	114	171	122	183	
		İ	1 <sup>3</sup> /8	119	179	128	191	111	167	119	179	116	175	125	187	
C	oped a	nt Top	11/2	122	183	130	195	114	171	122	183	119	178	127	190	
_	lange	_ · ·	1 <sup>5</sup> /8	124	186	132	199	116		124	186	121	182	129	194	
	•	-	2	132	197	140	210	124	185	132	197	129	193	137	205	
			3	151	227	159.	239	143	215	151	227	148	222	156	234	
			11/4	107	161	107	161	99,9	150	99.9	150	107	161	107	161	
			1 <sup>3</sup> /8	112	168	112	168	105	157	105	157	112	168	112	168	
Co	oped a		11/2	117	176	117	176	110 🎉	165	110	165	117	176	117	176	
	Flang	jes	1 <sup>5</sup> /8	122	183	122	183	115	172	115	172	121	182	122	183	
			2	132	197	137	205	124	185	129	194	129	193	137	205	
	11		3	1513	227	159	239	143	215	151	227	148	222	156	234	
		coped		205	307	205	307	205	307	205	307	205	307	205	307	
	Stre Inch 1	rt Availabl ngth per Thickness, ips/in.		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												
Hol Typ Std Ovs SSL	) )/ 5/		.RFD 614	* Tabulated values include 1/4-in. reduction in end distance, Leh, to account for possible underrun in beam length.  Note: Slin-critical holf values assume no more than one filler has been provided or holfs have												

End with the second se		Al		olt	ed	1 (c Do	e-/	-	gle		7/8 Bol	;-in. Its		
<b>Y</b>   <b>F</b> u = 30 KSI				В	olt and	Angle Available Strength, kips								
2 Rows	Bolt	Thread		Hole		<u> </u>								
W12 10 0	Group	i	nd.	1	/pe		/4	5/16		3/8			/2	
W12, 10, 8	<u> </u>		.,		<u> </u>	ASD LRFD		ASD LRFC		ASD LRFD		ASD	LRFD	
		1	N Y		TD TD	30.5	45.7 45.7	38.1 38.1	57.1 57.1	45.7 45.7	68.5 68.5	60.9	91.4	
			SC		TD TD	30.5	45.7	35.3	52.9	35.3	52.9	35.3	52.9	
	Group	1			VS	28.3	42.4	30.0	45.0	30.0	45.0	30.0	45.0	
Varies ,	Α	Class A		SSLT		30.5	45.7	35.3	52.9	35.3	52.9	35.3	52.9	
		SC		S	TD	30.5 28.3	45.7	-38.1	57.1	45.7	68.5	58.8	88.1	
		1	Class B		OVS		42.4	35.3	53.0	42.4	63.6	50.1	74.9	
L <sub>ob</sub>		ļ			SLT	30.5	45.7	38.1	57.1	45.7	68.5	58.8	88.1	
3	Group B	1	N		TD	30.5	45.7	38.1	57.1	45.7	68.5	60.9	91.4	
3		X			TD TD	30.5	45.7 45.7	38.1 38.1	57.1 57.1	45.7 44.3	68.5 66.4	60.9 44.3	91.4 66.4	
4		SC Class A		STD OVS		28.3	42.4	35.3	53.0	37.8	56.5	37.8	56.5	
					SLT	30.5	45.7	38.1	57.1	44.3	66.4	44.3	66.4	
			·^		TD	30.5	45.7	38.1	57.1	45.7	68.5	60.9	91.4	
		1	SC SS B		VS	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8	
		l Cla	22 D	SS	SLT	30.5	45.7	38.1	57.1	45.7	68.5	60.9	91.4	
	Be	am We	b Avai	lable S	trength	per In	ch Thio	kness,	kips/i	n.				
Hole Type		STD OVS SS $L_{eh}^{\star}$ , in.									SLT			
		4	1/_	<u> </u>	1,				.,	11/2		۱ ۵۰	1,	
<i>L<sub>ev</sub>,</i> in.		11/2 ASD LRFD		1 <sup>3</sup> / <sub>4</sub> ASD LRFD		1 <sup>1</sup> / <sub>2</sub> ASD LRFD		1 <sup>3</sup> / <sub>4</sub> ASD LRFD		ASD LRFD		1 <sup>3</sup> / <sub>4</sub> ASD LRF		
	11/4	78.0	117	86.1	129	72.3		80,4		75.0	112	83.1	<b>LRFD</b> 125	
	13/8	80.4	121	88.6	133	74.8		82.9	124	77.4	116	85,5	128	
Coped at Top	11/2	82.9	3	91.0	137	77.2		85.3		79.8	120	88.0	132	
Flange Only	1 <sup>5</sup> /8	85.3		93.4	140	79.6		87.8	132	82.3		90.4	136	
	2	92.6		101	151	86.9		1.00	143	89.6		97.7	147	
	3	112	168	120 🖫	180	106:	160	115	172	109	164	117 🖁	176	
	11/4	68,3	102	68.3	102	63.4	95.1	63,4	95.1	68.3	102	<b>.</b> 68.3	102	
0	13/8	73.1	110	73.1	110	68.3		68.3	102	73.1	110	73.1	110	
Coped at Both	11/2	78.0		78.0	117	73.1		73.1		78.0	117	78.0	117	
<b>Flanges</b>	1 <sup>5</sup> /8	82.9		82.9	124	78.0		78.0		82.3	123	82.9	124	
	2	92.6 112	139 168	97.5 120	146 180	86.9. 106	130 160	92.6 115	139 172	89.6 109	134 164	97.5 117	146 176	
Uncoped	J	137	205	137	205		205		205	137	:	137	205	
Support Availab Strength per Inch Thickness kips/in.		Notes: STD = OVS =												
Hole Type ASD   STD/OVS/SSLT 273	410	under Note: S	țun in b lip-critic	eam leng al bolt v	gth. alues as	i, reducti sume no n the fille	more th				-		ave	

	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		Table 10-1 (continued) All-Bolted Double-Angle Connections  Bolt and Angle Available Strength, kips												
4	<b>10</b> - <b>30</b> 1101				В	olt and	Angle A	Availab		• •					
	12 Rows	Bolt	Thi	read	Hole		Angle Thickness, in.								
	WAA	Group		nd.		Туре		1/4		5/16		3/8		/2	
	W44						ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
	Varios /	İ	N		STD		191	287	239	359	287	431	383	574	
[			<u> </u>	X		TD TD	191	287 287	239 239	359 359	287 277	431 415	383 277	574 415	
li		Group		SC		VS	191 172	258	215	322	236	353	236	353	
	1003=X	A	Class A		1	SLT	191	287	239	359	277	415	277	415	
		"	<b></b>			TD	191	287	239	359	287	431	383	574	
l		<b>l</b> .	1	SC		OVS		258	215	322	258	387	.344	515	
	11.3	İ	Cla	Class B		SLT	191	287	239	359	287	431	383	574	
J.				N	S	TD	191	287	239	359	287	431	383	574	
<b>!</b>			X			STD		287	239	359	287	431	383	574	
	Group		SC Class A			TD	191	287	239	359	287	431	347	521	
3.					OVS SSLT		172	258	215	322	258	387	296	443	
136					-	TD	191 <sup>©</sup>   191	287 287	239 239	359	287	431	347 383	521	
			5	SC		VS	172	258	215	359 322	287 258	431 387	344	574 515	
7			Cla	ss B	1	SLT	191	287	239	359	287	431	383	574	
		Be	am We	h Avail	•	trength						, , , ,		, ,,,	
					TD			0\		144		SS	1 T		
	Hole Type						<u> </u>	L <sub>eh</sub> *			}		<u></u>		
			1	1/2	1:	3/4	11/2 13/			/4	11	//2	13/4		
	<i>L<sub>ev</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
	•••		- Auu				I AJU	LMD			MOU				
		11/4												663	
		1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	438 440	657 661	446 449	669 673	393 395	589 593	401 403	601 605	434 436	651 654	442 444	663 667	
C	coped at Top		438	657	446	669	393	589	401	601	434	651	442		
_	Politica de la constantina del constantina de la constantina de la constantina del constantina de la constantina de la constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del constantina del	1 <sup>3</sup> /8	438 440	657 661	446 449	669 673	393 395	589 593	401 403	601 605	434 436	651 654	442 444	667	
_	Coped at Top	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2	438 440 443 445 453	657 661 664 668 679	446 449 451 453 461	669 673 676 680 691	393 395 398 400 407	589 593 597 600 611	401 403 406 408 416	601 605 609 612 623	434 436 439 441 449	651 654 658 662 673	442 444 447 449 457	667 670 674 685	
_	Coped at Top	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3	438 440 443 445 453 472	657 661 664 668 679 708	446 449 451 453 461 480	669 673 676 680 691 720	393 395 398 400 407 427	589 593 597 600 611 640	401 403 406 408 416 435	601 605 609 612 623 653	434 436 439 441 449 468	651 654 658 662 673 702	442 444 447 449 457 476	667 670 674 685 714	
_	Coped at Top	13/8 1 <sup>1</sup> /2 1 <sup>5</sup> /8 2 3 1 <sup>1</sup> /4	438 440 443 445 453 472 429	657 661 664 668 679 708 644	446 449 451 453 461 480 429	669 673 676 680 691 720	393 395 398 400 407 427 385	589 593 597 600 611 640	401 403 406 408 416 435 385	601 605 609 612 623 653 578	434 436 439 441 449 468	651 654 658 662 673 702 644	442 444 447 449 457 476	667 670 674 685 714 644	
	Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8	438 440 443 445 453 472 429 434	657 661 664 668 679 708 644 651	446 449 451 453 461 480 429 434	669 673 676 680 691 720 644 651	393 395 398 400 407 427 385 390	589 593 597 600 611 640 578 585	401 403 406 408 416 435 385 390	601 605 609 612 623 653 578 585	434 436 439 441 449 468 429 434	651 654 658 662 673 702 644 651	442 444 447 449 457 476 429 434	667 670 674 685 714 644 651	
	Soped at Top Flange Only oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2	438 440 443 445 453 472 429 434 439	657 661 664 668 679 708 644 651 658	446 449 451 453 461 480 429 434 439	669 673 676 680 691 720 644 651 658	393 395 398 400 407 427 385 390 395	589 593 597 600 611 640 578 585 592	401 403 406 408 416 435 385 390 395	601 605 609 612 623 653 578 585 592	434 436 439 441 449 468 429 434 439	651 654 658 662 673 702 644 651 658	442 444 447 449 457 476 429 434 439	667 670 674 685 714 644 651 658	
ı	Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	438 440 443 445 453 472 429 434 439 4444	657 661 664 668 679 708 644 651 658	446 449 451 453 461 480 429 434 439	669 673 676 680 691 720 644 651 658	393 395 398 400 407 427 385 390 395	589 593 597 600 611 640 578 585 592 600	401 403 406 408 416 435 385 390 395 400	601 605 609 612 623 653 578 585 592 600	434 436 439 441 449 468 429 434 439 441	651 654 658 662 673 702 644 651 658 662	442 444 447 449 457 476 429 434 439	667 670 674 685 714 644 651 658	
ı	Soped at Top Flange Only oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2	438 440 443 445 453 472 429 434 439 444 453	657 661 664 668 679 708 644 651 658 665 679	446 449 451 453 461 480 429 434 439 444 458	669 673 676 680 691 720 644 651 658 665 687	393 395 398 400 407 427 385 390 395 400 407	589 593 597 600 611 640 578 585 592 600 611	401 403 406 408 416 435 385 390 395 400 414	601 605 609 612 623 653 578 585 592 600 622	434 436 439 441 449 468 429 434 439 441 449	651 654 658 662 673 702 644 651 658 662 673	442 444 447 449 457 476 429 434 439 444 457	667 670 674 685 714 644 651 658 665 685	
	Soped at Top Flange Only oped at Both Flanges	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	438 440 443 445 453 472 429 434 439 444 453 472	657 661 664 668 679 708 644 651 658 665 679 708	446 449 451 453 461 480 429 434 439 444 458 480	669 673 676 680 691 720 644 651 658 665 687 720	393 395 398 400 407 427 385 390 395 400 407 427	589 593 597 600 611 640 578 585 592 600 611 640	401 403 406 408 416 435 385 390 395 400 414 '435	601 605 609 612 623 653 578 585 592 600 622 653	434 436 439 441 449 468 429 434 439 441 449 468	651 654 658 662 673 702 644 651 658 662 673 702	442 444 447 449 457 476 429 434 439 444 457 476	667 670 674 685 714 644 651 658 665 685 714	
Co	Soped at Top Flange Only oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	438 440 443 445 453 472 429 434 439 444 453 472 909 Notes: STD = OVS =	657 661 664 668 679 708 644 651 658 665 679 708 1360	446 449 451 453 461 480 429 434 439 444 458 480 909	669 673 676 680 691 720 644 651 658 665 687 720 1360	393 395 398 400 407 427 385 390 395 400 407 427 829	589 593 597 600 611 640 578 585 592 600 611 640 1240	401 403 406 408 416 435 385 390 395 400 414 435 829	601 605 609 612 623 653 578 585 592 600 622	434 436 439 441 449 468 429 434 439 441 449 468 909	651 654 658 662 673 702 644 651 658 662 673	442 444 447 449 457 476 429 434 439 444 457	667 670 674 685 714 644 651 658 665 685	
Co	Oped at Top Flange Only  Oped at Both Flanges  Uncoped Support Availabl Strength per Inch Thickness kips/in.	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	438 440 443 445 453 472 429 434 439 444 453 472 909 Notes: STD = 0VS = SSLT =	657 661 664 668 679 708 644 651 658 665 679 708 1360 Standal Oversiz Short-s to direct	446 449 451 453 461 480 429 434 439 444 458 480 909 d holes ed holes lotted ho	669 673 676 680 691 720 644 651 658 665 687 720 1360	393 395 398 400 407 427 385 390 395 400 407 427 829	589 593 597 600 611 640 578 585 592 600 611 640 1240	401 403 406 408 416 435 385 390 395 400 414 1435 829 N = Thi X = Thi SC = Slip	601 605 609 612 623 653 578 585 592 600 622 653 1240 reads increads excoordical	434 436 439 441 449 468 439 441 449 468 909	651 654 658 662 673 702 644 651 658 662 673 702	442 444 447 449 457 476 429 434 439 444 457 476 909	667 670 674 685 714 651 658 665 685 714 1360	

e Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$		A		Bolt	ted	Do	cont	le-	An	gle	<b>,</b>	•	-in. olts
Angle	$F_y = 36 \text{ ksi}$					,011	ne	ctic	)115					
Ā	$F_u = 58 \text{ ksi}$	<u> </u>			В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	11 Rows	Bolt	Thi	read	н	ole			An	gle Thi	ckness	, in.		
	W44, 40	Group	1	nd.	1	/pe	<del></del>	/4		16	<del> </del>	/8		/2
-	1177, 70	<u> </u>	-	N	<u> </u>	TD	175	263	ASD 219	LRFD 328	263	LRFD 394	<b>ASD</b> 350	LRFD 525
	Varios 1			X		TD	175	263	219	328	263	394	350	525
				 SC	1	TD	175	263	219	328	254	380	254	380
	8	Group	1	ss A	1	VS	157	236	196	295	216	323	216	323
	1063 - 30	A			<del></del>	<u>slt</u> TD	175 175	263 263	219 219	328 328	254 263	380 394	254 350	380 525
			1	SC		VS	157	236	196	295	236	354	314	471
	-1-3			ss B	<del></del>	SLT	175	263	219	328	263	394	350	5 <b>2</b> 5
]			1	N	1	TD	175	263	219	328	263	394	350	525
	TT			<u>X</u>		TD TD	175 175	263 263	219 219	328 328	263 263	394 394	350 318	525 477
8		C		C A		VS	157	236	196	295	236	354	271	406
10001 - 30	1	Group B	Cla	ss A 	<del></del>	SLT	175	263	219	328	263	394	318	477
	<u> </u>		l s	C	1	TD	175	263	219	328	263	394	350	525
1			Clas	ss B		VS Slt	157 175	236 263	196 219	295 328	236 263	354 394	314 350	471 525
<del></del>		Be	am We	b Avail	<u> </u>			ch Thic			نسلسستنا	00.		020
					TD		<u> </u>	01				SS	LT	
	Hole Type							L <sub>eh</sub> *			<u> </u>			
	<i>!</i> :-		11	1/2	1	3/4	1	1/2	13	/4	11	//2	13	/4
	<i>L<sub>ev</sub>,</i> in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		11/4	401	602	410	614	360	540	368	552	397	596	405	608
ذِ ا		1 <sup>3</sup> /8	404	606	412	618	362	544	371	556	400	600 603	408	612
•	Coped at Top Flange Only	1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub>	406 409	609 613	414 417	622 625	365 367	547 551	373 375	559 563	402 405	607	410 413	615 619
		2	416	624	424	636	375	562	383	574	412	618	420	630
		3	436	653	de legacional	665	394	591	402	603	431	647	440	659
	•	11/4	392	589	392	589	352	528	352	528	392	589	392	589
	: loped at Both	1 <sup>3</sup> /8 1 <sup>1</sup> /2	397	596	397 402	596	357 362	536	357 362	536 543	397 402	596	397 402	596 603
"	Flanges	1 <sup>5</sup> /8	402 407	603	407	603 611	367	543 550	367	550	405	603 607	407	611
		2	416	624	422	633	375	562	381	572	412	618	420	630
		3	436	653	444	665	394	591	402	603	431	647	440	659
	Uncoped		834	1250	834	1250	761	1140	761	1140	834	1250	834	1250
	3		0VS =	Standar Oversiz Short-si to direc	ed holes	oles trans	sverse	:	X = Th	reads inc reads exc o critical	cluded			
Ho Typ Sti	pe ASU	LRFD	undei	rrun in b	eam len	gth.						nt for pos		
SSI	LT 1970	2500 2280					sume no n the fill		an one f	iller has	been pr	ovided or	oolts h	ave

gle	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$	ı	A		Bolt	e 10 ted on	Do	oub	le-	An	gle	•	-	-in. olts
Ā	$F_u = 58 \text{ ksi}$				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	10 Rows	Polt	Th	rood	Ц				An	gle Thi	ckness	, in.		
	W	Bolt Group	1	read Ind.	1	ole /pe	1	/4	5,	16	3	/8	1	/2
1	W44, 40, 36	aroup	00	mu.	''	, pc	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			l l	N	S	TD	159	238	198	298	238	357	318	476
и П	/arios			<u>X</u>		TD	159	238	198	298	238	357	318	476
l‡	<del>##1 -    </del>		,	SC	1	TD	159	238	198	298	231	346	231	346
		Group		iss A	1	VS	142	214	178	267	196	294	196	294
ļ	8	A			<del></del>	SLT	159	238	198	298	231	346	231	346
I			8	SC		TD	159	238	198	298	238	357	318	476
1	<u>ijij</u>	· ·	Cla	ss B	1	ivs Slt	142 159	214 238	178 198	267 298	214 238	321 357	. 285 318	427 476
. <del>. •</del> 1	L <sub>m</sub>	<b> </b>		N	<del></del>	TD	159	238	198	298	238	357	318	476
1			1	X	1	TD	159	238	198	298	238	357	318	476
11	<b>‡</b>					TD	159	238	198	298	238	357	289	434
AG3 = 27	Į	Group	1	SC .	1	VS	142	214	178	267	214	321	247	369
32	i i	В	Cla	ss A		SLT	159	238	198	298	238	357	289	434
	<u> </u>			'n	S	TD	159	238	198	298	238	357	318	476
3			ı	SC	0	VS	142	214	178	267	214	321	285	427
			Cla	ss B	SS	SLT	159	238	198	298	238	357	318	476
		Be	am We	b Avail	lable S	trength	per In	ch Thic	kness,	kips/iı	١.			
				S	TD			0	/S			SS	LT	
	Hole Type							Lehi	, in.					
			1	1/2	13	3/4	1	1/2		1/4	11	1/2	13	1/4
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	<i>L<sub>ev</sub></i> , in.			LIII D	nou.	559		491	335	503	361	541	369	553
	L <sub>ev</sub> , in.	11/4		547	373		377			000			000	1
	<i>L<sub>ev</sub>,</i> in.	1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	365	547 551	373 375	:	327 329			506	363	545	and the state of t	557
		1 <sup>3</sup> /8	365 367	551	375	563	329	494	338	506 510	363 366	545 548	371	557 561
	oped at Top	1 <sup>3</sup> /8 1 <sup>1</sup> /2	365 367 370	551 555	375 378	563 567	329 332	494 498	338 340	510	366	548	371 374	561
		1 <sup>3</sup> /8	365 367 370 372	551	375	563	329 332 334	494	338				371	
	oped at Top	1 <sup>3</sup> /8 1 <sup>1</sup> /2 1 <sup>5</sup> /8	365 367 370	551 555 558	375 378 380	563 567 570	329 332	494 498 502	338 340 342	510 514	366 368	548 552	371 374 376	561 564
	oped at Top	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2	365 367 370 372 379	551 555 558 569	375 378 380 388	563 567 570 581	329 332 334 342	494 498 502 512	338 340 342 350	510 514 525	366 368 375	548 552 563	371 374 376 384	561 564 575
	oped at Top	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3	365 367 370 372 379 399	551 555 558 569 598	375 378 380 388 407	563 567 570 581 611	329 332 334 342 361	494 498 502 512 542	338 340 342 350 369	510 514 525 554	366 368 375 395	548 552 563 592	371 374 376 384 403	561 564 575 605
<b>.</b>	oped at Top	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3 1 <sup>1</sup> / <sub>4</sub>	365 367 370 372 379 399 356	551 555 558 569 598 534	375 378 380 388 407 356	563 567 570 581 611 534	329 332 334 342 361 3319	494 498 502 512 542 479	338 340 342 350 369 319	510 514 525 554 479	366 368 375 395 356	548 552 563 592 534	371 374 376 384 403 356	561 564 575 605 534
<b>.</b>	coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8	365 367 370 372 379 399 356 361	551 555 558 569 598 534 541	375 378 380 388 407 356 361	563 567 570 581 611 534 541	329 332 334 342 361 319 324	494 498 502 512 542 479 486	338 340 342 350 369 319 324	510 514 525 554 479 486	366 368 375 395 356 361	548 552 563 592 534 541	371 374 376 384 403 356 361	561 564 575 605 534 541
	coped at Top Flange Only Oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2	365 367 370 372 379 399 356 361 366	551 555 558 569 598 534 541 548	375 378 380 388 407 356 361 366	563 567 570 581 611 534 541 548	329 332 334 342 361 319 324 329	494 498 502 512 542 479 486 494	338 340 342 350 369 319 324 329	510 514 525 554 479 486 494	366 368 375 395 356 361 366	548 552 563 592 534 541 548	371 374 376 384 403 356 361 366	561 564 575 605 534 541 548
<b>.</b>	coped at Top Flange Only Oped at Both Flanges	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	365 367 370 372 379 399 356 361 366 371	551 555 558 569 598 534 541 548 556	375 378 380 388 407 356 361 366 371	563 567 570 581 611 534 541 548 556 578 611	329 332 334 342 361 319 324 329 334	494 498 502 512 542 479 486 494 501	338 340 342 350 369 319 324 329 334	510 514 525 554 479 486 494 501	366 368 375 395 356 361 366 368	548 552 563 592 534 541 548 552	371 374 376 384 403 356 361 366 371	561 564 575 605 534 541 548
	coped at Top Flange Only Oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2	365 367 370 372 379 399 356 361 366 371 379	551 555 558 569 598 534 541 548 556 569	375 378 380 388 407 356 361 366 371 385	563 567 570 581 611 534 541 548 556 578	329 332 334 342 361 319 324 329 334 342	494 498 502 512 542 479 486 494 501 512	338 340 342 350 369 319 324 329 334 349	510 514 525 554 479 486 494 501 523	366 368 375 395 356 361 366 368 375	548 552 563 592 534 541 548 552 563	371 374 376 384 403 356 361 366 371 384	561 564 575 605 534 541 548 556 575
Co	coped at Top Flange Only Oped at Both Flanges	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	365 367 370 372 379 399 356 361 366 371 379 399 758 Notes: STD = OVS =	551 558 569 598 534 541 548 556 569 598 1140	375 378 380 388 407 356 361 366 371 385 407 758	563 567 570 581 611 534 541 548 556 578 611 1140	329 332 334 342 361 319 324 329 334 342 361 692	494 498 502 512 542 479 486 494 501 512 542 1040	338 340 342 350 369 319 324 329 334 349 369 692 N = Th X = Th	510 514 525 554 479 486 494 501 523 554	366 368 375 395 356 361 366 368 375 395 758	548 552 563 592 534 541 548 552 563 592	371 374 376 384 403 356 361 366 371 384 403	561 564 575 605 534 541 548 556 575 605
Co	oped at Top Flange Only  oped at Both Flanges  Uncoped Support Availabl Strength per Inch Thickness kips/in.	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	365, 367, 370, 372, 379, 399, 356, 361, 366, 371, 379, 399, 758, Notes: STD = 0VS = SSLT =	551 558 569 598 534 541 548 556 569 598 1140 • Standar • Oversiz • Short-s to direc	375 378 380 388 407 356 361 366 371 385 407 758 ord holes ed holes lotted hot tion of ko	563 567 570 581 611 534 541 548 556 578 611 1140	329 332 334 342 361 319 324 329 334 342 361 692	494 498 502 512 542 479 486 494 501 512 542 1040	338 340 342 350 369 319 324 329 334 349 369 692 N = Th X = Th SC = Sli	510 514 525 554 479 486 494 501 523 554 1040 reads increads experitical	366 368 375 395 356 361 366 368 375 395 758	548 552 563 592 534 541 548 552 563 592	371 376 384 403 356 361 366 371 384 403 758	561 564 575 605 534 541 548 556 575 605

$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		A		3ol	ted	Do	cont oub ctic	le-	An	gle	<b>;</b>	<b>1</b>	-in. olts
<b>▼</b>   1u - 30 ks				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
9 Rows	Bolt	Th	read	Н	ole				gle Thi	ckness	, in.		
W44, 40, 36, 33	Group	i	ond.	1	ype		/4		16		3/8		/2
1141, 10, 30, 33	<u> </u>	<u> </u>	N	<del>                                     </del>	TD	ASD 142	LRFD 214	178	<b>LRFD</b> 267	ASD 214	LRFD 321	<b>ASD</b> 285	LRFD
			X	1	STD	142	214	178	267	214	321	285	427 427
Vanes /				<del></del>	TD	142	214	178	267	207	311	207	311
	Group	1	SC		VS	128	192	160	240	177	265	177	265
603-24	Α	Cla	ISS A	S	SLT	142	214	178	267	207	311	207	311
		9	SC		TD	142	214	178	267	214	321	285	427
		I	ss B		VS	128	192	160	240	192	288	256	383
La ANT.	ļ			· · · · · · · · · · · · · · · · · · ·	SLT	142	214	178	267	214	321	285	427
1			N X	1	TD TD	142 -142	214 214	178 -178	267 267	214. 214	321 321	285 285	427 427
					TD	142	214	178	267	214	321	260	391
\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	Group	1	SC	1	VS	128	192	160	240	192	288	222	332
	В	Cla	ss A		SLT	142	214	178.	267	214	321	260	391
3			SC	S	TD	142	214	178	267	214	321	285	427
11	l		ss B	1	VS	128	192	160	240	192	288	256	383
		l Cla	99 D	S	SLT	142	214	178	267	214	321	285	427
	Ве	am We	b Avai	lable S	trength	per in	ch Thic	kness,	kips/ir	1.			
Hole Type			S	TD			0\	/S			SS	LT	
noie type							L <sub>eh</sub> *	, in.					
L <sub>ev</sub> , in.		1	1/2	1	3/4	1	//2	13	/4	1	1/2	13	/4
Ley, III.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	1 <sup>1</sup> /4	328	492	336	505	294	441	302	453	324	486	332	498
	1 <sup>3</sup> /8	331	496	339	508	297	445	305	457	327	490	335	502
Coped at Top	11/2	333	500	341	512	299	449	307	461	329	494	337	506
Flange Only	1 <sup>5</sup> /8	336	503	344	516	301	452	310	464	332	497	340	509
	2	343	514	351	527	309	463	317	475	339	508	347	520
	3 1 <sup>1</sup> / <sub>4</sub>	362	544	371	556	328	492	336	505	358	537	366	550
	1 <sup>3</sup> /8	319 324	479 486	319 324	479 486	286 291	430 437	286 291	430 437	319 324	479 486	319° 324	479 486
Coped at Both	11/2	329	494	329	494	296	444	296	444	329	494	329	494
Flanges	1 <sup>5</sup> /8	334	501	.334;	501	301	452	301.	452	332.	497	334	501
	2	343	514	349	523	309	463	316	473	339	508	347	520
	3	362	544	371	556	328	492	336	505	358	537	366	550
Uncoped		683	1020	683	1020	624	936	624	936	683	1020	683	1020
Support Availabl Strength per Inch Thickness kips/in.		OVS = SSLT =	to direc	ed holes lotted ho tion of lo	oles trans oad			X = Thi SC = Slip	reads inc reads exc o critical	cluded	nt for	naih!-	
STD/ SSLT 1370	2050 1870	under Note: S	rrun in b Slip-critic	eam lenç al bolt v	gth.	sume no	more tha				nt for pos		ave

DESIGN TABLES 10-39

Angle Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		A		Bolt	e 10 ted on	Do	oub	le-	An	gle	<b>)</b>	<b>1</b>	-in. olts
<u> </u>	1 U = 00 KGI				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	8 Rows	Bolt	The	read	) <u>.</u>	ole			Ang	gle Thi	ckness	, In.		
		Group	1	nd.		/pe	1	/4	5/	16	3	<b>/</b> 8	1	/2
W4	4, 40, 36, 33, 30	aroup	00	iiu.	י'	, pe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
				N	1	TD	126	189	158	237	189	284	252	378
İ				Χ	<del></del>	TD	126	189	158	237	189	284	252	378
	Varies /			SC SC		TD	126	189	158	237	184	277	184	277
ſ		Group	1	ss A		VS	113	170	141	212	157	235	157	235
	763-21	Α	Oid			SLT	126	189	158	237	184	277	184	277
	<b>2</b>		9	SC .	1	TD	126	189	158	237	189	284	252	378
			I	ss B		VS	113	170	141	212	170	254	226	339
		<u> </u>				SLT	126	189	158	237	189	284	252	378
3			1	N		TD	126	189	158	237	189	284	252	378
=				X		TD	126	189	.158	237	189	284	252	378
763-21	ļ .	_	8	C		TD	126	189	158	237	189	284	231	347
2		Group		ss A	1	VS	113	170	141	212	170	254	197	295
		В				SLT	126	189	158	237	189	284	231	347
. 1	l		5	C		TD	126	189	158	237	189	284	252	378
			l	ss B	1	VS	113	170	141	212	170	254	226	339
			<u> </u>			SLT	126	189	158	237	189	284	252	378
:		Ве	am We	b Avail	able S	trength	per In	ch Thic	Kness,	kips/ii	٦.			
	Hole Type			S	TD			O\ L <sub>eh</sub> *				SS	LT	
			<u> </u>   ••	1/2	1:	3/4	1 41	1/2	13	/_	11	1/2	13	1/4
:	<i>L<sub>ev</sub></i> , in.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD .	LRFD	ASD	LRFD	ASD	LRFD
				438	300	450	261	392	269	404	288	431	296	444
		11/4	202			750		1 332 1	200			1 1		
		1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>9</sub>	292	ı	54-54	453			272	<b>4</b> 08	290	1 434 1	208	1 44/
•	Coned at Ton	1 <sup>3</sup> /8	294	441	302	453 457	264	395	272 274	408 411	290 293	435 439	298 301	447 451
	Coped at Top	1 <sup>3</sup> /8 1 <sup>1</sup> /2	294 297	441 445	302 305	457	264 266	395 399	274	411	293	439	301	451
	Coped at Top Flange Only	1 <sup>3</sup> /8 1 <sup>1</sup> /2 1 <sup>5</sup> /8	294 297 299	441 445 449	302 305 307	457 461	264 266 269	395 399 403	274 277	411 415	293 295	439 442	301 303	451 455
	•	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2	294 297 299 306	441 445 449 459	302 305 307 314	457 461 472	264 266 269 276	395 399 403 414	274 277 284	411 415 426	293 295 302	439 442 453	301 303 310	451 455 466
ľ	•	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3	294 297 299 306 326	441 445 449 459 489	302 305 307 314 334	457 461 472 501	264 266 269 276 295	395 399 403 414 443	274 277 284 303	411 415 426 455	293 295 302 322	439 442 453 483	301 303 310 330	451 455 466 495
ľ	•	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3 1 <sup>1</sup> / <sub>4</sub>	294 297 299 306 326 283	441 445 449 459 489 424	302 305 307 314 334 283	457 461 472 501 424	264 266 269 276 295 254	395 399 403 414 443 380	274 277 284 303 254	411 415 426 455 380	293 295 302 322 283	439 442 453 483 424	301 303 310 330 283	451 455 466 495 424
	Flange Only	13/8 11/2 15/8 2 3 11/4 13/8	294 297 299 306 326 283 288	441 445 449 459 489 424 431	302 305 307 314 334 283 288	457 461 472 501 424 431	264 266 269 276 295 254 258	395 399 403 414 443 380 388	274 277 284 303 254 258	411 415 426 455 380 388	293 295 302 322 283 288	439 442 453 483 424 431	301 303 310 330 283 288	451 455 466 495 424 431
	•	13/8 11/2 15/8 2 3 11/4 13/8 11/2	294 297 299 306 326 283 288 293	441 445 449 459 489 424 431 439	302 305 307 314 334 283 288 293	457 461 472 501 424 431 439	264 266 269 276 295 254 258 263	395 399 403 414 443 380 388 395	274 277 284 303 254 258 263	411 415 426 455 380 388 395	293 295 302 322 283 288 293	439 442 453 483 424 431 439	301 303 310 330 283 288 293	451 455 466 495 424 431 439
	Flange Only  oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	294 297 299 306 326 283 288 293	441 445 449 459 489 424 431 439	302 305 307 314 334 283 288 293	457 461 472 501 424 431 439 446	264 266 269 276 295 254 258 263 268	395 399 403 414 443 380 388 395 402	274 277 284 303 254 258 263 268	411 415 426 455 380 388 395 402	293 295 302 322 283 288 293	439 442 453 483 424 431 439 442	301 303 310 330 283 288 293	451 455 466 495 424 431 439 446
	Flange Only  oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2	294 297 299 306 326 283 288 293 297 306	441 445 449 459 489 424 431 439 446 459	302 305 307 314 334 283 288 293 297 312	457 461 472 501 424 431 439 446 468	264 266 269 276 295 254 258 263 268 276	395 399 403 414 443 380 388 395 402 414	274 277 284 303 254 258 263 268 283	411 415 426 455 380 388 395 402 424	293 295 302 322 283 288 293 295 302	439 442 453 483 424 431 439 442 453	301 303 310 330 283 288 293 297 310	451 455 466 495 424 431 439 446 466
	Flange Only  oped at Both Flanges	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	294 297 299 306 326 283 288 293 297 306 326	441 445 449 459 489 424 431 439 446 459 489	302 305 307 314 334 283 288 293 297 312 334	457 461 472 501 424 431 439 446 468 501	264 266 269 276 295 254 258 263 268 276 295	395 399 403 414 443 380 388 395 402 414 443	274 277 284 303 254 258 263 268 283 303	411 415 426 455 380 388 395 402 424 455	293 295 302 322 283 288 293 295 302 322	439 442 453 483 424 431 439 442 453 483	301 303 310 330 283 293 293 310 330	451 455 466 495 424 431 439 446 466 495
C	Flange Only  oped at Both	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	294 297 299 306 326 283 288 293 297 306 326 607 Notes: STD = OVS =	441 445 449 459 489 424 431 439 446 459 489 910 Standar Oversiz Short-s	302 305 307 314 334 288 293 297 312 334 607	457 461 472 501 424 431 439 446 468 501 910	264 266 269 276 295 254 258 263 268 276 295 556	395 399 403 414 443 380 388 395 402 414 443 834	274 277 284 303 254 258 263 268 283 303 556 N = Thi X = Thi	411 415 426 455 380 388 395 402 424	293 295 302 322 283 288 293 295 302 322 607	439 442 453 483 424 431 439 442 453	301 303 310 330 283 288 293 297 310	451 455 466 495 424 431 439 446 466
C	oped at Both Flanges  Uncoped Support Availabl Strength per Inch Thickness kips/in.	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	294 297 299 306 326 283 288 293 297 306 326 607 Notes: STD = 0VS = SSLT =	441 445 449 459 489 424 431 439 446 459 489 910 Standar Oversiz Short-s to direct	302 305 307 314 334 288 293 297 312 334 607 d holes ed holes lotted ho tion of lo	457 461 472 501 424 431 439 446 468 501 910	264 269 276 295 254 258 263 268 276 295 556 sverse	395 399 403 414 443 380 388 395 402 414 443 834	274 277 284 303 254 258 263 268 283 303 556 N = Thi X = Thi SC = Slip	411 415 426 455 380 388 395 402 424 455 834 reads increads ex- or critical	293 295 302 322 283 288 293 295 302 322 607	439 442 453 483 424 431 439 442 453 483	301 303 310 330 283 293 297 310 330 607	451 455 466 495 424 431 439 446 466 495 910

Angle Beam	F	; = ; =	50 ksi 65 ksi 36 ksi 58 ksi		A		Bol <sup>1</sup>	ted on	ne	cont oub ctic	le- ons	An		<b>)</b>	<b>1</b>	-in. olts
A				<u> </u>			B	olt and	Angle	Availab			•			
		7 Ro		Bolt	Thi	read	н	ole				gle Thi		-		
W44	-	10, 30 27, 2	6, 33, 30, 24	Group	Co	nd.	T	/pe		/4 LRFD	<del>!</del>	11000	<u> </u>	/8		/2
		21,		<u> </u>		N	S	TD	ASD 110	165	137	<b>LRFD</b> 206	<b>ASD</b> 165	LRFD 247	<b>ASD</b> 220	LRFD 330
					ľ	X	1	TD	110	165	137	206	165	247	220	330
,	/anies	ı			5	SC		TD	110	165	137	206	161	242	161	242
<b>1</b> 6		<del> </del>	<del>,   </del>	Group	1	ss A	i .	VS	98.4	148	123	185	138	206	138	206
	Ħ	6 <b>0</b> 3 = 18	‡	A				<u>slt</u> TD	110 110	165 165	137 137	206	161 165	242	161 220	330
		8	<u>                                      </u>		1	SC	1	VS	98.4	148	123	185	148	221 .	197	295
		L <sub>ab</sub>	-1 3 mare		<u> </u>	ss B		SLT	110	165	137	206	165	247	220	330
15					1	N	1	TD TD	110	165	137	206	165	247	220	330
2	I					<u>X</u>	<del></del>	TD TD	110 110	165 165	137 137	206 206	165 165	247 247	220 202	330 304
80 - 18	Ħ		Ļ	Group	1	SC .		VS	98.4	148	123	185	148	221	173	258
1 5	H			В	Cla	ss A	1	SLT	110	165	137	206	165	247	202	304
1 21			,		9	SC SC		TD	110	165	137	206	165	247	220	330
1					1	ss B	1	VS	98.4	148	123	185	148	221	197	295
<u> </u>				P.	11/-	h Avail	1	SLT	110	165	137_	206	165	247	220	330
<u> </u>				ье	am we			trengtn	per in	ch Thic		KIPS/II	1.			
		Но	le Type		<u>.                                    </u>	5	TD		<u> </u>	O\ L <sub>eh</sub> *				SS	LI	
<u> </u> 					   •1	1/2	1 4:	3/4		/ <sub>2</sub>		1/4	41	/2	13	//4
		L	<sub>ev</sub> , in.		ASD	LRFD	ASD	LRFD	ASD:	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
-				11/4	255	383	263	395	228	342	236	355	251	377	259	389
				1 <sup>3</sup> /8	258	386	266	399	231	346	239	358	254	380	262	392
	•		t Top	11/2	260	390	268	402	233	350	241	362	256	384	264	396
	Fla	nge	Only	1 <sup>5</sup> /8	262	394	271	406	236	353	244	366	258	388	267	400
				2 3	270 289	405 434	278 297	417 446	243 262	364 394	251 271	377 406	266 285	399 428	274 293	411 440
-	-		***	1 <sup>1</sup> /4	246	369	246	369	221	331	221	331	246	369	246	369
				1 <sup>3</sup> /8	251	377	251	377	225	338	225	338	251	377	251	377
C	ope	ed af	t Both	11/2	256	384	256	384	230	346	230	346	256	384	256	384
	F	lang	es	1 <sup>5</sup> /8	261	391	261	391	235	353	235	353	258	388	261	391
				2	270	405	275	413	243	364	250	375	266	399	274	411
ļ		He	coped	3	289	434	297	446	262	394	271	406	285	428	293	440
-	<u> </u>			<u> </u>	531 Notes:	797	531	797	488	731	488	731	2531	797	531	797
		Stre ch T	rt Availabl ngth per 'hickness ps/in.		STD = OVS =	Standar Oversize Short-sl to direc	ed holes lotted ho	les trans	sverse	\$	X = Thi	reads inc reads ex o critical	cluded			
Hol Typ	е			.RFD		ated valu			. reducti	on in end	d distanc	ce, L <sub>eh</sub> , to	o accoui	nt for pos	sible	
ST	)/	2.5	1060	1590							-			ovided or		

	i	T										***************************************		
Beam	$F_y = 50 \text{ ksi}$	1				e 10	•			-			4	•
m	$F_u = 65 \text{ ksi}$		Α	II-E	<b>3ol</b> t	ted	Do	oub	le-	·An	gle	)		-in.
Angle	$F_y = 36 \text{ ksi}$	1			C	on	ne	ctic	ns	;			В	olts
A	$F_u = 58 \text{ ksi}$	<u> </u>			В	olt and	Angle	Availab	le Stre	nath. k	ips		<u></u>	
	6 Rows		Τ		I					gle Thi		, in.		
W4	0, 36, 33, 30, 27,	Bolt Group	1	read ond.		ole	1	/4	T	/16	T	/8	1	/2
	24, 21	aioup	G	niu.	''	уре	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			1	N		TD	93.5	140	117	175	140	210	187	281
				Х	<del></del>	TD TD	93.5	140	117 117	175 175	140	210	187 138	281
	Varios (	Group	ł	SC	1	IVS	83.7	126	105	157	118	176	118	176
F		A	Cla	ss A		SLT	93.5	140	117	175	138	207	138	207
	33 - 16			SC	<del></del>	TD	93.5	140	117	175	140	210	187	281
	<b>§</b>		1	ss B	,	VS	83.7	126	105	157	126	188.	167	251
١.	<u></u>	ļ	<u> </u>			<u>slt</u>	93.5	140	117	175	140	210	187	281
5			1	N X	1	TD TD	93.5	140 140	117 117	175 175	140 140	210 210	187 187	281 281
5	<u>                                     </u>					TD	93,5	140	117	175	140	210	174	260
5@3 - 15		Group	l .	SC .		VS	83.7	126	105	157	126	188	148	221
1	=	В	Cla	ss A		SLT	93.5	140	117	175	140	210	174	260
			9	SC	I .	TD	93.5	140	117	175	140	210	187	281
			l	ss B		VS	83.7	126	105	157	126	188	167	251
		<u> </u>				SLT	93.5	140	117	175	140	210	187	281
		Be	am We	eb Avail	lable S	trength	per in	ch Thic	:Kness,	, Kips/ii	n.			
							1							
	Hole Type			S	TD				VS			SS	LT	
	Hole Type					1,		L <sub>eh</sub> *	, in.					
	Hole Type			1/2	1	3/4	**************************************	L <sub>eh</sub> 1	', in. 1 <sup>3</sup>	9/4		//2	13	)/4 LDED
		11/4	ASD	1/2 LRFD	1 <sup>2</sup>	LRFD	ASD	L <sub>eh</sub> <sup>1</sup> / <sub>2</sub> LRFD	', in. 1 <sup>2</sup> ASD	LRFD	ASD	/2 LRFD	1 <sup>3</sup> ASD	LRFD
		1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	<b>ASD</b> 219	1/2 LRFD 328	1: ASD 227	LRFD 340	ASD 195	L <sub>eh</sub> <sup>1</sup> LRFD 293	, in. 1 <sup>3</sup> <b>ASD</b> 204	LRFD 305	<b>ASD</b> 215	<b>LRFD</b> 322	1 <sup>3</sup> ASD 223	LRFD 334
		1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub>	ASD	1/2 LRFD	1 <sup>2</sup>	LRFD	ASD	L <sub>eh</sub> <sup>1</sup> / <sub>2</sub> LRFD	', in. 1 <sup>2</sup> ASD	LRFD	ASD	/2 LRFD	1 <sup>3</sup> ASD	LRFD
	<i>L<sub>ev</sub></i> , in.	1 <sup>3</sup> /8	219 221	1/2 LRFD 328 332	1 <sup>2</sup> ASD 227 229	340 344	195 198	L <sub>eh</sub> <sup>1</sup> LRFD 293 297	, in. 1 <sup>3</sup> <b>ASD</b> 204 206	305 309	<b>ASD</b> 215 217	LRFD 322 325	1 <sup>3</sup> ASD 223 225	334 338
	L <sub>ey</sub> , in.	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2	219 221 223 226 233	1/2 LRFD 328 332 335 339 350	13 ASD 227 229 232 234 241	340 344 347 351 362	195 198 200 203 210	L <sub>eh</sub> */2 LRFD 293 297 300 304 315	, in. 13 ASD 204 206 208 211 218	305 309 313 316 327	215 217 219 222 229	I/2 LRFD 322 325 329 333 344	13 ASD 223 225 228 230 237	334 338 341 345 356
	L <sub>ey</sub> , in.	1 <sup>3</sup> / <sub>8</sub> 1 <sup>1</sup> / <sub>2</sub> 1 <sup>5</sup> / <sub>8</sub> 2 3	219 221 223 226 233 253	1/2 LRFD 328 332 335 339 350 379	13 ASD 227 229 232 234 241 261	340 344 347 351 362 391	195 198 200 203 210 230	L <sub>eh</sub> <sup>1</sup> /2 LRFD 293 297 300 304 315 344	7, in. 13 ASD 204 206 208 211 218 238	305 309 313 316 327 356	215 217 219 222 229 249	LRFD 322 325 329 333 344 373	13 ASD 223 225 228 230 237 257	334 338 341 345 356 385
	L <sub>ey</sub> , in.	13/8 11/2 15/8 2 3 11/4	219 221 223 226 233 253 210	1/2 LRFD 328 332 335 339 350 379 314	13 ASD 227 229 232 234 241 261 210	340 344 347 351 362 391 314	ASD 195 198 200 203 210 230 188	L <sub>eh</sub> <sup>4</sup>  /2    LRFD   293   297   300   304   315   344   282	7, in. 13 ASD 204 206 208 211 218 238 188	305 309 313 316 327 356 282	215 217 219 222 229 249 210	1/2 LRFD 322 325 329 333 344 373 314	13 ASD 223 225 228 230 237 257 210	334 338 341 345 356 385 314
	L <sub>ev</sub> , in. Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8	219 221 223 226 233 253 210 215	1/2 LRFD 328 332 335 339 350 379 314 322	13 ASD 227 229 232 234 241 261 210 215	340 344 347 351 362 391 314 322	195 198 200 203 210 230 188 193	L <sub>eh</sub> <sup>4</sup> //2  LRFD  293 297 300 304 315 344 282 289	7, in. 13 ASD 204 206 208 211 218 238 188 193	305 309 313 316 327 356 282 289	215 217 219 222 229 249 210 215	1/2 LRFD 322 325 329 333 344 373 314 322	13 ASD 223 225 228 230 237 257 210 215	334 338 341 345 356 385 314 322
	L <sub>ev</sub> , in.  Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8 11/2	219 221 223 226 233 253 210 215 219	1/2 LRFD 328 332 335 339 350 379 314 322 329	13 ASD 227 229 232 234 241 261 210 215 219	340 344 347 351 362 391 314 322 329	195 198 200 203 210 230 188 193 197	L <sub>eh</sub> <sup>1</sup> /2  LRFD  293 297 300 304 315 344 282 289 296	7, in. 13 ASD 204 206 208 211 218 238 188 193 197	305 309 313 316 327 356 282 289 296	215 217 219 222 229 249 210 215 219	/2 LRFD 322 325 329 333 344 373 314 322 329	13 ASD 223 225 228 230 237 257 210 215 219	334 338 341 345 356 385 314 322 329
	L <sub>ev</sub> , in. Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8	219 221 223 226 233 253 210 215 219	1/2 LRFD 328 332 335 339 350 379 314 322 329 336	13 ASD 227 229 232 234 241 261 210 215 219 224	340 344 347 351 362 391 314 322 329 336	195 198 200 203 210 230 188 193 197 202	L <sub>eh</sub> <sup>4</sup>  /2    LRFD     293     297     300     304     315     344     282     289     296     303	7, in. 13 ASD 204 206 208 211 218 238 188 193 197 202	305 309 313 316 327 356 282 289 296 303	215 217 219 222 229 249 210 215 219 222	//2 LRFD 322 325 329 333 344 373 314 322 329 333	13 ASD 223 225 228 230 237 257 210 215 219 224	334 338 341 345 356 385 314 322 329 336
	L <sub>ev</sub> , in.  Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8 11/2	219 221 223 226 233 253 210 215 219	1/2 LRFD 328 332 335 339 350 379 314 322 329	13 ASD 227 229 232 234 241 261 210 215 219	340 344 347 351 362 391 314 322 329	195 198 200 203 210 230 188 193 197	L <sub>eh</sub> <sup>1</sup> /2  LRFD  293 297 300 304 315 344 282 289 296	7, in. 13 ASD 204 206 208 211 218 238 188 193 197	305 309 313 316 327 356 282 289 296	215 217 219 222 229 249 210 215 219	/2 LRFD 322 325 329 333 344 373 314 322 329	13 ASD 223 225 228 230 237 257 210 215 219	334 338 341 345 356 385 314 322 329
	L <sub>ev</sub> , in.  Coped at Top Flange Only	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2	219 221 223 226 233 253 210 215 219 224 233	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350	19 ASD 227 229 232 234 241 261 210 215 219 224 239	340 344 347 351 362 391 314 322 329 336 358	195 198 200 203 210 230 188 193 197 202 210	L <sub>eh</sub> <sup>1</sup> /2 LRFD 293 297 300 304 315 344 282 289 296 303 315	7, in.  13  ASD  204 206 208 211 218 238 188 193 197 202 217	305 309 313 316 327 356 282 289 296 303 325	215 217 219 222 229 249 210 215 219 222 229	1/2 LRFD 322 325 329 333 344 373 314 322 329 333 344	13 ASD 223 225 228 230 237 257 210 215 219 224 237	334 338 341 345 356 385 314 322 329 336 356
C	L <sub>ev</sub> , in.  Coped at Top Flange Only  Coped at Both Flanges	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes:	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684	19 ASD 227 229 232 234 241 261 210 215 219 224 239 261 456	340 344 347 351 362 391 314 322 329 336 358 391 684	195 198 200 203 210 230 188 193 197 202 210 230	L <sub>eh</sub> <sup>1</sup> /2 LRFD 293 297 300 304 315 344 282 289 296 303 315 344	204 204 206 208 211 218 238 188 193 197 202 217 238 419	305 309 313 316 327 356 282 289 296 303 325 356 629	215 217 219 222 229 249 210 215 219 222 229 249 456	/2 LRFD 322 325 329 333 344 373 314 322 329 333 344 373	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257	334 338 341 345 356 385 314 322 329 336 356 385
C	Lev, in.  Coped at Top Flange Only  Coped at Both Flanges  Uncoped  Support Availab Strength per	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD =	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684	14 ASD 227 229 232 234 241 261 215 219 224 239 261 456 ard holes	340 344 347 351 362 391 314 322 329 336 358 391 684	195 198 200 203 210 230 188 193 197 202 210 230	L <sub>eh</sub> <sup>1</sup> /2 LRFD 293 297 300 304 315 344 282 289 296 303 315 344	7, in.  13  ASD 204 206 208 211 218 238 188 193 197 202 217 238 419 N = The	305 309 313 316 327 356 282 289 296 303 325 356 629	215 217 219 222 229 249 210 215 219 222 229 249 456	/2 LRFD 322 325 329 333 344 373 314 322 329 333 344 373	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257	334 338 341 345 356 385 314 322 329 336 356 385
C	Lev, in.  Coped at Top Flange Only  Coped at Both Flanges  Uncoped  Support Availab Strength per Inch Thickness	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD = OVS =	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684	11 ASD 227 229 232 234 241 261 210 215 219 224 239 261 456 and holes ed holes	340 344 347 351 362 391 314 322 329 336 358 391 684	195 198 200 203 210 230 188 193 197 202 210 230 419	Leh <sup>4</sup> /2 LRFD 293 297 300 304 315 344 282 289 296 303 315 344 629	7, in.  13  ASD 204 206 208 211 218 238 188 193 197 202 217 238 419  N = Thi X = Thi	305 309 313 316 327 356 282 289 296 303 325 356 629	215 217 219 222 229 249 210 215 219 222 229 249 456	/2 LRFD 322 325 329 333 344 373 314 322 329 333 344 373	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257	334 338 341 345 356 385 314 322 329 336 356 385
C	Lev, in.  Coped at Top Flange Only  Coped at Both Flanges  Uncoped  Support Availab Strength per	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD = OVS =	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684	11 ASD 227 229 232 234 241 261 210 215 219 224 239 261 456 and holes ed holes	340 344 347 351 362 391 314 322 329 336 358 391 684	195 198 200 203 210 230 188 193 197 202 210 230 419	Leh <sup>4</sup> /2 LRFD 293 297 300 304 315 344 282 289 296 303 315 344 629	7, in.  13  ASD 204 206 208 211 218 238 188 193 197 202 217 238 419  N = Thi X = Thi	305 309 313 316 327 356 282 289 296 303 325 356 629	215 217 219 222 229 249 210 215 219 222 229 249 456	/2 LRFD 322 325 329 333 344 373 314 322 329 333 344 373	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257	334 338 341 345 356 385 314 322 329 336 356 385
C	Lev, in.  Coped at Top Flange Only  Coped at Both Flanges  Uncoped  Support Availab Strength per Inch Thickness kips/in.	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD = OVS = SSLT =	1/2 LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684 Standar Oversiz Short-s to direct	11 ASD 227 229 232 234 241 261 210 215 219 224 239 261 456 and holes lotted hotton of knues includes i	340 344 347 351 362 391 314 322 329 336 358 391 684	195 198 200 203 210 230 188 193 197 202 210 230 419	L <sub>eh</sub> <sup>1</sup> /2   LRFD   293   297   300   304   315   344   282   289   296   303   315   344   629	13 ASD 204 206 208 211 218 238 193 197 202 217 238 419 N = Th X = Th SC = Sli	305 309 313 316 327 356 282 289 296 303 325 356 629	215 217 219 222 229 249 210 215 219 222 229 249 456	72 LRFD 322 325 329 333 344 373 314 322 329 333 344 373 684	223 225 228 230 237 257 210 215 219 224 237 257 456	334 338 341 345 356 385 314 322 329 336 356 385
Ho Ty	Coped at Top Flange Only  Coped at Both Flanges  Uncoped Support Availabi Strength per Inch Thickness kips/in.	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD = OVS = SSLT =	1/2  LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684  Standar Oversiz Short-s to direct	11 ASD 227 229 232 234 241 261 215 219 224 239 261 456 rd holes ed holes lotted hotion of known includes include am length and lengt	340 344 347 351 362 391 314 322 329 336 358 391 684	ASD 195 198 200 203 210 230 188 193 197 202 210 230 419	Left 293 297 300 304 315 344 282 289 296 303 315 344 629	13 ASD 204 206 208 211 218 238 193 197 202 217 238 419 N = Thi X = Thi SC = Slii	305 309 313 316 327 356 282 289 296 303 325 356 629 reads increads exp critical	215 217 219 222 229 249 210 215 219 222 229 249 456 cluded cluded	72 LRFD 322 325 329 333 344 373 314 322 329 333 344 373 684	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257 456	334 338 341 345 356 385 314 322 329 336 356 385 684
C Ho	Lev, in.  Coped at Top Flange Only  Coped at Both Flanges  Uncoped Support Availab Strength per Inch Thickness kips/in.  Sile ASD I	13/8 11/2 15/8 2 3 11/4 13/8 11/2 15/8 2 3	219 221 223 226 233 253 210 215 219 224 233 253 456 Notes: STD = OVS = SSLT =	1/2  LRFD 328 332 335 339 350 379 314 322 329 336 350 379 684  Standar Oversiz Short-s to direct	11 ASD 227 229 232 234 241 261 215 219 224 239 261 456 rd holes ed holes lotted hotton of keues inclues inclues inclues inclues inclues all bott v	340 344 347 351 362 391 314 322 329 336 358 391 684	ASD 195 198 200 203 210 230 188 193 197 202 210 230 419	Left 293 297 300 304 315 344 282 289 296 303 315 344 629	13 ASD 204 206 208 211 218 238 193 197 202 217 238 419 N = Thi X = Thi SC = Slii	305 309 313 316 327 356 282 289 296 303 325 356 629 reads increads exp critical	215 217 219 222 229 249 210 215 219 222 229 249 456 cluded cluded	72 LRFD 322 325 329 333 344 373 314 322 329 333 344 373 684	13 ASD 223 225 228 230 237 257 210 215 219 224 237 257 456	334 338 341 345 356 385 314 322 329 336 356 385 684

$F_y = 50 \text{ ks}$ $F_u = 65 \text{ ks}$ $F_y = 36 \text{ ks}$ $F_u = 58 \text{ ks}$	i	A		Bolt C	e 10 ted on	Do ne	oub ctic	ole- ons	An		•		-in. olts
<b>▼</b>  10 = 00 KS	<u>'</u>			В	olt and	Angle .	Availab			•			
5 Rows	Bolt	Thi	read	Н	ole			,		ckness	<del></del>		
W00 07 04 04 40	Group	1	nd.	1	/pe		/4	<b></b>	16	<del> </del>	/8		/2
W30, 27, 24, 21, 18		ļ				ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		1	N	1	TD	77.2	116	96,5	145	116	174	154	232
	l	ļ	Χ		TD TD	77.2 77.2	116 116	96.5 96.5	145 145	116 115	174	154 115	232 173
	Group	8	SC	1	VS	69.1	104	86.3	129	98.2	147	98.2	147
Varies	A	Cla	ss A		SLT	77.2	116	96.5	145	115	173	115	173
633=12	^				TD	77.2	116	96.5	145	116	174	154	232
<u> </u>	1.	1	SC		VS	69.1	104	86,3	129	104	155.	138	207
1.3		Cla	ss B	1	SLT	77.2	116	96.5	145	116	174	154	232
3 T			N		TD	77.2	116	96.5	145	116	174	154	232
2			Χ	S	TD	77.2	116	96.5	145	116	174	154	232
	1	,	SC	1	TD	77.2	116	96.5	145	116	174	145	217
<u>*</u>	Group	1	ss A		VS	69.1	104	86.3	129	104	155	123	184
	В				SLT	77.2	116	96.5	145	116	174	145	217
		8	C		TD	77.2	116	96.5	145	116	174	154	232
		Cla	ss B	4	VS	69.1 77.2	104	.86.3 .96.5	129 145	104	155	138. 154	207
	l Da	11/-	L A.zail		SLT	•	116			116	174	134	232
	DE	am we			trength	per iii			KIPS/II	11.			
Hole Type			S	TD				VS			SS	LT	
							L <sub>eh</sub> *	', in.					
<i>L<sub>ev</sub>,</i> in.		1	1/2	1	3/4	11	/2	13	/4	11	/2	13	/4
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	11/4	182	273	190	285	163	244	<b>`171</b> ()	256	178	267	186	279
	1 <sup>3</sup> /8	184	277	193	289	165	247	173	260	180	271	189	283
Coped at Top	11/2	187	280	195	293	167	251	176	263	, 183	274	191	286
Flange Only	1 <sup>5</sup> /8	189	284	197	296	170	255	178	267	185	278	193	290
	2	197	295	205	307	177	266	185	278	193	289	201	301
	3	216	324	224	336	197	295	205	307	212	318	220	330
	1 <sup>1</sup> / <sub>4</sub> 1 <sup>3</sup> / <sub>8</sub>	173 178	260 267	173 178	260 267	155 160	232 239	155 160	232 239	173 178	260 267	173 178	260 267
Coped at Both	11/2	183	274	183	274	165	239	165	239	183	207 274	183	274
Flanges	15/8	188	282	188	282	169	254	169	254	185	278	188	282
						I VV.				4, 1, 24, 13,			301
		1000000		Contract of the contract of th		:177	266	184	276	193	289	ZUII	
	2 3	197. 216	295 324	202 224	303 336	-177 -197	266 295	184 205	276 307	193 212	289 318	201 220	330
Uncoped	2	197	295	202	303	sargers of the							
Uncoped Support Availal Strength per Inch Thicknes kips/in.	2 3 ole	197. 216 380 Notes: STD = OVS =	295 324 570 Standar Oversiz Short-s	202 224 380 rd holes ed holes	303 336 570	197 351	295 527	205 351 N = Th	307 527 reads increads ex	212 380 cluded cluded	318	220	330

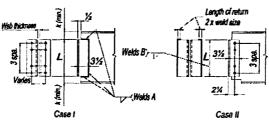
DESIGN TABLES 10-43

e Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$		A		3ol	ted	Do	cont oub	le-	An	gle	<b>)</b>		-in. olts
Angle	$F_y = 36 \text{ ksi}$	1				<i>,</i> 011		Guc	)I 13	1				
A	$F_u = 58 \text{ ksi}$				В	olt and	Angle	Availab	le Stre	ngth, k	ips			
	4 Rows	Bolt	The	read	н	ole			An	gle Thi	ckness	, in.		
-	104 04 40 46	Group	1	nd.	1	/pe		/4	<u> </u>	16		/8		/2
W	24, 21, 18, 16	ļ		••		•	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
				N X	1	TD TD	60.9 60.9	91.4 91.4	76.1 76.1	114 114	91.4 91.4	137 137	122 122	183 183
					+	TD	60.9	91.4	76.1	114	91.4	137	92.2	138
		Group	1	SC	1	VS	54,4	81.6	68.0	102	78.6	118	78.6	118
زا	Varios	Α	Ula	ss A		SLT	60.9	91.4	76.1	114	91.4	137	92.2	138
			5	SC SC	1	TD	60.9	91.4	76.1	114	91.4	137	122	183
			1	ss B	,	VS	54.4	81.6	68.0	102	81.6	122	109	163
	La mar.			N	<del></del>	<u>slt</u> TD	60.9	91.4 91.4	76.1 76.1	114	91.4 91.4	137 137	122 122	183 183
1			1	X	•	TD	60.9	91.4	76.1	114	91.4	137	122	183
6-69	<u></u>				<del></del>	TD	60,9	91.4	76,1	114	91.4	137	116	174
3	<u> </u>	Group	I	SC ss A		VS	54.4	81.6	68.0	102	81.6	122	98.6	148
		В	Cia			SLT	60.9	91.4	76.1	114	91.4	137	116	174
			S	C		TD	60.9	91.4	76.1	114	91.4	137	122	183
			Cla	ss B	1	VS Slt	54.4 60.9	81.6 91.4	68.0 76.1	102 114	81.6 91.4	122 137	109 t. 122	163 183
		l Ro	ı am We	h Avai				ch Thic				13/	122	103
<u> </u>			<u> </u>		TD			0\				SS	LT	
	Hole Type						1	L <sub>eh</sub> *		!				
	<i>L<sub>ey</sub>,</i> in.		11	1/2	1	3/4	11	//2	1 <sup>3</sup>	/4	11	//2	13	/4
	Ley, III.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		11/4	145	218	154	230	130	194	138	207	141	212	150	224
		1 <sup>3</sup> /8	148	222	156	234	132	198	140	210	144	216	152	228
	oped at Top	1 <sup>1</sup> / <sub>2</sub>	150	225	158	238	134	202	143	214	146	219	154	232
•	Flange Only	1 <sup>5</sup> /8 2	153 160	229 240	161 168	241 252	137 144	205 216	145 152	218 229	149 156	223 234	157 164	235 246
		3	180	269	188	282	164 164	246	172	258	176	263	184	275
		11/4	137	205	137	205	122	183	122	183	137	205	137	205
		1 <sup>3</sup> /8	141	212	141	212	127	190	127	190	141	212	141	212
Co	oped at Both	11/2	146	219	146	219	132	197	132	197	146	219	146	219
	Flanges	1 <sup>5</sup> /8	151	227	151	227	137	205	137	205	149	223	151	227
		2	160	240	166	249	144	216	151	227	156	234	164	246
	Unconed	3	180	269	188	282	164	246	172	258	176	263	184	275
	Uncoped	la	305	457	305	457	283	424	283	424	305	457	305	457
	Support Availabl Strength per Inch Thickness kips/in.		0VS =	Short-s	ed holes	les trans	sverse	;	X = Thr	reads inc reads exc o critical				
Hol Typ	e ASU '	.RFD			ues inclu eam lenç		. reduction	on in end	distanc	e, L <sub>eh</sub> , to	accour	nt for pos	sible	
STE	J 603	914 848	Note: S been a	lip-critic dded to	al bolt v distribut	alues as e loads i	sume no n the fille	more tha	an one f	ller has	been pro	ovided or	bolts ha	ave

$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$ $F_u = 58 \text{ ksi}$		A		3oli	ted	)-1 (i Do	oub	le-	An	gle	<b>;</b>		-in. olts
				В	olt and	Angle A	Availab	le Stre	ngth, k	ips			
3 Rows	Bolt	The	read	н	ole			An	gle Thi	ckness	, in.	,	
W18, 16, 14, 12, 10 <sup>+</sup> *Ltd. to W10x12, 15, 17,	Group		nd.	1	rpe	<u></u>	/4	ļ	16		/B	ļ	/2
19, 22, 26, 30	ļ <u>.</u>	ļ				ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			N		TD	44.6	66.9	55.7	83.6	66.9	100	89.2	134
		<u> </u>	<u>X</u>	<del></del>	TD	44.6	66.9	55.7	83.6	66.9	100	89.2	134
	Croun	8	SC		TD VS	44.6 39.7	66.9 59.5	55.7 49.6	83.6 74.4	66.9 58.9	100 88.2	69.2 58,9	104 88.2
Varine	Group A	Cla	ss A	1	vs SLT	44.6	66.9	49.0 55.7	83.6	66.9	100	69.2	104
	^	ļ			TD	44.6	66.9	55.7	83.6	66.9	100	89.2	134
3		l .	C		VS	39.7	59.5	49.6	74.4	59.5	89.3	79.4	119
13	Ì	Cla	ss B	1	SLT	44.6	66.9	55.7	83.6	66.9	100	89.2	134
3 1 4			N	<del></del>	TD	44.6	66.9	55.7	83.6	66.9	100		134
		:	X		TD	44.6	66.9	55.7	83.6	66.9	100	89.2	134
3 3	Ì		SC .	S	TD	44.6	66.9	55.7	83.6	66.9	100	86.8	130
3	Group	1	ss A	1	VS	39.7	59.5	49.6	74.4	,59.5	89.3	74.0	111
	В	Cia	33 N		SLT	44.6	66.9	55.7	83.6	66.9	100	86.8	130
		l s	C	i	TD	44.6	66.9	55.7	83.6	66.9	100	89.2	134
			ss B		VS	39.7	59.5	49.6	74.4	59.5	89.3	79.4	119
	<u> </u>			•	SLT	44.6	66.9	55.7	83.6	66.9	100	89.2	134
·	Re	am we			trengtn	per In			KIPS/II	n. ·			
Hole Type			S	TD		<u> </u>		/S			SS	SLT	
							L <sub>eh</sub> *	', in.					
L <sub>ev</sub> , in.		11	1/2	1	3/4	11	/2	13	/4	1	1/2	13	/4
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	11/4	109	163	117 <sub>5</sub> .	176	96.7	145	105	157	105	157	113	169
		111	167	119	179	99.1	149	107	161	107	161	115	173
Coped at Top		114		122		102	152	110		110	165	118	177
Flange Only	1 <sup>5</sup> /8	116	174	124	186	104	156	112	168	112	168	120	180
	2	124	185	132	197	111	167	119	179	119	179	128	191
	3	143 /	215	151	227	131	196	139	208	139	208	147	221
	11/4	99.9	150	99.9	150	89.0	133	89.0	133	99.9	150	99.9	150
Coped at Both	1 <sup>3</sup> /8 1 <sup>1</sup> / <sub>2</sub>	105 110	157 165	105 110	157 165	93.8 98.7	141 148	93.8 98.7	141 148	105 110	157 165	105 110-	157 165
Flanges		115	172	115	172	104	155	104	155	112	168	115	172
langoo	2	124	185	129 :	194	111	167	118	177	119	179	128	191
	3	143	215	151	227	131	196	139	208	139	208	147	221
Uncoped		229	344	229	344	215	322	215	322	229	344	229	344
Support Availab Strength per Inch Thickness kips/in.	,	Notes: STD = OVS =	Standar Oversiz Short-s to direc	rd holes ed holes	les trans	sverse		N = Thr	reads inc reads ex	cluded			
Note	687 644	under Note: S	rrun in b Slip-critic	eam lenç al bolt v	gth. alues as	. reducti sume no n the fill	more th					ssible r bolts h	ave

Angle Beam	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$ $F_y = 36 \text{ ksi}$		A		Bolt	ted	)-1 (   Do ne	ouk	ole-	An	gle	)	•	-in. olts
A	$F_u = 58 \text{ ksi}$				В	olt and	Angle	Availat	le Stre	ngth, k	ips			
	2 Rows	Dall	Th		Ι.,		Γ		An	gle Thi	ckness	s, in.		
		Bolt Group		read ond.	1	ole /pe	1	/4	5	16	3	3/8	1	/2
	W12, 10, 8	Сисир		····			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
			1	N		TD	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
l				<u>X</u>		TD TD	28.3	42.4	35.3 35.3	53.0	42.4		56.6 46.1	84.8
		Group	5	SC		VS	28.3 25.0	42.4 37.5	31.3	53.0 46.9	42.4 37.5	63.6 56.3	39.3	69.2 58.8
		A	Cla	ss A		SLT	28.3	42.4	35.3	53.0	42.4	63.6	46.1	69.2
l r	aries !	''	ļ	·		TD	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
	31		1	SC ss B	. 0	VS	25.0	37.5	31,3	46.9	37.5	56.3	50.0	75.0
	Las max.				<del></del>	SLT	28.3	42.4	35.3	53.0	42.4		56.6	84.8
£	T		•	N		TD	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
] a	+ -			<u>X</u>		TD	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
15		Croup	8	C		TD VS	28.3 25.0	42.4 37.5	35.3	53.0 46.9	42.4 37.5	63.6 56.3	56.6 49.3	84.8 73.8
1		Group B	Cla	ss A		SLT	28.3	42.4	31,3 35.3	53.0	42.4	63.6	56.6	84.8
						TD	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
				SC _	3	VS	25.0	37.5	31.3	46.9	37.5	56.3	50.0	75.0
			Cla	ss B		SLT	28.3	42.4	35.3	53.0	42.4	63.6	56.6	84.8
		Ве	am We	b Avai	lable S	trength	per In	ch Thic	kness,	kips/i	n.			
	Uolo Tuno			S	TD			0'	vs			SS	LT	
	Hole Type							L <sub>eh</sub> ¹	', in.					
	L <sub>ev</sub> , in.		11	1/2	1:	3/4	1	1/2	12	1/4	1	1/2	13	/4
	Lev, III.		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		11/4	72.3	1	80.4	121	63.8		71.9		68.3	102	76.4	115
		1 <sup>3</sup> /8	74.8	ì	82.9	124	66.2		. 74.3		and the second second	106	78.8	
	oped at Top	11/2			85.3		68.7		76.8		73.1	110	81.3	
	Flange Only	1 <sup>5</sup> /8	79.6		÷ 87,8		71.1	4	79.2		75.6	1	83.7	
		2	86.9	1	95.1		78.4		86,5		82.9	1	91.0	
		3 1 <sup>1</sup> /4	106 63.4	160 95.1	115	172	97.9		106	159	102	154	111 63.4	166
		1 <sup>-</sup> /4 1 <sup>3</sup> /8	68.3		63.4 68.3		56.1 60.9		56.1 60.9	84.1 91.4	63.4 68.3	95.1 102	68.3	
C	oped at Both	11/2	73.1		73.1	1	65.8		65.8	98.7	73.1		73.1	
	Flanges	1 <sup>5</sup> /8	78.0		78.0		70.7		70.7		75.6		78.0	
	-	2	86.9		92.6		78.4		3.55 - 55 NA 11		82.9		91.0	,
L		3	106	160	115	172	97.9		106	159	102	154	200 A 200 A	166
	Uncoped		154	230	154⊡	230	146	219	146	219	154	230	154	230
	Support Availab Strength per Inch Thickness kips/in.		OVS =	Short-s	rd holes ed holes lotted ho tion of lo	oles trans	sverse			reads ind reads ex o critical	cluded			
Hol Typ	e ASU '	RFD			ues inclu eam leng		. reducti	on in en	d distan	ce, <i>L<sub>eh</sub></i> , t	o accou	nt for po	ssible	
STE	ı 🥍 📜	461 439					sume no n the fille		an one f	iller has	been pr	ovided o	r bolts ha	ave

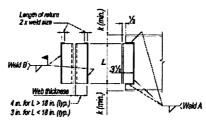
## Table 10-2 Available Weld Strength of Bolted/Welded Double-Angle Connections



			Welds A	(70 ksi)			Welds	B (70 ksi)	
	. :_		$R_n/\Omega$	φ <i>R</i> <sub>n</sub>	Minimum		$R_n/\Omega$	φ <b>R</b> <sub>n</sub>	Minimum
n	L, in.	Weld Size in	kips	kips	Web Thickness,	Weld Size in	kips	kips	Support
		Size, in.	ASD	LRFD	in.	Size, in.	ASD	LRFD	Thickness, in.
12	35 <sup>1</sup> / <sub>2</sub>	5/16	393	589	0.476	3/8	366	550	0.286
		1/4	314	471	0.381	5/ <sub>16</sub>	305	458	0.238
		<sup>3</sup> / <sub>16</sub>	236	353	0.286	1/4	244	366	0.190
11	321/2	<sup>5</sup> / <sub>16</sub>	365	548	0.476	3/8	331	496	0.286
		1/4	292	438	0.381	<sup>5</sup> /16	276	414	0.238
		3/ <sub>16</sub>	219	329	0.286	1/4	221	331	0.190
<u>;</u> 10	29 <sup>1</sup> / <sub>2</sub>	5/16	337	505	0.476	3/8	295	443	0.286
		1/4	269	404	0.381	5/16	246	369	0.238
		3/16	202	303	0.286	1/4	197	295	0.190
.9	26 <sup>1</sup> / <sub>2</sub>	5/16	309	463	0.476	3/8	259	389	0.286
		1/4	247	371	0.381	5/16	216	324	0.238
		3/ <sub>16</sub>	185 💯	278	0.286	1/4	173	259	0.190
<b>⊹8</b>	231/2	5/16	281	422	0.476	3/8	223	335	0.286
•		1/4	225	337	0.381	<sup>5</sup> /16	186	279	0.238
		3/16	169	253	0.286	1/4	149	223	0.190
7	201/2	<sup>5</sup> /16	253	379	0.476	3/8	187	280	0.286
ļ		1/4	202	303	0.381	5/16	156	234	0.238
ļ		<sup>3</sup> / <sub>16</sub>	152	227	0.286	1/4	125	187	0.190
6	171/2	5/ <sub>16</sub>	222	334	0.476	3/8	: 150	226	0.286
		1/4	178	267	0.381	5/16	125	188	0.238
		<sup>3</sup> /16	133	200	0.286	1/4	3100 🗐	150	0.190
5	141/2	5/16	191	287	0.476	3/8	115	172	0.286
		1/4	153	229	0.381	5/16	95.5	143	0.238
		<sup>3</sup> / <sub>16</sub>	7115	172	0.286	1/4	76.4	115	0.190
4	111/2	5/16	158	237	0.476	3/8	79.9	120	0.286
		1/4	127	190	0.381	5/16	66.6	99.9	0.238
		3/16	95.0	142	0.286	1/4	53.3	79.9	0.190
3	81/2	5/16	122	184	0.476	3/8	48.1	72.2	0.286
	]	1/4	98,0	147	0.381	5/16	40.1	60.2	0.238
1		3/16	73.5	110	0.286	1/4	32.1	48.1	0.190
2	5 <sup>1</sup> / <sub>2</sub>	5/16	83.7	125	0.476	3/8	21.9	32.8	0.286
	- '-	1/4	66.9	100	0.381	5/16	18.2	27.3	0.238
		3/16	50.2	75.3	0.286	1/4	14.6	21.9	0.190
ASD	LRFD	1	pag (B) — Elber (Sp.)		<u> </u>	!	raterati Na	Be	am
$\Omega = 2.00$	φ = 0.75	1						$F_{y} = 50 \text{ ksi}$	
36 - E.UU	ψ0.13							'y - 50 k31	. u = 00 kai

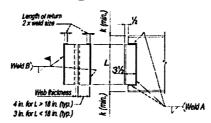
DESIGN TABLES 10-47

## Table 10-3 Available Weld Strength of All-Welded Double-Angle Connections



		Weld	s A (70 ksi	)		Welds	B (70 ksi)	
L, in.	Weld	$R_n/\Omega$	φ <b><i>R</i></b> <sub>n</sub>	Minimum	Weld	$R_n/\Omega$	φ <b>R</b> n	Minimum
£, III.	Size, in.	kips	kips	Web	Size, in.	kips	kips	Web
	Oize, iii.	ASD	LRFD	Thickness, in.	3126, 111.	ASD	LRFD	Thickness, in.
36	<sup>5</sup> /16	397	596	0.476	3/8	372	558	0.286
	1/4	318	477	0.381	5/16	310	465	0.238
	<sup>3</sup> / <sub>16</sub>	238	357	0.286	1/4	248	372	0.190
34	5/16	379	568	0.476	3/8	349	523	0.286
	1/4	303 🗎	455	0.381	5/16	291	436	0.238
	<sup>3</sup> / <sub>16</sub>	227	341	0.286	1/4	232	349	0.190
32	<sup>5</sup> / <sub>16</sub>	360	541	0.476	3/8	325	487	0.286
	1/4	288	432	0.381	<sup>5</sup> /16	271	406	0.238
	<sup>3</sup> /16	216	324	0.286	1/4	. 217:≘	325	0.190
30	<sup>5</sup> / <sub>16</sub>	341 ⋅	512	0.476	3/8	301	452	0.286
	1/4	273	410	0.381	5/16	251	377	0.238
	<sup>3</sup> /16	205	307	0.286	1/4	201	301	0.190
28	5/16	323	484	0.476	3/ <sub>8</sub>	277	416	0.286
	1/4	258	387	0.381	5/16	231	347	0.238
	<sup>3</sup> / <sub>16</sub>	194	291	0.286	1/4	185	277	0.190
26	5/16	304	457	0.476	<sup>3</sup> /8	253	380	0.286
	1/4	243	365	0.381	<sup>5</sup> /16	211	317	0.238
	<sup>3</sup> /16	183	274	0.286	1/4	169	253	0.190
24	5/16	286	429	0.476	3/8	229	344	0.286
	1/4	229	343	0.381	<sup>5</sup> / <sub>16</sub>	191	286	0.238
	3/16	171	257	0.286	1/4	153	229	0.190
22	5/16	267	401	0.476	3/8	205	308	0.286
	1/4	214	321	0.381	<sup>5</sup> / <sub>16</sub>	171	256	0.238
	<sup>3</sup> /16	160	240	0.286	1/4	137	205	0.190
20	<sup>5</sup> /16	248	372	0.476	3/8	€ 181	271	0.286
i	1/4	198	297	0.381	5/16	151	226	0.238
	<sup>3</sup> / <sub>16</sub>	149	223	0.286	1/4	121	181	0.190
18	<sup>5</sup> /16	227	341	0.476	3/8	157	235	0.286
j	1/4	182	273	0.381	<sup>5</sup> / <sub>16</sub>	`130	196	0.238
	3/16	136	205	0.286	1/4	104	157	0.190
16	<sup>5</sup> /16	207	310	0.476	3/8	148	222	0.286
l	1/4	166	248	0.381	5/16	123	185	0.238
: 1	<sup>3</sup> / <sub>16</sub>	124	186	0.286	1/4	98.5	148	0.190
ASD	LRF	D					E	Seam .
$\Omega = 2.00$	φ=0	.75				Ī	<i>F</i> <sub>y</sub> = 50 ksi	$F_u = 65 \text{ ksi}$

## Table 10-3 (continued) Available Weld Strength of All-Welded Double-Angle Connections



		Weld	s A (70 ksi	)		Welds	B (70 ksi)	
<i>L</i> , in.	Wold	$R_n/\Omega$	φRn	Minimum	Wold	$R_n/\Omega$	φ <b>R</b> n	Minimum
L, III.	Weld Size, in.	kips	kips	Web	Weld Size, in.	kips	kips	Web
	3126, 111.	ASD	LRFD	Thickness, in.	512e, III.	ASD	LRFD	Thickness, in.
14	<sup>5</sup> /16	186	279	0.476	3/8	123	185	0.286
	1/4	149	223	0.381	5/16	∴103	154	0.238
	3/16	1,11	167	0.286	1/4	82.3	123	0.190
12	5/16	164	246	0.476	3/8	99.3	149	0.286
	1/4	131	197	0.381	5/16	82.8	124	0.238
	3/16	98.5	148	0.286	1/4	66.2	99.3	0.190
10	5/16	141	211	0.476	3/8	75.7	113	0.286
	1/4	112	169	0.381	<sup>5</sup> /16	63.1	94.6	0.238
	<sup>3</sup> / <sub>16</sub>	84,3	127	0.286	1/4	50.4	75.7	0.190
9	<sup>5</sup> /16	129	193	0.476	3/8	64.2	96 3	0.286
	1/4	103	154	0.381	<sup>5</sup> / <sub>16</sub>	53.5	802	0.238
	<sup>3</sup> / <sub>16</sub>	77.2	116	0.286	1/4	42.8	642	0.190
8	<sup>5</sup> /16	116	174	0.476	3/8	53.0	79.5	0.286
	1/4	92.9	139	0.381	5/16	44.2	66.3	0.238
	<sup>3</sup> /16	69.7	105	0.286	1/4	35,4	53.0	0.190
7	<sup>5</sup> /16	103	155	0.476	3/8	42.4	63.6	0.286
	1/4	82.6	124	0.381	5/16	35,3	53.0	0.238
	<sup>3</sup> / <sub>16</sub>	62.0	92.9	0.286	1/4	28.3	42.4	0.190
6	5/ <sub>16</sub>	90.4	136	0.476	3/8	32.5	48.7	0.286
	1/4	72.3	108	0.381	<sup>5</sup> / <sub>16</sub>	27.0	40.6	0.238
	<sup>3</sup> /16	54.2	81.3	0.286	1/4	21.6	32.5	0.190
5	<sup>5</sup> /16	77,1	116	0.476	3/8	23.4	35.1	0.286
	1/4	61.7	92.6	0.381	5/16	19.5	29.2	0.238
	<sup>3</sup> /16	46.3	69.4	0.286	1/4	⊟,15.6	23.4	0.190
4	5/16	64.2	96.3	0.476	3/8	15.5	23.2	0.286
	1/4	51.4	<b>7</b> 7.0	0.381	5/16	12.9	19.3	0.238
	3/ <sub>16</sub>	38.5	57.8	0.286	1/4	10.3	15.5	0.190
ASD	LRF	D					В	eam
$\Omega = 2.00$	φ = 0	.75				Ī	$F_y = 50$ ksi	<i>F</i> <sub>u</sub> = 65 ksi

#### SHEAR END-PLATE CONNECTIONS

A shear end-plate connection is made with a plate length less than the supported beam depth, as illustrated in Figure 10-6. The end plate is always shop-welded to the beam web with fillet welds on each side and usually field-bolted to the supporting member. Welds connecting the end plate to the beam web should not be returned across the thickness of the beam web at the top or bottom of the end plate because of the danger of creating a notch in the beam web.

If the end plate is field-welded to the support, adequate flexibility must be provided in the connection. Line welds are placed along the vertical edges of the plate with a return at the top per AISC *Specification* Section J2.2b. Note that welding across the entire top of the plate must be avoided as it would inhibit the flexibility and, therefore, the necessary end rotation of the connection. The performance of the resulting connection would not be as intended for simple shear connections.

#### **Design Checks**

The available strength of a shear end-plate connection is determined from the applicable limit states for bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). Note that the limit state of shear rupture of the beam web must be checked along the length of weld connecting the end plate to the beam web. In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n$ .

#### **Recommended End-Plate Dimensions and Thickness**

To provide for stability during erection, it is recommended that the minimum end-plate length be one-half the *T*-dimension of the beam to be supported. The maximum length of the end plate must be compatible with the clear distance between the flanges of an uncoped beam and the remaining clear distance of a coped beam.

To provide for flexibility, the combination of plate thickness and gage should be consistent with the recommendations given previously for a double-angle connection of similar thickness and gage.

#### **Shop and Field Practices**

When framing to a column web, the associated constructability considerations should be addressed (see the preceding discussion under "Constructability Considerations").

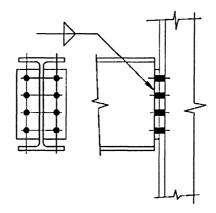


Fig. 10-6. Shear end-plate connections.

When framing to a column flange, provision must be made for possible mill variation in the depth of the columns, particularly in fairly long runs (i.e., six or more bays of framing). The beam length can be shortened to provide for mill overrun with shims furnished at the appropriate intervals to fill the resulting gaps or to provide for mill underrun. Shear end-plate connections require close control in cutting the beam to the proper length and in squaring the beam ends such that both end plates are parallel, particularly when beams are cambered.

#### **DESIGN TABLE DISCUSSION (TABLE 10-4)**

#### Table 10-4. Bolted/Welded Shear End-Plate Connections

Table 10-4 is a design aid for shear end-plate connections bolted to the supporting member and welded to the supported beam. Available strengths are tabulated for supported and supporting member material with  $F_y = 50$  ksi and  $F_u = 65$  ksi, and end-plate material with  $F_y = 36$  ksi and  $F_u = 58$  ksi. Electrode strength is assumed to be 70 ksi. All values, including slip-critical bolt available strengths, are for comparison with the governing LRFD or ASD load combination.

Tabulated bolt and end-plate available strengths consider the limit states of bolt shear, bolt bearing on the end plate, shear yielding of the end plate, shear rupture of the end plate, and block shear rupture of the end plate. Values are included for 2 through 12 rows of  $^{3}/_{4-in}$ ,  $^{7}/_{8-in}$ , and 1-in.-diameter Group A and Group B bolts at 3-in. spacing. End-plate edge distances,  $L_{ev}$  and  $L_{eh}$ , are assumed to be  $1^{1}/_{4}$  in.

Tabulated weld available strengths consider the limit state of weld shear assuming an effective weld length equal to the end-plate length minus twice the weld size. The tabulated minimum beam web thickness matches the shear rupture strength of the web material to the strength of the weld metal. As derived in Part 9, the minimum supported beam web thickness for two lines of weld is

$$t_{min} = \frac{6.19D}{F_{u}} \tag{9-3}$$

where D is the number of sixteenths-of-an-inch in the weld size. When less than the minimum material thickness is present, the tabulated weld available strength must be reduced by the ratio of the thickness provided to the minimum thickness.

Tabulated supporting member available strengths, per in. of flange or web thickness, consider the limit state of bolt bearing.

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# Table 10-4 Bolted/Welded Shear End-Plate Connections

 $\frac{3}{4}$ -in. Bolts 12 Rows  $L = 35^{1/2}$  in.

		Bort and	End-Plate A	valiable 5ti	engui, kips			
Boit	Thread	Hole			End-Plate T	hickness, i	n.	
Group	Cond.	Туре	1	/4	5/	16		<sup>3</sup> /8
а.оар	N   STD   197   295   246   369   28	ASD	LRFD					
	N	STD	197	295	246	<b>3</b> 69	286	430
	Х	STD	197	295	246	369	295	443
		STD	152	228	. 152	228	152	228
Group A	SC Class A	ovs	129	194	129	194	129	194
aloup A		SSLT	152	228	152	228	152	228
		STD	197	295	246	369	253	380
	SC Class B	OVS	196	294	216	323	216	323
		SSLT	195	293	244	366	253	380
	N	STD	197	295	246	369	<u> </u>	443
	X	STD	197	295	246	369	295	443
		STD	190 🕯	285	190 😅	285	190	285
Group B	SC Class A	OVS	:: 162	242	162	242	1,62	242
aroup D		SSLT	190	285	190	285	190	285
		STD	197	295	246	369	295	443
	SC Class B	OVS	196	294	245	367	270	403
		SSLT	195	293	244	366	293	440
١	Weld and Beam \	Web Availa	ble Strengti	ı, kips		Sup	port Avail	able
70-ksi Weld	Minimu	ım Poom V	Voh	$R_n/\Omega$	φ <b>R</b> n		ength per	
Size, in.			-	kips	kips	Thi	ckness, ki	p/in.
				ASD	LRFD	ASD	Ť.	LRFD
<sup>3</sup> / <sub>16</sub>		0.286	ļ	196	293			
1/4		0.381		260	390		701 (1998) 2 4 2 2 2 3 2 1 1 2 4 1	0110
<sup>5</sup> /16		0.476		324	486	1400		2110
3/8	:	0.571		387	581			
TD = Standard h	oles	N	= Threads inc	or sections		End-Pla	te	Beam
IVS = Oversized to SLT = Short-slotted to direction	ed holes transverse	Х	= Threads exc = Slip critical		Ī	F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k	si /	y = 50 ksi u = 65 ksi

 $L = 32^{1/2}$  in.

### Table 10-4 (continued) 3/4-in. Bolts 11 Rows Bolted/Welded Shear End-Plate **Connections**

W44, 40

	1	1	1	ailable Str		.1.1		
Bolt	Thread	Hole			End-Plate Ti	<u>-</u>	/	
Group	Cond.	Туре	1/		5/-	16	3	/B
			ASD	LRFD	ASD	LRFD	ASD	LRFI
	N	STD	<b>, 181</b> · ·	271	226	338	263	394
	X	STD	181	271	226	338	271	406
		STD	139	209	139	209	139	209
Group A	SC Class A	ovs	119	178	119	178	.∝ 119	178
aroup A		SSLT	139	209	139	209	<b>139</b>	209
		STD	181	271	226	338	232	348
	SC Class B	OVS	180	269	198	296	198	296
		SSLT	179	269	224	336	232	348
	N	STD	181,	271	226	338	271	406
	X	STD	i≩ 181 →	271	226	338	271	406
		STD	174	261	174	261	174	261
Group B	SC Class A	OVS	148	222	148	222	148	222
dioup b		SSLT	174	261	174	261	174	261
		STD	181	271	226	338	271	406
	SC Class B	ovs	180	269	225	337	247	370
		SSLT	179	269	224	336	269	403
V	Veld and Beam \	Neb Availa	ble Strength	ı, kips		Sup	port Availa	ble
70-ksi Weld	861-1	ım Beam V	Vah.	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength per l	
Size, in.		im beam v kness, in.	ven	kips	kips	Thi	ckness, kip	/in.
O120, III.		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		ASD 1	LRFD	ASD		LRFD
3/16		0.286		179	268		6	_
1/4		0.381		238	356			1000
5/16		0.476		296	444	1290		1930
3/8		0.571		354	530			
TD = Standard ho		N	= Threads incl	uded		End-Pla	te	Beam
VS = Oversized h LT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded	Ī	F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k	isi Fy	= 50 ks = 65 ks

DESIGN TABLES 10-53

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# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

 $\frac{3}{4}$ -in. Bolts 10 Rows  $L = \frac{29}{2}$  in.

		Bolt and	<b>End-Plate Av</b>	<u>railable</u> St	rength, kips			
DelA	Thursday				End-Plate Ti	nickness, i	n.	
Bolt Group	Thread Cond.	Hole Type	1/	/4	5/	16		3/8
uloup	Gona.	Type	ASD	LRFD	ASD	LRFD	ASD	LRF
	N	STD	164	246	205	308	239	35
	X	STD	<b>£164</b>	246	205	308	246	37
		STD	127	190	127	190	127	19
Group A	SC Class A	OVS	108	161	108	161	108	16
aloup A		SSLT	127	190	127	190	127	19
		STD	164	246	205	308	211	31
	SC Class B	OVS	163	245	180	269	180	26
		SSLT	163 🖫	244	204	306	211	31
	N	STD	164	246	<b>± 205</b>	308	246	37
4	X	STD	164	246	205	308	<b>£ 246</b>	37
		STD	158	237	158	237	158	23
Group B	SC Class A	ovs	135	202	135	202	135	20
alopp b		SSLT	158	237	158	237	158	23
;		STD	164	246	205	308	. 246	370
i	SC Class B	ovs	163	245	204	306	225	33
		SSLT	163	244	204	306	244	36
V	<b>Veld and Beam </b> \	Neb Availa	ble Strength	, kips		Su	pport Av	ailable
70-ksi Weld	Minimu	ım Beam V	Vah	$R_n/\Omega$	φ <i>R<sub>n</sub></i>		ength pe	
Size, in.		:kness, in.		kips	kips	Thi	ckness,	klp/in.
<b>,</b>				ASD	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		162	243			
1/4		0.381		215	323			4=00
<sup>5</sup> /16		0.476	],	268	402	1170		1760
3/8		0.571		320	480	artings :		
TD = Standard ho	= Standard holes N = Threads include					End-Pla	nte	Beam
VS = Oversized h ELT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded		F <sub>y</sub> = 36   F <sub>u</sub> = 58	ksi ksi	$F_y = 50 \text{ kg}$ $F_u = 65 \text{ kg}$

in the fillers.

9 Rows  $L = 26^{1/2}$  in.

#### Table 10-4 (continued) 3/4-in. Bolts Bolted/Welded **Shear End-Plate Connections**

W44, 40, 36, 33

			1	1	End-Plate Th	ickness, i	n.	
Bolt Group	Thread Cond.	Hole Type	1,	/4	5/-	6	3	/8
dioup	Conu.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRF
	N	STD	148	222	185	278	215	322
	X	STD	148	222	185	278	222	333
		STD	114	171	114	171	114	171
Group A	SC Class A	OVS	97.1	145	97.1	145	97.1	145
divup A		SSLT	114	171	114	171	114	171
		STD	∷148	222	185	278	190	285
	SC Class B	OVS	147	221	162	242	<b>,</b> 162	242
		SSLT	147 🚉	220	183	275	190	285
	N	STD	148	222	185	278	≥222.	333
	X	STD	148	222	185	278	222	333
		STD	142	214	- 142	214	142	214
Group B	SC Class A	OVS	121	182	£ 121	182	-121	182
aroup b		SSLT	142	214	142°	214	142	214
		STD	148	222	≥185	278	222	333
	SC Class B	OVS	147	221	, 184	276	-202	303
		SSLT	147 🤄	220	183	275	220	330
V	Veld and Beam \	Neb Availa	ble Strengtt	ı, kips			pport Availa	
70-ksi Weld	Minimu	m Beam V	Veh	$R_0/\Omega$	φ <b>R</b> n		ength per l	
Size, in.		kness, in.	_	kips	kips		ckness, kip	/in.
				ASD	LRFD	ASD	\$ \$1.1	LRFD
<sup>3</sup> / <sub>16</sub>		0.286		145	218			
1/4		0.381		193	290	4050		1500
<sup>5</sup> / <sub>16</sub>		0.476		240	360	1050		1580
3/8		0.571		287	430			
TD = Standard he	oles	N	= Threads inc	luded	! :	End-Pla	ite	Beam
VS = Oversized h LT = Short-slotte	oles d holes transverse		= Threads exc = Slip critical	cluded		F <sub>V</sub> = 36 I		= 50 ks

W44, 40, 36, 33, 30

OVS = Oversized holes

SSLT = Short-slotted holes transverse

to direction of load

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

**Bolt and End-Plate Available Strength, kips** 

 $\frac{3}{4}$ -in. Bolts 8 Rows  $L = \frac{231}{2}$  in.

Bolt	Thread	Hole			End-Plate Ti	nickness, i	n.	
Group	Cond.	Туре	1	/4	5/	16	3/	<b>8</b>
aloup	Jona.	1,750	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N	STD	132	198	165	247	191	286
	X	STD	±132	198	165	247	198	297
		STD	101	152	101	152	101	152
Group A	SC Class A	OVS	86.3	129	86.3	129	86.3	129
aloup A		SSLT	101	152	101	152	101	152
		STD	132	198	165	247	169	253
	SC Class B	OVS	131	197	144	215	144	215
		SSLT	<b>-131</b>	196	163	245	169	253
	N	STD	132	198	165	247	⊴198 🥳	297
	X	STD	132	198	165	247	198	297
		STD	127	190	/ 127	190	127	190
Group B	SC Class A	OVS	108	161	108	161	108	161
Gloup D		SSLT	127	190	127	190	127	190
		STD	132	198	165	247	198	297
	SC Class B	OVS	131	197	164	246	180	269
		SSLT	131	196	163	245	196	294
V	Veld and Beam \	Neb Availa	ble Strengt	h, kips		Suj	port Availa	ble
70-ksi Weld	Minimu	m Beam V	Voh	$R_{\rm fl}/\Omega$	φ <i>R</i> <sub>n</sub>		ength per In	
Size, in.		:Kness, in.	- · · -	kips	kips	Thi	ckness, klp/	in.
,				ASD 🚐	LRFD	ASD		LRFD
<sup>3</sup> /16		0.286		129	193			
1/4		0.381		171	256			4 400
<sup>5</sup> /16		0.476		212	318	936		1400
3/8		0.571		253	380			
TD = Standard ho	oles	N	= Threads inc	luded		End-Pla	te E	Beam

Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.

 $F_y = 36 \text{ ksi}$ 

 $F_u = 58 \text{ ksi}$ 

 $F_{\nu} = 50 \text{ ksi}$ 

 $F_{\nu} = 65 \text{ ksi}$ 

X = Threads excluded

SC = Slip critical

 $\frac{3}{4}$ -in. Bolts 7 Rows  $L = 20^{1/2}$  in. Table 10-4 (continued)
Bolted/Welded
Shear End-Plate
Connections

W44, 40, 36, 33, 30, 27, 24

					End-Plate TI	hickness.	in.	
Bolt Group	Thread Cond.	Hole	1	/4	5/			3/8
aroup	Conu.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N	STD	116	174	145	217	167	251
	X	STD	118	174	- 145	217	174	260
		STD	₹88.6	133	88.6	133	88.6	133
Group A	SC Class A	OVS	75.5	113	75.5	113	75.5	113
dioup A		SSLT	88.6	133	88.6	133	88.6	133
		STD	116	174	145	217	148	221
	SC Class B	ovs	115	172	126	188	126	188
		SSLT	114	172	143	214	148	221
	N	STD	116	174	145	217.	174	260
	X	STD	116	174	145	217	174	260
		STD	111	166	111	166	111	166
Group B	SC Class A	OVS	94.4	141	<b>:</b> 94.4	141	94,4	141
dioup D		SSLT	111	166	111	166	111	166
		STD	116	174	145	217	174	260
	SC Class B	OVS	115	172	144	215	157	235
		SSLT	114	172	143	214	172	257
V	<b>Veld and Beam \</b>	Neb Availa	ble Strengt	h, kips		Su	pport Avai	lable
70-ksi Weld	Minimu	ım Beam V	Noh	$R_n/\Omega$	φR <sub>n</sub>		rength per	
Size, in.		:kness, in.		kips	kips	Th	ickness, k	ip/in.
				ASD	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		112	168			
1/4		0.381		. 148	223	010		1020
5/16		0.476		184	277	<b>3 819</b>		1230
3/8		0.571		220	330			
TD = Standard h	oles	N	= Threads inc	luded	<u> </u>	End-Pla	ate	Beam
VS = Oversized t SLT = Short-slotte to direction	ed holes transverse	-	= Threads exc = Slip critical	cluded	İ	F <sub>y</sub> = 36 F <sub>u</sub> = 58		<i>F<sub>y</sub> =</i> 50 ksi <i>F<sub>u</sub> =</i> 65 ksi

DESIGN TABLES 10–57

W44, 40, 36, 33, 30, 27, 24, 21

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

 $\frac{3}{4}$ -in. Bolts 6 Rows  $L = \frac{17}{2}$  in.

	,	- Dort and	End-Plate A					
Bolt	Thread	Hole			End-Plate Ti	hickness, i	n.	
Group	Cond.	Туре	1,	/4	5/	16	3	/B
aroup	301iu.	1,700	+ ASD	LRFD	ASD	LRFD	ASD	LRFD
	N	STD	99.5	149	124	187	143	215
	X	STD	99.5	149	124	187	149	224
		STD	75.9	114	75.9	114	75.9	114
Group A	SC Class A	ovs	64.7	96.8	64.7	96.8	64.7	96.8
Gloup A		SSLT	75.9	114	75.9	114	75.9	114
		STD	99.5	149	124	187	127	190
	SC Class B	OVS	98.6	148	108	161	108	161
		SSLT	98.2	147	123	184	127	190
	N	STD	. 99.5	149	£124	187	149	224
	X	STD	99.5	149	124	187	149	224
		STD	94.9	142	94.9	142	94.9	142
Group B	SC Class A	OVS	80.9	121	80.9	121	80.9	121
Group D		SSLT	94.9	142	94.9	142	94.9	142
		STD	99.5	149	124	187	149	224
	SC Class B	OVS	98.6	148	123	185	135	202
		SSLT	98.2	147	123	184	147	221
1	<b>Neld and Beam </b> \	Web Availa	able Strength	ı, kips			port Availa	
70-ksl Weld	Minim	ım Beam \	Noh	$R_n/\Omega$	φ <i>R<sub>n</sub></i>		ength per l	
Size, in.		ckness, in	1	kips	kips	Thi	ckness, kip	/in.
				ASD	LRFD	ASD		LRFD
3/16		0.286		95.4	143	团 續 "		
1/4		0.381		126	189	700		1050
5/16		0.476		157	235	702		1050
3/8		0.571		187	280			
TD = Standard h	oles	N	l = Threads inc	luded		End-Pla	ite	Beam
OVS = Oversized t	holes ed holes transverse		C = Threads exc C = Slip critical	cluded		$F_y = 36 \text{ I}$ $F_y = 58 \text{ I}$	ksi Fj	, = 50 ksi , = 65 ksi

Note: Slip-critical bolt values assume no more than one filler has been provided or bolts have been added to distribute loads in the fillers.

...,.,.,.....,,,,.,,,,...,,,...

 $L = 14^{1/2}$  in.

#### Table 10-4 (continued) 3/4-in. Bolts Bolted/Welded 5 Rows Shear End-Plate **Connections**

W30, 27, 24, 21,

			End-Plate Thickness, in.							
Bolt	Thread Cond.	Hole	1	/4		16		3/8		
Group	Conu.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFD		
	N	STD	2,83.3 ⊕	125	104	156	119	179		
	X	STD	83.3	125	104	156	125	187		
		STD	63.3	94.9	63.3	94.9	63,3	94.9		
Group A	SC Class A	OVS	53.9	80.7	53.9	80.7	53,9	80.7		
aloup A		SSLT	63.3	94.9	63.3	94.9	63.3	94.9		
		STD	83,3	125	104	156	105	158		
	SC Class B	OVS	82.4	124	89.9	134	89.9	134		
		SSLT	<b>. 82.0</b> 🔆	123	ີ 102	154	105	158		
	N	STD	83.3	125	.:104	156	125	187		
	X	STD	83.3	125	104	156	125	187		
		STD	₹79,1;	119	79.1	119	79.1	119		
Group B	SC Class A	OVS	67.4	101	67.4	101	<b>&gt;67.4</b>	101		
		SSLT	79.1	119	79.1	119	₹79.1	119		
:		STD	83,3	125	. 104	156	125	187		
	SC Class B	OVS	82,4	124	103	155	112	168		
		SSLT	82.0	123	<b>∷102</b>	154	123	184		
V	Veld and Beam \	<b>Neb Availa</b>	ble Strengt	· ·			ort Avail			
70-ksi Weld	Minimu	ım Beam V	Noh	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ngth per l			
Size, in.		ckness, in.		kips	kips	Thic	kness, ki	p/in.		
				ASD	LRFD	ASD	· 188	LRFD		
<sup>3</sup> / <sub>16</sub>		0.286		78.7	118					
1/4		0.381		₹104	156	585		878		
<sup>5</sup> /16		0.476		<b>=129</b>	193		iago.	010		
3/8		0.571		153	230					
STD = Standard ho	oles	N	= Threads inc	luded		End-Plat	e	Beam		
OVS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	cluded		F <sub>y</sub> = 36 ks F <sub>u</sub> = 58 ks	si /	y = 50 ksi u = 65 ksi		

W24, 21, 18, 16

**Bolt** 

to direction of load

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

**Bolt and End-Plate Available Strength, kips** 

1/4

Hole

**Thread** 

End-Plate Thickness, in.

5/16

 $F_u = 58 \text{ ksi}$ 

 $F_{\nu} = 65 \text{ ksi}$ 

 $\frac{3}{4}$ -in. Bolts 4 Rows  $L = \frac{11}{2}$  in.

3/8

Group	Cond.	Type		/ <del>*</del>		, o		70	
агоар	33.12.	.,,,,	ASD	LRFD	ASD	LRFD	ASD	LRFD	
	N	STD	67.1	101	83.9	126	95.5	143	
	X	STD	67.1	101	83.9	126	101	151	
		STD	<b>50.6</b>	75.9	50,6	75.9	50.6	75.9	
Cuaum A	SC Class A	ovs	,43.1	64.5	43.1	64.5	43.1	64.5	
Group A		SSLT	₹50.6	75.9	50.6	75.9	50.6	75.9	
		STD	67,1	101	83.9	126	84.4	127	
	SC Class B	ovs	65.3	97.9	71.9	108	71,9	108	
		SSLT	65.8	98.7	82.2	123	84.4	127	
•	N	STD	<b>∂67.1</b>	101	83.9	126.	101	151	
	х	STD	67.1	101	83.9	126	101	151	
		STD	63.3	94.9	÷ 63.3	94.9	63.3	94.9	
Group B	SC Class A	ovs	53.9	80.7	53.9	80.7	53.9	80.7	
		SSLT	63.3	94.9	63.3	94.9	63.3	94.9	
		STD	67.1	101	83.9	126	101,	151	
	SC Class B	OVS	65.3	97.9	81.6	122	89.9	134	
		SSLT	65.8	98.7	82.2	123	98.7	148	
V	Weld and Beam \	Web Availa	ble Strengt	h, kips		Suj	port Ava	ilable	
70 les: Weld		D V	W-6-	$R_n/\Omega$	φ <b>R</b> n		ength pe		
70-ksi Weld Size, in.		ım Beam V ckness, in.		kips	kips	Thi	ckness, k	dp/in.	
Oize, III.		ornoss, in.		ASD	LRFD	ASD		LRFD	
3/16		0.286		61.9	92.9				
1/4		0.381		81.7	123	400		700	
<sup>5</sup> /16		0.476		101	151	468	ħ.J	702	
3/8		0.571		120	180				
STD = Standard h			= Threads inc			End-Pla	te	Beam	
OVS = Oversized t SLT = Short-slotte	oles ed holes transverse		= Threads ex = Slip critical			F <sub>y</sub> = 36 !	csi	<i>F</i> <sub>y</sub> = 50 ksi	

End-Plate Thickness, in.

 $\frac{3}{4}$ -in. Bolts 3 Rows  $L = 8^{1/2}$  in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

Bolt and End-Plate Available Strength, kips

W18, 16, 14, 12, 10\*

Bolt	Thread	Hole			Ellu-Plate II		<u>`</u> ,			
Group	Cond.	Туре	1/	<b>'</b> 4	5/1	16	1	<sup>3</sup> /8		
aloup	30114.	',,,,,	ASD	LRFD	ASD	LRFD	ASD	₩ L	.RFD	
	N	STD	50.9	76.4	63.7	95.5	71.6	1	07	
	x	STD	50.9	76.4	63.7	95.5	.76.4	1	15	
		STD	38.0	57.0	38.0	57.0	38.0		57.0	
0	SC Class A	ovs	32.4	48.4	32.4	48.4	32.4		<b>1</b> 8.4	
Group A		SSLT	38.0	57.0	38.0	57.0	38.0		57.0	
		STD	50.9	76.4	63.3	94.9	63.3		94.9	
	SC Class B	ovs	47.9	71.8	53.9	80.7	53.9		30.7	
		SSLT	49.6	74.4	62.0	92.9	63.3		94.9	
	N	STD	50.9	76.4	63.7	95.5	76.4		15	
•	x	STD	50.9	76.4	63.7	95.5	76.4	1	15	
		STD	47.5	71.2	47.5	71.2	47.5		71.2	
Group B	SC Class A	ovs	40.4	60.5	40.4	60.5	<i>-</i> 40.4		30.5	
		SSLT	47.5	71.2	47.5	71.2	47.5		71.2	
		STD	50.9	76.4	63.7	95.5	76.4	1	15	
	SC Class B	ovs	47,9	71.8	59.8	89.7	67.4	1(	)1	
		SSLT	49.6	74.4	62.0	92.9	74.4	3 (1	12	
1	Veld and Beam \	Web Availa	TO BE ONLY THE PROPERTY.	, kips	Fridelika da 1. da.	Su	pport Av	ailable		
				$R_0/\Omega$	φ <i>R</i> <sub>n</sub>		ength pe			
70-ksi Weld		ım Beam V		kips	kips		ickness,			
Size, in.	Inic	ckness, in.		ASD	LRFD	ASD		LRF	D	
3/16		0.286		45.2	67.9		X.			
1/4		0.381		59.4	89.1					
<sup>5</sup> /16		0.476	×	73.1	110	351		526	)	
3/8		0.571		88.3	129					
	D = Standard holes N = Threads included					End-Pla	ate	Bear	m	
OVS = Oversized t SLT = Short-slotte to direction	ed holes transverse		= Threads exc = Slip critical	luded	Ī	F <sub>y</sub> = 36 F <sub>u</sub> = 58		F <sub>y</sub> = 50 F <sub>u</sub> = 60		

\*Limited to W10×12, 15,17, 19, 22, 26, 30

DESIGN TABLES 10-61

W12, 10, 8

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

 $\frac{3}{4}$ -in. Bolts 2 Rows  $L = \frac{5^{1}}{2}$  in.

					End-Plate Ti	hickness, ir	 ).	
Bolt	Thread Cond.	Hole Type	1,	/4	5/			3/8
Group	Conu.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFE
	N	·STD	32.6	48.9	40.8	61.2	47.7	71.6
	x	STD	32.6	48.9	<b>40.8</b>	61.2	48.9	73.4
		STD	25.3	38.0	25.3	38.0	25.3	38.0
Group A	SC Class A	OVS	21.6	32.3	21.6	32.3	21.6	32.3
Group A		SSLT	25.3	38.0	25.3	38.0	25.3	38.0
		STD	32.6	48.9	40.8	61.2	42.2	63.3
	SC Class B	OVS	30.5	45.7	36.0	53.8	36.0	53.8
		SSLT	32.6	48.9	40.8	61.2	42,2	63.3
	N	STD	32.6	48.9	40.8	61,2	48,9	73.4
	X	STD	32.6	48.9	40.8	61.2	48.9	73.4
		STD	31.6	47.5	31.6	47.5	31.6	47.5
Group B	SC Class A	OVS	27.0	40.3	27.0	40.3	₫ 27.0	40.3
Group 6		SSLT	31.6	47.5	31.6	47.5	31.6	47.5
		STD	32.6	48.9	40.8	61.2	48.9	73.4
	SC Class B	OVS	30.5	45.7	38.1	57.1	44.9	67.2
		SSLT	32.6	48.9	∴40.8	61.2	48.9	73.4
V	Weld and Beam \	Web Availa	ble Strengt	1, kips		Sup	port Ava	ilable
TO Ital Wald	Beinim	ım Beam V	l/ah	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength per	
70-ksi Weld Size, in.		ım beam v :kness, in.		kips	kips	Thic	kness, k	ip/in.
OIZC, III.		mileos, iii.		- ASD +	LRFD	ASD	No.	LRFD
<sup>3</sup> / <sub>16</sub>		0.286		28.5	42.8			
1/4		0.381		37.1	55.7			054
<sup>5</sup> /16		0.476		45,2	67.9	234		351
3/8		0.571		52.9	79.4			
TD = Standard h			= Threads inc			End-Plat	te	Beam
VS = Oversized t LT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	cluded		$F_y = 36 \text{ kg}$ $F_u = 58 \text{ kg}$		F <sub>y</sub> = 50 ksi F <sub>u</sub> = 65 ksi

Fnd-Plate Thickness in

 $L = 35^{1/2}$  in.

### Table 10-4 (continued) 7/8-in. Bolts 12 Rows Bolted/Welded Shear End-Plate **Connections**

**Bolt and End-Plate Available Strength, kips** 

**W44** 

Bolt	Thread	Hole		:nd-Plate If	ate Thickness, in.				
Group	Cond.	Туре	1	/4	5/.	16		<sup>3</sup> /8	
Group	J Conta.	Турс	ASD =	LRFD	ASD	LRFD	ASD	LRFD	
	N	· STD	196	294	245	367	294	441	
	X	STD	196	294	245	367	294	441	
		STD	196	294	212	317	212	317	
Cuoun A	SC Class A	ovs	180	270	180	270	180	270	
Group A		SSLT	ें 194≟	292	212	317	212	[a] 317	
		STD	196	294	245	367	294	441	
	SC Class B	ovs	191	287	239	359	287	431	
		SSLT	194	292	243	365	292	438	
	N	STD	196	294	245	367	294	441	
	X	STD	196	294	. 245	367	294	441	
Group B		STD	: 196 🔆	294	<b>∵245</b> }	367	266	399	
	SC Class A	ovs	191	287	227⁵	339	227	339	
		SSLT	194	292	243	365	266	399	
		STD	196	294	245	367	294	441	
	SC Class B	ovs	191	287	239	359	287	431	
		SSLT	194	292	243	365	292	438	
V	Veld and Beam \	Web Availa	ble Strengt	h, kips		Su	pport Ava	ailable	
				$R_{\rm fl}/\Omega$	φ <b>R</b> n		rength pe		
70-ksl Weld	_	ım Beam V Ekness, in.		kips	kips	Th	ickness,	kip/in.	
Size, in.	''''	Kiicəə, III.		ASD	LRFD	ASD		LRFD	
3/16		0.286		196	293				
1/4		0.381		260	390				
5/16		0.476		324	486	1640		2460	
<sup>3</sup> /8		0.571		387	581				
STD = Standard ho	l bles		= Threads inc	luded	<u> </u>	End-Pl	ate	Beam	
VS = Oversized to	oles d holes transverse		= Threads ext = Slip critical	cluded		$F_y = 36$ $F_u = 58$	ksi	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$	

**DESIGN TABLES** 10-63

W44, 40

### Table 10-4 (continued) Bolted/Welded 7/8-in. Bolts Shear End-Plate 11 Rows Connections

 $L = 32\frac{1}{2}$  in.

	1	Juit allu	End-Plate A		<del></del>				
Bolt	Thread	Hole			End-Plate Ti		n.		
Group	Cond.	Type	1/4		· · · · · · · · · · · · · · · · · · ·	16		3/8	
			ASD	LRFD	ASD	LRFD	AS	D ::	LRFD
ţ	N	STD	180	269	225	337	269	)	404
	Х	STD	< 180 €	269	225	337	269	) :	404
		STD	180	269	194	291	<u></u> 194	1	291
: Group A	SC Class A	ovs	165	247	165	247	16	5	247
Gloup A		SSLT	178	267	194	291	194	1	291
		STD	180	269	<b>₹225</b>	337	269	9	404
Ï	SC Class B	ovs	175	263	219	328	263	3	394
		SSLT	178	267	223	334	267	7	401
	N	STD	180	269	225	337	269	) :	404
Group B	X	STD	180	269	225	337	269	)	404
		STD	180	269	225	337	244		365
	SC Class A	OVS	175	263	208 🖫	311	208	3	311
Gloup b		SSLT	178 🐇	267	223	334	244	1	365
		STD	180.	269	225	337	269	)	404
	SC Class B	ovs	175	263	219	328	263	}	394
		SSLT	178	267	223	334	267		401
V	Veld and Beam	Web Availa	ble Strength	ı, kips		Sup	port A	vailal	ole
70 I.e. Wold	Minima	ım Doom l	l/ob	$R_0/\Omega$	φR <sub>n</sub>		ength p		
70-ksi Weld Size, in.		ım Beam V ckness, in.		kips	kips	Thi	ckness	, kip/	in.
	1 1101			ASD	LRFD	ASD		1	RFD
3/16		0.286		179	268		, , , , , , , , , , , , , , , , , , ,		
1/4		0.381		238	356		7 (1)		2056
<sup>5</sup> /16		0.476		296	444	1500		4	2250
3/8		0.571		354	530				
STD = Standard h	oles	N	= Threads incl	uded	1	End-Pla	ite		eam .
VS = Oversized t		X	= Threads exc = Slip critical			$F_{\rm y} = 36  \rm i$	i		= 50 ksi
to direction		00	- Jup Grada			$F_{u} = 58 \text{ f}$	rei	E	= 50 ksi = 65 ksi

in the fillers.

 $L = 29^{1/2}$  in.

#### Table 10-4 (continued) 7/8-in. Bolts Bolted/Welded 10 Rows Shear End-Plate **Connections**

**Bolt and End-Plate Available Strength, kips** 

		l			End-Plate Th	ickness, i	n	
Bolt Group	Thread Cond.	Hole	1,	/4	5/-			3/8
Group	Collu.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N	· STD	163	245	204	306	245	368
	X	STD	163	245	204	306	245	368
		STD	163	245	176	264	176	264
Group A	SC Class A	OVS	150	225	150	225	150	225
aloup A		SSLT	162	243	176	264	176	264
		STD	163	245	- 204	306	245	368
	SC Class B	OVS	159	238	198	298	238	357
		SSLT	₹ 162 <del>}</del>	243	203	304	243	365
	N	STD	<b>163</b>	245	204	306	245	368
	X	STD	- 163 €	245	204	306	245	368
		STD	163	245	<b>204</b>	306	221	332
Group B	SC Class A	OVS	159	238	189	282	189	282
aloup B		SSLT	162	243	203	304	221	332
		STD	163	245	204	306	245	368
	SC Class B	ovs	159	238	198	298	238	357
		SSLT	162	243	203	304	243	365
V	Weld and Beam \	Neb Availa	ble Strength	ı, kips		Suj	pport Avail	able
70-ksi Weld	Minimu	ım Beam V	Voh	$R_{\rm fl}/\Omega$	φ <b>R</b> n		ength per l	
Size, in.		:kness, in.		kips	kips	Thi	ckness, kij	p/in.
				ASD 🗄	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		162	243			
1/4		0.381		215	323	1070		0050
<sup>5</sup> /16		0.476		268	402	1370		2050
3/8		0.571		320	480			
STD = Standard h			= Threads incl			End-Pla	ite	Beam
OVS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded	Ī	F <sub>y</sub> = 36   F <sub>u</sub> = 58		y = 50 ksi u = 65 ksi

**DESIGN TABLES** 10-65

W44, 40, 36, 33

in the fillers.

### Table 10-4 (continued) Bolted/Welded 7/8-in. Bolts Shear End-Plate 9 Rows Connections

 $L = 26^{1/2}$  in.

	T		1		rength, kips			
Bolt	Thread	Hole			End-Plate Th			
Group	Cond.	Туре	1/	4	5/1	6	3	/B
		-7,	ASD	LRFD	S ASD S	LRFD	ASD	LRFD
	N	STD	147	221	184 🚯	276	221	331
	X	STD	, 147 ↔	221	184	276	221	331
		STD	147	221	159	238	159	238
Group A	SC Class A	OVS	135	202	135	202	135	202
Group A		SSLT	146	219	159	238	159	238
		STD	147	221	184	276	221	331
	SC Class B	OVS	142 .	214	178	267	214	321
		SSLT	146 🕆	219	182	273	219	328
	N	STD	147	221	184	276	221	331
	X	STD	147	221	184	276	221	331
		STD	147	221	184	276 <sup>-</sup>	199	299
Group B	SC Class A	OVS	142	214	170	254	170	254
Group B		SSLT	146	219	182	273	199	299
		STD	147	221	184	276	221	331
	SC Class B	OVS	142	214	178	267	214	321
		SSLT	146	219	182	273	219	328
V	Veld and Beam 1	Web Availa	ble Strength	, kips		Su	pport Availa	ble
70-ksi Weld	Minima	ım Beam V	lloh	$R_n/\Omega$	φ <i>R<sub>n</sub></i>		ength per li	
Size, in.		ckness, in.	-	kips	kips	Thi	ckness, kip	/in.
				ASD	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		145	218			
1/4		0.381		<b>½</b> `193	290	1000		1040
<sup>5</sup> /16		0.476		240	360	1230		1840
3/8		0.571		287	430			
STD = Standard h			= Threads incl			End-Pla	nte	Beam
OVS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded		F <sub>y</sub> = 36   F <sub>u</sub> = 58		= 50 ksi = 65 ksi

 $L = 23^{1/2}$  in.

### Table 10-4 (continued) 7/8-in. Bolts 8 Rows Shear End-Plate **Connections**

W44, 40, 36, 33,

		Bolt and	End-Plate Av	vailable St	rength, kips			
Delf	Thread	Hala			End-Plate Th	ickness, i	n.	
Bolt Group	Thread Cond.	Hole Type	1/4		5/1	6		3/8
Gloup	Goliu.	iyhe	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N	· STD	<b>131</b>	197	164	246	197	295
	x	STD	131	197	164	246	197	295
		STD	131	197	141	212	141	212
Group A	SC Class A	OVS	120	180	120	180	120	180
Group A		SSLT	130	194	141	212	141	212
		STD	131	197	<b>164</b>	246	197	295
	SC Class B	OVS	126	189	[]158	237	189	284
		SSLT	130	194	162	243	194	292
	N	STD	131	197	164	246	ં:197્	295
	Х	STD	131	197	164	246	:: 197	295
Group B		STD	131 🎉	197	164	246	177	266
	SC Class A	OVS	126	189	151	226	151	226
Group D		SSLT	130 🐔	194	162	243	177	266
		STD	131 🚎	197	164	246	197	295
	SC Class B	OVS	126	189	158	237	189	284
		SSLT	130 🚓	194	162	243 ·	194	292
	Weld and Beam \	Web Availa	ble Strength	ı, kips		Sup	port Avail	able
70-ksi Weld	Minima	ım Beam V	Nah	$R_n/\Omega$	φ <i>R<sub>B</sub></i>		ength per	
Size, in.	1	ckness, in.		kips	kips	Thi	ckness, ki	o/in.
C.20,				ASD	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		129	193	i i i i i i i i i i i i i i i i i i i		
1/4		0.381		171	256	1000		1640
5/16		0.476		212	318	1090		1040
3/8		0.571		253	380			
TD = Standard h		N	= Threads inc	luded	i	End-Pla	ite	Beam
VS = Oversized I SLT = Short-slotte to direction	ed holes transverse		= Threads exc = Slip critical	cluded	Ì	F <sub>y</sub> = 36   F <sub>u</sub> = 58	csi /	y = 50 ks u = 65 ks

W44, 40, 36, 33, 30, 27,

### Table 10-4 (continued) Bolted/Welded 7/8-in. Bolts Shear End-Plate 7 Rows Connections

 $L = 20^{1/2}$  in.

Bolt Group	Thread Cond. N X SC Class A	Hole Type STD STD STD OVS SSLT	115 115 115 115	172 172 172	5/ ASD 144 144	LRFD 215 215	ASD 172 172	3/8 LRFI 258 258
	N X	STD STD STD OVS	115 115 115	172 172	144 144	215	172	258
Group A	X	STD STD OVS	115 115	172	144			
Group A		STD OVS	115			215	172	258
Group A	SC Class A	OVS		172	and the second s			ii.4
Group A	SC Class A		105	Į.	123	185	123	185
		SSLT		157	105	157	105	157
Î			113	170	123	185	123	185
•	SC Class B	STD	115	172	144	215	172	258
		OVS	110	165	137	206	: :165	247
		SSLT	113	170	<b>142</b>	213	170	255
	N	STD	115	172	144	215	172	258
	X	STD	115	172	144	215	172	258
		STD	🦆 115 🐑	172	144	215	155	233
Group B	SC Class A	ovs	110	165	132 🖫	198	132	198
агоар Б		SSLT	113	170	142	213	155	233
		STD	115	172	::144	215	172	258
]	SC Class B	ovs	110	165	137	206	165	247
		SSLT	113 💷	170	142	213	170	255
We	ld and Beam V	Veb Availat	ole Strengt	ı, kips			pport Ava	
70-ksi Weld	Minimu	m Beam W	eh	$R_{R}/\Omega$	φRn		ength per	
Size, in.		kness, in.		kips	kips	Thi	ckness, k	ip/in.
		-		. ASD	LRFD	ASD		LRFD
3/16		0.286		112	168		x.,	
1/4		0.381	ļ	148	223	956		1430
5/16		0.476		184	277	900		1430
3/8		0.571		220	330			
TD = Standard holes	<u> </u>	N =	= Threads incl	uded	<b></b>	End-Pla	ite	Beam
VS = Oversized hole LT = Short-slotted h			= Threads exc = Slip critical	luded	ţ	F <sub>V</sub> = 36 1		<i>F<sub>v</sub></i> = 50 ks

6 Rows  $L = 17^{1/2}$  in.

Table 10-4 (continued) 7/8-in. Bolts Bolted/Welded **Shear End-Plate** Connections

W40, 36, 33, 30, 27, 24,

					End-Plate Th	ickness. i	n.	
Bolt	Thread Cond.	Hole	1/	1/4 5/			1	3/8
Group	Cona.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFC
	N	· STD	98.6	148	123	185	148	222
	X	STD	98.6	148	123	185	148-	222
		STD	98.6	148	106	159	106	159
Group A	SC Class A	ovs	90,1	135	90.1	135	90.1	Î 135
aloup A		SSLT	97.3	146	106	159	106	159
		STD	98.6	148	123	185	148	222
	SC Class B	ovs	93.5	140	117	175	140	210
		SSLT	97.3	146	122	182	146	219
Group B	N	STD	98,6	148	_123	185	148	222
	X	STD	98.6	148	123	185	148	222
		STD	98.6	148	123	185	<b>়133</b> ା	199
	SC Class A	OVS	93.5	140	113,	169	113	169
aroup D		SSLT	97.3	146	122	182	133	199
		STD	98.6	148	123	185	148	222
	SC Class B	OVS	93.5	140	117	175	140	210
		SSLT	97.3	146	122	182	146	219
	Weld and Beam \	Neb Availa	able Strength	, kips		Su	pport Avai	lable
70-ksi Weld	Minimu	ım Beam V	Noh -	$R_n/\Omega$	φ <b>R</b> n		ength per	
Size, in.	ł.	kness, in.	-	kips	kips	Thi	ckness, k	ip/in. 
		<u> </u>		ASD	LRFD	ASD	, i i i	LRFD
<sup>3</sup> / <sub>16</sub>		0.286		95.4	143			
1/4		0.381		126	189	819		1230
<sup>5</sup> /16		0.476		157	235	019		1230
3/8		0.571		187 👍	280			
TD <del>⊱</del> Standard h		N	= Threads incl	uded	1	End-Pla	ate	Beam
OVS = Oversized I SLT = Short-slotte to direction	ed holes transverse	-	<ul><li>Threads exc</li><li>Slip critical</li></ul>	luded		$F_y = 36 \mid F_u = 58 \mid$		<i>F<sub>y</sub></i> = 50 ks <i>F<sub>u</sub></i> = 65 ks

W30, 27, 24, 21, 18

### Table 10-4 (continued) Bolted/Welded 7/8-in. Bolts Shear End-Plate 5 Rows Connections

 $L = 14^{1/2}$  in.

		<b>Bolt and</b>	End-Plate A	vailable St	rength, kips			
Bolt	Thread	Hole			End-Plate Th	ickness, i	n.	
Group	Cond.	Type	1	/4	5/1	16	3	/B
Стоир	oona.	Турс	ਂ ASD ⇒	LRFD	ASD	LRFD	ASD	LRFD
	N	STD	82.4	124	103	155	124	185
	X	STD	82.4	124	103	155	124	185
		STD	.82.4	124	88.1	132	88.1	132
Group A	SC Class A	ovs	75.1	112	75.1	112	75.1	112
Gloup A		SSLT	81.1	122	88.1	132	88.1	132
		STD	€ 82.4	124	103	155	124	185
	SC Class B	OVS	<b>77.2</b>	116	96.5	145	116	174
		SSLT	81.1	122	101	152	122	182
	N	STD	82.4	124	103	155	124	185
	X	STD	82.4	124	103	155	124	185
		STD	82.4	124	103	155	<b>311</b>	166
Group B	SC Class A	OVS	77.2	116	94,4	141	94.4	141
a.cap 2		SSLT	81.1	122	101	152	111	166
		STD	82.4	124	103	155	124	185
	SC Class B	OVS	. ∻77.2	116	96.5	145	116	174
		SSLT	81.1	122	101	152	122	182
1	Weld and Beam	Web Availa	ble Strengt	h, kips		Sup	port Availa	ble
70-ksi Weld	Minima	ım Beam V	Neh	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength per li	
Size, in.		ckness, in.		kips	kips		ckness, kip	/in.
				ASD	LRFD	ASD		LRFD
3/16		0.286		78.7	118			
1/4		0.381		104	156	600		1000
<sup>5</sup> /16		0.476		193	193	683		1020
3/8		0.571		153	230			
STD = Standard h			= Threads inc			End-Pla	ite	Beam
OVS = Oversized I SSLT = Short-slotte to direction	ed holes transverse		= Threads exc = Slip critical	cluded		F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k		= 50 ksi = 65 ksi

in the fillers.

 $L = 11^{1/2}$  in.

### Table 10-4 (continued) 7/8-in. Bolts 4 Rows Bolted/Welded Shear End-Plate **Connections**

W24, 21, 18, 16

	T	Joil and	End-Plate A			loknoos !		
Bolt	Thread	Hole	<u> </u>		End-Plate Ti	<u>-</u>	<u>n.</u>	24
Group	Cond.	Туре		/4	5/			3/8
			ASD 🖽	LRFD	ASD	LRFD	ASD	
	N	STD	65.3	97.9	81.6	122	97.9	147
	Х	STD	65.3	97.9	81.6	122	97.9	
		STD	65.3	97.9	70.5	106	70.5	106
Group A	SC Class A	OVS	60.1	89.9	60,1	89.9	60.1	89.9
Gloup A		SSLT	64.9	97 <i>.</i> 3	70.5	106	70.5	106
		STD	65.3	97.9	81.6	122	97.9	147
	SC Class B	OVS	60.9	91.4	∴,76.1; <sub>∂</sub> .	114	91.4	137
		SSLT	64.9	97.3	81.1	122	97.3	146
	N	STD	65,3	97.9	₩81.6	122	97.9	147
	X	STD	65.3	97.9	81.6	122	97.9	147
		STD	65.3	97.9	81.6	122	88.6	133
Croup D	SC Class A	OVS	60.9	91.4	<i>₹</i> 75.5	113	75.5	113
Group B		SSLT	64.9	97.3	£81.1,	122	88.6	133
		STD	<b>65.3</b>	97.9	81.6	122	97.9	147
	SC Class B	OVS	60.9	91.4	76.1	114	91,4	137
		SSLT	64.9	97.3	81.1	122	97,3	146
	Weld and Beam \	Web Availa	ble Strengt	h, kips		Sui	pport Ava	ilable
				$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength pe	
70-ksi Weld Size, in.		ım Beam V Ekness, in.		kips	kips	Thi	ckness, l	kip/in.
3126, III.		Alicoo, III.		ASD	LRFD	asd 💮	14, 35	LRFD
<sup>3</sup> / <sub>16</sub>		0.286		61.9	92.9			
1/4		0.381		81.7	123			2.2
5/16		0.476		£ 101	151	546		819
3/8		0.571		120	180			
TD = Standard h	oles	N	l = Threads inc	cluded	L	End-Pla	ite	Beam
OVS = Oversized t SLT = Short-slotte to direction	d holes transverse	•	t = Threads exe s = Slip critical	cluded		F <sub>y</sub> = 36   F <sub>u</sub> = 58	ksi	$F_y = 50 \text{ ks}$ $F_u = 65 \text{ ks}$

W18, 16, 14, 12, 10\*

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

 $\frac{7}{8}$ -in. Bolts 3 Rows  $L = \frac{81}{2}$  in.

	ı		End-Plate Av					
Bolt	Thread	Hole			End-Plate Th			
Group	Cond.	Туре	1/	4	5/1	6	3	/8
		-74-	ASD	LRFD	ASD	LRFD	ASD	LRF
	N	STD	47.9	71.8	59.8	89.7	71.8	108
	X	STD	47.9	71.8	59.8	89.7	71.8	108
		STD	47.9	71.8	52.9	79.3	52.9	79.
Group A	SC Class A	ovs	44.6	66.9	45,1	67.4	45.1	67.
Group A		SSLT	47.9	71.8	52.9	79.3	52.9	79.
		STD	47.9	71.8	59.8	89.7	71.8	108
	SC Class B	OVS	44.6	66.9	55.7	83.6	66.9	100
		SSLT	47.9	71.8	59.8	89.7	71.8	108
	N	STD	₹ 47.9	71.8	59.8	.89.7	71.8	108
	X	STD	.47.9	71.8	<b>59.8</b>	89.7	71.8	108
Crown D		STD	47.9	71.8	₹ 59.8	89.7	66.4	99.7
	SC Class A	OVS	44.6	66.9	55.7	83.6	56.6	84.7
Group B		SSLT	47.9	71.8	59.8	89.7	66.4	99.7
		STD	47.9	71.8	59.8	89.7	71.8	108
	SC Class B	OVS	44.6	66.9	55.7	83.6	66,9	100
		SSLT	47.9	71.8	59.8	89.7	71.8	108
٧	Veld and Beam \	Neb Availa	ble Strength	, kips		Sup	pport Availa	ble
<b>20</b> 1 111-1-1	001-1	D V	W- L	$R_n/\Omega$	φ <b>R</b> <sub>n</sub>	Str	ength per l	nch
70-ksi Weld Size, in.	1	m Beam V kness, in.		kips	kips	Thi	ckness, kip	/in.
0120, 111.		, Kiloss, III.		ASD	LRFD	ASD	Z X	LRFD
3/16		0.286		45.2	67.9		Significant	
1/4	1	0.381		59.4	89.1			0.4.5
5/16		0.476		73.1	110	409		614
3/8	1	0.571		86.3	129			
TD = Standard ho	oles	N	= Threads incl	uded	<u> </u>	End-Pla	ite	Beam
OVS = Oversized h GLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded		F <sub>y</sub> = 36 l F <sub>u</sub> = 58 l	ksi <i>F</i> <sub>1</sub>	, = 50 ksi , = 65 ksi

\*Limited to W10×12, 15, 17, 19, 22, 26, 30

 $\frac{7}{8}$ -in. Bolts 2 Rows  $L = 5^{1/2}$  in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W12, 10,

D - 14					<b>End-Plate T</b>	hickness, i	in.		
Bolt Group	Thread Cond.	Hole Type	1	/4	5	16		3/1	В
aroup	Oonu.	Type	, ASD	LRFD	ASD	LRFD	i ASI	)	LRFC
	N	STD	30,5	45.7	38.1	57.1	45.7	<b>,</b>	68.
	X	STD	30.5	45.7	38.1	57.1	45.7	,	68.
		STD	30.5	45.7	35.3	52.9	35.3	3	52.9
Group A	SC Class A	OVS	28.3	42.4	<b>30.0</b> ∶	45.0	30.0	)	45.0
Group A		SSLT	30.5	45.7	35.3	52.9	35,3		52.9
		STD	30.5	45.7	38.1	57.1	<b>45.7</b>		68.5
j	SC Class B	OVS	28.3	42.4	≩ 35.3 <b>-</b>	53.0	42,4	) <b>`</b>	63.6
		SSLT	30.5	45.7	38.1	57.1	45.7		68.5
	N	STD	30.5	45.7	38.1	57.1	£ 45.7		68.5
<b>:</b>	X	STD	∂ 30.5	45.7	38.1	57.1	45.7		68.5
		STD	30.5	45.7	* 38.1 ·	57.1	44.3		66.4
Group B	SC Class A	OVS	28.3	42.4	35.3	53.0	37.8		56.5
divup b		SSLT	30.5	45.7	38.1	57.1	44.3		66.4
		STD	30.5	45.7	38.1	57.1	45.7		68.5
	SC Class B	OVS	28.3	42.4	35.3	53.0	42,4		63.6
		SSLT	30.5	45.7	∍ु 38.1	57.1	<b>45.7</b>		68.5
V	<b>Veld and Beam \</b>	Neb Availa	ble Strengt	h, kips		Su	pport Av	railat	ole
70-ksi Weld	Minimu	m Beam V	Vah	$R_n/\Omega$	φ <i>R<sub>n</sub></i>		ength p		
Size, in.	1	kness, in.		kips	kips		ickness,	kip/	in.
				ASD	LRFD	ASD		l	.RFD
<sup>3</sup> / <sub>16</sub>		0.286		28.5	42.8				
1/4		0.381			55.7	020			400
5/16		0.476		45.2	67.9	273	33.		409
3/8		0.571		52.9	79.4				
TD = Standard h	oles	N	= Threads inc	cluded	<u> </u>	End-Pla	ate	В	eam
VS = Oversized h LT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical		:	$F_y = 36$ $F_u = 58$	ksi		= 50 ks = 65 ks

W44

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

**1**-in. Bolts
12 Rows *L* = 35½ in.

	l	١		1	End-Plate Th	ickness, i	in.		
Bolt Group	Thread Cond.	Hole Type	1/	/4	5/1	6		3/8	
Gloup	Goila.	Type	ASD	LRFD	- ASD -	LRFD	ASI	)	LRFD
	N ·	STD	191	287	239	359	287	7.34	431
	X	STD	191	287	239	359	287		431
		STD	191	287	239	359	277		415
Group A	SC Class A	ovs	172	258	<b>£215</b>	322	, 236		353
Gloup A		SSLT	<b>191</b> 3	287	/ <b>239</b>	359	277		415
		STD	191	287	239	359	287		431
	SC Class B	ovs	172	258	215	322	258		387
		SSLT	191	287	239 ;	359	287		431
	N	STD	1,91	287	239:	359	287	* * *	431
	X	STD	191	287	239	359	ે.287		431
Group B		STD	- 191 %	287	.;⊢239 <sub>.*</sub>	359	-287		431
	SC Class A	OVS	172	258	215	322	258		387
dioup 5		SSLT	191	287	239	359	287		431
		STD	191	287	₂239	359	287		431
	SC Class B	OVS	172	258	215	322	258	93P 437	387
		SSLT	191	287	239	359	287		431
1	<b>Veld and Beam \</b>	Web Availa	ble Strength	ı, kips			pport Av		
70-ksi Weld	Minimu	ım Beam V	Veh	$R_0/\Omega$	φ <i>R<sub>n</sub></i>		ength p		
Size, in.		kness, in.		kips	kips		ckness,		
			1	ASD ₹	LRFD	ASD		L	RFD
<sup>3</sup> / <sub>16</sub>		0.286		196	293	1070 -	TD/	2730	STD
1/4		0.381		260	390	u S	SLT		SSL
5/16		0.476		324	486	1660 C	we l	2400	ovs
3/8		0.571		387	581	1000 (	פעי	2490	UVS
TD = Standard h	oles	N	= Threads incl	uded		End-Pla	ate	В	eam
VS = Oversized f SLT = Short-slotte	noles ed holes transverse		<ul><li>Threads exc</li><li>S = Slip critical</li></ul>	luded	Ī	$F_y = 36$ $F_u = 58$			50 ks 65 ks

**1**-in. Bolts
11 Rows *L* = 32<sup>1</sup>/<sub>2</sub> in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W44, 40

	<del></del>	DUIL BIIU	End-Plate A						
Bolt	Thread	Hole	<u></u>		End-Plate Th		n.		
Group	Cond.	Туре	1,	/4	5/-	16		3/8	
		.,,,,	ASD	LRFD	ASD	LRFD	ASD		LRFD
	N ·	STD	175	263	219	328	263		394
	X	STD	175	263	219	328	263	19	394
		STD	175	263	<b>½219</b>	328	254		380
Group A	SC Class A	ovs	157	236	196	295	216		323
Gloup A		SSLT	175	263	219	328	254		380
		STD	175	263	219	328	263		394
	SC Class B	OVS	157	236	1,96	295	236		354
		SSLT	175	263	219	328	263		394
	N	STD	175	263	219	328	263		394
	X	STD	. 175	263	219	328	<b>. 263</b>		394
		STD	175	263	∴ 219	328	263	- 1	394
Croup D	SC Class A	OVS	157	236	196	295	236		354
Group B		SSLT	175	263	219	328	263		394
		STD	⇒175,≧	263	219	328	263		394
	SC Class B	ovs	157	236	196	295	236		354
		SSLT	175	263	219	328	263		394
V	Veld and Beam \	Neb Availa	ble Strength	n, kips		Sui	pport Av	ailab	le
				$R_n/\Omega$	φ <i>R</i> <sub>n</sub>	•	ength pe		
70-ksi Weld Size, in.		m Beam V kness, in.		kips	kips	Thi	ckness,	kip/i	n.
3126, III.		Kiicəə, III.	Ì	ASD	LRFD	, ASD		L	RFD
3/16		0.286		179	268	`S	m/	٥٥٥٥	STD/
1/4	1	0.381		238	356	76761	SLT	2500	SSLT
<sup>5</sup> /16		0.476		296	444	Tijaa			
3/8		0.571		354	530	1520 <b>0</b>	VS	2280	OVS
			-	Paulius billio	330		## # <u> </u>		
iTD ⇒ Standard ho IVS ⇒ Oversized h			= Threads incl = Threads exc		<u> </u>	End-Pla	ite	В	eam
SLT ≟ Short-slotte	d holes transverse		= Slip critical			$F_{\rm y} = 36  {\rm I}$			: 50 ksi
to direction	of load					$F_u = 58 \text{ I}$	ksi	F <sub>U</sub> =	65 ksi

**DESIGN TABLES** 10-75

W44, 40,

### Table 10-4 (continued) Bolted/Welded 1-in. Bolts Shear End-Plate 10 Rows Connections

 $L = 29^{1/2}$  in.

					End-Plate Th	nickness, i	in.	
Bolt Group	Thread Cond.	Hole Type	1/	<b>'</b> 4	5/-	16		3/8
агоир	Conu.	Турс	ASD	LRFD	ASD	LRFD	. ∴ ASD	LRF
	N ·	STD	159	238	= 198	298	238	357
	X	STD	159	238	198	298	238	357
		STD	<b>159</b>	238	198	298	231	346
Group A	SC Class A	ovs	142	214	. 178	267	196	294
aloup A		SSLT	, 159 l	238	<b>198</b>	298	231	346
		STD	::159	238	198	298	238	357
	SC Class B	OVS	142	214	178	267	- 14 ≥	321
		SSLT	159	238	<b>5</b> 1198	298	238	357
	N	STD	159, 4	238	<b>198</b>	. 298	;, <b>238</b>	357
	X	STD	159	238	198	298	238	357
		STD	159	238	198	298	238	357
Group B	SC Class A	OVS	142	214	178	267	214	321
aloup b		SSLT	159	238	198	298	238.	357
		STD	159₄	238	198	298	238	357
	SC Class B	OVS	142	214	178	267	214	321
		SSLT	159	238	198	298	i⊹ 238 i	357
V	Veld and Beam \	<b>Neb Availa</b>	ble Strength	, kips			pport Ava	
70-ksi Weld	Minimu	ım Beam \	Neh -	$R_n/\Omega$	ψ <b>R</b> <sub>n</sub>		rength per	
Size, in.		:kness, in.		kips	kips	F100 12 2 2	ickness, k	ip/in.
				- ASD	LRFD	🕒 ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		162	243		TD/   2	270 STD
1/4		0.381		215	323	∵~~` S	SLT /	SSL
<sup>5</sup> /16		0.476		268	402	1000	MACO I	1000 0111
<sup>3</sup> /8		0.571	į	320	480	1380 (	)	2080 OVS
TD = Standard ho	oles	N	= Threads incl	uded	<u>'</u>	End-Pla	ate	Beam
IVS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded	1	F <sub>y</sub> = 36 F <sub>u</sub> = 58	ksi	F <sub>y</sub> = 50 ks F <sub>u</sub> = 65 ks

in the fillers.

**1**-in. Bolts 9 Rows *L* = 26<sup>1</sup>/<sub>2</sub> in.

## Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W44, 40, 36, 33

			1		End-Plate Th	icknoon	in .		
Bolt	Thread	Hole	-	/4	5/ <sub>1</sub>		3/8		
Group	Cond.	Туре	<u> </u>	<del>``</del>	1	-	l Britan		
	<u> </u>	OTD	ASD	LRFD	ASD	LRFD	AS	201.00	LRFD
	N ·	STD	142	214	178	267	214	23232	·321
	X	STD	142	214	178	267	214		321
		STD	142	214	178	267	207	1.7 354	311
Group A	SC Class A	ovs	128	192	160	240	177	é ".	265
		SSLT	142.	214	178	267	20		311
		STD	142	214	178	267	214	(A. 1	321
	SC Class B	ovs	128	192	160	240	192	2	288
		SSLT	142	214	178	267	214		321
	N	STD	142	214	178"-	267	<b>E</b> 214		321
	X	STD	142	214	178	267	214		321
		STD	142	214	178	267	214		321
Group B	SC Class A	ovs	128	192	160	240	192		288
alvuh p		SSLT	142 :	214	178	267	214		321
		STD	142	214	178	267	214		321
	SC Class B	ovs	128	192	160	240	192		288
		SSLT	142	214	178	267	214		321
١	Weld and Beam \	Neb Availa	ble Strengt	h, kips		Su	pport A	vailal	ble
70 1! 11/-!-		D V	U-L	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		rength p		
70-ksi Weld Size, in.		ım Beam V kness, in.		kips	kips	Thi	ickness	, kip/	in.
Oize, III.		Miless, III.		ASD	LRFD	ASD		ı	LRFD
3/16		0.286		145	218	1070 \$	TD/	205	STD
1/4		0.381		193	290	1370 <b>s</b>	SLT	205	U SSLI
5/16		0.476		240	360				
<sup>3</sup> /8		0.571		287	430	1250 0	IVS	187	0 <b>0V</b> S
TD = Standard h			= Threads inc	luded	1 <u>f.</u>	End-Pla	ate	B	eam
IVS = Oversized I	noles	X	= Threads ex		H				
	ed holes transverse of load	SC	= Slip critical		İ	$F_y = 36$ $F_u = 58$	ksi		= 50 ksi = 65 ksi

W44, 40, 36, 33, 30

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

Rolf and End-Diate Available Strength kins

1-in. Bolts 8 Rows L = 23<sup>1</sup>/<sub>2</sub> in.

Bolt	Thread	Hole			End-Plate TI		in.		
Group	Cond.	Туре	1	/4	5/	16		3/8	3
	00.10.	.,,,,	ASD	LRFD	ASD	LRFD	ASE		LRFD
	N ·	STD	126	189	158	237	189		284
	Х	STD	126	189	158	237	189		284
		STD	126	189	158	237	184	# T	277
Group A	SC Class A	OVS	113	170	141	212	157		235
Gloup A		SSLT	126	189	158	237	184		277
		STD	i'₁126	189	158	237	189		284
	SC Class B	OVS	113	170	141	212	170		254
		SSLT	126	189	158	237	189	2	284
•	N	STD	₹126 <u>:</u>	189	:-158	237	, 189	- 45	284
	X	STD	126	189	158	237	189		284
		STD	126	189	158	237	189		284
Group B	SC Class A	ovs	113	170	141	212	170		254
Gloup 5		SSLT	վ 126 🏃	189	158	237	189		284
		STD	= 126 ≥:	189	<b>.</b> 158	237	189		284
	SC Class B	ovs	113	170	141	212	170		254
		SSLT	126	189	158	237	189		284
١	Weld and Beam \	Veb Availa	ble Strengt	h, kips		Su	pport Av	ailat	ole
<b></b>	867-1	D	Made	$R_0/\Omega$	φ <i>R</i> <sub>0</sub>		ength p		
70-ksi Weld Size, In.		m Beam V kness, in.		kips	kips	Thi	ickness,	kip/i	in.
				ASD	LRFD	ASD		L	.RFD
<sup>3</sup> / <sub>16</sub>		0.286		129	193	1, <sub>210</sub> \$	TD/	1820	STD
1/4		0.381		171	256	1210 S	SLT-	1021	SSL
5/16		0.476		212	318				
3/8		0.571		253	380	1110 0	vs	1670	O OVS
TD = Standard h			= Threads inc			End-Pla	ate	В	eam
VS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads ext = Slip critical	cluded	Ī	F <sub>y</sub> = 36   F <sub>u</sub> = 58			= 50 ks = 65 ks

1-in. Bolts
7 Rows
L = 20<sup>1</sup>/<sub>2</sub> in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W44, 40, 36, 33, 30, 27, 24

		Bolt and	End-Plate A	vailable St	rength, kips			
Bolt	Thread	Hole			End-Plate Ti	nickness, i	n.	
Group	Cond.	Туре	1	/4	5/-	16		3/8
uroup	Joing.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N ·	STD	110	165	137	206	165	247
	X	STD	110	165	137	206	165	247
		STD	110	165	137	206	<u>,</u> 161	242
Group A	SC Class A	ovs	98.4	148	123	185	138	206
Gloup A		SSLT	110	165	137	206	161	242
		STD	110 👢	165	े <b>ी</b> 137	206	165	247
	SC Class B	ovs	98.4	148	123	185	148	221
		SSLT	110	165	137	206	165	247
	N	STD	110	165	137	206	165	247
	X	STD	110	165	137	206	165	247
		STD	110	165	137	206	165	247
Group B	SC Class A	OVS	98.4	148	123	185	148	221
Gloup B		SSLT	1110	165	. 137 n	206	165	247
		STD	110	165	137	206	165	247
	SC Class B	OVS	98.4	148	123	185	148	221
		SSLT	110	165	137	206	165	247
1	Weld and Beam \	Web Availa	ble Strengt	h, kips		Sur	port Avail	able
70 kai Wald		Doors 1	Val-	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength per	
70-ksi Weld Size, in.		ım Beam V ckness, in.	-	kips	kips	Thi	ckness, ki	p/in.
				ASD	LRFD	ASD	1 000 . 1 000 . 1 000 .	LRFD
3/16		0.286		112	168	1060 S1	rd/,	STD/
1/4		0.381		148	223	IUOU SS	SLT   "	SSLT SSLT
5/16		0.476		184	277			
3/8		0.571		. 220	330	975 <b>0</b>	<b>VS</b>   14	60 <b>OVS</b>
STD = Standard h		N	= Threads inc	luded		End-Pla	te	Beam
OVS = Oversized t SSLT = Short-slotte to direction	ed holes transverse		= Threads ext = Slip critical			F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k		y = 50 ksi u = 65 ksi

W40, 36, 33, 30, 27, 24, 21

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

**1** -in. Bolts 6 Rows *L* = 17<sup>1</sup>/<sub>2</sub> in.

	1	l	ļ	railable St	End-Plate Th	nickness i	n.	
Bolt	Thread	Hole	1,		5/-	•		3/8
Group	Cond.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFC
	N ·	STD	93.5	140	117	175	140	· 210
	x	STD	93.5	140	117	175	140	210
		STD	93.5	140	117	175	138	207
Group A	SC Class A	ovs	<b>383.7</b>	126	105	157	118	176
aloup A		SSLT	93.5	140	117	175	138	207
		STD	93.5	140	117	175	140	210
	SC Class B	ovs	83.7	126	105	157	126	188
		SSLT	93.5	140	117	175	140	210
	N	STD	93.5	140	117	175	140	210
	X	STD	93.5	140	117	175	140	210
		STD	93.5	140	117	175	140	210
Group B	SC Class A	OVS	83.7	126	105	157	126	188
Gloup D		SSLT	93.5	140	117	175	140	210
		STD	93.5	140	117	175	140	210
	SC Class B	ovs	83.7	126	105	157	126	188
		SSLT	93.5	140	117	175	140	210
1	Weld and Beam \	Neb Availa	ble Strength	ı, kips			pport Ava	
70-ksi Weld	Minimu	ım Beam V	Veh .	$R_n/\Omega$	φ <b>R</b> n		ength pe	
Size, in.		:kness, in.		kips	kips		ckness, l	(ip/in.
	-			ASD	LRFD	ASD	64.50 37.75	LRFD
<sup>3</sup> / <sub>16</sub>		0.286		95,4	143	U17 ::	TD/	1370 STD
1/4		0.381	ļ	126	189	S	SLT	SSL
<sup>5</sup> /16		0.476		157	235	000 0	ue I	ומכת מיים
3/8		0.571		187	280	839 0	vs	1260 <b>OVS</b>
D = Standard h			= Threads incl			End-Pla	nte	Beam
VS = Oversized I LT = Short-slotte to direction	ed holes transverse		= Threads exc = Slip critical	luded	Ī	F <sub>y</sub> = 36   F <sub>u</sub> = 58	ksi	$F_y = 50 \text{ ks}$ $F_u = 65 \text{ ks}$

**1**-in. Bolts
5 Rows
L = 14<sup>1</sup>/<sub>2</sub> in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W30, 27, 24, 21, 18

		ROIT AND	End-Plate A	valiable St	rengtn, Kips			
Bolt	Thread	Hole			End-Plate Th		n.	
Group	Cond.	Type	1/	/4	5/1	6		3/8
огоар	Jona.	1,700	ASD	LRFD	:: ASD	LRFD	ASD	LRFC
	N ·	STD	77.2	116	96,5	145	116	174
	X	STD	77.2	116	96.5	145	116	174
		STD	77.2	116	96.5	145	115	173
Group A	SC Class A	OVS	69.1	104	86.3	129	98.2	147
Gloup A		SSLT	77.2	116	96.5	145	115	173
		STD	77.2	116	96.5	145	116	174
	SC Class B	OVS	69.1	104	86.3	129	104	155
		SSLT	77.2	116	96,5	145	116	174
	N	STD	₹ <b>77</b> .2	116	96.5	145	116	174
	X	STD	77.2	116	96.5	145	116	174
		STD	77.2	116	96.5	145	116	174
Group B	SC Class A	OVS	69.1	104	86.3	129	104	155
aloup D		SSLT	77.2	116	96.5	145	116	174
		STD	77.2	116	96.5	145	116	174
	SC Class B	OVS	69.1	104	86.3	129	104	155
		SSLT	77.2	116	96.5	145	116	174
V	Veld and Beam \	Neb Availa	ible Strength	ı, kips		Suj	pport Ava	ilable
70-ksi Weld	Minimu	ım Beam V	Noh	$R_{\theta}/\Omega$	φ <i>R<sub>R</sub></i>		ength pe	
Size, in.		:kness, in.	-	kips	kips	Thi	ckness, l	dp/in.
C.120,				ASD	LRFD	ASD		LRFD
3/16		0.286		78.7	118		TD/	1140 STD
1/4		0.381		104	156	′′′′ s	SLT	SSL
5/16		0.476	ļ	129	193			
3/8		0.571	:	153	230	702 0	vs 📗	1050 <b>OVS</b>
TD = Standard h	oles	N	= Threads incl	luded		End-Pla	ite	Beam
OVS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded		F <sub>V</sub> = 36 I F <sub>U</sub> = 58 I	(Si	$F_y = 50 \text{ ksi}$ $F_u = 65 \text{ ksi}$

DESIGN TABLES 10–81

W24, 21, 18, 16

## Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

**1**-in. Bolts 4 Rows *L* = 11<sup>1</sup>/<sub>2</sub> in.

			1		End-Plate Th	ickness i	n	
Bolt	Thread	Hole	1	/4	5/-			)/8
Group	Cond.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N .	STD	60.9	91.4	76,1	114	91.4	137
	X	STD	60.9	91.4	76.1	114	91.4	137
		STD	60.9	91.4	76.1	114	91.4	137
	SC Class A	OVS	54.4	81.6	68.0	102	78.6	118
Group A		SSLT	60.9	91.4	76.1	114	91,4	137
		STD	60.9	91.4	76.1	114	91.4	137
	SC Class B	OVS	54.4	81.6	68.0	102	81.6	122
		SSLT	60.9	91.4	76.1	114	91.4	137
	N	STD	60.9	91.4	76.1	114	91.4	137
•	x	STD	60.9	91.4	76.1	114	91.4	137
		STD	60.9	91.4	76.1	114	91.4	137
	SC Class A	ovs	54.4	81.6	68.0	102	81,6	122
Group B		SSLT	60.9	91.4	76.1	114	91.4	137
		STD	60.9	91.4	76.1	114	91.4	137
	SC Class B	ovs	54,4	81.6	68.0	102	81.6	122
		SSLT	60.9	91.4	76.1	114	91.4	137
V	Veld and Beam \	Neb Availa	ble Strengtl	h, kips		Sur	port Availa	able
			v. 4	$R_n/\Omega$	φRn	•	ength per l	
70-ksi Weld Size, in.		m Beam V kness, in.		kips	kips	Thi	ckness, kip	o/in.
0120, 111.	, , ,	Miless, III.	Î	ASD	LRFD	ASD		LRFD
3/16		0.286		61.9	92.9	S	ID/ 0.	STD.
1/4		0.381		81.7	123	609 <b>S</b> S	SLT   9	I4 SSL1
5/16		0.476		101	151	· appirts		
3/8		0.571		120	180	566 <b>0</b>	<b>VS</b> 84	18 <b>OVS</b>
TD = Standard ho			= Threads inc		1	End-Pla	te	Beam
VS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	cluded	Ī	F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k	rsi F	y = 50 ksi y = 65 ksi

**1**-in. Bolts 3 Rows *L* = 8<sup>1</sup>/<sub>2</sub> in.

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

W18, 16, 14, 12, 10\*

			1	[	End-Plate Th	ickness. i	in.		
Bolt Group	Thread Cond.	Hole Type	1/		5/1		1	3/	/B
aroup	Conu.	Type	ASD	LRFD	ASD	LRFD	⇒ AS	SD	LRFC
	N ·	STD	44.6	66.9	\$55.7	83.6	66	.9	· 100
	X	STD	44.6	66.9	55.7	83.6	66	.9	100
		STD	44.6	66.9	55.7	83.6	66	.9	100
Group A	SC Class A	OVS	39.7	59.5	49,6	74.4	58	.9	88.
aloup A		SSLT	44.6	66.9	55.7	83.6	66	.9	100
		STD	44,6	66.9	55.7	83.6	66	.9	100
	SC Class B	ovs	39.7	59.5	49.6	74.4	59	.5	89.
		SSLT	44.6	66.9	55.7	83.6	66	.9	100
	N	STD	44.6	66.9	<i>5</i> 55.7 ≒	83.6	66	.9	100
	X	STD	44.6	66.9	.55.7	83.6	66	.9	100
		STD	44.6	66.9	55.7	83.6	66	.9	100
Group B	SC Class A	ovs	39.7	59.5	49,6	74.4	59	.5	89.3
aroup b		SSLT	44.6	66.9	55.7	83.6	66	9	100
		STD	44.6	66.9	55.7	83.6	66	9	100
	SC Class B	ovs	39.7	59.5	49.6	74.4	59	5	89.3
		SSLT	44.6	66.9	55.7	83.6	66	9	100
V	<b>Veld and Beam \</b>	Neb Availa	able Strength	, kips		Su	pport A	lvaila	ble
70-ksi Weld	Minimu	ım Beam V	Nob	$R_n/\Omega$	φ <i>R</i> <sub>n</sub>		ength	•	
Size, in.		kness, in.	- 1	kips	kips	Thi	icknes	s, kip/	/in
				ASD	LRFD	ASD			LRFD
3/16		0.286		45.2	67.9	AEO	TD/ :	68	, STD
1/4		0.381		59.4	89.1	ີ່ S	SLT	00	' SSL
<sup>5</sup> /16		0.476		73.1	110				
3/8		0.571		86.3	129	429 0	vs	64	4 OVS
TD = Standard ho			l = Threads incl			End-Pla	ate	E	Beam
VS = Oversized h LT = Short-slotte to direction	d holes transverse		<ul><li>Threads exc</li><li>Slip critical</li></ul>	luded		$F_y = 36  \mathrm{I}$ $F_u = 58  \mathrm{I}$			= 50 ksi = 65 ksi

<sup>\*</sup>Limited to W10×12, 15, 17, 19, 22, 26, 30

DESIGN TABLES 10-83

W12, 10, 8

# Table 10-4 (continued) Bolted/Welded Shear End-Plate Connections

1-in. Bolts 2 Rows L = 5<sup>1</sup>/<sub>2</sub> in.

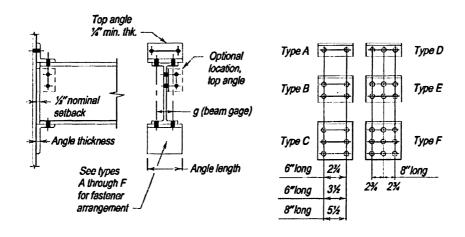
		<b>Bolt</b> and	End-Plate Av	<i>r</i> ailable St	rength, kips			
0-44					End-Plate TI	nickness, ir	n.	
Bolt Group	Thread Cond.	Hole Type	1/	4	5/	16		
divup	Ooliu.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFD
	N ·	STD	28.3	42.4	<b>35.3</b>	53.0	42.4	• 63.6
	X	STD	28.3	42.4	35.3	53.0	42.4	63.6
		STD	28.3	42.4	₹ 35.3 🔻	53.0	42.4	63.6
Group A	SC Class A	ovs	25.0	37.5	31.3	46.9	37.5	56.3
aloup A		SSLT	28.3	42.4	35.3	53.0	42.4	63.6
		STD	28.3	42.4	35.3	53.0	42.4	63.6
	SC Class B	OVS	25.0	37.5	313	46.9	37,5	56.3
		SSLT	28.3	42.4	35.3	53.0	42.4	63.6
	N	STD	<b>-</b> 28.3⊘	42.4	35.3 🚶	53.0	42,4	63.6
	X	STD	28.3	42.4	35.3	53.0	42.4	63.6
		STD	28.3	42.4	∄ 35.3 ∰	53.0	42.4	63.6
Group B	SC Class A	ovs	25.0	37.5	31,3	46.9	37.5	56.3
aloup b		SSLT	28.3	42.4	35.3	53.0	42.4	63.6
		STD	28.3	42.4	35.3	53.0	42.4	63.6
	SC Class B	OVS	25.0	37.5	31.3	46.9	37.5	56.3
		SSLT	28.3	42.4	35.3	53.0	42.4	63.6
٧	Veld and Beam \	Neb Availa	ble Strength	, kips		Sup	port Avai	lable
70-ksi Weld	Minimu	m Beam V	lich	$R_n/\Omega$	φ <b>R</b> n		ength per	
Size, in.		kness, in.		kips	kips	Thic	ckness, ki	p/in.
,				ASD	LRFD	ASD		LRFD
<sup>3</sup> / <sub>16</sub>		0.286		28.5	42.8		TD/ /	STD
1/4		0.381		37.1	55.7	ું∵′∴ ss	ilt i	SSL
<sup>5</sup> / <sub>16</sub>		0.476		45.2	67.9			
3/8		0.571		52.9	79.4	293 01	vs   4	39 <b>OVS</b>
TD = Standard h			= Threads incl			End-Pla	te	Beam
VS = Oversized h SLT = Short-slotte to direction	d holes transverse		= Threads exc = Slip critical	luded		F <sub>y</sub> = 36 k F <sub>u</sub> = 58 k	si si	F <sub>y</sub> = 50 ks F <sub>u</sub> = 65 ks

### **UNSTIFFENED SEATED CONNECTIONS**

An unstiffened seated connection is made with a seat angle and a top angle, as illustrated in Figure 10-7. These angles may be bolted or welded to the supported beam as well as to the supporting member.

While the seat angle is assumed to carry the entire end reaction of the supported beam, the top angle must be placed as shown or in the optional side location for satisfactory performance and stability (Roeder and Dailey, 1989). The top angle and its connections are not usually sized for any calculated strength requirement. A <sup>1</sup>/<sub>4</sub>-in.-thick angle with a 4-in. vertical leg dimension will generally be adequate. It may be bolted with two bolts through each leg or welded with minimum size welds to either the supported or the supporting members.

When the top angle is welded to the support and/or the supported beam, adequate flexibility must be provided in the connection. As illustrated in Figure 10-7(b), line welds are placed along the toe of each angle leg. Note that welding along the sides of the vertical angle leg must be avoided as it would inhibit the flexibility and, therefore, the necessary end rotation of the connection. The performance of such a connection would not be as intended for unstiffened seated connections.



(a) All-bolted

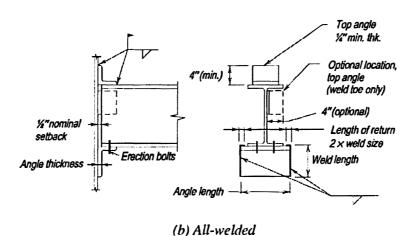


Fig. 10-7. Unstiffened seated connections.

### **Design Checks**

The available strength of an unstiffened seated connection is determined from the applicable limit states for bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). Additionally, the strength of the supported beam web must be checked for the limit states of web local yielding and web local crippling. In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n/\Omega$ , is determined per AISC Specification Sections J10.2 and J10.3, respectively, which is simplified using the constants in Table 9-4. For further information, see Carter et al. (1997).

### **Shop and Field Practices**

Unstiffened seated connections may be made to the webs and flanges of supporting columns. If adequate clearance exists, unstiffened seated connections may also be made to the webs of supporting girders.

To provide for overrun in beam length, the nominal setback for the beam end is <sup>1</sup>/<sub>2</sub> in. To provide for underrun in beam length, this setback is assumed to be <sup>3</sup>/<sub>4</sub> in. for calculation purposes.

The seat angle is preferably shop-attached to the support. Since the bottom flange typically establishes the plane of reference for seated connections, mill variation in beam depth may result in variation in the elevation of the top flange. Such variation is usually of no consequence with concrete slab and metal deck floors, but may be a concern when a grating or steel-plate floor is used. Unless special care is required, the usual mill tolerances for member depth of ½ in. to ¼ in. are ignored. However, when the top angle is shop-attached to the supported beam and field bolted to the support, mill variation in beam depth must be considered. Slotted holes, as illustrated in Figure 10-8(a), will accommodate both overrun and underrun in the beam depth and are the preferred method for economy and convenience to both the fabricator and erector. Alternatively, the angle could be shipped loose with clearance provided, as shown in Figure 10-8(b). When the top angle is to be field-welded to the support, no provision for mill variation in the beam depth is necessary.

When the top angle is shop-attached to the support, an appropriate erection clearance is provided, as illustrated in Figure 10-8(c).

### **Bolted/Welded Unstiffened Seated Connections**

Tables 10-5 and 10-6 may be used in combination to design unstiffened seated connections that are welded to the supporting member and bolted to the supported beam, or bolted to the supporting member and welded to the supported beam.

### **DESIGN TABLE DISCUSSION (TABLES 10-5 AND 10-6)**

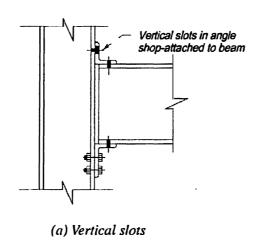
### Table 10-5. All-Bolted Unstiffened Seated Connections

Table 10-5 is a design aid for all-bolted unstiffened seats. Seat available strengths are tabulated, assuming a 4-in. outstanding leg, for angle material with  $F_y = 36$  ksi and  $F_u = 58$  ksi and beam material with  $F_y = 50$  ksi and  $F_u = 65$  ksi. All values are for comparison with the governing LRFD or ASD load combination.

Tabulated seat available strengths consider the limit states of shear yielding and flexural yielding of the outstanding angle leg. The required bearing length,  $l_{b.\,req}$ , is determined by

the designer as the larger value of  $l_b$  required for the limit states of local yielding and crippling of the beam web. As noted in AlSC Specification Section J10.2,  $l_{b, req}$  must not be less than  $k_{des}$ . A nominal beam setback of  $^{1}/_{2}$  in. is assumed in these tables. However, this setback is increased to  $^{3}/_{4}$  in. for calculation purposes in determining the tabulated values to account for the possibility of underrun in beam length.

Bolt available strengths are tabulated for the seat types illustrated in Figure 10-7(a) with <sup>3</sup>/<sub>4</sub>-in.-, <sup>7</sup>/<sub>8</sub>-in.- and 1-in.-diameter Group A and Group B bolts. Vertical spacing of bolts and gages in seat angles may be arranged to suit conditions, provided the edge distance and spacing requirements in AISC *Specification* Section J3 are met. Where thick angles are used, larger entering and tightening clearances may be required in the outstanding angle leg. The suitability of angle sizes and thicknesses for the seat types illustrated in Figure 10-7(a) is also listed in Table 10-5.



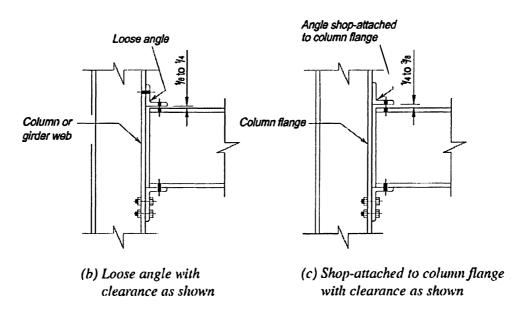


Fig. 10-8. Providing for variation in beam depth with seated connections.

### Table 10-6. All-Welded Unstiffened Seated Connections

Table 10-6 is a design aid for all-welded unstiffened seats (exception: the beam is bolted to the seat). Seat available strengths are tabulated, assuming either a  $3^{1/2}$ -in. or 4-in. outstanding leg (as indicated in the table), for angle material with  $F_y = 36$  ksi and  $F_u = 58$  ksi and beam material with  $F_y = 50$  ksi and  $F_u = 65$  ksi. Electrode strength is assumed to be 70 ksi.

Tabulated seat available strengths consider the limit states of shear yielding and flexural yielding of the outstanding angle leg. The required bearing length,  $l_{b, req}$ , is to be determined by the designer as the larger value of  $l_b$  required for the limit states of local yielding and crippling of the beam web. As noted in AISC Specification Section J10.2,  $l_{b, req}$  must not be less than  $k_{des}$ . A nominal beam setback of  $^{1}/_{2}$  in. is assumed in these tables. However, this setback is increased to  $^{3}/_{4}$  in. for calculation purposes in determining the tabulated values to account for the possibility of underrun in beam length.

Tabulated weld available strengths are determined using the elastic method. The minimum and maximum angle thickness for each case is also tabulated. While these tabular values are based upon 70-ksi electrodes, they may be used for other electrodes, provided the tabular values are adjusted for the electrodes used (e.g., for 60-ksi electrodes, the tabular values are to be multiplied by 60/70 = 0.866, etc.) and the welds and base metal meet the required strength level provisions of AISC Specification Table J2.5. Should combinations of material thickness and weld size selected from Table 10-6 exceed the limits in AISC Specification Section J2.2, the weld size or material thickness should be increased as required. Table 8-4 is not applicable to the design of these welds in this type of connection.

As can be seen from the following, reduction of the tabulated weld strength is not normally required when unstiffened seats line up on opposite sides of the supporting web. From Salmon et al. (2009), the available strength,  $\phi R_n$  or  $R_n/\Omega$ , of the welds to the support is

LRFD	ASD						
$\phi R_n = 2 \left( \frac{1.392DL}{\sqrt{1 + \frac{20.25e^2}{L^2}}} \right) $ (10-2a)	$\frac{\Phi R_n}{\Omega} = 2 \left( \frac{0.928DL}{\sqrt{1 + \frac{20.25e^2}{L^2}}} \right) $ (10-2b)						

#### where

D = number of sixteenths-of-an-inch in the weld size

L = vertical leg dimension of the seat angle, in.

e = eccentricity of the beam end reaction with respect to the weld lines, in.

The term in the denominator that accounts for the eccentricity, e, increases the weld size far beyond what is required for shear alone, but with seats on both sides of the supporting member web, the forces due to eccentricity react against each other and have no effect on the web. Furthermore, as illustrated in Figure 10-9, there are actually two shear planes per weld; one at each weld toe and heel for a total of four shear planes. Thus, for an 8-in.-long L7×4×1 seat angle supporting a LRFD required strength of 70 kips or an equivalent ASD required strength of 46.7 kips, the minimum support thickness is determined as follows:

LRFD	ASD
$\frac{70 \text{ kips}}{0.75(0.6)(65 \text{ ksi})(7 \text{ in.})(4 \text{ planes})} = 0.0855 \text{ in.}$	$\frac{2.0(46.7 \text{ kips})}{0.6(65 \text{ ksi})(7 \text{ in.})(4 \text{ planes})} = 0.0855 \text{ in.}$

For the identical connection on both sides of the support, the minimum support thickness is less than <sup>3</sup>/16 in. Thus, the supporting web thickness is generally not a concern.

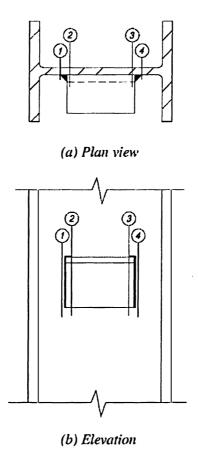


Fig. 10-9. Shear planes in column web for unstiffened seated connections.

Angle  $F_y = 36$  ksi

## Table 10-5 All-Bolted Unstiffened Seated Connections

L6

				Outstand	ling Angl	le Leg Le	ength Str	ength, ki	ps									
		1				Angle L	ength, in					Min.						
	quired		6															
	earing				A	Ingle Thi	ckness, i	in.		Angle Leg								
_	ength <sub>req</sub> , in.		3/8	1	/2		5/8	3	3/4		1	Ley						
101	req, ····	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	in.						
	1/2	18.2	27.3															
	<sup>9</sup> /16	16.2	24.3	43.2	64.8	<b>.</b>	3											
	<sup>5</sup> /8 <sup>11</sup> /16	14.6 13.2	21.9 19.9	43.1 37.0	64.8 55.5													
	3/4	12.1	18.2	32.3	48.6				1									
	13/16	11.2	16.8	28.7	43.2	7 12 24												
	<sup>7</sup> /8 <sup>15</sup> / <sub>16</sub>	10.4	15.6	25.9	38.9		01.0											
1		9.70 9.09	14.6	23.5 21.6	35.3 32.4	54.0 50.5	81.0 75.9		97.2									
	1/ <sub>16</sub>	8.56	12.9	19.9	29.9	44.9	67.5											
1	1 <sup>1</sup> /8	8.08	12.2	18.5	27.8	40.4	60.8											
	1 <sup>3</sup> /16	7.66	11.5	17.2	25.9	36.7	55.2											
	<sup>1</sup> /4   <sup>5</sup> / <sub>16</sub>	7.28 6.93	10.9	16.2 15.2	24.3 22.9	33.7 31.1	50.6 46.7	64.8 64.7	97.2 97.2	\$. P/ .		31/2						
	3/8	6.61	9.94	14.4	21.6	28.9	43.4	58.2	87.5			312						
1	<sup>7</sup> /16	6.33	9.51	13.6	20.5	26.9	40.5	52.9	79.5			1						
1	<sup>1</sup> /2	6.06	9.11	12.9	19.4	. 25.3	38.0	48.5	72.9									
	<sup>5</sup> /8	5.60 5,20	8,41 7,81	11.8 10.8	17.7 16.2	22.5 20.2	30.4		33.8					41.6 36.4	62.5 54.7			
1 <sup>3</sup> /4 1 <sup>7</sup> /8 2		4.85	7.29	10.0	15.0	18.4	27.6	32.3	48.6	86.4	130							
		4.55	6.83	9.24	13.9	16.8	25.3	29.1	43.7	86.2	130	1						
	2 <sup>1</sup> /8	4.28	6.43	8.62	13.0	15.5	23.4	26.5	39.8	73.9	111							
2	2 <sup>1</sup> /4 2 <sup>3</sup> /8	4.04 3.83	6.08 5.76	7.61	.61   11.4   <b>13.5</b>   20.3   <b>22.4</b>   33.6	64.7 57,5	97.2 86.4											
2	1/2	3.64	5.47	7.19	10.8	12.6	19.0	20.8	31.2	51.7	77.8							
2	25/8	3,46	5.21	6.81	10.2	11.9	17.9	19.4	29.2	47.0	70.7							
2	1 <sup>3</sup> / <sub>4</sub> 1 <sup>7</sup> / <sub>8</sub>	3.31	4.97 4.75	6.47	9.72	11.2	16.9	18.2	27.3	43.1	64.8 59.8							
3		3,16 3,03	4.75	6.16 5.88	9.26 8.84	10.6 10.1	16.0 15.2	17.1 16.2	25.7 24.3	39.8 37.0	55.5							
3	1 <i>†</i> 8	2.91	4.37	5.62	8.45	9.62	14.5	15.3	23.0	34.5	51.8	4						
3	31/4	2.80	4.21	5.39	8.10	9.19	13.8	14.6	21.9	32.3	48.6	<u> </u>						
	<u>:</u>		Bolt Avail							Available	e Angles							
Bolt	Bolt	Thread					re 10-7(a		Conn	ection	Angle	t,						
Dia., in.	Group	Cond.	400			3	(		Ty	pe	Size	in.						
	Group	N	ASD 23.9	LRFD	ASD	LRFD	ASD 71.6	LRFD			4×3	3/8 - 1						
٠.	A	X	30.1	35.8 45.1	47.7 60.1	71.6 90.2	71.6 90.2	107 135	A,	D	4×3 <sup>1</sup> /2	3/8 - 1						
3/4	Group	N	30.1	45.1	60.1	90.2	90.2	135			4×4	3/8 - 3						
	В	X	37.1	<b>5</b> 5.7	74.3	111	111	167			6×4	$\frac{3}{8} - \frac{3}{4}$						
	Group	N	32.5	48.7	- 64.9	97.4	97.4	146	B, E 7×4 8×4			$^{3}/_{8} - ^{3}/_{3}$						
7/8	A	X	40.9	61.3	81.7	123	123	184			1/2 - 1							
	Group	N	40.9	61.3	81.7	123	123	184	Cº,	Cb, Fb 8×4 1		<sup>1</sup> /2 - 1						
	В	X	50.5	75.7	101	151	₹ <b>1</b> 51	227										
	Group	N X	42,4 53.4	63.6 80.1	84.8 107	127 160				able for us								
1 Group		N	53.4	80.1	107	160			- 1-indiameter bolts.		ts.							
	В	X	65.9	98.9	132	198	<u>-</u>											
ASI	D.,,	.RFD			above the	heavy line	e, shear yie	lding of th	e angle leg	controls t	he							
	2.00 ø	= 0.75	available s	svengtn.														

Min.

**Angle** 

Leg

in.

31/2

4

Table 10-5 (continued) **Angle** All-Bolted Unstiffened **L8**  $F_y = 36 \text{ ksi}$ **Seated Connections Outstanding Angle Leg Length Strength, kips** Angle Length, in. Required Bearing Angle Thickness, in. Length 3/8 3/4 1/2 5/8  $l_b$ , req, in. **ASD LRFD ASD LRFD ASD LRFD ASD LRFD ASD LRFD** 1/2 24.3 36.5 9/16 21.6 32.4 57.6 86.4 5/8 19.4 29.2 57.5 86.4 <sup>11</sup>/16 17.6 26.5 49.3 74.1 3/4 16.2 24.3 43.1 64.8 <sup>13</sup>/16 14.9 22.4 38,3 57.6 7/8 13.9 20.8 34.5 51.8 <sup>15</sup>/16 72.0 108 12.9 19.4 31.4 47.1 12.1 18.2 28.7 43.2 67.4 101 11/16 59.9 11.4 17.2 26.5 39.9 90 1<sup>1</sup>/8 10.8 16.2 24,6 37.0 53.9 81.0 13/16 49.0 23.0 10.2 15.3 34.6 73.6 11/4 9.70 21,6 32.4 44.9 67.5 14.6 86.4 15/16 9.24 20.3 30.5 86.2 13.9 41.5 62.3 130 1<sup>3</sup>/8 8.82 19.2 28.8 38.5 57.9 77.6 117 13.3 17/16 12.7 18.2 35.9 8.44 27.3 54.0 70.5 106 11/2 8.08 12.2 17.2 25.9 33.7 50.6 64.7 97.2 15/8 55.4 23.6 29.9 45.0 83.3 7.46 11.2 15.7  $1^{3}/4$ 6.93 10.4 14.4 21.6 26.9 40.5 48.5 72.9 17/8 13.3 💀 6.47 9.72 19.9 24.5 36.8 43.1 64.8 115 2 6.06 9.11 12,3 18.5 22.5 33.8 38.8 58.3 173 2<sup>1</sup>/8 5.71 8.58 11.5 17.3 20.7 31.2 35.3 53.0 98.5 148 2<sup>1</sup>/4 5.39 8.10 10.8 16.2 19.2 28.9 32.3 48.6 86.2 130 2<sup>3</sup>/8 7.67 15.2 18.0 27.0 29.8 44.9 76.6 115 5,11 10.1 21/2 7.29 14.4 16.8 25.3 41.7 69.0 104 4.85 9.58 27.7 2<sup>5</sup>/8 4.62 6.94 9,08 13.6 15.9 23.8 25.9 38.9 62.7 94.3  $2^{3}/4$ 4.41 6.63 8.62 13.0 15.0 22 5 24.3 36.5 57.5 86.4 2<sup>7</sup>/8 4.22 6.34 8.21 12.3 14.2 21.3 22.8 34.3 53.1 79.8 13.5 4.04 6.08 7.84 11.8 20.3 21,6 32.4 49.3 74.1 31/8 3.88 5.83 7.50 11.3 12.8 19.3 20.4 30.7 46.0 69.1

#### 19.4 43.1 3.73 5.61 7.19 10.8 12.2 18.4 29.2 64.8 **Bolt Available Strength, kips Available Angles** Connection Type from Figure 10-7(a) **Bolt Bolt Connection Angle Thread** t, Dia.. Group Cond. **Type** Size in. in. ASD **LRFD ASD LRFD ASD LRFD** 4x3 $\frac{3}{8} - \frac{1}{2}$ N 35.8 71.6 107 107 161 Group 53.7 X A, D 4×3<sup>1</sup>/2 $\frac{3}{8} - \frac{1}{2}$ 45.1 67.6 90.2 203 135 135 3/4 3/8 - 3/44×4 Group 45.1 90.2 135 203 N 67.6 135 3/8 - 3/4X 167 6×4 55.7 83.5 111 167 251 3/8 - 3/4Group N 48.7 73.0 97,4 146 146 219 B, E 7×4 X 92.0 123 184 184 276 8×4 $^{1}/_{2}-1$ 61.3 7/8 Group N 61.3 92.0 123 184 184 276 Cb, Fb 8×4 $\frac{1}{2} - 1$ X 114 151 227 227 341 75.7 Group N 63.6 95.4 127 191 <sup>b</sup>Not suitable for use with X 240 80.1 120 160 1 1-in.-diameter bolts. Group N 120 240 80.1 160 X 198 98.9 148 297 For tabulated values above the heavy line, shear yielding of the angle leg controls the **ASD LRFD**

available strength.

 $\Omega = 2.00$ 

 $\phi = 0.75$ 

Angle  $F_y = 36 \text{ ksi}$ 

### Table 10-6 All-Welded Unstiffened Seated Connections

L6

_					Angle Le	ngth, in					Min.		
Required		6											
Bearing				A	Ingle Thic		n.			······································	Angl		
Length $l_b$ , req, in.	3	/8	1/		5,		3,	/4		1	Leg		
ib, req, III.	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	in.		
1/2	18.2	27.3									ļ		
<sup>9</sup> /16	16.2	24.3									ľ		
5/8	14.6	21.9	43.1	64.8	164								
<sup>11</sup> /16	13.2	19.9	37,0	55.5							l		
3/4	12.1	18.2	32.3	48.6									
<sup>13</sup> /16	11.2	. 16.8	28.7	43.2							ł		
7/8	10.4	15.6	25,9	38.9							l		
<sup>15</sup> /16	9.70	14.6	23.5	35.3	54.0	81.0					ŀ		
1	9.09	13.7	21.6	32.4	50.5	75.9							
1 <sup>1</sup> /16	8,56	12.9	19.9	29.9	44.9	67.5					l		
1 <sup>1</sup> /8	8,08	12.2	18.5	27.8	40.4	60.8							
1 <sup>3</sup> /16	7.66	11.5	17.2	25.9	36.7	55.2							
1 <sup>1</sup> /4	7.28	10.9	16.2	24.3	33.7	50.6							
1 <sup>5</sup> /16	6.93	10.4	15.2	22.9	31.1	46.7	64.7	97.2			31/2		
1 <sup>3</sup> /8	6.61	9.94	14.4	21.6	28.9	43.4	58.2	87.5					
1 <sup>7</sup> /16	6.33	9.51	13.6	20.5	26.9	40.5	52.9	79.5					
1 <sup>1</sup> /2	6.06	9.11	12.9	19.4	25.3	38.0	48.5	72.9					
1 <sup>5</sup> /8	5,60	8.41	11.8	17.7	22.5	33.8	41.6	62.5					
1 <sup>3</sup> /4	5.20	7.81	10.8	16.2	20,2	30.4	36,4	54.7					
1 <sup>7</sup> /8	4.85	7.29	9.95	15.0	18.4	27.6	32.3	48.6					
2	4.55	6.83	.9.24	13.9	16.8	25.3	29.1	43.7	86.2	130			
2 <sup>1</sup> /8	4.28	6.43	8.62	13.0	15.5	23.4	26.5	39.8	73.9	111			
2 <sup>1</sup> /4 2 <sup>3</sup> /8	4.04	6.08	8.08	12.2	14.4	21.7	24.3	36.5	64.7	97.2			
2 <sup>1</sup> /2	3.83	5.76	7.61	11.4	13.5	20.3	22.4 20.8	33.6 31.2	57.5	86.4 77.8			
2 <sup>-</sup> /2 2 <sup>5</sup> /8	3.64 3.46	5.47 5.21	7.19 6.81	10.8 10.2	12.6	19.0 17.9	19.4	31.2 29.2	51.7 47.0	70.7			
2 <sup>3</sup> /4	3.40	4.97	6.47	9.72	11.9 11.2	16.9	18.2	29.2 27.3	43.1	64.8			
2 <sup>7</sup> /8	-3.16	4.75	6.16	9.26	10.6	16.0	17.1	25.7	39.8	59.8			
3	3.03	4.75	5.88	8.84	10.1	15.2	16.2	24.3	37.0	55.5			
3 <sup>1</sup> /8	2.91	4.37	5.62	8.45	9.62	14.5	15.3	23.0	34.5	51.8	4		
3 <sup>1</sup> /4	2.80	4.21	5,39	8.10	. 9.19	13.8	14.6	21.9	32.3	48.6			
		4.21	1		Available			21.0	<b>YE.</b>	40.0			
		1	weiu (		Seat Ang			vortical)					
70-ksi Wel	d Size, in.			4 × 3 <sup>1</sup> / <sub>2</sub>		ic Size (	long leg		5 × 3 <sup>1</sup> / <sub>2</sub>				
Desi			ASD	+ X 372	LRFD			ASD.	9 X 3.72	LRFD			
1/4		ar erga hiller Maria	11.5		17.2		Control (Control Control	17.2		25.8			
5/ <sub>1</sub> /			14.3		21.5			21.5		32.2			
3/8			17.2	\$	25.8			25.8		38.7			
7/10			20.1		30.1			30.1		45.2			
1/2		l Rija 🖁						34.4		51.6			
9/1	9/16						J	38.7		58.1			
5/8							43.0 64.5						
11/1	The state of the s							47.3 71.0					
			Av	ailable /	Angle Thi	ckness,	in.						
Minimum <sup>3</sup> / <sub>8</sub>									<sup>3</sup> /8				
Maxin		1/2					3/4						
ASD	LRFD For tabulated values above the heavy line, shear yielding of the angle leg controls the available strength.												
		$\phi = 0.75$ available strength.  — Indicates weld size exceeds that permitted for maximum angle thickness of $1/2$ in.											

L8

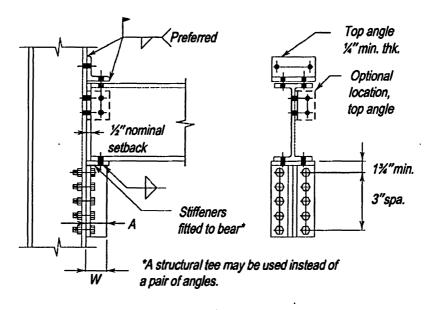
### Table 10-6 (continued) All-Welded Unstiffened Seated Connections

Angle  $F_y = 36 \text{ ksi}$ 

			Jeal	ea t				13				
			Ou <b>ts</b> tand	ling Angl				os				
Required	.				Angle Le		•				Min.	
Bearing											Angle	
Length			Angle Thickness, in.									
<i>l<sub>b</sub></i> , <sub>req</sub> , in	.	3/8	1	/2	5,	/8	3,	/4	1 .	1	Leg	
•	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	in.	
1/2	24.3	36.5							i jiyar			
<sup>9</sup> /16 <sup>5</sup> /8	21.6	32.4		00.4					F. 34.		1	
<sup>978</sup>	19.4 17.6	29.2 26.5	57.5 49.3	86.4 74.1			airy a 73 y			}	l	
3/4	16.2	24.3	43.1	64.8						1		
13/16	14.9	22.4	38.3	57.6	HAR		l Mi			]	J	
7/8	13,9	20.8	34.5	51.8					19 /編.	l ·		
15/16	12,9	19.4	31.4	47.1	72.0	108						
1	12.1	18.2	28.7	43.2	67.4	101						
11/16	11.4	17.2	26.5	39.9	59.9	90.0			La de la la la la la la la la la la la la la			
1 <sup>1</sup> /8	10.8	16.2	24.6	37.0	53.9	81.0						
1 <sup>3</sup> /16	10.2	15.3	23.0	34.6	49.0	73.6						
1 <sup>1</sup> /4	9.70	14.6	21.6	32.4	44.9	67.5	4.7					
1 <sup>5</sup> /16	9.24	13.9	20.3.	30.5	41.5	62.3	86.2	130			31/2	
1 <sup>3</sup> /8	8.82	13.3	19.2	28.8	38.5	57.9	77.6	117			1	
1 <sup>7</sup> /16	8.44	12.7	18.2	27.3	35,9	54.0	70.5	106				
11/2	8.08	12.2	17.2	25.9	33.7	50.6	64.7	97.2			i	
1 <sup>5</sup> /8	7.46	11.2	15.7	23.6	29.9	45.0	55.4	83.3	Š			
1 <sup>3</sup> /4	6.93	10.4	14.4	21.6	26.9	40.5	48:5	72.9			İ	
1 <sup>7</sup> /8	6.47	9.72	13.3	19.9	24.5	36.8	43.1	64.8				
2	6.06	9.11	12.3	18.5	22.5	33.8	38.8	58.3	115	173		
2 <sup>1</sup> /8	5.71	8.58	11.5	17.3	20.7	31.2	35.3	53.0	98.5	148		
2 <sup>1</sup> /4 2 <sup>3</sup> /8	5.39 5.11	8.10 7.67	10.8 10.1	16.2	19.2 18.0	28.9 27.0	32.3 29.8	48.6 44.9	86.2 76.6	130 115		
2 <sup>1</sup> /2	4.85	7.07	9.58	15.2 14.4	16.8	27.0 25.3	29.0 27,7	44.9 41.7	69.0	104		
2 <sup>5</sup> /8	4.62	6.94	9.08	13.6	15.9	23.8	25.9	38.9	62.7	94.3		
2 <sup>3</sup> /4	4.41	6.63	8.62	13.0	15.0	22.5	24.3	36.5	57.5	86.4		
2 <sup>7</sup> /8	4.22	6.34	8.21	12.3	14.2	21.3	22.8	34.3	53.1	79.8		
3	4.04	6.08	7.84	11.8	13.5	20.3	21,6	32.4	49,3	74.1		
3 <sup>1</sup> /8	3.88	5.83	7.50	11.3	12.8	19.3	20.4	30.7	46.0	69.1	4	
3 <sup>1</sup> /4	3.73	5.61	7.19	10.8	12.2	18.4	19.4	29.2	43.1	64.8		
	F :	•	Weld	(70 ksi) <i>l</i>	Available	Strengt	h, kips					
70-ksi Wel	ld Size in			;	Seat Ang	le Size (	long leg	vertical				
:		V. 10.	6×4			7>	<4			8×4		
Des		ASI	).##  	LRFD		SD	LRFI	) [	ASD	L	RFD	
: 1/		21.8		32.7		8.5	42.7		35.6		53.4	
5/	16	27.3		40.9		5.6	53.4				66.7	
3/		32.7		49.1	107 SERVICE AND 1	2.7	64.1		53,4		80.1	
7/		38.2		57.2	******* * * *** ***	9.8	74.7		62,3		93.4	
1/		43.6		65.4		7.0	85.4		71.2		07	
9 <sub>/1</sub> 5/		49.1		73.6	, , , , b	4.1	96.1		80.1		20	
11/		54.5 60.0		81.8 90.0		1.2 8.3	107 117	js.	89.0 97.9		33 47	
<u> </u>				vailable <i>A</i>	200000000000000000000000000000000000000	17 314			**************************************	<u>=164</u>		
Minir	num								1/2			
Maxi	mum		3/4		İ	3/		i		1		
ASD	LRFD	LRFD For tabulated values above the heavy line, shear yielding of the angle leg controls					the					
$\Omega = 2.00$	φ = 0.75	available strength.										
2.50	7											

### STIFFENED SEATED CONNECTIONS

A stiffened seated connection is made with a seat plate and stiffening element (e.g., a plate, structural tee, or pair of angles) and a top angle, as illustrated in Figure 10-10. The top angle may be bolted or welded to the supported beam as well as to the supporting member and the stiffening element may be bolted or welded to the support. The supported beam is bolted to the seat plate.



(a) All-bolted

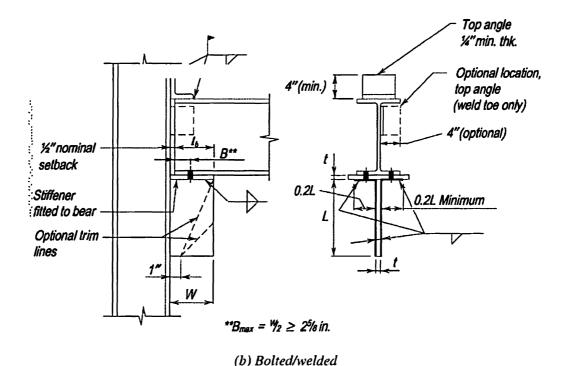


Fig. 10-10. Stiffened seated connections.

The stiffening element is assumed to carry the entire end reaction of the supported beam applied at a distance equal to 0.8W, where W is the dimension of the stiffening element parallel to the beam web. The top angle must be placed as shown or in the optional side location for satisfactory performance and stability (Roeder and Dailey, 1989). The top angle and its connections are not usually sized for any calculated strength requirement. A \(^1/4\-\)-in-thick angle with a 4-in. vertical leg dimension will generally be adequate. It may be fastened with two bolts through each leg or welded with minimum size welds to either the supported or the supporting members.

When the top angle is welded to the support and/or the supported beam, adequate flexibility must be provided in the connection. As illustrated in Figure 10-10(b), line welds are placed along the toe of each angle leg. Note that welding along the sides of the vertical angle leg must be avoided as it would inhibit the flexibility and, therefore, the necessary end rotation of the connection. The performance of such a connection would not be as intended for simple shear connections.

### **Design Checks**

The available strength of a stiffened seated connection is determined from the applicable limit states for the bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). Additionally, the strength of the supported beam web must be checked for the limit states of web local yielding and web local crippling. In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n/\Omega$ , is determined per AISC Specification Sections J10.2 and J10.3, respectively, which is simplified using the constants in Table 9-4.

When stiffened seated connections, such as the one shown in Figure 10-10(b), are made to one side of a supporting column web, the column web may also need to be investigated for resistance to punching shear. In lieu of a more detailed analysis, Sputo and Ellifritt (1991) showed that punching shear will not be critical if the design parameters following and those summarized graphically in Figure 10-10(b) are met.

1. This simplified approach is applicable to the following column sections:

W14×43 to 730 W12×40 to 336 W10×33 to 112 W8×24 to 67 W6×20 and 25 W5×16 and 19

- 2. The supported beam must be bolted to the seat plate with high-strength bolts to account for the prying action caused by rotation of the connection. Welding the beam to the seat plate is not recommended because welds may lack the required strength and ductility. The centerline of the bolts should be located no more than the greater of W/2 or 25/8 in. from the column web face.
- 3. For seated connections where W = 8 in. or 9 in. and  $3^{1}/2$  in.  $< B \le W/2$ , or where W = 7 in. and 3 in.  $< B \le W/2$  for a W14×43 column, refer to Sputo and Ellifritt (1991).
- 4. The top angle may be bolted or welded, but must have a minimum <sup>1</sup>/<sub>4</sub>-in. thickness.
- 5. The seat plate should not be welded to the beam flange.

See also Ellifritt and Sputo (1999).

...,.,.,.....,,,..,,,..,,,..,.,.,..

### **Shop and Field Practices**

The comments for unstiffened seated connections are equally applicable to stiffened seated connections.

### **DESIGN TABLE DISCUSSION (TABLES 10-7 AND 10-8)**

### Table 10-7. All-Bolted Stiffened Seated Connections

Table 10-7 is a design aid for all-bolted stiffened seats. Stiffener available strengths are tabulated for stiffener material with  $F_y = 36$  ksi and  $F_u = 58$  ksi and with  $F_y = 50$  ksi and  $F_u = 65$  ksi.

Tabulated values consider the limit state of bearing on the stiffening material. The designer must independently check the available strength of the beam web based upon the limit states of web local yielding and web local crippling. A nominal beam setback of  $^{1}/_{2}$  in. is assumed in these tables. However, this setback is increased to  $^{3}/_{4}$  in. for calculation purposes in determining the tabulated values to account for the possibility of underrun in beam length.

Bolt available strengths are tabulated for two vertical rows of from three to seven <sup>3</sup>/<sub>4</sub>-in.-, <sup>7</sup>/<sub>8</sub>-in.- and 1-in.-diameter Group A and Group B high-strength bolts based upon the limit state of bolt shear. Vertical spacing of bolts and gages in seat angles may be arranged to suit conditions, provided the edge distance and spacing requirements in AISC *Specification* Section J3 are met.

### Table 10-8. Bolted/Welded Stiffened Seated Connections

Table 10-8 is a design aid for stiffened seated connections welded to the support and bolted to the supported beam. Electrode strength is assumed to be 70 ksi.

Weld available strengths are tabulated using the elastic method. While these tabular values are based upon 70-ksi electrodes, they may be used for other electrodes, provided the tabular values are adjusted for the electrodes used (e.g., for 60-ksi electrodes, the tabular values are multiplied by 60/70 = 0.866, etc.) and the weld and base metal meet the required strength provisions of AISC Specification Table J2.5.

The thickness of the horizontal seat plate or tee flange should not be less than <sup>3</sup>/<sub>8</sub> in. If the seat and stiffener are built up from separate plates, the stiffener should be finished to bear under the seat. The welds connecting the two plates should have a strength equal to or greater than the horizontal welds to the support under the seat plate.

The designer must independently check the beam web for web local yielding and web local crippling. The nominal beam setback of <sup>1</sup>/<sub>2</sub> in. should be assumed to be <sup>3</sup>/<sub>4</sub> in. for calculation purposes to account for possible underrun in beam length.

The stiffener thickness is conservatively determined as follows. The minimum stiffener plate thickness, t, for supported beams with unstiffened webs is the supported beam web thickness,  $t_w$ , multiplied by the ratio of  $F_y$  of the beam material to  $F_y$  of the stiffener material (e.g.,  $F_{y, \text{beam}} = 50$  ksi,  $F_{y, \text{stiffener}} = 36$  ksi,  $t = t_w \times 50/36$  minimum). Additionally, the minimum stiffener plate thickness, t, should be at least 2w for stiffener material with

 $F_y = 36$  ksi or 1.5w for stiffener material with  $F_y = 50$  ksi, where w is the weld size for 70-ksi electrodes.

For 70-ksi electrodes, the minimum column web thickness is

$$t_{min} = \frac{3.09D}{F_u} \tag{9-2}$$

where

D = weld size in sixteenths of an inch

 $F_u$  = specified minimum tensile strength of the connecting element, ksi

When welds line up on opposite sides of the support, the minimum thickness is the sum of the thicknesses required for each weld. In either case, when less than the minimum material thickness is present, the weld available strength must be reduced by the ratio of the thickness provided to the minimum thickness. As with unstiffened seated connections, the contribution of eccentricity to the required shear yielding strength is negligible. Should combinations of material thickness and weld size selected from Table 10-8 exceed the limits of AISC Specification Section J2.2, the weld size or material thickness must be increased.

DESIGN TABLES 10–97

### Table 10-7 All-Bolted Stiffened Seated Connections

Stiffener M	lotorial		Outstanding Angle Leg Available Strength, kips <sup>a</sup>											
Sunenern	ialeriai			$F_y = 3$	36 ksi					$F_y = $	50 ksi			
Stiffener Outstanding Leg, W, in. <sup>b</sup>		31	//2	4 5		31/2		4		5				
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	
	<sup>5</sup> / <sub>16</sub>	55.7	83.5	65.8	98.7	86.1	129	77.3	116	91.4	137	120	179	
Thickness	3/8	66.8	100	79.0	118	103	155	92.8	139	110	165	143	215	
of Stiffener Outstanding	1/2	89.1	134	105	158	138	207	124	186	146	219	191	287	
Legs, in.	5/8	111	167	132	197	172	258	155	232	183	274	239	359	
	3/4	134	200	158	237	207	310	186	278	219	329	287	430	

Use minimum <sup>3</sup>/<sub>8</sub>-in.-thick seat plate wide enough to extend beyond outstanding legs of stiffener.

<sup>&</sup>lt;sup>b</sup> Beam bearing length assumed <sup>3</sup>/<sub>4</sub> in. less for calculation purposes.

			E	Bolt Ava	ilable S	trength,	kips							
Ş	D-14	<b>Th</b> and		Number of Bolts in One Vertical Row										
Bolt Diameter, in.	Bolt Group	Thread Cond.		3	4		5		6			7		
	uioup	Joinu.	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
:	Group	N	71.6	107	95.5	143	119	179	143	215	167	251		
3/4	A	X	90.2	135	120	180	150	225	180	271	210	316		
74	Group	N	90.2	135	120	180	150	225	180	271	210	316		
	В	X	111	167	149	223	186	278	223	334	260	390		
	Group	N	.97.4	146	130	195	162	243	195	292	227	341		
7/8	A	X	123	184	163	245	204	307	245	368	286	429		
78	Group	N	123	184	163 5	245	204	307	245	368	286	429		
	В	X	151	227	202	303	252	379	303	454	353	530		
	Group	N	127	191	170	254	212	318	254	382	297	445		
1	A	X	160	240	214	320	267	400	320	480	374	560		
•	Group	N	160	240	214	320	:267	400	320	480	374	560		
	В	X	198	297	264	396	330	495	396	593	462	692		

ASD	LRFD
$\Omega = 2.00$	φ = <b>0.75</b>
$\frac{R_n}{\Omega} = \frac{1.8F_y A_{pb}}{2.00}$	$\phi R_n = 0.75 \left( 1.8 F_y A_{\rho b} \right)$

<sup>&</sup>lt;sup>a</sup> See AISC Specification Section J7.

### Table 10-8 Bolted/Welded Stiffened Seated Connections

### Weld Available Strength, kips

					W	idth of S	Seat, <i>W</i> , i	in.						
					4						5			
<i>L</i> , in.			7	O-ksi We	eld Size, i	in.			70-ksi Weld Size, in.					
	1	/4	5,	16	3	/8	7/16		5/16		3/8			
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
6	22,7	34.0	28.4	42.5	34.0	51.1	39.7	59.6	23.5	35.2	28.2	42.2		
7	29.9	44.9	37,4	56.1	44.9	67.3	52.4	78.6	31.2	46.9	37.5	56.2		
8	37.8	56.7	47,2	70.8	56.7	85.0	66.1	99.2	39.8	59.8	47.8	71.7		
9	46.1	69.2	57.7	86.5	69.2	104	80.7	121	49.1	73.7	59.0	88.5		
10	54.9	82.3	68.6	103	82,3	123	96.0	144	59.0	88.5	<b>⊹70.8</b>	106		
11	63.9	95.8	79.8	120	95.8	144	112	168	69.4	104	83.3	125		
12	<b>73.1</b>	110	91.4	137	110	165	128	192	80.2	120	96.2	144		
13	82.5	124	103	155	124	186	144	217	91.3	137	110	164		
14	92,1	138	115	173	138	207	161	242	103	154	123	185		
15	102	152	127	191	152	229	178	267	114	171	137 🛴	206		
16	1113	167	139	209	167	250	195	292	126	189	151	227		
17	121	181	151	227	181	272	212	318	138	207	165	248		
18	131	196	163	245	196	294	229	343	150	225	180	270		
19	140	211	175	263	211	316	246	369	162	243	194	291		
20	150	225	188	281	225	338	263	394	174	261	209	313		
21	160	240	200	300	240	359	280	419	186	279	223	335		
22	169	254	212	318	254	381	296	445	198	297	238	357		
23	179	269	224	336	269	403	313	470	210	315	252 👙	378		
24	189	283	236	354	283 -	425	330	495	222	334	267	400		
25	198	297	248	372	297	446	347	520	235	352	281	422		
26	208	312	260	390	312 🖔	468	364	546	247	370	296	444		
27	217	326	272	408	326	489	380	571	259	388	310	466		

#### **Limitations for Connections to Column Webs**

B = 25/8 in. max	$B = 2^{5}/8$ in. max
W12×40, W14×43	
for <i>L</i> ≥ 9 in.	None
limit weld ≤ ¹/₄ in.	

#### Notes:

- Values shown assume 70-ksi electrodes. For 60-ksi electrodes, multiply tabular values by 0.857, or enter table with 1.17 times
  the required strength, R<sub>u</sub> or R<sub>a</sub>. For 80-ksi electrodes, multiply tabular values by 1.14, or enter table with 0.875 times the
  required strength.
- 2. Tabulated values are valid for stiffeners with minimum thickness of

$$t_{min} = \left(\frac{F_{y, beam}}{F_{y, stiffener}}\right) t_{w}$$

but not less than 2w for stiffeners with  $F_y = 36$  ksi nor 1.5w for stiffeners with  $F_y = 50$  ksi. In the above,  $t_w$  is the thickness of the unstiffened supported beam web and w is the nominal weld size.

3. Tabulated values may be limited by shear yielding of, or bearing on, the stiffener; refer to AISC Specification Sections J4.2 and J7; respectively............

ASD	LRFD
$\Omega = 2.00$	φ = <b>0.75</b>

DESIGN TABLES 10–99

### Table 10-8 (continued) Bolted/Welded Stiffened Seated Connections

### Weld Available Strength, kips

					V	Vidth of	Seat, W,	in.							
	1		5						<b>6</b> .						
<i>L</i> , in.	7	'O-ksi We	eld Size,	in.		70-ksi Weld Size, in.									
1	7,	/16	1	/2	5	5/16 3/8			7,	1	1/2				
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD			
6	32.8	49.3	37.5	56.3	19.9	29.9	23.9	35.9	27.9	41.9	31.9	47.8			
7	43.7	65.6	50.0	75.0	26.7	40.1	32.0	48.1	37.4	56.1	42.7	64.1			
8	55.8	83.7	63.8	95.6	34.3	51.4	41.1	61.7	48.0	72.0	54.8	82.2			
9	68.8	103	78.6	118	42.5	63.8	51.1	76.6	59.6	89.3	68.1	102			
10	82.6	124	94.4	142	51.4	77.2	61.7	92.6	72.0	108	82.3	123			
11	97.2	146	111	167	60.9	91.3	73.1	110	85.3	128	97.4	146			
12	112	168	128	192	70.8	106	85.0	127	99.2	149	113	170			
13	128	192	146	219	81,2	122	97,4	146	114	170	130	195			
14	144	216	164	246	91.9	138	110	165	129	193	147	220			
15	160	240	183	274	103	154	123	185	144	216	165	247			
16	176	265	202	302	114	171	137	205	160	240	183	274			
17	193	290	221	331	126	188	151	226	176	264	201	301			
18	210	315	240	360	137 😓	206	165	247	192	288	219	329			
19	227	340	259	388	149	223	179	268	208	313	238	357			
20	244	365	278	417	161	241	193	289	225	337	257	386			
21	260	391	298	446	173	259	207	311	242	362	276	414			
22	277	416	317	476	185	277	222	332	258	388	295	443			
23	294	442	336	505	197	295	236	354	275	413	315	472			
24	311	467	356	534	209	313	250	376	292	438	334	501			
25	328	492	375	563	221	331	265	397	309	464	353	530			
26	345	518	395	592	233	349	280	419	326	489	373	559			
27	362	543	414	621	245	368	294	441	343	515	392	588			

**Limitations for Connections to Column Webs** 

$B = 2^5/8$ in. max	<i>B</i> = 3 in. max
None	None

#### Notes:

- Values shown assume 70-ksi electrodes. For 60-ksi electrodes, multiply tabular values by 0.857, or enter table with 1.17 times
  the required strength, R<sub>u</sub> or R<sub>a</sub>. For 80-ksi electrodes, multiply tabular values by 1.14, or enter table with 0.875 times the
  required strength.
- 2. Tabulated values are valid for stiffeners with minimum thickness of

$$t_{\min} = \left(\frac{F_{y, \text{ beam}}}{F_{y, \text{ stiffener}}}\right) t_{w}$$

but not less than 2w for stiffeners with  $F_y = 36$  ksi nor 1.5w for stiffeners with  $F_y = 50$  ksi. In the above,  $t_{sv}$  is the thickness of the unstiffened supported beam web and w is the nominal weld size.

3. Tabulated values may be limited by shear yielding of, or bearing on, the stiffener; refer to AISC Specification Sections J4.2 and J7, respectively.

ASD LRFD  $\Omega = 2.00$   $\phi = 0.75$ 

## Table 10-8 (continued) Bolted/Welded Stiffened Seated Connections

### Weld Available Strength, kips

	Width of Seat, W, in.													
		7									8			
<i>L</i> , in.	70-ksi Weld Size, in.								70-ksi Weld Size, in.					
	5/16		3/8		<sup>7</sup> /16		1/2		<sup>5</sup> /16		3/8			
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD		
11	54.0	81.0	64.8	97.2	75.6	113	86.4	130	48.4	72.5	58.0	87.1		
12	63.1	94.7	75.7	114	88.4	133	101	151	56.7	85.1	68.1	102		
13	72,7	109	87.2	131	102	153	116	174	65.6	98.3	78.7	118		
14	82.6	124	99.2	149	116	174	132	198	74.8	112	89.8	135		
15	93.0	139	112	167	130	195	149	223	84,5	127	101	152		
16	104	155	124	186	145	217	166	249	94.4	142	113	170		
17	114	172	137	206	160	240	183	275	105	157	126	189		
18	126	188	151	226	176	264	201	301	115	173	138	208		
19	137	205	164	246	192	287	219	329	126	189	151	227		
20	148	223	178	267	208	312	237	356	137	206	165	247		
21	160	240	192	288	224	336	256	384	148	222	178	267		
22	172	258	206	309	240	361	275	412	160	240	192	287		
23	184	275	220	330	257	385	294	440	171	257	205	308		
24	195	293	234 🕏	352	274	410	313	469	183	274	219	329		
25	207	311	249	373	290	435	332	498	195	292	233	350		
26	219	329	263	395	307	461	351.	526	206	309	248	371		
27	231	347	278	417	324	486	370	555	218	327	262	393		
28	244	365	292	438	341	511	390	584	230	345	276	414		
29	256	383	307	460	358	537	409	613	242	363	291	436		
30	268	402	321	482	375	562	428	643	254	381	305	457		
31	280	420	336	504	392	588	448	672	266	399	319	479		
32	292	438	350	526	409	613	467	701	278	417	334	501		

B = 31/2 in. max	$B = 3^{1}/2$ in. max
W14×43, limit <i>B</i> ≤ 3 in.	See item 3 in preceding
See item 3 in preceding discussion "Design Checks"	discussion "Design Checks"

**Notes** 

Values shown assume 70-ksi electrodes. For 60-ksi electrodes, multiply tabular values by 0.857, or enter table with 1.17 times
the required strength, R<sub>u</sub> or R<sub>a</sub>. For 80-ksi electrodes, multiply tabular values by 1.14, or enter table with 0.875 times the
required strength.

**Limitations for Connections to Column Webs** 

2. Tabulated values are valid for stiffeners with minimum thickness of

$$t_{min} = \left(\frac{F_{y, beam}}{F_{y, stiffner}}\right) t_w$$

but not less than 2w for stiffeners with  $F_y = 36$  ksi nor 1.5w for stiffeners with  $F_y = 50$  ksi. In the above,  $t_{w}$  is the thickness of the unstiffened supported beam web and w is the nominal weld size.

Tabulated values may be limited by shear yielding of, or bearing on, the stiffener; refer to AISC Specification Sections J4.2 and J7, respectively.  $\begin{array}{|c|c|c|c|c|}\hline + \textbf{ASD} & \textbf{LRFD}\\\hline \Omega = \textbf{2.00} & \phi = \textbf{0.75}\\\hline \end{array}$ 

DESIGN TABLES 10–101

### Table 10-8 (continued) Bolted/Welded Stiffened Seated Connections

### Weld Available Strength, kips

	Width of Seat, W, in.											
			8			9						
<i>L</i> , in.	7(	0-ksi We	eld Size, i	n.	70-ksi Weld Size, in.							
	1,	/2	5,	/8	5,	16	3	/8	1,	/2	5,	/8
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
11	77.4	116	96.7	145	43.7	65.6	52.5	78.7	69.9	105	87.4	131
12	90.8	136	113	170	51.4	77.1	61.7	92.5	82.2	123	103	154
13	105	157	131	197	59.6	89.3	71.5	107	95.3	143	119	179
14	120	180	150	224	68.2	102	81.8	123	109	164	136	204
15	135	203	169	253	77.2	116	92.6	139	123	185	154	232
16	151	227	189	283	86.5	130	104	156	138	208	173	260
17	168	251	209	314	96.2	144	115	173	154	231	192	289
18	184	277	231	346	106	159	.127	191	170	255	212	319
19	202	303	252	378	117	175	140	210	186	280	233	350
20	219	329	274	411	127	191	152	229	203	305	254	381
21	237	356	297	445	138	207	165	248	220	331	276	413
22	256	383	319	479	149	223	178	268	238	357	297	446
23	274	411	342	514	160 ⊴	240	192	288	256	384	320 .	480
24	292	439	366	548	171%	257	205	308	274 😤	411	342	513
25	311	467	389	584	183	274	219	329	292	438	365	548
26	330	495	413	619	194	291	233	349	310	466	388	582
27	349	524	436	655	206	308	247	370	329	494	411	617
28	368	552	460	690	217	326	261	391	348	522	435	652
29	387	581	484	726	229	344	275	412	367	550	458	687
30	407	610	508	762	241	362	289	434	386	578	482	723
31	426	639	532	799	253	379	304	455	405	607	506	759
32	445	668	557	835	265	397	<b>.</b> 318	477	424	636	530	795

#### **Limitations for Connections to Column Webs**

$B = 3^{1}/2$ in. max	$B = 3^{1}/2$ in. max
See item 3 in preceding discussion "Design Checks"	See item 3 in preceeding discussion "Design Checks"

#### Notes:

- Values shown assume 70-ksi electrodes. For 60-ksi electrodes, multiply tabular values by 0.857, or enter table with 1.17 times
  the required strength, R<sub>u</sub> or R<sub>a</sub>. For 80-ksi electrodes, multiply tabular values by 1.14, or enter table with 0.875 times the
  required strength.
- 2. Tabulated values are valid for stiffeners with minimum thickness of

$$t_{min} = \left(\frac{F_{y, beam}}{F_{y, stiffener}}\right) t_{w}$$

but not less than 2w for stiffeners with  $F_y = 36$  ksi nor 1.5w for stiffeners with  $F_y = 50$  ksi. In the above,  $t_w$  is the thickness of the unstiffened supported beam web and w is the nominal weld size.

Tabulated values may be limited by shear yielding of, or bearing on, the stiffener; refer to AISC Specification Sections J4.2 and J7, respectively.  $\begin{array}{c|c} \textbf{ASD} & \textbf{LRFD} \\ \hline \Omega = \textbf{2.00} & \phi = \textbf{0.75} \\ \hline \end{array}$ 

### SINGLE-PLATE CONNECTIONS

A single-plate connection is made with a plate, as illustrated in Figure 10-11. The plate must be welded to the support on both sides of the plate and bolted to the supported member.

### **Design Checks**

The available strength of a single-plate connection is determined from the applicable limit states for the bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n$ , respectively.

Single-plate shear connections that satisfy the corresponding dimensional limitations can be designed using the simplified design procedure for the "conventional" configuration. Other single-plate shear connections can be designed using the procedure for the "extended" configuration, which is applicable to any configuration of single-plate shear connections, regardless of connection geometry.

Both the conventional and extended configurations permit the use of Group A or Group B bolts. The procedure is valid for bolts that are snug-tightened, pretensioned or slip-critical. In both the conventional and extended configuration, the design recommendations are equally applicable to plate and beam web material with  $F_y = 36$  ksi or 50 ksi. In both cases, the weld between the single plate and the support should be sized as  $(5/8)t_p$ , which will develop the strength of either a 36-ksi or 50-ksi plate.

### **Conventional Configuration**

The following method may be used when the dimensional and other limitations upon which it is based are satisfied. See Muir and Thornton (2011).

### Dimensional Limitations

- 1. Only a single vertical row of bolts is permitted. The number of bolts in the connection, n, must be between 2 and 12.
- 2. The distance from the bolt line to the weld line, a, must be equal to or less than  $3^{1}/2$  in.

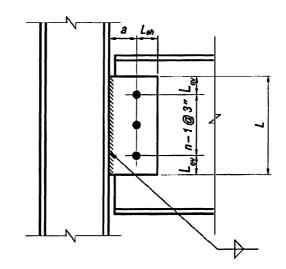


Fig. 10-11. Single-plate connection.

## Table 10-9 Design Values for Conventional Single-Plate Shear Connections

п	Hole Type	<i>e</i> , in.	Maximum $t_p$ or $t_m$ in.	
2 to 5	SSLT	a/2	None	
2105	STD	a/2	d/2 + <sup>1</sup> / <sub>16</sub>	
6 to 12	SSLT	a/2	d/2 + <sup>1</sup> / <sub>16</sub>	
01012	STD	а	d/2 - 1/16	

- 3. Standard holes (STD) or short-slotted holes transverse to the direction of the supported member reaction (SSLT) are permitted to be used as noted in Table 10-9.
- 4. The vertical edge distance,  $L_{cv}$ , must satisfy AISC Specification Table J3.4 requirements. The horizontal edge distance,  $L_{eh}$ , should be greater than or equal to 2d, where d is the bolt diameter.
- 5. Either the plate thickness,  $t_p$ , or the beam web thickness,  $t_w$ , must satisfy the maximum thickness requirement given in Table 10-9.

### Design Checks

- 1. The bolts and plate must be checked for required shear with an eccentricity equal to e, as given in Table 10-9.
- 2. Plate buckling will not control for the conventional configuration.

### **Extended Configuration**

The following method can be used when the dimensional and other limitations of the conventional method are not satisfied. This procedure can be used to determine the strength of single-plate shear connections with multiple vertical rows or in the extended configuration, as shown in Figure 10-12.

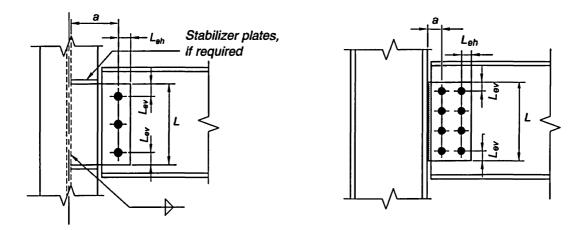


Fig. 10-12, Single-plate connection—Extended Configuration.

#### Dimensional Limitations

- 1. The number of bolts, n, is not limited.
- 2. The distance from the weld line to the bolt line closest to the support, a, is not limited.
- 3. The use of holes must satisfy AISC Specification Section J3.2 requirements.
- 4. The horizontal and vertical edge distances,  $L_{eh}$  and  $L_{ev}$ , must satisfy AISC Specification Table J3.4 requirements.

### Design Checks

- 1. Determine the bolt group required for bolt shear and bolt bearing with eccentricity e, where e is defined as the distance from the support to the centroid of the bolt group. Exception: Alternative considerations of the design eccentricity are acceptable when justified by rational analysis. For example, see Sherman and Ghorbanpoor (2002).
- 2. Determine the maximum plate thickness permitted such that the plate moment strength does not exceed the moment strength of the bolt group in shear, as follows:

$$t_{max} = \frac{6M_{max}}{F_{\nu}d^2} \tag{10-3}$$

where

$$M_{max} = \frac{F_{\nu}}{0.90} (A_b C') \tag{10-4}$$

 $\frac{F_{\nu}}{0.90}$  = shear strength of an individual bolt from AISC Specification Table J3.2, ksi, divided by a factor of 0.90 to remove the 10% reduction for uneven force distribution in end-loaded bolt groups (Kulak, 2002). The joint in question is not end-loaded.

 $A_b$  = area of an individual bolt, in.<sup>2</sup>

C' = coefficient from Part 7 for the moment-only case (instantaneous center of rotation at the centroid of the bolt group)

 $F_{\nu}$  = specified minimum yield stress of plate, ksi

d = depth of plate, in.

The foregoing check is made at the nominal strength level, since the check is to ensure ductility, not strength.

### Exceptions:

- a. For a single vertical row of bolts only, the foregoing criterion need not be satisfied if either the beam web or the plate satisfies  $t \le d_b/2 + \frac{1}{16}$  and both satisfy  $L_{eh} \ge 2d_b$ .
- b. For a double vertical row of bolts only, the foregoing criterion need not be satisfied if both the beam web and the plate satisfy  $t \le d_b/2 + \frac{1}{16}$  and  $L_{eh} \ge 2d_b$ .
- 3. Check the plate for the limit states of shear yielding, shear rupture, and block shear rupture.
- 4. Check the plate for the limit states of shear yielding, shear buckling, and yielding due to flexure as follows:

$$\left(\frac{V_r}{V_c}\right)^2 + \left(\frac{M_r}{M_c}\right)^2 \le 1.0 \tag{10-5}$$

where

 $A_g$  = gross cross-sectional area of the shear plate, in.<sup>2</sup>

 $M_c = \phi_b M_n$  (LRFD) or  $M_n/\Omega_b$  (ASD), kip-in.

 $M_{ii} = F_y Z_{pl}$ , kip-in.

 $M_r = M_u$  (LRFD) or  $M_a$  (ASD)

=  $V_{l}e$ , kip-in.

 $V_c = \phi_v V_n$  (LRFD) or  $V_n/\Omega_v$ , (ASD), kips

 $V_n = 0.6F_y A_g$ , kips

 $V_r = V_u$  (LRFD) or  $V_a$  (ASD), kips

 $Z_{pl}$  = plastic section modulus of the shear plate, in.<sup>3</sup>

e = distance from support to centroid of bolt group, in.

 $\phi_b = 0.90$ 

 $\phi_{v} = 1.00$ 

 $\Omega_b = 1.67$ 

 $\Omega_{\rm v} = 1.50$ 

- 5. Check the plate for the limit state of buckling using the double-coped beam procedure given in Part 9.
- 6. Ensure that the supported beam is braced at points of support.

The design procedure for extended single-plate shear connections permits the column to be designed for an axial force without eccentricity. In some cases, economy may be gained by considering alternative design procedures that allow the transfer of some moment into the column. A percentage of the column's weak-axis flexural strength, such as 5%, may be used as a mechanism to reduce the required eccentricity on the bolt group, provided that this moment is also considered in the design of the column. Larger percentages of the column's weak-axis flexural strength may be justified at the roof level.

Short-slotted holes can be used with the extended configuration with the bolts designed as bearing. Any slip of the bolts is a serviceability issue and does not affect the connection strength (Muir and Hewitt, 2009).

### **Requirement for Stabilizer Plates**

Lateral displacement of beams with extended single-plate connections is resisted by the torsional strength of the plate and beam in the connection region. Thornton and Fortney (2011) show that stabilizing plates are not required when the required shear strength,  $R_u$  or  $R_a$ , respectively, is equal to or less than the available strength to resist lateral displacement,  $\phi R_n$  or  $R_n/\Omega$ , where

$$R_n = 1,500\pi \frac{Lt_p^3}{a^2}$$

$$\Phi = 0.90 \qquad \Omega = 1.67$$
(10-6)

where

a =distance from the support to the first line of bolts, in.

L = depth of plate, in.

 $t_p$  = thickness of plate, in.

When the required shear strength exceeds the available strength to resist lateral displacement, stabilizer plates are required. These plates can be of nominal size and are connected

to the single plate and column flanges with minimum size fillet welds as shown in Figure 10-12. They need not be connected to the column web.

The torsional strength of single-plate shear connections is the sum of two components: the lateral shear strength of the single plate and the lateral bending strength of the beam in the connection region. The first component always is present. The second component occurs as bending of the beam flange in contact with the slab, and should only be considered when a slab is present. Thornton and Fortney (2011) provide the sum of these components as follows:

LRFD	ASD
$M_{tu} \leq \left[\phi_{\nu}\left(0.6F_{yp}\right) - \frac{R_{u}}{Lt_{p}}\right] \frac{Lt_{p}^{2}}{2}  (10-7a)$	$M_{ta} \le \left(\frac{0.6F_{yp}}{\Omega_{v}} - \frac{R_{a}}{Lt_{p}}\right) \frac{Lt_{p}^{2}}{2} \qquad (10-7b)$
$+\frac{2R_u^2(t_w+t_p)b_f}{\left(\phi_bF_{yb}\right)L_st_w^2}$	$+\frac{\Omega_b 2R_a^2 (t_w + t_p)b_f}{F_{yb}L_s t_w^2}$

where

 $F_{yp}$  = specified minimum yield stress of the plate, ksi

$$M_{tu} = R_u \left(\frac{t_w + t_p}{2}\right) \text{ (LRFD)}$$

$$M_{ta} = R_a \left(\frac{t_w + t_p}{2}\right) \text{ (ASD)}$$

 $L_s$  = span length of beam, in.

 $R_a$  = required strength (ASD), kips

 $R_{ii}$  = required strength (LRFD), kips

 $b_f$  = width of beam flange, in.

 $t_w$  = thickness of beam web, in.

 $\phi_b = 0.90$ 

 $\phi_{1'} = 1.00$ 

 $\Omega_b = 1.67$ 

 $\Omega_{v} = 1.50$ 

### **Recommended Plate Length**

To provide for stability during erection, it is recommended that the minimum plate length be one-half the *T*-dimension of the beam to be supported. The maximum length of the plate must be compatible with the *T*-dimension of an uncoped beam and the remaining web depth, exclusive of fillets, of a coped beam. Note that the plate may encreach upon the fillet(s) as given in Figure 10-3.

### **Shop and Field Practices**

Conventional and extended single-plate connections may be made to the webs of supporting girders and to the flanges of supporting columns. Extended single-plate connections are suitable for connections to the webs of supporting columns when the bolt line is located a sufficient distance beyond the column flanges.

With the plate shop-attached to the support, side erection of the beam is permitted. Play in the open holes usually compensates for mill variation in column flange supports and other field adjustments.

### **DESIGN TABLE DISCUSSION (TABLE 10-10)**

### **Table 10-10. Single-Plate Connections**

Table 10-10 is a design aid for single-plate connections welded to the support and bolted to the supported beam. Available strengths are tabulated in Table 10-10a for plate material with  $F_v = 36$  ksi and Table 10-10b for plate material with  $F_v = 50$  ksi.

Tabulated bolt and plate available strengths consider the limit states of bolt shear, bolt bearing on the plate, shear yielding of the plate, shear rupture of the plate, block shear rupture of the plate, and weld shear. Values are tabulated for two through twelve rows of  $^{3}/_{4-in.-}$ ,  $^{7}/_{8-in.-}$ ,  $^{1-in.-}$  and  $^{1}/_{8-in.-}$ diameter Group A and Group B bolts at 3-in. spacing. For calculation purposes, plate edge distance,  $L_{ev}$ , is in accordance with AISC Specification Section J3.10 and Table J3.4. End distance,  $L_{ch}$ , is provided as 2 times the diameter of the bolt, to match tested connections. Weld sizes are tabulated equal to  $^{(5}/_{8})t_{p}$ .

While the tabular values are based on a=3 in., they may conservatively be used when the distance from the support to the bolt line, a, is between  $2^{1}/2$  in. and 3 in. The tabulated values are valid for laterally supported beams in steel and composite construction, all types of loading, snug-tightened or pretensioned bolts, and for supported and supporting members of all grades of steel.

3/4-in.diameter bolts

## Table 10-10a Single-Plate Connections Plate

Bolt, Weld and Single-Plate Available Strengths, kips  $F_y = 36 \text{ ksi}$ 

								Plat	e Thic	knes	s, in.				
n	Bolt	Thread	Hole	1	/4	5/	16		/8		/ <sub>16</sub>	1	/2	9,	/16
	Group	Cond.	Туре		LRFD	1	LRFD		LRFD		LRFD	ASD	LRFD	ASD	LRFE
		N	STD	100	150	125	188		_	_			_		_
	Group	М	SSLT	99.5	149	124	187	138	208	138	208	12.112	_		_
	A	X	STD	100	150	125	188	##		<u></u>		-		-	
12		^	SSLT	99.5	149	124	187	149	224	174	261				_
$(L=35^1/2)$		N	STD	100	150	125	188	2.555			_			_	
	Group	14	SSLT	99.5	149	124	187	149	224	174	261	_			<u></u>
	В	X	STD	100	150	125	188	4			_	-	_		
		^	SSLT	99.5	149	124	187	149	224	174	261	12.			
		N	STD	92.1	138	115	173	7		4		#3		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
	Group	- 14	SSLT	91.4	137	114	171	126	190	126	190				<u></u>
	A	х	STD	92.1	138	115	173			_		;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;		4	_
11		^	SSLT	91.4	137	114	171	137	206	159	239				_
$(L=32^1/2)$		N	STD	92.1	138	115	173								
	Group		SSLT	91.4	137	114	171	137	206	159	239		_		_
	В	X	STD	92.1	138	115	173	×15	_	1	_	1		1	_
		^	SSLT	91.4	137	114	171	137.	206	160	240	7			
		N	STD	84.0	126	105	157					_			
	Group		SSLT	83.3	125	104	156	115	173	115	173				
	A	X	STD	84.0	126	1 05	157	₩.	-	- <u></u>	—	-	_		_
10			SSLT	83.3	125	104	156	125	187	145	217	·-			
$(L=29^{1/2})$		N	STD	84.0	126	105	157	ζ. Σ.	<u> </u>					-	
	Group	.,	SSLT	83.3	125	104	156	125	187	145	217				
	В	x	STD	84.0	126	105	157		<b></b>	#	_		_		_
			SSLT	83.3	125	104	156	125	187	146	219				_
		N	STD	75,9	114	94.8	142				_	#1		-	_
	Group		SSLT	75.2	113	94.0	141	103	155	103	155				_
	A	x	STD	75.9	114	94.8	142		-						
9			SSLT	75.2		-	141		169	130	194				
$(L=26^{1}/2)$		N	STD	75.9		94.8			-			*		-	
	Group	,,	SSLT	75.2				113	169	130	194	-		<b>—</b>	
	В	X	STD	75.9		94.8		<u>**</u>			-				
			SSLT	75.2		94.0		113		132		-		- "	
	Weld S	ize		3/	16	1/	4	1/	4	5/-	16	5/	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

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Plate F<sub>y</sub> = 36 ksi

## Table 10-10a (continued) Single-Plate Connections

3/4-in.diameter bolts

**Bolt, Weld and Single-Plate Available Strengths, kips** 

	D-14	<b>.</b>						Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5	/16	3	/8	7/	16	1	/2	9,	16
	aroup	Collu.	iype	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFC
		N	STD	67.8	102	84.7	127	2	<del>-</del>		-		_	5	<del>  -</del>
	Group		SSLT	67,1	101	83.9	126	90.8	137	90.8	137		—		l –
	Α	X	STD	67.8	102	84.7	127	l —	—			-	-	_	_
8		^	SSLT	67.1	101	83.9	126	101	151	114	172		—	_	<b> </b>
$(L=23^1/2)$		N	STD	67.8	102	84.7	127		_		—	H	—		—
	Group	"	SSLT	67.1	101	83.9	126	101	151	114	172		—		—
	В	X	STD	67.8	102	84.7	127		_				—		<del> </del>
		^	SSLT	67.1	101	83.9	126	101	151	117	176		<b> </b> —		—
		N	STD	59.7	89.5	72.1	108		_		-		—		<del>  -</del>
	Group	, N	SSLT	59.0	88.5	73.7	111	78.7	118	78.7	118	<b> </b>	—	-	<b> </b>
	Α	X	STD	59.7	89.5	74.6	112		_	+	_	-#	_		—
7		^	SSLT	59.0	88.5	73.7	111	88.5	133	99.2	149		—		—
$(L=20^1/2)$		N	STD	59.7	89.5	74.6	112		_	<u> </u>			_	<b>,</b> — .	<del>  -</del>
	Group	"	SSLT	59.0	88.5	73,7	111	88.5	133	99,2	149		—	-,,	—
	В	X	STD	59.7	89.5	74.6	112	ļ:	_	-	_	7	—		—
		^	SSLT	59.0	88.5	73.7	111	88.5	133	103	155	<b>.</b>	_	-	_
		N	STD	51.6	77.4	59.3	89.1		_	15	_	<b>-</b>	_	-	_
	Group	,,	SSLT	50.9	76.3	63.6	95.4	66.5	100	66.5	100	<u></u>	—		_
	A	x	STD	51.6	<i>7</i> 7.4	64.5	96.7		_		<b> </b> —		—		_
6		^	SSLT	50.9	76.3	63.6	95.4	76.3	115	83.8	126	-	_		_
$(L=17^1/2)$		N	STD	51.6	77.4	64.5	96.7		-		_	-	-		_
	Group	.,	SSLT	50.9	76.3	63.6	95.4	76.3	115	83.8	126		—		_
	В	x	STD	51.6	77.4	64.5	96.7	_	_	-	_	$\stackrel{\sim}{=}$	_	4	_
		^	SSLT	50.9	76.3	63.6	95.4	76.3	115	89.1	134	#	_	_	_
		N	STD	43.5	65.2	54.1	81.3	54.1	81.3	54.1	81.3		<b>—</b>		_
	Group		SSLT	42.8	64.2	53.5	80.2	54.1	81.3	54.1	81.3	54.1	81.3	54.1	81.3
:	A	x	STD	43.5			81.5			** * * · ·	102	***	_	-	_
5		^	SSLT	42.8	64.2	53.5	80.2	64.2	96.3	68.1	102	68.1	102	68.1	102
$(L=14^1/2)$		N	STD	43.5	65.2	54,3	81.5	65.2	97.8	68.1	102		_		_
	Group		SSLT	42.8	64.2	53.5	80.2	64.2	96.3	68.1	102	68.1	102	68.1	102
	В	х	STD	43.5	65.2	54.3	81.5	65.2	97.8	76.1	114	7	-		_
			SSLT	42.8	64.2	53.5	80.2	64.2	96.3	74.9	112	84.5	126	84.5	126
	Weld S		3/	16	1/	/4	1/	4	5/-	16	5/	16	3/	8	

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

<sup>—</sup> Indicates that the plate thickness is greater than the maximum given in Table 10-9.

 $F_y = 36 \text{ ksi}$ 

3/4-in.diameter
bolts

### Table 10-10a (continued)

### Single-Plate Connections Plate

Bolt, Weld and Single-Plate Available Strengths, kips

	I	<u> </u>	l	1				Plat	e Thic	knes	e in				
n	Bolt	Thread	Hole	1	/4	5,	16		/8		7 <sub>16</sub>	1	/2	9,	16
	Group	Cond.	Type		LRFD	<del></del>	LRFD			ASD	,		LRFD		LRFD
			STD	34.8	52.2	41.5	62.5	41.5	62.5	41.5	62.5	<u> </u>	_		_
	Group	N	SSLT	34.7	52.0	41.5	62.5	41.5	62.5	41.5	62.5	41.5	62.5	41.5	62.5
	A	X	STD	34.8	52.2	43.5	65.3	52.2	78.3	52.4	78.5			4	_
4		^	SSLT	34.7	52.0	43.4	65.1	52.0	78.1	52.4	78.5	52.4	78.5	52.4	78.5
$(L=11^1/2)$		· N	STD	34.8	52.2	43.5	65.3	52.2	78.3	52.4	78.5		_	4	_
	Group	14	SSLT	34.7	52.0	43,4	65.1	52.0	78.1	52.4	78.5	52.4	78.5	52.4	78.5
	B	X	STD	34,8	52.2	43.5	65.3	52.2	78.3	60.9	91.4				-
		^	SSLT	34.7	52.0	43.4	65.1	52.0	78.1	60.7	91.1	64.9	97.0	64.9	97.0
		N	STD	25.6		28.8				28.8			<u> </u>	-	_
	Group		SSLT	ļ		28.8						28.8	43.4		43.4
	A	x	STD	25.6		Facilità III	47.9	358L 371		36.3		-	_		-
3			SSLT			31.9				36.3			54.5		54.5
$(L=8^{1/2})$		N	STD	25.6		31.9		F31. SH	54.5	2.5			_		_
	Group	SSLT			31,9							54.5		54.5	
	В	x	STD	25.6	38.3	31.9		38.3		44.7	67.1		-		
			SSLT	25.6		31.9				1		45.1	67.3	45.1	67.3
		N	STD	16.3		16.5		\$1.50				100	_	100	-
	Group A		SSLT	16,3 16.3		20.4						10.0	24.8	16.5	24.8
2	^	X	STD SSLT	37				3.3				と進し	31.2		21.2
$(L=5^{1}/2)$			STD			20.4						20.0	31.2	20.0	J1.2
(2 - 0 72)	Group	N	SSLT	121 - 111-14		20.4		BES.		20.8			31.2	100	31.2
	В		STD		24.5		30.6				38.5	20,0	_		_
		X	SSLT	6.2 4.4		PARKET 1				4 7.19		25.8	38.5	25.8	38.5
	Weld S	ize		3/	16	1/	4	1/	4	5/	16	5/	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

<sup>-</sup> Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate F<sub>y</sub> = 36 ksi

## Table 10-10a (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

7/8-in.diameter bolts

				l				Plat	e Thic	kness	s, in.				
n	Bolt	Thread Cond.	Hole	1	/4	5/	16	3	/8	7/	16	1	/2	9/	16
	Group	Colla.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	102	153	128	192	153	230		—	Ŧ	_		_
	Group		SSLT	102	152	127	190	152	228	178	267	188	282	_	_
	Α	X	STD	102	153	128	192	153	230	_	—		-		—
12			SSLT	102	152	127	190	152	228	178	267	203	305		
(L=36)		N	STD	102	153	128	192	153	230	<u> </u>	—		—		_
	Group		SSLT	102	152	127	190	152	228	178	267	203	305		_
	B	x	STD	102	153	128	192	153	230		—		_		—
			SSLT	102	152	127	190	152	228	178	267	203	305		
		N	STD	94.1	141	118	176	141	212		_				_
	Group		SSLT	93,4	140	117	175	140	210	164	245	172	258		_
	A	X	STD	94.1	141	118	176	141	212		-		_		_
11			SSLT	93.4	140	117	175	140	210	164	245	187	280		_
(L=33)	_	N	STD	94.1	141	118	176	141	212			107	200		_
	Group B		SSLT	93.4	140	117	175	140	210 212	164	245	187	280		_
	<b>B</b>	X	STD	94.1	141 140	118 117	176 175	141 140	210	一 164	245	187	280		
	<u> </u>		SSLT	93.4 86.0	129	108	161	129	194	104		(0)	200		
	C	N	STD SSLT	85.3	128	107	160	128	192	149	224	156	234		_
	Group A		STD	86.0	129	108	161	129	194	179	_				
10	"	X	SSLT	85.3	128	107	160	128	192	149	224	171	256	1:1	_
(L=30)			STD	86.0	129	108	161	129	194				_		
(2 = 35)	Group	N	SSLT	85.3	128	107	160	128	192	149	224	171	256		
	В		STD	86.0	129	108	161	129	194				_	<del>, , ,</del>	_
		X	SSLT	85.3	128	107	160	128	192	149	224	171	256		_
			STD	77.9	117	97,4	146	117	175		_	<b>;</b>	_	14.3	_
	Group	N	SSLT	77.2	116	96.5	145	116	174	135	203	140	210		_
	Α		STD	77.9	117	97.4	146	117	175		<b>—</b>		_		_
9		X	SSLT	77.2	116	96.5	145	116	174	135	203	154	232		_
(L = 27)		N	STD	77.9	117	97.4	146	117	175		_				_
	Group	N	SSLT	77.2	116	96.5	145	116,	174	135	203	154	232	-2	_
	Group B X		STD	77.9	117	97,4	146	117	175		_		_	7	_
			SSLT	77.2	116	96.5	145	116	174	135	203	154	232		_
	Weld S		3/	16	1,	/4	1	/4	5/	16	5	16	3	8	

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included X = Threads excluded

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

7/8-in.diameter bolts

### Table 10-10a (continued)

### Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

Plate  $F_y = 36 \text{ ksi}$ 

N   STD   Go.   Po.   SSLT   Go.		Delt	Three	Vals					Plat	e Thic	knes	s, in.				
RFO   ASD   LRFO   LRF	n	Bolt	Thread	Hole Type	1	/4	5,	16	3	/8	7/	16	1	/2	9,	/16
8 (L = 24)   A		Gioup	Joniu.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
8			M	STD	69.6	104	87.0	131	104	157			<b>-</b>		1 <u>19</u> 31.77	_
CL = 24    Group B		Group		SSLT	69.1	104	86.4	130	104	156	121	181	124	185		_
Care   Care		Α	v	STD	69.6	104	87.0	131	104	157			_			
Group B	8		^	SSLT	69.1	104	86.4	130	104	156	121	181	138	207		
SIT   69.1   104   86.4   130   104   156   121   181   138   207	(L=24)		N	STD	69.6	104	87.0	131	104	157		-			1	
Group  Group  Group  A  X  STD  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  Group  B  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  Group  B  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  A  X  SSLT  Go.9  G		Group		SSLT	69.1	104	86.4	130	104	156	121	181	138	207		
Group  Group  Group  A  X  STD  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  B  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  Group  B  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  Group  B  X  SSLT  Go.9  Group  A  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  Group  Group  Group  B  X  SSLT  Go.9  Group  Group  Group  A  X  SSLT  Go.9  G		В	v	STD	69.6	104	87.0	131	104	157	1			_		
Caroup   N   SSLT   60.9   91.4   76.1   114   91.4   137   107   160   107   161     107   108			^	SSLT	69.1	104	86.4	130	104	156	121	181	138	207		
Caroup   Selt   Glo.9   91.4   76.1   114   91.4   137   107   160   107   161			N	STD	60.9	91.4	76.1	114	91.4	137	_		_			
7 (L = 21)         X         SSLT         60.9         91.4         76.1         114         91.4         137         107         160         122         183         -		Group	.,	SSLT	60.9	91.4	76.1	114	91.4	137	107	160	107	161		
SSLT   60.9   91.4   76.1   114   91.4   137   107   160   122   183		A	v	STD	60.9	91.4	76,1	114	91,4	137	_					
Compage   Comp	7		^	SSLT	60.9	91.4	76.1	114	91.4	137	107	160	122	183	-	_
SSLT   60.9   91.4   76.1   114   91.4   137   107   160   122   183	(L=21)		N	STD	60.9	91.4	76.1	114	91.4	137	1			_	<b>.</b>	_
SSLT   60.9   91.4   76.1   114   91.4   137   107   160   122   183		Group N SSI			60.9	91.4	76,1	114	91,4	137		160		183		_
SSLT   60.9   91.4   76.1   114   91.4   137   107   160   122   183		В	¥	STD	60.9	91.4	76.1	114	91.4	137			-			
Group A X STD 52.2 78.3 65.3 97.9 78.3 117 90.5 136 90.5 136 — — — — — — — — — — — — — — — — — — —		ł	^	SSLT	60.9	91.4	100000000000000000000000000000000000000	114	91.4	137		160	122	183	<b>—</b>	
Group B		Group N S			52.2	78.3	65.3	97.9	78.3	117						
6 (L = 18)    N   STD   52.2   78.3   65.3   97.9   78.3   117   91.4   137   104   157		Group N SS				78.3			78.3	117		136		136		
Caroup B   N		Group S X					9 223 20		50 P.							
B       X       STD       52.2       78.3       65.3       97.9       78.3       117       —				SSLT	52.2	78.3					****	137		157		
B       X       STD       52.2       78.3       65.3       97.9       78.3       117       —	(L=18)		N I	STD	F91 91					1 1				_		
N   STD   43.5   65.3   54.4   81.6   65.3   97.9   73.6   110   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73		-										137	104	157		
N   STD   43.5   65.3   54.4   81.6   65.3   97.9   73.6   110   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73.6   130   73		В	x		479,271,574		17.44° s. 111						-		+	
SSLT   43.5   65.3   54.4   81.6   65.3   97.9   73.6   110   73.6   130   73.6			- 1	SSLT									1000			
A       X       STD       43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131       5   114   87.0   131   92.7   13   131   1			N				200 LB00		Charles 1							
5 (L = 15)  Group  B  X  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 92.7 13  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 92.7 13  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 92.7 13  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 92.7 13  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131  — —  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 97.9 14																110
5 (L = 15)   SSLT   43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131   92.7   13   (L = 15)   SSLT   43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131   92.7   13   SSLT   43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131   92.7   13   92.7   13   93.7   13   93.7   13   93.7   13   93.7   13   93.7   13   93.7   13   93.7   13   93.7   13   93.7   14   93.7   14   93.7   15	į.	A	x				**				进口 计算		369 (B.C.)	- 1		
Group B SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 92.7 13  STD 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 — —  SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 97.9 14	:'						1 111111								92.7	139
Group   SSLT   43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131   92.7   13   13   14   15   15   15   15   15   15   15	( <i>L</i> = 15)	15) X S					******		K N				Same			
X SSLT 43.5 65.3 54.4 81.6 65.3 97.9 76.1 114 87.0 131 97.9 14															92.7	139
SSLT 43.5   65.3   54.4   81.6   65.3   97.9   76.1   114   87.0   131   97.9   14	)	B	x		11.0		A 150 A 150									
Weld Size 3/16 1/4 1/4 5/16 5/16 3/8	<u>:</u>			SSLT			أنسسنند									
		Weld S		3/	16	1/	4	1/	4	5/-	16	5/	16	3/	8	

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = hreads excluded

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate *F<sub>y</sub>* = 36 ksi

## Table 10-10a (continued) Single-Plate Connections

## Bolt, Weld and Single-Plate Available Strengths, kips

7/8-in.diameter bolts

		I						Plat	e Thic	knes	s, in.				
n	Bolt	Thread	Hole	1,	/4	5,	<sup>1</sup> 16	3	/a	7/	16	1	/2	9/	16
	Group	Cond.	Туре	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	34.8	52.2	43.5	65.3	52.2	78.3	56.5	84.8	56.5	84.8	4	<u> </u>
	Group		SSLT	34.8	52.2	43.5	65.3	52.2	78.3	56.5	84.8	56.5	84.8	56.5	84.8
	A	X	STD	34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69,6	104		
4		_ ^	SSLT	34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104	71.2	107
(L=12)		N	STD	34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104		
	Group		SSLT	34.8			65.3							71.2	107
	В	x	STD	34.8	l	- 1	65.3				1	1.0	104	Ţ,	J
			SSLT	34.8	<u> </u>		65.3					1100 110			117
	1	N	STD	26.1	1		48.9	Sept. 1		- 3	ſ	12077		_	
	Group		SSLT	26.1									58.9		58.9
_	A	x	STD	26.1		32,6	i	39.2		45.7		145. 15	1		
3	<u> </u>		SSLT	26.1		- L 1 11/2				46-41.60		r delengation :	74.4	49.4	74.4
(L=9)		N	STD	26.1		32.6		39.2		45.7		49.4			
	Group		SSLT	26.1			48.9						74.4		74.4
	В	x	STD	26.1		.56	48.9	* 13.0		~		25.			-
	<u> </u>		SSLT	26.1		1400	48.9	The state of the state of		17. M12					88.1
	C	N	STD	1,131		×2	32.6 32.6			15 m. l		Sq. 1447		798 - N	22.7
	Group A		SSLT	17.4			32.6								33.1
2		X	SSLT	CHIPPE		1072	32.6	ry tares				85,000 T			42.5
(L=6)		! 	STD	17.4			32.6		39.2			28.3		20.5	4L.J
(= - 5)	Group	N	SSLT	10 10 m		3.5	32.6			1.4	1	A	42.5		42.5
	В		STD	17.4			32.6								
		X	SSLT	17.4		100				41.44		1000000	52.2	異様ない。	52.5
	Weld S	ize		3/-	16	1/	4	1/	4	5/-	16	5/	16	3/	8

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

X = Threads excluded

1-in.diameter
bolts

# Table 10-10a Single-Plate Connections Plate Bolt Weld and Single-Plate F<sub>V</sub> = 36 ksi

**Bolt, Weld and Single-Plate Available Strengths, kips** 

	DoM	<b>Th</b>	11-1-	1				Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5	16	3	/8	7	/16	1	/2	9/	16
	агоар	Ound.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	İ	<b>.</b>	STD	100	150	125	188	150	225	175	263	-	<u> </u>		<u> </u>
	Group	N	SSLT	100	150	125	188	150	225	175	263	200	300	225	338
	A	X	STD	100	150	125	188	150	225	175	263		<b>—</b>		_
12	1	^	SSLT	100	150	125	188	150	225	175	263	200	300	225	338
$(L=36^{1/2})$		N	STD	100	150	125	188	150	225	175	263	-	—		-
	Group	14	SSLT	100	150	125	188	150	225	175	263	200	300	225	338
	В	X	STD	100	150	125	188	150	225	175	263		—	_	—
		^	SSLT	100	150	125	188	150	225	175	263	200	300	225	338
		N	STD	91.9	138	115	172	138	207	161	241	<u> </u>	—		—
	Group	.,	SSLT	91.9	138	115	172	138	207	161	241	184	276	207	310
	A	X	STD	91.9	138	115	172	138	207	161	241	7	<b>—</b>	-	—
11		, ^	SSLT	91.9	138	115	172	138	207	161	241	.184	276	207	310
$(L=33^1/2)$		N	STD	91.9	138	115	172	138	207	161	241	-	—		_
	Group	.,	SSLT	91.9	138	115	172	138	207	161,	241	184	276	207	310
	В х	x	STD	91.9	138	115	172	138	207	161	241			_	—
	X		SSLT	91.9	138	115	172	138	207	161	241	184	276	207	310
	Group N	N	STD	83.7	126	105	157	126	188	147	220		_	7	_
	Group		SSLT	83.7	126	105		126	188	147	220	167	251	188	283
	A	x	STD	83.7	126	105	157	126	188	147	220		<b>—</b>	7	_
10			SSLT	83.7	126	105	157	126		147	220	167	251	188	283
$(L=30^{1/2})$		N	STD	83.7	126	105	157	126	188	147	220		_		_
	Group		SSLT	83.7	126	105	157	126	188	147	220	167	251	188	283
	В	х	STD	83.7	126	105	157	126	188	.147	220		_		_
			SSLT	83.7	126	105	157	126	188	147	220	167	251	188	283
		N	STD	75.6	113	94.5	142	113	170	132	198		_		_
	Group		SSLT	75.6	113	94.5	142	113	170	132	198	151	227	170	255
	AX	x	STD	75.6	113	94.5	142	113	170	132	198		-		_
9	1/2)		SSLT	75.6	113	94.5	142	113	170	132	198	151	227	170	255
$(L=27^1/2)$	'   N	N	STD	75.6	113	94,5	142	113	170	132	198		_		_
	Group N	SSLT	75.6	113	94.5	142	113	170	132	198	151	227	170	255	
	R	x	STD	75.6	113	94.5	142	113	170	132	198		-		_
			SSLT	75.6	113	94,5	142	113	170	132	198	151	227	170	255
	Weld S	ize		3/.	16	1/	4	1/	4	5/	16	5/-	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

<sup>-</sup> Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate F<sub>y</sub> = 36 ksi

## Table 10-10a (continued) Single-Plate Connections

1-in.diameter

**Bolt, Weld and Single-Plate Available Strengths, kips** 

			•												
	Bolt	Thread	Hole						te Thic	knes	s, in.				
n	Group	Cond.	Туре	1	/4	5	/16	3	/8	7,	/16	1	/2	9/	16
			.,,,,	ASD.	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	67.4	101	84.3	126	101	152	118	177		—	-	—
	Group	.,	SSLT	67.4	101	84.3	126	101	152	118	177	135	202	152	228
	Α	X	STD	67.4	101	84.3	126	101	152	118	177		l —	<b>-</b>	
8		^	SSLT	67.4	101	84.3	126	101	152	118	177	135	202	152	228
$(L=24^{1/2})$		N	STD	67.4	101	84.3	126	101	152	118	177				
	Group	"	SSLT	67.4	101	84.3	126	101	152	118	177	135	202	152	228
	В	х	STD	67.4	101	84.3	126	101	152	118	177			<b>,</b> —,	
		^	SSLT	67.4	101	84.3	126	101	152	118	177	135	202	152	228
		N	STD	59.3	88.9	74.1	111	88.9	133	104	156	-			
	Group	14	SSLT	59.3	88.9	74.1	111	88.9	133	104	156	119	178	133	200
	Α	Х	STD	59.3	88.9	74.1	111	88.9	133	104	156				_
7		^	SSLT	59.3	88.9	74.1	111	88.9	133	104	156	119	178	133	200
$(L=21^1/2)$		N	STD	59.3	88.9	74.1	111	88.9	133	104	156	l.		<u>;</u>	_
	Group	14	SSLT	59.3	88.9	74.1	111	88.9	133	104	156	119	178	133	200
	В	х	STD	59.3	88.9	74.1	111	88.9	133	104	156		_		
		^	SSLT	59.3	88.9	74.1	111	88.9	133	104	156	119	178	133	200
		N	STD	51.1	76.7	63.9	95.8	76.7	115	89.4	134		_		
	Group		SSLT	51.1	76.7	63.9	95.8	76.7	115	89.4	134	102	153	115	173
	A	х	STD	51.1	76.7	63.9	95.8	76.7	115	89.4	134		_		
6		^	SSLT	51.1	76.7	63.9	95.8	76.7	115	89.4	134	102	153	115	173
$(L=18^1/2)$		N	STD	51,1	76.7	63,9	95.8	76.7	115	89,4	134		_	` <u>t ``</u> `\	_
	Group	.,	SSLT	51.1	76.7	63.9	95.8	76.7	115	89,4	134	102	153	115	173
	В	х	STD	51.1	76.7	63.9	95.8	76.7	115	89.4	134	_			
		_ ^	SSLT	51.1	76.7	63.9	95.8	76.7	115	89.4	134	102	153	115	173
	Group	N		43.0	64.4	53.7	80.5	64.4	96.7	75.2	113	85.9	129	96.3	144
5	Α	X	STD/	43.0	64.4	53.7	80.5	64.4		75.2	113	85.9	129	96.7	145
$(L=15^{1/2})$	Group	N	SSLT	43.0	64.4	53.7		64.4	96.7	1.000	113	85.9	129	96.7	145
	В	X				_					113			96.7	
	Group	N				et in etc. 4		21 24 PC		17 : 1	91.4	11	•	74.0	111
4	A	X	STD/	34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104	78.3	117
$(L=12^1/2)$	Group	N	SSLT	34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104	78.3	117
	В	X		34.8	52.2	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104	78.3	117
	Weld S	ize		3/	16	1/	4	1/	4	5/	16	5/	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

1-in.diameter

### Table 10-10a (continued)

### Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

 $F_y = 36 \text{ ksi}$ 

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

Plate  $F_y = 36 \text{ ksi}$ 

## Table 10-10a (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

1<sup>1</sup>/8-in.diameter bolts

	Dall	Thrond	u <sub>c</sub> !-					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	5	16	3	/8	7,	16	1	/2	9	16	5	<b>/</b> 8
	aloup	oonu.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRF
		N	STD	120	179	144	215	167	251	191	287	-			<b>—</b>
	Group	.,4	SSLT	120	179	144	215	167	251	191	287	215	323	239	359
	Α	X	STD	120	179	144	215	167	251	191	287				
12		^	SSLT	120	179	144	215	167	251	191	287	215	323	239	359
(L=37)		N	STD	120	179	144	215	167	251	191	287	-	—		
	Group		SSLT	120	179	144	215	167	251	191	287	215	323	239	359
	В	X	STD	120	179	144	215	167	251	191	287	_ <u>3</u> _4,			
		_ ^	SSLT	120	179	144	215	167	251	191	287	215	323	239	359
		N	STD	110	165	132	198	154	231	176	264			-	
	Group		SSLT	110	165	132	198	154	231	176	264	198	297	220	330
	A	x	STD	110	165	132	198	154	231	176	264		_		
11			SSLT	110	165	132	198	154	231	176	264	198	297	220	330
(L=34)		N	STD	110	165	132	198	154	231	176	264		_		_
	Group		SSLT	110	165	132		154	231	176	264	198	297	220	330
	В	x	STD	110	165	132	198	154	231	176	264			7	
			SSLT	110	165	132	198	154	231	176	264	198	297	220	330
	<u> </u>	N	STD	101	151	121	181	141	211	161	241		_		
	Group		SSLT	101	151	121	181	141	211	161	241	181	272	201	302
40	A	x	STD	101	151	121	181	141	211	161	241				
10			SSLT	101	151	121	181	141	211	161	241	181	272	201	302
(L=31)		N	STD	101	151	121	181	141	211	161	241		-	11.	
				101	151	121	181	141	211	161	241	181	272	201	302
		x		101 101	151	121.	181	141 141	211	161 161	241	101	270	~~	
<del>- :</del>	<u> </u>			91.1	151 137	121 109	181 164	128	211 191	146	241 219	181	272	201	302
Ì	Croun	N		91.1	137	109	164	128	191	146	219	164	246	182	273
				91.1	137	109	164	128	191	146	219	104	240	102	213
9		x		91.1 91.1		109		128	191	S. 10 - 15	1	164	246	182	273
(L=28)				91.1	137	109	164	128	191	146	219	104		102	
(L — 20)	Group	N		91.1	137	109		128	191	146	219	164	246	182	273
				91.1	137	109	164	128	191	146	219	104	240	102	213
		X		91.1	137	109	164	128	191	146	219	164	246	182	273
	Wold S	izo	JULI	1/		1/1		5/		5/		3/		7/	
	SSLT   STD   SSLT				• [	.,	•	7	10	7/1	סו	٩	8	1	10

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

**bolts** 

### Table 10-10a (continued) 1<sup>1</sup>/8<sup>-in.-</sup> Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

**Plate**  $F_V = 36 \text{ ksi}$ 

	Doll	Throad	Uolo					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	5	/16	3	/8	7	/16	1	/2	9,	16	5	/8
	Giodp	Joing.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFC
		N	STD	81.6	122	97.9	147	114	171	131	196		—	+	-
	Group		SSLT	81.6	122	97,9	147	114	171	131	196	147	220	163	245
	Α	X	STD	81.6	122	97.9	147	114	171	131	196				_
8		^	SSLT	81.6	122	97.9	147	114	171	131	196	147	220	163	245
(L=25)		N	STD	81.6	122	97.9	147	114	171	131	196	1	<b> </b> —	<b>-5.</b>	<u> </u>
	Group		SSLT	81.6	122	97.9	147	-1,14	171	131	196	147	220	163	245
	В	X	STD	81.6	122	97.9	147	114	171	131	196	<b> </b>			
		^	SSLT	81.6	122	97.9	147	114	171	131	196	147	220	163	245
		N	STD	72.0	108	86.5	130	101	151	115	173	-	_	==;	—
	Group		SSLT	72.0	108	86.5	130	101	151	115	173	130	195	144	216
	A	X	STD	72.0	108	86.5	130	101	151	115	173				
7			SSLT	72.0	108	86.5	130	101	151	115	173	130	195	144	216
(L=22)		N	STD	72.0	108	86.5	130	101	151	115	173		_		-
	Group		SSLT	72.0	108	86.5	130	101	151	115	173	130	195	144	216
	В	x	STD	72.0	108	86.5	130	101	151	115	173	1	<b>—</b>		_
			SSLT	72.0	108	86.5	130	101	151	115	173	130	195	144	216
		N	STD	62.5	93.8	75.0	113	87.5	131	100	150		_	4	_
	Group		SSLT	62.5	93.8	75.0		87.5	131	100	150	113	169	125	188
	A	x	STD	62.5		75.0	113	87.5	131	100	150				_
6			SSLT	62.5		75.0		87.5	131	100	150	113	169	125	188
(L=19)	_	N	STD	62.5		75.0		87.5	131	100	150	- 3	_	$\pm$	_
	Group		SSLT		93.8		113	87.5	131	100	150	113	169	125	188
	В	x	STD	62.5		75.0	113	87.5	131	100	150				
			SSLT	62.5	93.8	75.0	113	87.5	131	100	150	113	169	125	188
-	Group A	N	CTD/	53.0		63,6		74.2	111	84.8	127	95,4	143	106	159
5 (/ = 16)		X	STD/	53.0		63.6		74.2	111	84.8		95.4	143	106	159
(L=16)	Group B	N	SSLT	53.0	1	63.6	1	74.2	111	84.8	127	95.4	143	106	159
		X			79.5			X.1		84.8	_	95.4	_	106	159
	Group A	N	CTD/			7	,	1000000		3.69 (3.1)	104			34.00%	131
4		X	STD/								104				131
(L=13)	Group	N "	SSLT	1111111111111111							104	10.00	1	87.0	
	В	. X				استناسا					104			87.0	
	Weld S	ıze		1/	4	1/	4	5/	16	5/.	16	3/	8	7/1	16

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

Plate  $F_y = 36 \text{ ksi}$ 

## Table 10-10a (continued) Single-Plate Connections 1/8-in.-

Bolt, Weld and Single-Plate diameter
Available Strengths, kips

	D-14							Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	5/	16	3	/8	7/	16	1,	/2	9/	16	5	/a
	агоар	Cond.	Type	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
	Group	N		34.0	51.0	40.8	61.2	47.6	71.4	54.4	81.6	61.2	91.8	64.9	97.6
3	Α	X	STD/	34.0	51.0	40.8	61.2	47.6	71.4	54.4	81.6	61.2	91.8	68.0	102
(L=10)	Group	N	SSLT	34.0	51.0	40.8	61.2	47,6	71.4	54,4	81.6	61.2	91.8	68.0	102
	В	Х		34.0	51.0	40.8	61.2	47.6	71.4	54.4	81.6	61.2	91.8	68.0	102
	Group	N		24.5	36.7	29.4	44.0	34.3	51.4	37.1	55.8	37.1	55.8	37.1	55.8
2	Α	X	STD/	24.5	36.7	29.4	44.0	34.3	51.4	39.2	58.7	44.0	66.1	46.8	70.2
(L=7)	Group	N	SSLT	24.5	36.7	29.4	44.0	34.3	51.4	39.2	58.7	44.0	66.1	46.8	70.2
	В	Х		24.5	36.7	29.4	44.0	34.3	51.4	39.2	58.7	44.0	66.1	48.9	73.4

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

**Weld Size** 

N = Threads included X = Threads excluded

7/16

3/8

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

1/4

Tabulated values are grouped when available strength is independent of hole type.

1/4

5/16

5/16

3/4-in.diameter bolts

## Table 10-10b Single-Plate Connections Plate

**Bolt, Weld and Single-Plate Available Strengths, kips** 

 $F_y = 50 \text{ ksi}$ 

	Dell	Throad	Uele					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5	16	3	/8	7/	16	1	/2	9/	16
	агоар	Conu.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	122	183	134	202	77	—	-	_				-
	Group	14	SSLT	122	183	138	208	138	208	138	208				_
	Α	Х	STD	122	183	152	229		<u> </u>		_			-	
12		^	SSLT	122	183	152	229	174	262	174	262	1 240 1 20 1 3		11.	
$(L=35^1/2)$		N	STD	122	183	152	229					-			_
	Group	17	SSLT	122	183	152	229	174	262	174	262				_
	В	Х	STD	122	183	152	229	-	_	4				1.	_
		^	SSLT	122	183	152	229	183	274	213	320		_	-	
		N	STD	112	167	121	183		_	_			-		
	Group	''	SSLT	112	167	126	190	126	190	126	190	4	_	X	
	A	Х	STD	112	167	139	209	¥,							_
11		^	SSLT	112	167	139	209	159	239	159	239	-			
$(L=32^1/2)$		N	STD	112	167	139	209							4	
	Group		SSLT	112	167	139	209	159	239	159	239	-			
	В	X	STD	112	167	139	209	4							
			SSLT	112	167	139	209	167	251	195	293			<b>2</b>	
		N	STD	101	152	110	165		_		-	$\perp$			
	Group		SSLT	101	152	115	173	115	173	115	173				
	A	x	STD	101	152	126	190				_		-		
10 <sup>1</sup>			SSLT	101	152	126	190	145	217	145	217				
$(L=29^{1/2})$		N	STD	101	152	126	190	; <u> </u>	-		-	-			_
	Group		SSLT	101	152	126	190	145	217	145	217	$\exists$			
	В	x	STD	101	152	126	190	-1	_	Ĭ.,			-	-	_
			SSLT	101	152	126	190	152	228	177	266		_		
		N	STD	90.8		97.2	146		_				-		_
j	Group		SSLT	90.8	136	103		103	155	103	155		_		
	A	x	STD	90.8	136	113	170				_		-	,	_
9			SSLT	90.8	136	113	170	130	194	130	194		_		_
$(L=26^1/2)$		N	STD	90.8		113	170		_	اتندا	_		-	-1	
	Group		SSLT	90.8		113	170	130	194	130	194				
	В	x	STD	90.8	ı	113	170								
			SSLT	90.8	136	113	170	136		159	238	<u> </u>			
	Weld S	ize		3/	16	1/	4	1/	4	5/-		5/-	ireads	3/	

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included X = Threads excluded

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate  $F_V = 50$  ksi

## Table 10-10b (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

3/4-in.diameter bolts

	D-44	Theread						Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5,	/16	3	/8	7,	/16	1	/2	9,	/16
	агоар	Jona.	Турс	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	80.4	121	84.7	127	124	_		_			ا نیا	<b> </b> -
	Group		SSLT	80.4	121	90.8	137	90.8	137	90.8	137		_	_	
	Α	X	STD	80,4	121	101	151		-			_	_		
8		^	SSLT	80.4	121	101	151	114	172	114	172				
$(L=23^1/2)$		N	STD	80.4	121	101	151								
	Group	14	SSLT	80.4	121	101	151	114	172	114	172				
	В	Х	STD	80.4	121	101	151	<u>.</u>						3	_
		^	SSLT	80.4	121	101	151	121	181	141	211			Ī	
		N	STD	70.1	105	72.1	108		_	_					_
	Group	14	SSLT	70.1	105	78.7	118	78.7	118	78.7	118		_		—
	A	Х	STD	70.1	105	87.6	131		_				_		_
7		^	SSLT	70.1	105	87.6	131	99.2	149	99.2	149		—		<b> </b> —
$(L=20^1/2)$		N	STD	70.1	105	87.6	131			_		<u> </u>			
	Group	N	SSLT	70.1	105	87.6	131	99.2	149	99.2	149				
	В	Х	STD	70,1	105	87.6	131			-		-4			
		^	SSLT	70.1	105	87.6	131	105	158	123	184		_		
		N	STD	59.3	89.1	59.3	89.1	1	_			<u> </u>			_
-	Group		SSLT	59.7	89.6	66.5	100	66.5	100	66.5	100	-		, <del>, , , , ,</del> ,	
	A	X	STD	59.7	89.6	74.6	112	4	_	$\pm$		<u> </u>	_	Ţ	
6		^	SSLT	59.7	89.6	74.6	112	83.8	126	83.8	126		_		
$(L=17^1/2)$		N	STD	59.7	89.6	74.6	112	1			_	1	_	-	
	Group	.,	SSLT	59.7	89.6	74.6	112	83.8	126	83.8	126	7		$\mathbf{L}$	
	В	X	STD	59.7	89.6	74.6	112	Ť				-	_		
		^	SSLT	59.7	89.6	74.6	112	89.6	134	104	155				
		N	STD	49.4	74.0	54,1	81.3	54.1	81.3	54.1	81.3		_	E	_
	Group		SSLT	49.4	74.0	54.1	81.3	54.1	81.3	54.1	81.3		81.3	54.1	81.3
ĺ	Α	χ	STD	49.4	74.0	61.7	92.5	68.1	102	68.1	102		—		
5			SSLT	49.4	74.0	61.7	92.5	68.1	102	68.1	102	68.1	102	68.1	102
$(L=14^1/2)$		N	STD	49,4	74.0	61.7	92.5	68.1	102	68.1	102				
	Group	14	SSLT	49.4	74.0	61.7	92.5	68.1	102	68.1	102	68.1	102	68.1	102
	В	х	STD	49.4	74.0	61.7	92.5	74.0	111	84.5	126		-	-1	
		^	SSLT	49.4	74.0	61.7	92.5	74.0	111	84.5	126	84.5	126	84.5	126
	Weld S	ize		3/-	16	1/	4	1/	4	5/-	16	5/-	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

<sup>—</sup> Indicates that the plate thickness is greater than the maximum given in Table 10-9.

3/4-in.diameter bolts

### Table 10-10b (continued)

### Single-Plate Connections Plate

**Bolt, Weld and Single-Plate Available Strengths, kips** 

 $F_y = 50 \text{ ksi}$ 

	D-14	Theres	lle!=					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5/	/16	3	<b>/</b> 8	7/	16	1	/2	9/	16
	Group	Collu.	iyhe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFC
			STD	39.0	58.5	41.5	62.5	41.5	62.5	41.5	62.5		_	4	<u> </u>
	Group	N	SSLT	39.0	58.5	41.5	62.5	41.5	62.5	41.5	62.5	41.5	62.5	41.5	62.5
	Α	х	STD	39.0	58.5	48.8	73.1	52.4	78.5	52.4	78.5			-	
4		^	SSLT	39.0	58.5	48.8	73.1	52.4	78.5	52.4	78.5	52.4	78.5	52.4	78.5
$(L=11^1/2)$		N	STD	39.0	58.5	48.8	73.1	52.4	78.5	52.4	78.5				
	Group		SSLT	39.0	58.5	48.8	73.1	52.4	78.5	52.4	78.5	52.4	78.5	52,4	78.5
	В	Х	STD	39.0	58.5	48.8	73.1	58.5	87.8	64.9	97.0				_
		^	SSLT	39.0	58.5	48.8	73.1	58.5	87.8	64.9	97.0	64.9	97.0	64.9	97.0
		N	STD	28.6	i	28.8	1	28.8	1		J		_		_
	Group		SSLT	28.6			43.4						43.4		43.4
	A	х	STD	28.6		35.8		36.3		36.3	54.5				
3			SSLT				53.7	3 mg - 1 mg		4-5040 0	<u>.                                      </u>	36.3	54.5	36.3	54.5
$(L=8^1/2)$		N	STD	28.6		35.8		36.3	54.5		54.5			1	
	Group		SSLT	28.6			53.7					-	54.5		54.5
	В	x	STD	28.6		- X	53.7	1.00		Dec 1982		in the			
			SSLT	28.6			53.7			-		45.1	67.3		67.3
	_	N	STD	16.5		in Alburi	24.8		24.8		24.8				
	Group A		SSLT	16.5			24.8						24.8	16.5	24.8
2	Α	х	STD	18.3		Abdella M.	31.2	7 35375		98441. 4		300	24.0		-
$(L=5^{1}/2)$			SSLT	18.3			31.2					20.8	31.2	20.8	31.2
(L=5.72)	0	N	STD	18.3			31.2	H12 12	31.2	20.8	31.2	20.0	24.0	1:4	24.0
	Group B		SSLT	18.3			31.2	25.8		25.8	38.5	20.8	31.2	20.8	31.2
	D	х	STD SSLT	18.3 18.3	27.4	22.9		25.6 25.8		340,000,00		7	38.5	00.89	38.5
	Weld S	ize		3/-	16	1/	4	1/	4	5/.	16	5/-	16	3/	8

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included X = Threads excluded

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

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Plate  $F_V = 50$  ksi

## Table 10-10b (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

7/8-in.diameter bolts

	D-M	Thursd	ue!-					Plat	te Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5/	16	3	/8	7,	16	1	/2	9/	16
	Group	Colla.	iype	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFI
		N	STD	117	176	146	219	176	263	-	-		_		-
	Group		SSLT	117	176	146	219	176	263	188	282	188	282		_
	A	X	STD	117	176	146	219	176	263					#	
12		^	SSLT	117	176	146	219	176	263	205	307	234	351		_
(L=36)		N	STD	117	176	146	219	176	263		-	<u> </u>	_		
	Group		SSLT	117	176	146	219	176	263	205	307	234	351		_
	В	X	STD	117	176	146	219	176	263	-	_				-
		^	SSLT	117	176	146	219	176	263	205	307	234	351		_
		N	STD	107	161	134	201	161	241	1	_		-	_	
	Group		SSLT	107	161	134	201	161	241	172	258	172	258	-	
	A	X	STD	107	161	134	201	161	241	1				+	
11		^	SSLT	107	161	134	201	161	241	188	282	215	322		_
(L=33)		N	STD	107	161	134	201	161	241		_				_
	Group		SSLT	107	161	134	201	1.61	241	188	282	215	322		_
	В	x	STD	107	161	134	201	161	241		-		-		
		^	SSLT	107	161	134	201	161	241	188	282	215	322		
		N	STD	97.5	146	122	183	146	219	ì	_	#		1	
	Group		SSLT	97.5	146	122	183	146	219	156	234	156	234		_
	A	x	STD	97.5	146	122	183	146	219		-				_
10			SSLT	97.5	146	122	183	146	219	171	256	195	293		_
(L=30)		N	STD	97.5	146	122	183	146	219	*	-		-		_
4	Group		SSLT	97.5	146	122	183	146	219	171	256	195	293		
ļ	В	x	STD	97.5	146	122	183	146	219			7			
<u> </u>			SSLT	97.5	146	122	183	146	219	171	256	195	293		
		N	STD	87.8	132	110	165	132	197				-	<b>7</b>	_
į.	Group		SSLT	87.8	132	110	_	1,32	197	140	210	140	210		
•	A	x	STD	87.8	132	110	165	132	197		-		-	# . #	
9			SSLT	87.8		110				154	230	176	263	25.36.1	_
(L=27)		N	STD	87.8	132	110	165	132	197	1			-		
	Group		SSLT	87.8	132	110		132	197	154	230	176	263		
	В	x	STD	87.8	132	110		132	197		-		-	<del>-</del> ,	
			SSLT		132	110	165	132		154		176			_
	Weld S	ize		3/	16	1/	4	1,	4	5/	16	5/	16	3/	В

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

**Plate** 

 $F_y = 50 \text{ ksi}$ 

bolts

### Table 10-10b (continued)

### **Single-Plate Connections**

**Bolt, Weld and Single-Plate Available Strengths, kips** 

		l		1				Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5/	16		/8		16	1	/2	9/	/16
	агоир	Conu.	iyhe	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	78.0	117	97.5	146	115	173	-			_		_
	Group		SSLT	78.0	117	97.5	146	117	176	124	185	124	185		<u> </u>
	A	X	STD	78.0	117	97.5	146	117	176		—				_
8			SSLT	78.0	117	97.5	146	117	176	137	205	156	234		<u> </u>
(L=24)		N	STD	78.0	117	97.5	146	117	176		_		-	-	-
	Group		SSLT	78.0	117	97.5	146	117	176	137	205	156	234	-	
	В	X	STD	78.0	117	97.5	146	117	176						—
			SSLT	78.0	117	97.5	146	117	176	137	205	156	234		—
	]	N	STD	68.3	102	85.3	128	98.2	147		_				
	Group		SSLT	68.3	102	85.3	128	102	154	107	161	107	161		
_	A	X	STD	68.3	102	85.3	128	102	154		—		<b>—</b>		
7	<u> </u>		SSLT	68,3	102	85.3	128	102	154	119	179	135	203		_
(L=21)		N	STD	68.3	102	85.3	128	102	154						_
	Group		SSLT	68.3	102	85.3	128	102	154	119	179	135	203	3.7	_
	В	X	STD	68.3	102	85.3	128	102	154		470				-
			SSLT	68.3		85.3	128	102	154	119	179	137	205		
		N	STD	58.5		73.1	110	80.7	121	<u></u>	100				
	Group A		SSLT	58.5		73.1		87.8	132	90.5	136	90.5	136	22	
6	^	X	STD	58.5	•	73.1		87.8	132	100	151		170		
( <i>L</i> = 18)			SSLT	58.5 58.5	87.8 87.8	73.1 73.1	110 110	87.8 87.8	132 132	102	154	114	172		
(L = 10)	Cuann	N	STD SSLT	58.5	87.8	73.1 73.1		87.8	132	102	154	114	— 172		
	Group B		STD	58.5	87.8	73.1		87.8	132	102	104	4	172		
		X	SSLT	58.5	87.8	## (###		87.8	132	102	154	117	176		
	<u> </u>		STD	48.8		60.9	91.4		110	73.6	110	73.6	110	192022	
	Group	N	SSLT	1 344		· · · · · · · · · · · · · · · · · · ·	91.4	5 P 5 (45 ) (C)	110	73.6	110	73.6	110	73.6	110
	A		STD	48.8		60.9		73.1	110	85.3	128	92.7	139		_
5	^	X	SSLT			* * *				<b>A</b>		is the total		92.7	139
(L = 15)			STD					73.1				92.7	139		_
•	Group	N	SSLT	7 × 7			91.4	32		85.3	128	92.7		92.7	139
	В		STD					73.1		85.3		97.5	146	12.	
		X	SSLT			7.90		73.1		~ ?		97.5		110	165
	Weld S	ize		3/	16	1/	4	1/	4	5/	16	5/	16	3/	8

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included

X = Threads excluded - Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate  $F_y = 50$  ksi

## Table 10-10b (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

7/8<sup>-in.-</sup> diameter bolts

	<u> </u>			ļ				Plat	e Thic	knes	s, in.				
n	Bott Group	Thread Cond.	Hole Type	1	/4	5/	16		/8		16	1	/2	9/	16
	Group	COIIG.	туре	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFC
		N	STD	39.0	58.5	48.8	73.1	56.5	84.8	56.5	84.8	56.5	84.8	l <del>-</del> -	—
	Group		SSLT	39.0	58.5	48.8	73.1	56.5	84.8	56.5	84.8	56.5	84.8	56.5	84.8
	A	X	STD	39.0	58.5	48.8	73.1	58.5	87.8	68.3	102	71.2	107		
4		_ ^	SSLT	39.0	58.5	48.8	73.1	58.5	87.8	68.3	102	71.2	107	71.2	107
(L=12)		N	STD	39.0	58.5	48.8	73.1	58.5	87.8	68.3	102	71.2	107	<b>!</b> —	
	Group		SSLT	39.0	58.5	48.8	73.1	58.5			102	71.2	107	71.2	107
	В	X	STD	39.0	58.5	48.8	73.1	58.5	87.8	68.3	102	78.0	117	<b>.</b>	_
			SSLT	39.0	58.5	48.8			87.8		102	78.0	117	87.8	132
		N	STD	29.3	43.9	36.6	54.8	39.2	58.9	39.2	58.9	39.2	58.9		_
	Group	.,	SSLT	29.3	43.9	36.6	54.8							39.2	58.9
	A	x	STD	29.3	l	36,6		43.9		^ .,		· .		_	_
3			SSLT	29.3			54.8						74.4	49.4	74.4
(L=9)		N	STD	29.3	ŀ		54 <i>.</i> 8	2 at				100		_	-
	Group	.,	SSLT	29.3			54.8				74.4		74.4		74.4
	В	x	STD	29.3		36.6		43.9	65.8		76.8		87.8		_
			SSLT	29.3		-	54.8						87.8		91.8
		N	STD	19.5		104,54	33.7	4;2X			33.7	1.46			_
	Group		SSLT	19.5	29.3			22.4			33.7			22.4	33.7
	A	x	STD	19.5		fattar Mital	36.6	- : : : : : : : : : : : : : : : : : : :			42.5	. # P (-)	42.5		
2			SSLT	19.5			36.6							28.3	42.5
(L=6)		N	STD	19.5			36.6	Carrie		28.3		28,3			_
	Group		SSLT			-	36.6								42.5
	В	x	STD	19.5		2 - 40 C	36.6	400	- 1	1,333,333	51.2	1965.1   19	52.5		_
		<u> </u>	SSLT	19.5	29.3	24,4	36.6	29.3	43.9	34.1	51.2	34.9	52.5	34.9	52.5
	Weld S	ize		3/-	16	1/	<u> </u>  4	1/	4	5/-	16	5/-	16	3/	8

STD = Standard holes

SSLT = Short-slotted holes transverse to direction of load

N = Threads included

- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

X = Threads excluded

1-in.diameter

### Table 10-10b (continued)

### Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

Plate  $F_y = 50$  ksi

	1	1		1				<b>P</b> 1			- 1				
	Bolt	Thread	Hole	<u></u>		<del>.</del> -			e Thic		<u> </u>	1 .			
n	Group	Cond.	Type		/4	ļ	16	ļ	/8		16	ļ	/2		16
				ASD	LRFD	ASD	LRFD	1000	LRFD		LRFD	ASD	LRFD	ASD	LRFC
		N	STD	112	168	140	210	168	252	196	294		-		
	Group		SSLT	112	168	140	210	168	252	196	294	224	336	246	370
	A	X	STD	112	168	140	210	168	252	196	294				_
12			SSLT	112	168	140	210	168	252	196	294	224	336	252	378
$(L=36^1/2)$		N	STD	112	168	140	210	168	252	196	294		_		
	Group		SSLT	112	168	140	210	168	252	196	294	224	336	252	378
	В	Х	STD	112	168	140	210	168	252	196	294				
	<u> </u>	 	SSLT	112	168	140	210	168	252	196	294	224	336	252	378
		N	STD	103	154	129	193	154	232	180	270		000		
	Group A		SSLT	103	154	129	193	154	232	180	270	206	309	225	338
44	A	х	STD	103	154	129	193	154	232	180	270	000	000	4.3	
11			SSLT	103	154	129	193	154	232	180	270	206	309	232	348
$(L=33^1/2)$		N	STD	103	154	129	193	154	232	180	270	Na i			
	Group B		SSLT	103	154	129	193	154	232	180	270	206	309	232	348
	В	х	STD	103	154	129	193	154	232	180	270	<b>.</b>	-		240
			SSLT	103	154	129	193	154	232	180	270	206	309	232	348
		N	STD	93.8	141	117	176	141	211	164 164	246 246		202		207
	Group A		SSLT	93.8 93.8	141	117	176	141 141	211 211	164	246	188	282	205	307
10	^	X	STD	93.8	141 141	117	176	141 141	211	164	246	 188	282	211	317
$(L=30^1/2)$			SSLT	93.8	141	117 117	176 176	141	211	164	246	100	202	211	317
(L = 30 /2)	Cuan	N	SSLT	93.8	141	117	176	141	211	164	246	188	282	211	317
	Group B		STD	93.8	141	117	176	141	211	164	246	100	202	<u> </u>	317
		x	SSLT	93.8	141	117	176	141	211	164	246	188	282	211	317
			STD	84.7	127	106	159	127	191	148	222	100		<u>+''</u>	- 017
	Group	N	SSLT	84.7	127	106		127	191	148	222	169	254	183	275
	А		STD	84.7	127	106	159	127	191	148	222				
9		X	SSLT	84.7		14 A 1		***		148	222		254	191	286
$(L=27^1/2)$			STD	84.7	127	106		127	191	148	222			ارد. چيت	
~ = = · · · · ·	Group	N	SSLT	84.7	127	106	1	127	191	148	222	169	254	191	286
	В		STD	84.7	127	106	159	127	191	148	222	130			
		X	SSLT	84.7		106	159	127		1 1 1 2 1	222		254	191	286
	Weld S	ize	OOLI	3/		1/		1/		5/		5/		3/	
	11010 0	ILV					<u> </u>		<u> </u>						

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Plate  $F_y = 50$  ksi

## Table 10-10b (continued) Single-Plate Connections

1-in.diameter
bolts

**Bolt, Weld and Single-Plate Available Strengths, kips** 

	<b>D</b>	Γ	<u> </u>					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	1	/4	5,	16	3	/8	7	16	1	/2	9	/16
	dioup	Joing.	iype	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	75.6	113	94.5	142	113	170	132	198		—		_
	Group		SSLT	75.6	113	94.5	142	113	170	132	198	151	227	162	243
	A	X	STD	75.6	113	94.5	142	113	170	132	198		_	4	
8			SSLT	75.6	113	94.5	142	113	170	132	198	151	227	170	255
$(L=24^1/2)$		N	STD	75.6	113	94.5	142	113	170	132	198		-		
	Group		SSLT	75.6	113	94,5	142	113	170	132	198	151	227	170	255
	В	Ιx	STD	75.6	113	94.5	142	113	170	132	198			÷	
			SSLT	75.6	113	94.5	142	113	170	132	198	151	227	170	255
		N	STD	66.4	99.6	, . T. 7	125	99.6	149	116	174		_		_
	Group		SSLT	66.4	99.6		125	99.6	149	116	174	133	199	140	210
	A	x	STD	66.4	99.6		125	99,6	149	116	174		—		_
7	ļ		SSLT	66.4	99.6	***************************************	125	99.6	149	116	174	133	199	149	224
$(L=21^1/2)$		N	STD	66.4	99.6	64	125	99.6	i	116	174		_		
	Group		SSLT	66.4	99.6		125	99.6		116	174	133	199	149	224
	В	x	STD	66.4	1	83.0	125	99.6	149	116	174	7 <u></u> 12. ve v			
			SSLT	66.4		83.0	125	99.6	149	116	174	133	199	149	224
		N	STD	57.3	85.9	71.6	107	85.9	129	100	150		_		_
	Group		SSLT	57.3		71,6	107	85.9	129	100	150	115	172	118	178
•	A	х	STD	57.3		71.6	107	85.9		100	150				_
6			SSLT			71,6	107	85.9		100	150	115	172	129	193
$(L=18^{1/2})$		N	STD	57.3	1	71.6		85.9	129	100	150	1	470		
	Group B		SSLT	57.3		71.6		85.9	129	100	150	115	172	129	193
	Ь	х	STD	57.3	85.9	71.6		85.9	129	100	150		170		100
		N	SSLT	57.3 48.1	_	71.6		85.9 72.2		100 84.2	150	115 96,3	172	129	193 144
5	Group A	X	STD/		72.2	60.2	90.3			84.2	126	96.3	144	96.3	
$(L=15^{1}/2)$		N	SSLT	48.1			90.3		108	84.2	126 126	96.3	144	108 108	162
(L = 13 /2)	Group B	X	JJLI	100 m				A 10 4 6 4 6 4	108	( market and ) and ) and		1.0		A 100	162 162
·		N							87.8					74.0	
4	Group A	X	STD/	<ul> <li>85 Levil</li> </ul>				*****	87.8	look out		2.4	111 117	,4.0 ,87.8	
$(L=12^{1/2})$		N	SSLT	-	58.5				87.8	-				87.8	
(= 12 /2)	Group B	X	JOLI	SQ. "44.1 S		1 24-4			87.8			2, 1, 2, -1		9.41000	
								56.5 1			102			87.8	
	Weld S	1 <b>2</b> 8		1	16	1/	4		•		16	5/1	16	3/	8

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

**1**-in.diameter bolts

## Table 10-10b (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

Plate  $F_y = 50 \text{ ksi}$ 

			Avaii	avi	<b>5</b> 3	u Ci	ıyu	13,	vih	3					
	Bolt	Thread	Hole					Plat	e Thic	knes	s, in.	·			
n	Group	Cond.	Type	1	/4	5/	16	3	/8	7/	16	1	/2	9/	16
	шопр		.,,,,,											ASD	
	Group	N		\$1.50 2.5X 150	1		1		1	1	1			51.4	•
3	A	X	STD/											64.7	
$(L=9^1/2)$	Group	N	SSLT	546464646	1		1	S		<ul><li>4565 **</li></ul>	1	100000000000000000000000000000000000000	1	64.7	l
	В	Х												67.2	
_	Group	N		0.000	ı	1.00	1	a.ridialija			1	2.3	1	29.4	ŧ
2	A	X	STD/					***********						37,0	
$(L=6^1/2)$	Group	N	SSLT			A 1		1000		1160 1 4 5	1	1 1 1 1 1 1	1	37.0	
	В	X		20.7	31.1	25.9	38.8	31.1	46.6	36.3	54.4	41.4	62.2	45.7	68.6
	Weld S	ize		3/.	16	1/	4	1/	-	5/1	16	5/1	16	3/2	в

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

Plate  $F_y = 50$  ksi

## Table 10-10b (continued) Single-Plate Connections 1 1/8-in.-

**Bolt, Weld and Single-Plate Available Strengths, kips** 

1 78<sup>-in.</sup>
diameter
bolts

	т	1	r	т—				Die	- Th!			<del></del>			
	Bolt	Thread	Hole	<u> </u>					e Thic						
n	Group	Cond.	Туре		16		/8	1	16	1	/2		/16	!	/8
				ASD	LRFD	ASD	}	1 2	LRFD		LRFD		LRFD	444	LRFD
	_	N	STD	134	201	161	241	188	282	215	322				<b></b>
	Group		SSLT	134	201	161	241	188	282	215	322	241	362	268	402
40	A	X	STD	134	201	161	241	:188	282	215	322				_
12			SSLT	134	201	161	241	188	282	215	322	241	362	268	402
(L=37)		N	STD	134	201	161	241	188	282	215	322				
<u> </u>	Group		SSLT	134	201	161	241	188	282	215	322	241	362	268	402
	B	x	STD	134	201	161	241	188	282	215	322		-	<b>-</b>	
			SSLT	134	201	161	241	188	282	215	322	241	362	268	402
		N	STD	123	185	148	222	173	259	197	296		—		—
Ì	Group		SSLT	123	185	148	222	173	259	197	296	222	333	247	370
11	A	x	STD	123	185	148	222	173	259	197	296		—		—
• •			SSLT	123	185	148	222	173	259	197	296	222	333	247	370
(L=34)		N	STD	123	185	148	222	173	259	197	296	-			—
	Group		SSLT	123	185	148	222	173	259	197	296	222	333	247	370
	В	х	STD	123	185	148	222	173	259	197	296	- <b>-</b>			-
			SSLT	123	185	148	222	173	259	197	296	222	333	247	370
		N	STD	113	169	135	203	158	237	180	271	<b>1</b>	—		
	Group		SSLT	113	169	135	203	158	237	180	271	203	304	225	338
	A	x	STD	113	169	135	203	158	237	180	271	عطر	—	<del>;</del>	—
10			SSLT	113	169	135	203	158	237	180	271	203	304	225	338
(L=31)		N	STD	113	169	135	203	158	237	180	271				—
	Group		SSLT	113	169	135	203	158	237	180	271	203	304	225	338
	В	х	STD	113	169	135	203	158	237	180	271		_		
			SSLT	113	169	135	203	158	237	180	271	203	304	225	338
		N	STD	102	153	122	184	143	214	163	245		_	+	_
	Group		SSLT	102	153	122	184	143	214	163	245	184	276	204	306
	A	x	STD	102	153	122	184	143	214	163	245		_	-41	
9			SSLT	102	153	122	184	143	214	163	245	184	276	204	306
(L=28)		N	STD	102	153	122	184	143	214	163	245				
	Group		SSLT	102	153	122	184	143	214	163	245	184	276	204	306
	В	X	STD	102	153	122	184	143	214	163	245				
		^	SSLT	102	153	122	184	143	214	163	245	184	276	204	306
	Weld S		1/	4	1/	4	5/.	16	5/.	16	3/	8	7/-	16	

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

<sup>—</sup> Indicates that the plate thickness is greater than the maximum given in Table 10-9. Tabulated values are grouped when available strength is independent of hole type.

**bolts** 

### Table 10-10b (continued) 1<sup>1</sup>/8<sup>-in.-</sup> Single-Plate Connections

### **Bolt, Weld and Single-Plate Available Strengths, kips**

 $F_y = 50 \text{ ksi}$ 

	D-W	<b>Th</b>	ll ala					Plat	e Thic	knes	s, in.				
n	Bolt Group	Thread Cond.	Hole Type	5/	16	3	/8	7,	16	1	/2	9	16	5	/8
	aroup	Collu.	iype	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
		N	STD	91.4	137	110	165	128	192	146	219		_	-	_
	Group	14	SSLT	91.4	137	110	165	128	192	146	219	165	247	183	274
	Α	X	STD	91,4	137	110	165	128	192	146	219	-			
8		^	SSLT	91.4	137	110	165	128	192	146	219	165	247	183	274
(L=25)		N	STD	91.4	137	110	165	128	192	146	219				
	Group	.,,	SSLT	91.4	137	110	165	128	192	146	219	165	247	183	274
	В	X	STD	91.4	137	110	165	128	192	146	219			Щ <u>.</u>	
			SSLT	91.4	137	110	165	128	192	146	219	165	247	183	274
	1	N	STD	80.7	121	96.9	145	113	170	129	194		—	-	
	Group		SSLT	80.7	121	96.9	145	113	170	129	194	145	218	161	242
	A	x	STD	80.7	121	96.9	145	113	170	129	194		_		
7			SSLT	80.7	121	96.9	145	113	170	129	194	145	218	161	242
(L=22)		N	STD	80.7	121	96.9	145	113	170	129	194				
	Group		SSLT	80.7	121	96.9	145	113	170	129	194	1,45	218	161	242
	В	X	STD	80.7	121	96.9	145	113	170	129	194				
			SSLT	80.7	121	96.9	145	113	170	129	194	145	218	161	242
		N	STD	70.1	105	84.1	126	98.1	147	112	168	\$ 100 miles			
	Group A		SSLT	70.1	105	84.1	126	98.1	147	112	168	126	189	140	210
6	^	X	STD SSLT	70.1 70.1	105 105	84.1 84.1	126 126	98.1 98.1	147 147	112 112	168 168	— 126	189	140	210
( <i>L</i> = 19)	l I		S D	70.1	105	84.1	126	98.1	147	112	168	120	109	140	210
(L = 13)	Group	N	SSLT	70.1 70.1	105	84.1	126	98.1	147	112	168	126	189	 140	210
	В		STD	70.1	105	84.1	126	98.1	147	112	168	120	109	140	210
		X	SSLT	70.1	105	84.1	126	98.1	147	112	168	126	189	140	210
	Group	N	001.	59.4	89.1	71.3	107	83.2	125	95,1	143	107	160	119	178
5	A	X	STD/	59.4	89,1	71.3	107	83.2		95.1	143	107	160	119	178
(L=16)	Group	N	SSLT	59.4		71.3	107	83.2		95.1	143	107	160	119	178
,	В	X		59.4		71.3	107	83.2		95.1	143	107	160	119	178
	Group	N		48.8		58.5	87.8	68.3		78.0	117	87,8	132	93.5	141
4	Α	X	STD/	48.8	- 1	He 19-47-	87.8	68.3		78.0	117	87.8	132	97.5	146
(L = 13)	Group	N	SSLT	48.8		58.5	87.8	68.3	102	78.0		87.8	132	97.5	146
•	В	X		48.8	73.1	58.5	87.8	68.3	102	78.0	117	87.8	132	97.5	146
	Weld S	ize		1/	4	1/	4	5/	16	5/	16	3/	8	7/	16

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

— Indicates that the plate thickness is greater than the maximum given in Table 10-9.

Tabulated values are grouped when available strength is independent of hole type.

Plate  $F_V = 50 \text{ ksi}$ 

## Table 10-10b (continued) Single-Plate Connections

**Bolt, Weld and Single-Plate Available Strengths, kips** 

1<sup>1</sup>/8-in. diameter bolts

STD = Standard holes

N = Threads included

SSLT = Short-slotted holes transverse to direction of load

X = Threads excluded

STD/SSLT = Standard holes or short-slotted holes transverse to direction of load

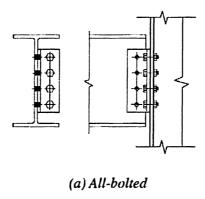
- Indicates that the plate thickness is greater than the maximum given in Table 10-9.

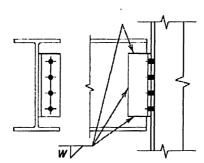
Tabulated values are grouped when available strength is independent of hole type.

#### SINGLE-ANGLE CONNECTIONS

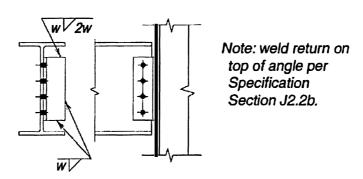
A single-angle connection is made with an angle on one side of the web of the beam to be supported, as illustrated in Figure 10-13. This angle is preferably shop-bolted or welded to the supporting member and field-bolted to the supported beam.

When the angle is welded to the support, adequate flexibility must be provided in the connection. As illustrated in Figure 10-13(c), the weld is placed along the toe and across the bottom of the angle with a return at the top per AISC Specification Section J2.2b. Note that welding across the entire top of the angle must be avoided as it would inhibit the flexibility and, therefore, the necessary end rotation of the connection. The performance of the resulting connection would not be as intended for simple shear connections.





(b) Bolted/welded, angle welded to supported beam



(c) Bolted/welded, angle welded to support

Fig. 10-13. Single-angle connections.

#### **Design Checks**

The available strength of a single-angle connection is determined from the applicable limit states for bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n$ .

As illustrated in Figure 10-14, the effect of eccentricity must be considered in the angle leg attached to the supporting member. Additionally, eccentricity must be considered if the eccentricity exceeds 3 in. (to the face of the supporting member) or if a double vertical row of bolts through the web of the supported member is used. Eccentricity must be considered in the design of welds for single-angle connections. Holes in the angle leg to the supporting member must be standard holes. Holes in the angle leg to the supported member can be standard holes or horizontal short slots.

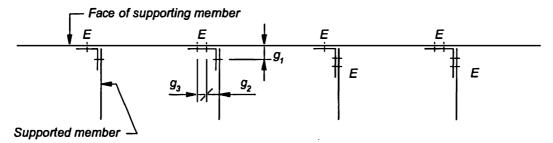
#### **Recommended Angle Length and Thickness**

To provide for stability during erection, it is recommended that the minimum angle length be one-half the *T*-dimension of the supported beam. The maximum length of the connection angle must be compatible with the *T*-dimension of an uncoped beam and the remaining web depth of a coped beam. Note that the angle may encroach upon the fillet(s) as given in Figure 10-3.

A minimum angle thickness of <sup>3</sup>/<sub>8</sub>-in. for <sup>3</sup>/<sub>4</sub>-in.- and <sup>7</sup>/<sub>8</sub>-in.-diameter bolts, and <sup>1</sup>/<sub>2</sub>-in. for 1-in.-diameter bolts should be used. A 4×3 angle is normally selected for a single angle welded to the support with the 3-in. leg being the welded leg.

### **Shop and Field Practices**

Single-angle connections may be readily made to the webs of supporting girders and to the flanges of supporting columns. When framing to a column flange, provision must be made for possible mill variation in the depth of the column. Since the angle is usually shop-attached to the column flange, play in the open holes or horizontal slots in the outstanding angle leg may be used to provide the necessary adjustment to compensate for the mill variation. Attaching the angle to the column flange offers the advantage of side erection of the beam. The same is true for a girder web or truss support. Additionally, proper bay dimensions may be maintained without the need for shims. This advantage is lost when the angle is shop-attached to the supported beam web.



E indicates that eccentricity must be considered in this leg.

Gages g<sub>1</sub>, g<sub>2</sub> and g<sub>3</sub> are workable gages as shown in Table 1-7A.

Fig. 10-14. Eccentricity in angles.

#### **DESIGN TABLE DISCUSSION (TABLES 10-11 AND 10-12)**

#### **Table 10-11. All-Bolted Single-Angle Connections**

Table 10-11 is a design aid for all-bolted single-angle connections. The tabulated eccentrically loaded bolt group coefficients, C, are used to determine the available strength,  $\phi R_n$  or  $R_n/\Omega$ , where

$$R_n = Cr_n \tag{10-9}$$

$$\phi = 0.75 \qquad \Omega = 2.0$$

where

C = coefficient from Table 10-11

 $r_n$  = the nominal strength of one bolt in shear or bearing, kips

#### Table 10-12. Bolted/Welded Single-Angle Connections

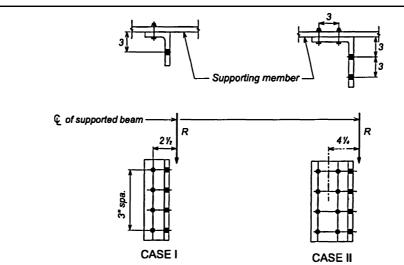
Table 10-12 is a design aid for bolted/welded single-angle connections. Electrode strength is assumed to be 70 ksi and Group A bolts are used. In the rare case where a single-angle connection must be field-welded, erection bolts may be placed in the field-welded leg.

Weld available strengths are determined by the instantaneous center of rotation method using Table 8-10 with  $\theta=0^{\circ}$ . The tabulated values assume a half-web thickness of  $^{1}/_{4}$  in. and may be used conservatively for lesser half-web thicknesses. For half-web thicknesses greater than  $^{1}/_{4}$  in., the tabulated values should be reduced proportionally by an amount up to 8% at a half-web thickness of  $^{1}/_{2}$  in. The tabulated minimum supporting flange or web thickness is the thickness that matches the strength of the support material to the strength of the weld material. In a manner similar to that illustrated previously for Table 10-2, the minimum material thickness (for one line of weld) is:

$$t_{min} = \frac{3.09D}{F_{\nu}} \tag{9-2}$$

where D is the number of sixteenths in the weld size. When welds line up on opposite sides of the support, the minimum thickness is the sum of the thicknesses required for each weld. In either case, when less than the minimum material thickness is present, the tabulated weld available strength should be multiplied by the ratio of the thickness provided to the minimum thickness.

## Table 10-11 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, <i>n</i>	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 1		0.518		

 $\phi R_n = C(\phi r_n)$  or  $R_n/\Omega = C(r_n/\Omega)$ 

where

C = coefficient from Table above

 $\phi r_n$  = design strength of one bolt in shear or bearing, kips/bolt

 $r_n/\Omega$  = allowable strength of one bolt in shear or bearing, kips/bolt

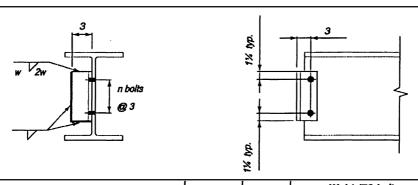
#### Notes:

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.

# Table 10-12 Bolted/Welded Single-Angle Connections



Number of Bolts in One Vertical Row	Bolt and Angle Strength, kips Group A Bolts				Angle Size _(F <sub>y</sub> = 36 ksi)	Angle Length, in.	Weld (70 ksi)			Minimum
							Size, w, in.	Available Strength, kips		t <sub>w</sub> of Supporting Member with Angles
	ASD ASD	LRFD	ASD ASD	LRFD	-			ASD	LRFD	Both Sides of Web, in.
	L L	LNID	ASU	LNIU			5/16	179	268	0.475
12	143	215	144	216		351/2	1/4	143	214	0.380
,-		2.0					3/16	107	161	0.285
	7.79		ž,	198	L4 ×3׳/8	32 <sup>1</sup> / <sub>2</sub>	5/16	165	247	0.475
11	131	197	132				1/4	132	198	0.380
							<sup>3</sup> / <sub>16</sub>	98.8	148	0.285
	1111			180		29¹/₂	5/16	151	226	0.475
10	119	179	120				1/4	121	181	0.380
							3/16	90.4	136	0.285
				4. X		<sup>5</sup> / <sub>16</sub>	137	205	0.475	
9	107	161	108	162		26 <sup>1</sup> /2	1/4	110	164	0.380
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1						3/16	82.2	123	0.285
			95,6 143			23 <sup>1</sup> /2	<sup>5</sup> /16	123	185	0.475
8	8 95.5 14	143		143			1/4	98.5	148	0.380
							<sup>3</sup> / <sub>16</sub>	73.9	111	0.285
	83.5 12		<b>125 83.4</b> 12			20 <sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>16</sub>	109	164	0.475
7		125		125			1/4	87.4	131	0.380
			i v				<sup>3</sup> / <sub>16</sub>	65.6	98.4	0.285

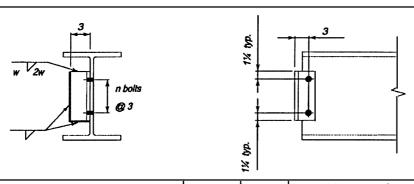
#### Notes:

Gage in angle leg attached to beam web as well as leg width may be decreased. 3-in. welded leg may not be increased or decreased.

Tabulated weld available strengths are based on a 1/4-in. half web for the supported member. Smaller half webs will result in these values being conservative. For half webs over 1/4 in., weld values must be reduced proportionally by an amount up to 8% for a 1/2-in. half web or recalculated.

When the beam web thickness of the supporting member is less than the minimum and single-angle connections are back to back, either stagger the angles, or multiply the weld design strength by the ratio of the actual web thickness to the tabulated minimum thickness to determine the reduced weld design strength.

# Table 10-12 (continued) Bolted/Welded Single-Angle Connections



Number of Bolts in One Vertical Row	Bolt and Angle Strength, kips Group A Bolts				Angle Size (F <sub>y</sub> = 36 ksi)	Angle Length, in.	Weld (70 ksi)			Minimum
							Size, w, in.	Available Strength, kips		t <sub>w</sub> of Supporting Member with Angles Both Sides
	ASD	LRFD	ASD	LRFD	1	,		ASD	LRFD	of Web, in.
						<sup>5</sup> /16	94.3	141	0.475	
6	71.6	107	71,3	107		171/2	1/4	75.5	113	0.380
				<sup>3</sup> / <sub>16</sub>	56.6	84.9	0.285			
			5 59.1	88.7	3/8	14 <sup>1</sup> / <sub>2</sub>	<sup>5</sup> / <sub>16</sub>	79.1	119	0.475
5	59.7	89.5					1/4	63.3	94.9	0.380
	1 128						<sup>3</sup> /16	47.4	71.2	0.285
	3-7-3 3-7-3 3-7-3		<b>47.0</b>			111/2	<sup>5</sup> /16	62.9	94.4	0.475
4	₹47.6	71.4		70.4	L4×3×3/8		1/4	50.3	75.5	0.380
					[43]		<sup>3</sup> / <sub>16</sub>	37.8	56.6	0.285
							<sup>5</sup> / <sub>16</sub>	45.7	68.5	0.475
3	35.5	53.2	34.8	52.2		8 <sup>1</sup> /2	1/4	36.6	54.8	0.380
							<sup>3</sup> /16	27,4	41.1	0.285
							<sup>5</sup> /16	28.2	42.2	0.475
2	23.3	35.0	22.7	34.0		5 <sup>1</sup> /2	1/4	22.5	33.8	0.380
							<sup>3</sup> / <sub>16</sub>	16.9	25.3	0.285

#### Notes:

Gage in angle leg attached to beam web as well as leg width may be decreased. 3-in. welded leg may not be increased or decreased.

Tabulated weld available strengths are based on a <sup>1</sup>/<sub>4</sub>-in. half web for the supported member. Smaller half webs will result in these values being conservative. For half webs over <sup>1</sup>/<sub>4</sub> in., weld values must be reduced proportionally by an amount up to 8% for a <sup>1</sup>/<sub>2</sub>-in. half web or recalculated.

When the beam web thickness of the supporting member is less than the minimum and single-angle connections are back to back, either stagger the angles, or multiply the weld design strength by the ratio of the actual web thickness to the tabulated minimum thickness to determine the reduced weld design strength.

#### TEE CONNECTIONS

A tee connection is made with a structural tee, as illustrated in Figure 10-15. The tee is preferably shop-bolted or welded to the supporting member and field-bolted to the supported beam.

When the tee is welded to the support, adequate flexibility must be provided in the connection. As illustrated in Figure 10-15(b), line welds are placed along the toes of the tee flange with a return at the top per AISC Specification Section J2.2b. Note that welding across the entire top of the tee must be avoided as it would inhibit the flexibility and, therefore, the necessary end rotation of the connection. The performance of the resulting connection would not be as intended for simple shear connections.

#### **Design Checks**

The available strength of a tee connection is determined from the applicable limit states for bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_n$  or  $R_n$ .

Eccentricity must be considered when determining the available strength of tee connections. For a flexible support, the bolts or welds attaching the tee flange to the support must be designed for the shear,  $R_u$  or  $R_a$ . Also, the bolts through the tee stem must be designed for the shear and the eccentric moment,  $R_u a$  or  $R_a a$ , where a is the distance from the face of the support to the centroid of the bolt group through the tee stem.

For a rigid support, the bolts or welds attaching the tee flange to the support must be designed for the shear and the eccentric moment; the bolts through the tee stem must be designed for the shear.

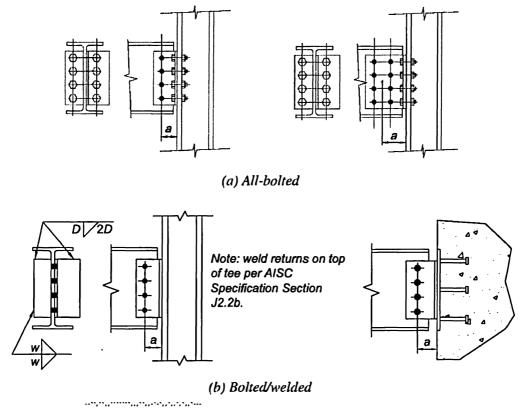


Fig. 10-15. Tee connections.

SHEAR SPLICES 10–139

### Recommended Tee Length and Flange and Web Thicknesses

To provide for stability during erection, it is recommended that the minimum tee length be one-half the *T*-dimension of the beam to be supported. The maximum length of the tee must be compatible with the *T*-dimension of an uncoped beam and the remaining web depth, exclusive of fillets, of a coped beam. Note that the tee may encroach upon the fillet(s) as given in Figure 10-3.

To provide for flexibility, the tee selected should meet the ductility checks illustrated in Part 9. The flange thickness of tees used in simple shear connections should be held to a minimum to permit the flexure necessary to accommodate the end rotation of the beam, unless the tee stem connection is proportioned to meet the geometric requirements for single-plate connections.

#### **Shop and Field Practices**

When framing to a column flange, provision must be made for possible mill variation in the depth of the columns. If the tee is shop-attached to the column flange, play in the open holes usually furnishes the necessary adjustment to compensate for the mill variation. This approach offers the advantage of side erection of the beam. Alternatively, if the tee is shop-attached to the supported beam web, the beam length could be shortened to provide for mill overrun and shims could be furnished at the appropriate intervals to fill the resulting gaps or to provide for mill underrun.

When a single vertical row of bolts is used in a tee stem, a 4-in. or 5-in. stem is required to accommodate the end distance of the supported beam and possible overrun/underrun in beam length. A double vertical row of bolts will require a 7-in. or 8-in. tee stem. There is no maximum limit on  $L_{eh}$  for the tee stem.

#### SHEAR SPLICES

Shear splices are usually made with a single plate, as shown in Figure 10-16(a), or two plates, as shown in Figures 10-16(b) and 10-16(c). Although the rotational flexibility required at a shear splice is usually much less than that required at the end of a simple-span beam, when a highly flexible splice is desired, the splice utilizing four framing angles, shown in Figure 10-17, is especially useful. These shear splices may be bolted and/or welded.

The available strength of a shear splice is determined from the applicable limit states for the bolts (see Part 7), welds (see Part 8), and connecting elements (see Part 9). In all cases, the available strength,  $\phi R_n$  or  $R_n/\Omega$ , must equal or exceed the required strength,  $R_u$  or  $R_a$ .

Eccentricity must be considered in the design of shear splices, with the exception of allbolted shear splices utilizing four framing angles, as illustrated in Figure 10-17. When the splice is symmetrical, as shown for the bolted splice in Figure 10-16(a), each side of the splice is equally restrained regardless of the relative flexibility of the spliced members. Accordingly, as illustrated in Figure 10-18, the eccentricity of the shear to the center of gravity of either bolt group is equal to half the distance between the centroids of the bolt groups. Therefore, each bolt group can be designed for the shear,  $R_u$  or  $R_a$ , and one-half the eccentric moment,  $R_ue$  or  $R_ae$  (Kulak and Green, 1990). This approach is also applicable to symmetrical welded splices.

When the splice is not symmetrical, as shown in Figures 10-16(b) and 10-16(c), one side of the splice will possess a higher degree of rigidity. For the splice shown in Figure 10-16(b),

the right side is more rigid because the stiffness of the weld group exceeds the stiffness of the bolt group, even if the bolts are pretensioned or slip-critical. Also, for the splice shown in Figure 10-16(c), the right side is more rigid since there are two vertical rows of bolts while the left side has only one. In these cases, it is conservative to design the side with the higher rigidity for the shear,  $R_u$  or  $R_a$ , and the full eccentric moment,  $R_ue$  or  $R_ae$ . The side with the lower rigidity can then be designed for the shear only. This approach is applicable regardless of the relative flexibility of the spliced members.

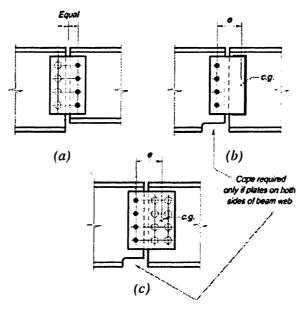


Fig. 10-16. Plate-type shear splices.

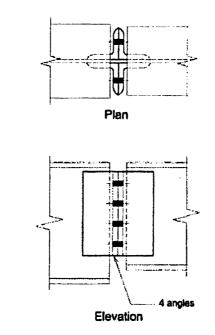


Fig. 10-17. Angle-type shear splice.

Some splices, such as those that occur at expansion joints, require special attention and are beyond the scope of this Manual.

### SPECIAL CONSIDERATIONS FOR SIMPLE SHEAR CONNECTIONS

#### Simple Shear Connections Subject to Axial Forces

When simple shear connections are subjected to axial load in addition to the shear, the important limit states are outstanding angle leg bending and prying action. These tend to require that the angle, plate or flange thickness increase or the gage decrease, or both, and these requirements may compromise the connection's ability to remain flexible enough to accommodate the simple beam end rotation. The shear connection rotational ductility checks derived in Part 9 can be used to ensure that adequate ductility exists.

### Simple Shear Connections at Stiffened Column-Web Locations

Stiffeners are obstacles to direct connections to the column web. Figure 10-19(a) illustrates a seat angle welded to the toes of the column flanges; Figure 10-19(d) shows a vertical plate extended beyond the column flanges. Figures 10-19(b) and 10-19(c) offer two additional options for framing at locations of diagonal stiffeners; these should be examined carefully as they may create erection problems. Additionally, the deep cope of Figure 10-19(c) may significantly reduce the available strength of the beam at the end connection. Alternatively, the bottom transverse stiffener could be extended to serve as a seat plate with a bearing stiffener provided to distribute the beam reaction.

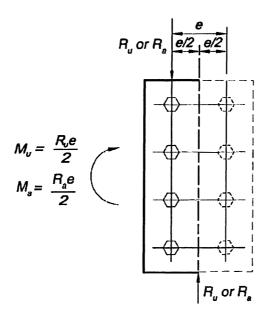
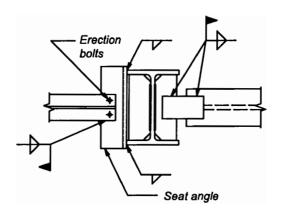


Fig. 10-18. Eccentricity in a symmetrical shear splice.



#### SECTION A-A

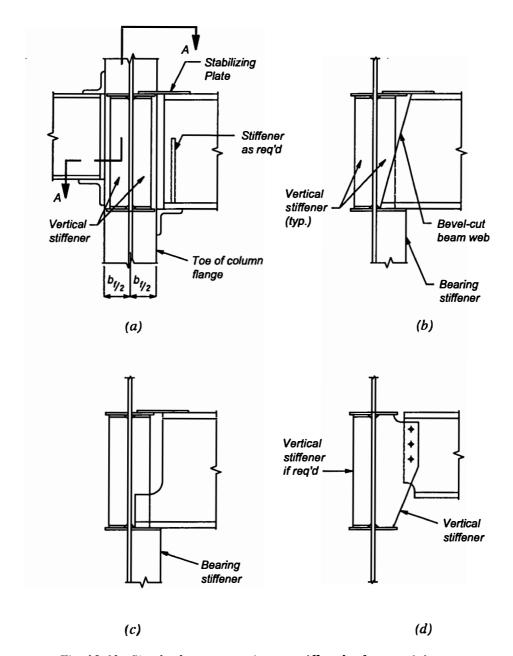


Fig. 10-19. Simple shear connections at stiffened column-web locations.

#### **Eccentric Effect of Extended Gages**

Consider a simple shear connection to the web of a column that requires transverse stiffeners for two concurrent beam-to-column-flange moment connections. If it were not possible to eliminate the stiffeners by selection of a heavier column section, the field connection would have to be located clear of the column flanges, as shown in Figure 10-20, to provide for access and erectability.

The extension of the connection beyond normal gage lines results in an eccentric moment. While this eccentric moment is usually neglected in a connection framing to a column flange, the resistance of the column to weak-axis bending is typically only 20% to 50% of that in the strong axis. Thus the eccentric moment should be considered in this column-web connection, especially if the eccentricity, e, is large. Similarly, eccentricities larger than normal gages may also be a concern in connections to girder webs.

### Column-Web Supports

There are two components contributing to the total eccentric moment: (1) the eccentricity of the beam end reaction, Re; and (2)  $M_{pr}$ , the partial restraint of the connection. To determine what eccentric moment must be considered in the design, first assume that the column is part of a braced frame for weak-axis bending, is pinned-ended with K=1, and will be concentrically loaded, as illustrated in Figure 10-21. The beam is loaded before the column and will deflect under load as shown in Figure 10-22. Because of the partial restraint of the connection, a couple,  $M_{pr}$ , develops between the beam and column and adds to the eccentric couple, Re. Thus,  $M_{con} = Re + M_{pr}$ .

As the loading of the column begins, the assembly will deflect further in the same direction under load, as indicated in Figure 10-23, until the column load reaches some magnitude,  $P_{sbr}$ , when the rotation of the column will equal the simply supported beam end rotation. At this load, the rotation of the column negates  $M_{pr}$  since it also relieves the partial restraint effect of the connection, and  $M_{con} = Re$ . As the column load is increased above  $P_{sbr}$ , the column rotation exceeds the simply supported beam end rotation and a moment  $M'_{pr}$  results such that  $M_{con} = Re - M'_{pr}$ .

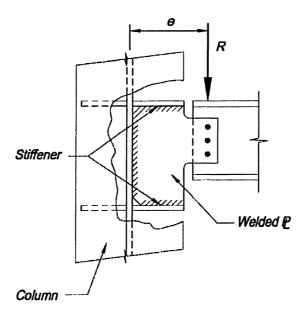


Fig. 10-20. Eccentric effect of extended gages.

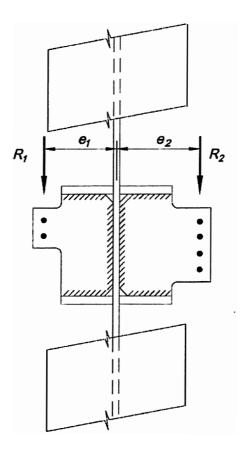


Fig. 10-21. Column subject to dual eccentric moments.

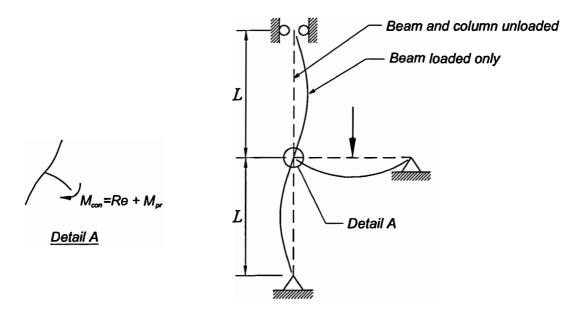


Fig. 10-22. Illustration of beam, column and connection behavior under loading of beam only.

...,.,.,.....

Note that the partial restraint of the connection now actually stabilizes the column and reduces its effective length factor, K, below the originally assumed value of 1. Thus, since  $M'_{pr}$  must be greater than zero, it must also be true that  $Re > M_{con}$ . It is therefore conservative to design the connection for the shear, R, and the eccentric moment, Re.

The welds connecting the plate to the supporting column web should be designed to resist the full shear, R, only; the top and bottom plate-to-stiffener welds have minimal strength normal to their length, are not assumed to carry any calculated force, and may be of minimum size in accordance with AISC Specification Section J2.

If simple shear connections frame to both sides of the column web, as illustrated in Figure 10-21, each connection should be designed for its respective shear,  $R_1$  and  $R_2$ , and the eccentric moment  $|R_2e_2 - R_1e_1|$  may be apportioned between the two simple shear connections as the designer sees fit. The total eccentric moment may be assumed to act on the larger connection, the moment may be divided proportionally among the connections according to the polar moments of inertia of the bolt groups (relative stiffness), or the moment may be divided proportionally between the connections according to the section moduli of the bolt groups (relative moment strength). If provision is made for ductility and stability, it follows from the lower bound theorem of limit states analysis that the distribution which yields the greatest strength is closest to the true strength. Note that the possibility exists that one of the beams may be devoid of live load at the same time that the opposite beam is fully loaded. This condition must be considered by the designer when apportioning the moment.

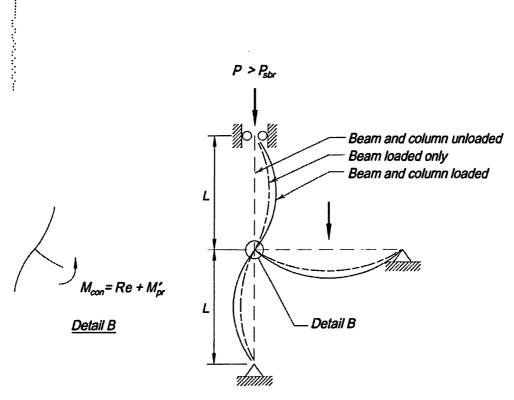


Fig. 10-23. Illustration of beam, column and connection behavior under loading of beam and column.

#### Girder-Web Supports

The girder-web support of Figure 10-24 usually provides only minimal torsional stiffness or strength. When larger-than-normal gages are used, the end rotation of the supported beam will usually be accommodated through rotation of the girder support. It follows that the bolt group should be designed to resist both the shear, R, and the eccentric moment, Re. The beam end reaction will then be carried through to the center of the supporting girder web.

The welds connecting the plate to the supporting girder web should be designed to resist the shear, R, only; the top and bottom plate-to-girder-flange welds have minimal strength normal to their length, are not assumed to carry any calculated force, and may be of minimum size in accordance with AISC Specification Section J2.

Similarly, for the girder illustrated in Figure 10-25 supporting two eccentric reactions, each connection should be designed for its respective shear,  $R_1$  and  $R_2$ , and the eccentric moment,  $|R_2e_2 - R_1e_1|$ , may be apportioned between the two simple shear connections as the designer sees fit.

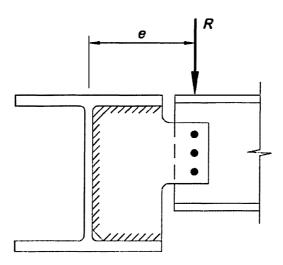


Fig. 10-24. Eccentric moment on girder-web support.

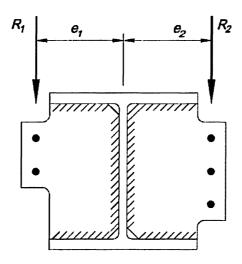


Fig. 10-25. Girder-web support subject to dual eccentric moments.

#### Alternative Treatment of Eccentric Moment

In the foregoing treatment of eccentric moments with column- and girder-web supports, it is possible to design the support (instead of the connection) for the eccentric moment, Re. Additionally, when metal deck is used with puddle welds or self-tapping screws, the metal deck tends to reduce relative movement between the two members and thus will tend to carry all or some of the eccentric moment. In these cases, the connection may be designed for the shear, R, only or the shear and a reduced eccentric moment.

#### **Double Connections**

When beams frame opposite each other and are welded to the web of the supporting girder or column, there are usually no dimensional constraints imposed on one connection by the presence of the other connection unless erection bolts are common to each connection. When the connections are bolted to the web of the supporting column or girder, however, the close proximity of the connections requires that some or all fasteners be common to both connections. This is known as a double connection. See also the discussion under "Constructability Considerations" in an earlier section in this Part.

#### Supported Beams of Different Nominal Depths

When beams of different nominal depths frame into a double connection, care must be taken to avoid interference from the bottom flange of the shallower beam with the entering and tightening clearances for the bolts of the connection for the deeper beam. Access to the bolts that will support the deeper beam may be provided by coping or blocking the bottom flange of the shallower beam. Alternatively, stagger may be used to favorably position the bolts around the bottom flange of the shallower beam.

#### Supported Beams Offset Laterally

Frequently, beams do not frame exactly opposite each other, but are offset slightly, as illustrated in Figure 10-26. Several connection configurations are possible, depending on the offset dimension.

If the offset were equal to the gage on the support, the connection could be designed with all bolts on the same gage lines, as shown in Figure 10-26(b), and the angles arranged, as shown in Figure 10-26(d). If the offset were less than the gage on the support, staggering the bolts, as shown in Figure 10-26(c), would reduce the required gage and the angles could be arranged, as shown in Figure 10-26(c). In any case, each bolt transmits an equal share of its beam reaction(s) to the supporting member, with the bolts that are loaded in double shear ultimately carrying twice as much force as those loaded in single shear. Once the geometry of the connection has been determined, the distribution of the forces is patterned after that in the design of a typical connection. For normal gages, eccentricity may be ignored in this type of connection.

#### **Beams Offset From Column Centerline**

#### Framing to the Column Flange from the Strong Axis

As illustrated in Figure 10-27, beam-to-column-flange connections offset from the column centerline may be supported on a typical welded seat, stiffened or unstiffened, provided the welds for the seat can be spaced approximately equal on either side of the beam centerline.

Two such seats offset from the W12×65 column centerline by  $2^{1/4}$  in. and  $3^{1/2}$  in. are shown in Figures 10-27(a) and 10-27(b), respectively. While not shown, top angles should be used with this connection.

Since the entire seat fits within the flange width of the column, the connection of Figure 10-27(a) is readily selected from the design aids presented previously. However, the larger

W16x45

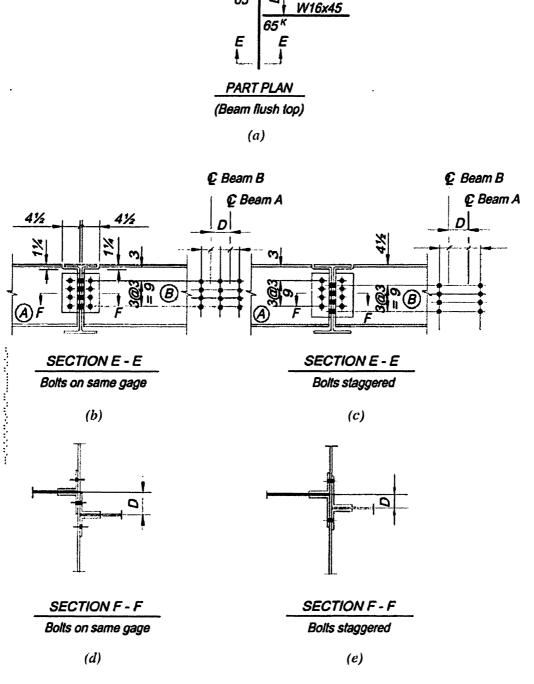
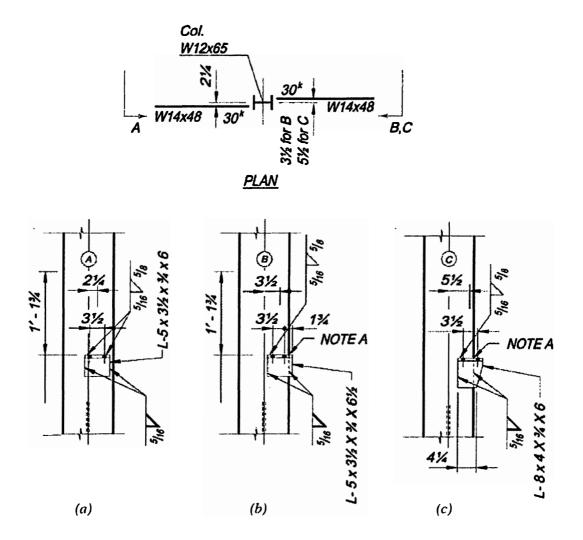


Fig. 10-26. Offset beams connected to girder.



#### NOTE A

End return is omitted because the AWS Code does not permit weld returns to be carried around the corner formed by the column flange toe and seat angle heel.

#### NOTE B

Beam and top angle not shown for clarity.

Fig. 10-27. Offset beams connected to column flanges.

beam offsets in Figures 10-27(b) and 10-27(c) require that one of the welds be made along the edge of the column flange against the back side of the seat angle. Note that the end return is omitted because weld returns should not be carried around such a corner.

For the beam offset of  $5^{1/2}$  in. shown in Figure 10-27(c), the seat angle overhangs the edge of the beam and the horizontal distance between the vertical welds is reduced to  $3^{1/2}$  in.; the center of gravity of the weld group is located  $1^{1/4}$  in. to the left of the beam centerline. The force on each weld may be determined by statics. In this case, the larger force is in the right-hand weld and may be determined by summing moments about the lefthand weld. Once the larger force has been determined, each weld should be designed to share the force in the more highly loaded weld.

#### Framing to the Column Flange from the Weak Axis

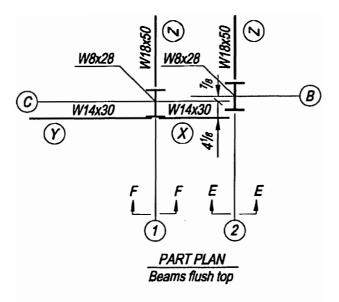
Spandrel beams X and Y in the partial plan shown in Figure 10-28 are offset 4<sup>1</sup>/<sub>8</sub> in. from the centerline of column C1, permitting the beam web to be connected directly to the column flange. At column B2, spandrel beam X is offset 5 in. and requires a <sup>7</sup>/<sub>8</sub>-in. filler between the beam web and the column flange. Beams X and Y are both plain-punched beams, with flange cuts on one side, as noted in Figure 10-28(a), Section F-F.

In establishing gages, the requirements of other connections to the column at adjacent locations must be considered. While the workable flange gage is  $3^{1}/2$  in. for the W8×28 columns supporting the spandrel beams, for beams Z, the combination of a 4-in. column gage and  $1^{1}/2$ -in. stagger of fasteners is used to provide entering and tightening clearance for the field bolts and sufficient edge distance on the column flange, as illustrated in Figure 10-28(b). The 4-in. column gage also permits a  $1^{1}/2$ -in. edge distance at the ends of the spandrel beams, which will accommodate the normal length tolerance of  $\pm 1^{1}/4$  in. as specified in "Standard Mill Practice" in Part 1.

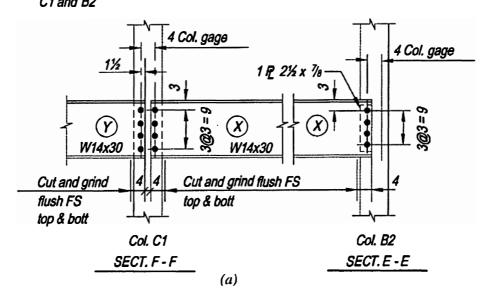
The spandrel beams are shown with the notation "Cut and Grind Flush FS" in Sections E-E and F-F. This cut permits the beam web to lie flush against the column flange. The uncut flange on the near side of the spandrel beam contributes to the stiffness of the connection. The  $2^{1}/2 \times^{7}/8$ -in. filler is required between the spandrel beam web and the flange of column B2 because of the  $^{7}/8$ -in. offset. Accordingly, the filler provisions of AISC Specification Section J5 must be satisfied.

In the part plan in Figure 10-29(a), the W16×40 beam is offset 6<sup>1</sup>/<sub>4</sub> in. from the centerline of column D1. This prevents the web of the W16×40 from being placed flush against the side of the column flange. A plate and filler are used to connect the beam to the column flange, as shown in Figure 10-29(b). Such a connection is eccentric and one group of fasteners must be designed for the eccentricity. Lack of space on the inner flange face of the column requires development of the moment induced by the eccentricity in the beam web fasteners.

To minimize the number of field fasteners, the plate in this case is shop-bolted to the beam and field-bolted to the column. A careful check must be made to ensure that the beam can be erected without interference from fittings on the column web. Some fabricators would elect to shop-attach the plate to the column to eliminate possible interference and permit use of plain-punched beams. Additionally, if the column were a heavy section, the fabricator may elect to shop-weld the plate to the column to avoid drilling the thick flanges. The welding of this plate to the column creates a much stiffer connection and the design should be modified to recognize the increased rigidity.



### PART COLUMN DETAILS C1 and B2



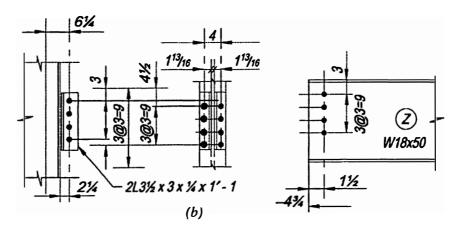
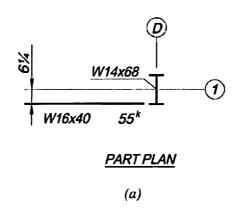
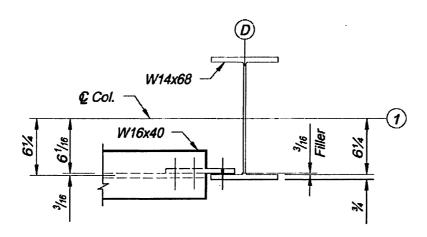


Fig. 10-28. Offset beams connected to column.





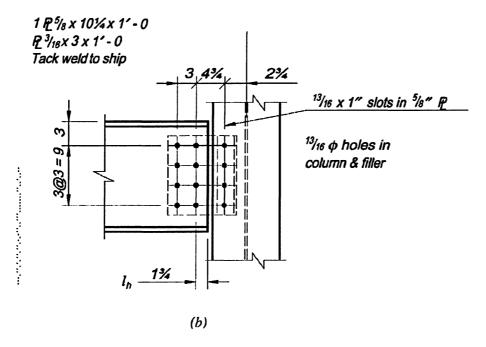


Fig. 10-29. Offset beam connected to column.

If the centerline of the W16 were offset  $6^{1}/16$  in. from line 1, it would be possible to cope or cut the flanges flush top and bottom and frame the web directly to the column flange with details similar to those shown in Figure 10-29. This type of framing also provides a connection with more rigidity than normally contemplated in simple construction. A coped connection of this type would create a bending moment at the root of the cope that might require reinforcement of the beam web.

One method frequently adopted to avoid moment transfer to the column because of beam connection rigidity is to use slotted holes and a bearing connection to provide some flexibility. The slotted holes would be provided in the connection plate only and would be in the field connection only. These slotted connections also would accommodate fabrication and erection tolerances.

The type of connection detailed in Figure 10-29 is similar to a coped beam and should be checked for buckling, as illustrated in Part 9. The following differences are apparent and should be recognized in the analysis:

- 1. The effective length of equivalent "cope" is longer by the amount of end distance to the first bolt gage line.
- 2. There is an inherent eccentricity due to the beam web and plate thickness. The ordinary web and plate thicknesses normally will not require an analysis for this condition, since the inelastic rotation allowed by the AISC Specification will relieve this secondary moment effect. Two plates may sometimes be required to counter this eccentricity when dimensions are significant.
- 3. The connection plate can be made of sufficient thickness as required for bending or buckling stresses with a minimum thickness of <sup>3</sup>/<sub>8</sub> in.

#### Framing to the Column Web

If the offset of the beam from the centerline of the column web is small enough that the connection may still be centered on or under the supported beam, no special considerations need be made. However, when the offset of the beam is too large to permit the centering of the connection under the beam, as in Figure 10-30, it may be necessary to consider the effect of eccentricity in the fastener group.

The offset of the beam in Figure 10-30 requires that the top and bottom flanges be blocked to provide erection clearance at the column flange. Since only half of each flange, then, remains in which to punch holes, a 6-in. outstanding leg is used for both the seat and top angles of these connections; this permits the use of two field bolts to each of the seat and top angles, which are required by OSHA.

#### **Connections for Raised Beams**

When raised beams are connected to column flanges or webs, there is usually no special consideration required. However, when the support is a girder, the differing tops of steel may preclude the use of typical connections. Figure 10-31 shows several typical details commonly used for such cases in bolted construction. Figure 10-32 shows several typical details commonly used in welded construction.

In Figure 10-31(a), since the top of the W12×35 is located somewhat less than 12 in. above the top of the W18 supporting beam, a double-angle connection is used. This

connection would be designed for the beam reaction and the shop bolts would be governed by double shear or bearing, just as if they were located in a vertical position. However, the field bolts are not required to carry any calculated force under gravity loading.

The maximum permissible distance, m, depends on the beam reaction, since the web remaining after the bottom cope must provide sufficient area to resist the vertical shear as well as the bending moment which would be critical at the end of the cope. The beam can be reinforced by extending the angles beyond the cope and adding additional shop bolts for development. The angle size and/or thickness can be increased to gain shear area or section modulus, if required. The effect of any eccentricity would be a matter of judgment, but could be neglected for small dimensions.

When this connection is used for flexure or for dynamic or cyclical loading, the web is subjected to high stress concentrations at the end of the cope, and it is good practice to extend the angles, as shown in Figure 10-31(a), to add at least two additional web fasteners.

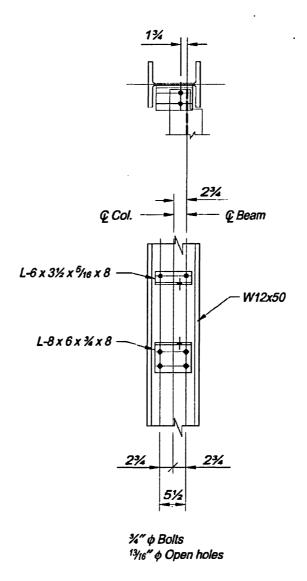


Fig. 10-30. Offset beam connected to column web.

Figure 10-31(b) covers the case where the bottom flange of the W12×35 is located a few inches above the top of the W18. The beam bears directly upon fillers and is connected to the W18 by four field bolts which are not required to transmit a calculated gravity load. If the distance m exceeds the thickest plate which can be punched, two or more plates may be used. Even though the fillers in this case need only be  $6^{1/2}$ -in. square, the amount of material required increases rapidly as m increases. If m exceeds 2 or 3 in., another type of detail may be more economical.

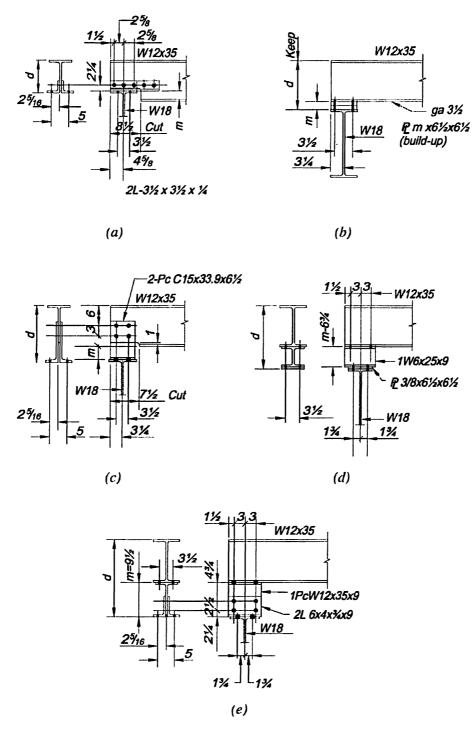


Fig. 10-31. Bolted raised-beam connections.

The detail shown in Figure 10-31(c) is used frequently when m is up to 6 or 7 in. The load on the shop bolts in this case is no greater than that in Figure 10-31(a). However, to provide more lateral stiffness, the fittings are cut from a 15-in. channel and are detailed to overlap the beam web sufficiently to permit four shop bolts on two gage lines.

A stool or pedestal, cut from a rolled shape, can be used with or without fillers to provide for the necessary m distance, as in Figure 10-31(d). A pair of connection angles and a tee will also serve a similar purpose, as shown in Figure 10-31(e). To provide adequate strength to carry the beam end reaction and to provide lateral stiffness, the web thickness of the pedestal in each of these cases should be at least as thick as the member being supported.

In Figure 10-32(a), welded framing angles are substituted for the bolted angles of Figure 10-31(a). In Figure 10-32(b), a single horizontal plate is shown replacing the pair of framing angles; this results in a savings in material and the amount of shop-welding. In this case, particular care must be taken in cutting the beam web and positioning the plate at right angles to the beam web. For this reason, if only a few connections of this type are to be made, some fabricators prefer to use the angles, as in Figure 10-32(a). If sufficient duplication were available to warrant making a simple jig to position the plate during welding, the solution of Figure 10-32(b) may be economical.

Figure 10-32(c) shows a tee centered on the beam web and welded to the bottom flange of the beam. The tee stem thickness should not be less than the beam web thickness. The welded solutions shown in Figures 10-32(d) and 10-32(e) are capable of providing good lateral stiffness. The latter two types also permit end rotation as the beam deflects under load. However, if the *m* distance exceeds 3 or 4 in., it is advisable to shop-weld a triangular bracket plate at one end of the beam, as indicated by the dashed lines, to prevent the beam from deflecting along its longitudinal axis.

Other equally satisfactory details may be devised to meet the needs of connections for raised beams. They will vary depending on the size of the supported beam and the distance m. When using this type of connection where the load is transmitted through bearing, the provisions of AISC Specification Sections J10.2 and J10.3 must be satisfied for both the supported and supporting members. For the detail of Figure 10-32(b), since the rolled fillet has been removed by the cut, the value of k would be taken as the thickness of the plate plus the fillet weld size.

AISC Specification Appendix 6 requires stability and restraint against rotation about the beam's longitudinal axis. This provision is most easily accomplished with a floor on top of the supported beam. In the absence of a floor, the top flange may be supported by a strut or bracket attached to the supporting member. When the beam is encased in a wall, this stability may also be provided with wall anchors.

This discussion has considered that the field bolts which attach the beam to the pedestal or support beam are subject to no calculated load. It is important, however, to recognize that when the beam deflects about its neutral axis, a tensile force can be exerted on the outside bolts. The intensity of this tensile force is a function of the dimension d, indicated in Figure 10-31, the span length of the supported member, and the beam stiffness. If these forces are large, high-strength bolts should be used and the connection analyzed for the effects of prying action.

Raised-beam connections such as these are used frequently as equipment or machinery supports where it is important to maintain a true and level surface or elevation. When this tolerance becomes important, the dimension d should be noted "keep" to advise the fabricator of this importance, as shown in Figure 10-31(b). Since the supporting beam is

subject to certain camber/deflection tolerances, it also may be appropriate to furnish shim packs between the connection and the supporting member.

#### **Non-Rectangular Simple Shear Connections**

It is often necessary to design connections for beams that do not frame into a support orthogonally. Such a beam may be inclined with respect to the supporting member in

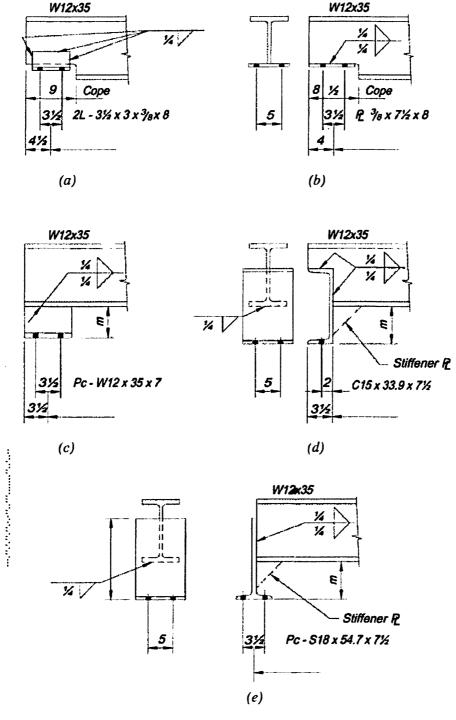


Fig. 10-32. Welded raised-beam connections.

various directions. Depending upon the relative angular position which a beam assumes, the connection may be classified among three categories: skewed, sloped or canted. These conditions are illustrated in Figure 10-33 for beam-to-girder web connections; the same descriptions apply to beam-to-column-flange and web connections. Additionally, beams may be oriented in a combination of any or all of these conditions. For any condition of skewed, sloped or canted framing, the single-plate connection is generally the simplest and most economical of those illustrated in this text.

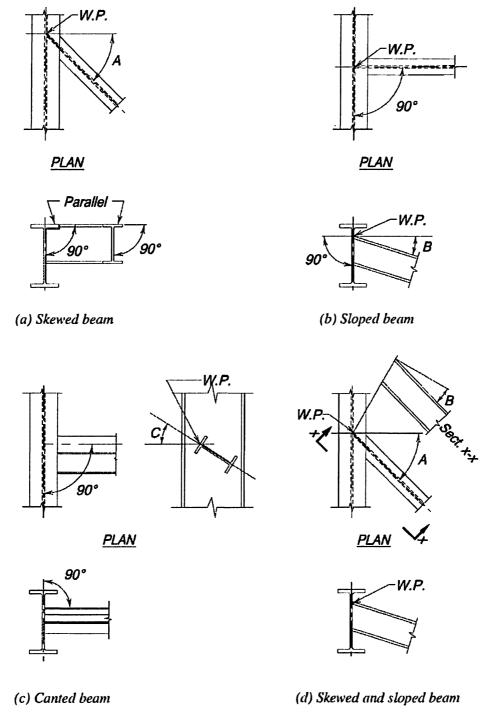


Fig. 10-33. Non-rectangular connections.

#### Skewed Connections

A beam is said to be skewed when its flanges lie in a plane perpendicular to the plane of the face of the supporting member, but its web inclined to the face of the supporting member. The angle of skew A appears in Figure 10-33(a) and represents the horizontal bevel to which the fittings must be bent or set, or the direction of gage lines on a seated connection.

When the skew angle is less than  $5^{\circ}$  (1-in-12 slope), a pair of double angles can be bent inward or outward to make the connection, as shown in Figure 10-34. While bent angle sections are usually drawn as bending in a straight line from the heel, rolled angles will tend to bend about the root of the fillet (dimension k in Manual Part 1). This produces a significant jog in the leg alignment, which is magnified by the amount of bend. Above this angle of skew, it becomes impractical to bend rolled angles.

For skews approximately greater than 5° (1-in-12 slope), a pair of bent plates, shown in Figure 10-35, may be a more practical solution. Bent plates are not subject to the deformation problem described for bent angles, but the radius and direction of the bend must be considered to avoid cracking during the cold-bending operation.

Bent plates exhibit better ductility when bent perpendicular to the rolling direction and are, therefore, less likely to crack. Whenever possible, bent connection plates should be billed with the width dimension parallel to the bend line. The length of the plate is measured

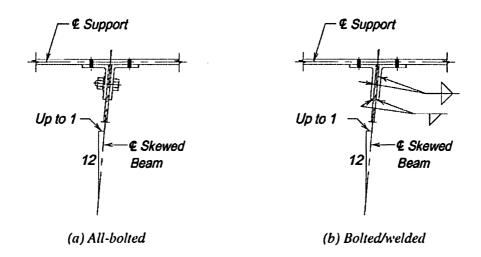


Fig. 10-34. Skewed beam connections with bent double angles.

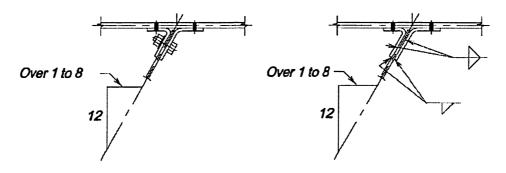


Fig. 10-35. Skewed beam connections with double bent plates.

on its mid-thickness, without regard to the radius of the bend. While this will provide a plate that is slightly longer than necessary, this will be corrected when the bend is laid out to the proper radius prior to fabrication.

Before bending, special attention should be given to the condition of plate edges transverse to the bend lines. Flame-cut edges of hardenable steels should be machined or softened by heat treatment. Nicks should be ground out and sharp corners should be rounded.

The strength of bent angles and bent plate connections may be calculated in the same manner as for square framed beams, making due allowances for eccentricity. The load is assumed to be applied at the point where the skewed beam center line intersects the face of the supporting member.

As the angle of skew increases, entering and tightening clearances on the acutely angled side of the connection will require a larger gage on the support. If the gage were to become objectionable, a single bent plate, illustrated in Figure 10-36, may provide a better solution. Note that the single-bent plate may be of the conventional type, or a more compact connection may be developed by "wrapping" the single bent plate, as illustrated in Figure 10-36(c).

In all-bolted construction, both the shop and field bolts should be designed for shear and the eccentric moment. A C-shaped weld is preferable to avoid turning the beam during shop fabrication. Single bent plates should be checked for flexural strength.

Skewed single-plate and skewed end-plate connections, shown in Figures 10-37 and 10-38, provide a simple, direct connection with a minimum of fittings and multiple punching requirements. When fillet-welded, these connections may be used for skews up to 30° (or a slope of 6<sup>5</sup>/16-in-12) provided the root opening formed does not exceed <sup>3</sup>/16 in. For skew angles greater than 30°, see AWS D1.1/D1.1M, Section 2.2.5.2 (AWS, 2010).

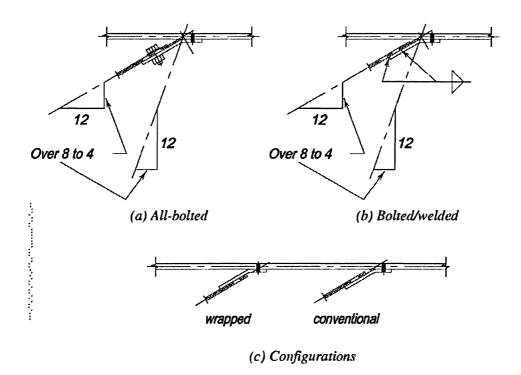
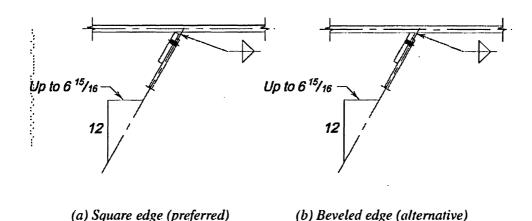


Fig. 10-36. Skewed-beam connections with single-bent plates.

The maximum beam-web thickness which may be supported is a function of the maximum root opening and the angle of skew. If the thickness of the beam web were such that a larger root opening were encountered, the skewed single plate or the web connecting to the skewed end plate may be beveled, as shown in Figures 10-37(b) and 10-38(b). Since no root opening occurs with the bevel, there is no limitation on the thickness of the beam web. However, beveling, especially of the beam web, requires careful finishing and is an expensive procedure which may outweigh its advantages.

The design of skewed end-plate connections is similar to that discussed previously in "Shear End-Plate Connections" in this Part. However, when the gage of the bolts is not centered on the beam web, this eccentric loading should be considered. The design of skewed single-plate connections is similar to that discussed previously in "Single-Plate Connections" in this Part.

When skewed, stiffened seated connections are used, the stiffening element should be located so as to cross the skewed beam centerline well out on the seat. This can be accomplished by shifting the stiffener to the left or right of center to support beams which skew to the left or to the right, respectively. Alternatively, it may be possible to skew the stiffening element.



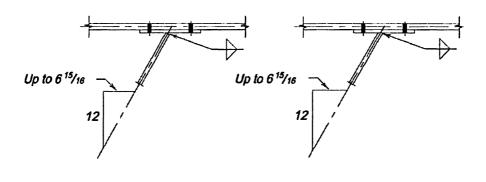


Fig. 10-37. Skewed single-plate connections.

Fig. 10-38. Skewed shear end-plate connections.

(b) Beveled edge (alternative)

(a) Square edge (preferred)

#### Sloped Connections

A beam is said to be sloped if the plane of its web is perpendicular to the plane of the face of the supporting member, but its flanges are not perpendicular to this face. The angle of slope B is shown in Figure 10-33(b) and represents the vertical angle to which the fittings must be set to the web of the sloped beam, or the amount that seat and top angles must be bent.

The design of sloped connections usually can be adapted directly from the rectangular connections covered earlier in this part, with consideration of the geometry of the connection to establish the location of fittings and fasteners. Note that sloped beams often require copes to clear supporting girders, as illustrated in Figure 10-39.

Figure 10-40 shows a sloped beam with double-angle connections, welded to the beam and bolted to the support. The design of this connection is essentially similar to that for rectangular double-angle connections. Alternatively, shear end-plate, tee, single-angle, single-plate, or seated connections could be used. Selection of a particular connection type may be influenced by fabrication economy, erectability, and/or by the types of connections used elsewhere in the structure.

Sloped seated beam connections may utilize either bent angles or plates, depending on the angle of slope. Dimensioning and entering and clearance requirements for sloped seated connections are generally similar to those for skewed connections. The bent seat and top plate shown in Figure 10-41 may be used for smaller bevels.

When the angle of slope is small, it is economical to place transverse holes in the beam web on lines perpendicular to the beam flange; this requires only one stroke of a multiple

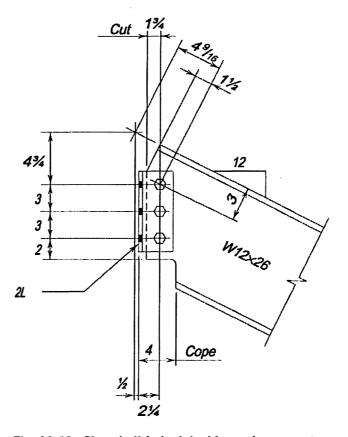


Fig. 10-39. Sloped all-bolted double-angle connection.

punch per line. Since non-standard hole arrangements, then, usually occur in the connecting materials (which are single-punched), this requires that sufficient dimensions be provided for the connecting material to contain fasteners with adequate edges and gages, and at the same time fit the angle to the web without encroaching on the flange fillets of the beam. For the end connection of the beam, this was accomplished by using a 6-in, angle leg; a 4-in, or even a 5-in, leg would not have furnished sufficient edge distance at the extreme fastener.

As the angle of slope increases, however, bolts for the end connections cannot conveniently be lined up to permit simultaneous punching of all holes in a transverse row. In this case, the fabricator may choose to disregard beam gage lines and arrange the hole-punching so that ordinary square-framed connection material can be used throughout, as shown in Figure 10-42.

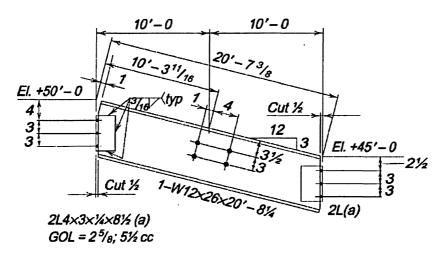


Fig. 10-40. Sloped bolted/welded double-angle connection.

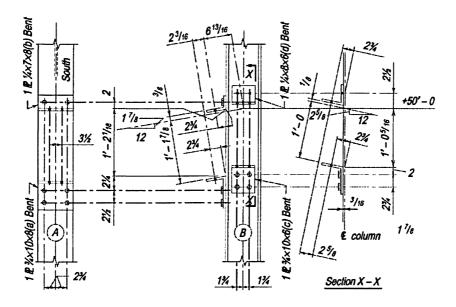


Fig. 10-41. Sloped seated connections.

#### Canted Connections

A beam perpendicular to the face of a supporting member, but rotated so that its flanges are tilted with respect to those of the support, is said to be canted. The angle of cant C is shown in Figure 10-33(c).

The design of canted connections usually can be adapted directly from the rectangular connections covered earlier in this part. In Figure 10-43, a double-angle connection is used.

Alternatively, shear end-plate, seated, single-angle, single-plate, and tee connections may also be used.

For channel B2 in Figure 10-44, which is supported by a sloping member B1 (not shown), to match the hole pattern in supporting member B1, the holes in the connecting materials

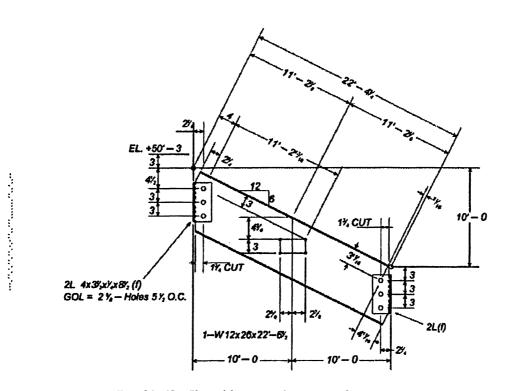


Fig. 10-42. Sloped beam with rectangular connections.

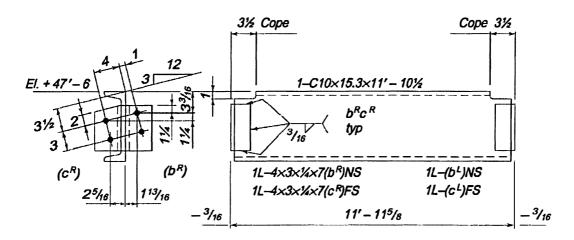


Fig. 10-43. Canted double-angle connections.

must be canted. As shown in Figure 10-44, the top flange of the channel and the connection angles,  $d^R$  and  $d^L$ , are cut to clear the flanges of beam B1. In this detail, with a 3-in-12 angle of cant, 4-in. legs were wide enough to contain the pattern of hole-punching.

Since the multiple punching or drilling of column flanges requires strict adherence to column gage lines, punching is generally skewed in the fittings. When, for some reason, this is not possible, as in Figure 10-45, skewed reference lines are shown on the column to aid in matching connections.

When canted connecting materials are assembled on the beam, particular care must be used in determining the direction of skew for punching the connection angles. An error reversing this skew may permit matching of holes in both members, but the beam will be canted opposite to the intended direction.

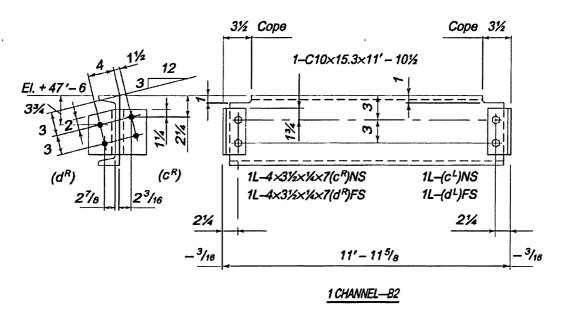


Fig. 10-44. Canted connections to a sloping support.

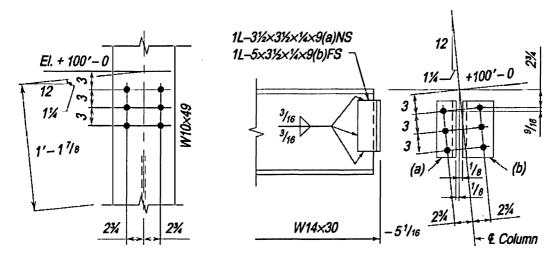


Fig. 10-45. Canted connection to column flange.

Note the connection angles in Figure 10-45 are shown shop-welded to the beam. This was done to provide tightening clearance for <sup>3</sup>/<sub>4</sub>-in. high-strength field bolts in the opposite leg. Had the shop fasteners been bolts, it would have been necessary to stagger the field and shop fasteners and provide longer angles for the increased spacing.

Canted seated beams, shown in Figure 10-46, present few problems other than those in ordinary square-end seated beams. Sufficient width and length of angle leg must be provided to contain the gage line punching or drilling in the column face, as well as the off-center location of the holes matching the punching in the beam flange. The elevation of the top flange centerline and the bevel of the beam flange may be given for reference on the beam detail, although the bevel shown will not affect the fabrication.

#### Inclines in Two or More Directions (Hip and Valley Framing)

When a beam inclines in two or more directions with respect to the axis of its supporting member, it can be classified as a combination of those inclination directions. For example, the beam of Figure 10-33(d) is both skewed and sloped. Angle A shows the skew and angle B shows the slope. Note that, since the inclined beam is foreshortened in the elevation, the

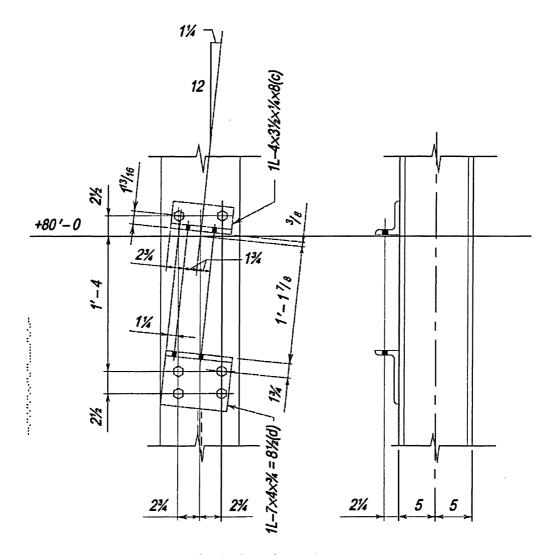


Fig. 10-46. Canted seated connections.

true angle B appears only in the auxiliary projection, Section X-X. The development of these details is quite complicated and graphical solutions to this compound angle work can be found in any textbook on descriptive geometry. Accurate dimensions may then be determined with basic trigonometry.

### DESIGN CONSIDERATIONS FOR SIMPLE SHEAR CONNECTIONS TO HSS COLUMNS

Many of the familiar simple shear connections that are used to connect to wide-flange columns can be used with HSS columns. These include double and single angles, unstiffened and stiffened seats, single plates, and tee connections. One additional connection that is unique for HSS columns is the through-plate; note that this alternative is seldom required structurally and presents a significant economic penalty when a single plate connection would otherwise suffice. Variations in attachments are more limited with HSS columns since the connecting element will typically be shop-welded to the HSS and bolted to the supported beam. Except for seated connections, the bolting will be to the web of a wide-flange or other open profile section. Coping is not required except for bottom-flange copes that facilitate knifed erection with double-angle connections.

#### Double-Angle Connections to HSS

Table 10-1 is a design aid for double-angle connections. The table shows the compatible sizes of W-shapes for the various connection configurations. Based on maximum beam web thickness, maximum weld size, maximum HSS corner radius and 4-in. outstanding angle legs, double-angle connections may be used with any HSS having a width greater than or equal to 12 in. If 3-in. outstanding angle legs are used for connections with six bolts or less, HSS with widths of 10 in. are acceptable for obtaining welds on the flat of the side. For smaller web thicknesses, welds and corner radii, it may be possible to fit the connection on widths of 10 in. if the outstanding angle legs are 4 in. and on widths of 8 in. for outstanding angle legs of 3 in. However, these dimensions must be verified for a particular case. See the tabulated workable flat dimensions for HSS in Part 1.

#### Single-Plate Connections to HSS

As long as the HSS wall is not classified as a slender element, the local distortion caused by the single-plate connection will be insignificant in reducing the column strength of the HSS (Sherman, 1996). Therefore, single-plate connections may be used with HSS when  $b/t \le 1.40(E/F_y)^{0.5}$  or 35.1 for  $F_y = 46$  ksi. Single-plate connections may also be used with round HSS as long as they are nonslender under axial load  $(D/t \le 0.11E/F_y)$ .

#### Unstiffened Seated Connections to HSS

In order to properly attach seat angles to the flat of the HSS, the workable flat must be large enough to accommodate both the width of the seat angle and the welds. Seat widths are usually 6 in. or 8 in., but other widths may also be used. See the tabulated workable flat dimensions for HSS in Part 1.

Table 10-6 may be used for unstiffened seated connections to HSS. The minimum HSS thicknesses are established based on the weld strength. If the HSS thickness is less than the minimum value, the weld strength must be reduced proportionally.

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#### Stiffened Seated Connections to HSS

Tables 10-8 and 10-14 are design aids for stiffened seated connections. Table 10-8 is applicable to all member types, and Table 10-14 presents specific limits for HSS, based on the yield-line mechanism limit state for HSS. Some values for small connection lengths, L, and large HSS widths, B, have been reduced to meet the limit state for a line load with a width of 0.4L across the HSS, per AISC Specification Section K1.

The design procedure for stiffened seated connections to W-shape column webs (Sputo and Ellifritt, 1991) includes a yield line limit state based on an analysis by Abolitz and Warner (1965). This has been applied to the HSS wall which is also supported on two edges. However, since the HSS side supports are the same thickness rather than much heavier as in the case of W-shape flanges, the equation (Abolitz and Warner, 1965) for rotationally free edge supports has been used instead of fixed edge supports.

The strength of the connection is obtained by multiplying the tabulated value for a particular HSS width and stiffener length by the square of the HSS thickness and dividing by the width of the seat. For combinations of B and L that are not listed in Table 10-14, the HSS does not have sufficient flat width to accommodate a weld to the seat that is 0.2L on each side of the stiffener. Because the required width also depends on the stiffener thickness and the HSS corner radius, the HSS width must be checked even when the values are tabulated. See the tabulated workable flat dimensions for HSS in Part 1.

The minimum HSS thicknesses associated with the weld strengths of Table 10-8 are given in Table 10-14. If the HSS thickness is less than the minimum tabulated value, the weld strength must be reduced proportionally.

#### Through-Plate Connections

In the through-plate connection shown in Figure 10-47, the front and rear faces of the HSS are slotted so that the plate can be passed completely through the HSS and welded to both faces. Through-plate connections should be used when the HSS wall is classified as a slender element  $(b/t > 1.40(E/F_y)^{0.5}$  or 35.1 for  $F_y = 46$  ksi for rectangular HSS;  $D/t > 0.11E/F_y$  for round HSS and Pipe) or does not satisfy the punching shear limit state. A single-plate connection is more economical and should be used if the HSS is neither slender nor inadequate for the punching shear rupture limit state.

Through-plate connections have the same limit states as single-plate connections and Table 10-10 may be used to determine the size and number of bolts and the plate thickness. The welds, however, are subject to direct shear and may not have to be as large as those for single-plate connections. For equilibrium of the forces in Figure 10-47, the shear in the welds on the front face should not exceed the strength of the pair of welds. The HSS wall strength can be matched to the weld shear strength to determine the minimum thickness, as illustrated in Part 9. If the thickness of the HSS is less than the minimum, the weld strength must be reduced proportionally. Conservatively, the welds on the rear face may be the same size.

When a connection is made on both sides of the HSS with an extended through-plate, the portion of the plate inside the HSS is subject to a uniform bending moment. For long connections, this portion of the plate may buckle in a lateral-torsional mode prior to yielding, unless H is very small. Using a thicker plate to prevent lateral-torsional buckling would restrict the rotational flexibility of the connection. Therefore, it must be recognized that the plate may buckle and that the moment will be shared with the HSS wall in a

complex manner. However, if the HSS would be satisfactory for a single-plate connection, the lateral-torsional buckling limit state is not a critical concern involving loss of strength.

#### Single-Angle Connections

For fillet welding on the flat of the HSS side, while keeping the center of the beam web in line with the center of the HSS, single-angle connections must be compatible with one-half the workable flat dimension provided in Part 1. Generally, the following HSS widths and thicknesses will work:

```
b = 8 in. and t \le \frac{1}{4} in.

b = 9 in. and t \le \frac{3}{8} in.

b \ge 10 in. and any nominal thickness
```

Alternatively, single angles can be welded to narrow HSS with a flare-bevel weld.

### **DESIGN TABLE DISCUSSION (TABLES 10-13, 10-14A, 10-14B, 10-14C AND 10-15)**

#### Table 10-13. Minimum Inside Radius for Cold-Bending

Table 10-13 is a design aid providing generally accepted minimum inside-bending radius for a given plate thickness, t, for various grades of steel. Values are for bend lines transverse to the direction of final rolling (Brockenbrough, 1998). When bend lines are parallel

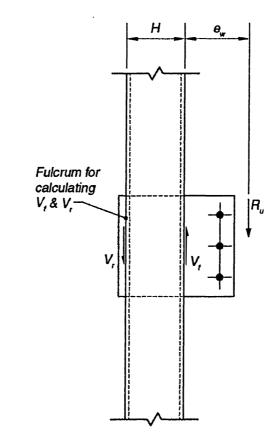


Fig. 10-47. Shear forces in a through-plate connection.

to the direction of final rolling, the tabular values should be increased by 50%. When bend lines are longer than 36 in., all radii may have to be increased if problems in bending are encountered.

### Table 10-14A. Clearances for All-Bolted Skewed Connections

Table 10-14A is a design aid providing clearance dimensions for skewed bent double-angle connections and double and single-bent plate all-bolted connections, and specifies beam set-backs and gages. Since these dimensions are based on the maximum material thicknesses and fastener sizes indicated, it is suggested that in cases where many duplicate connections with less than maximum material or fasteners are required, savings can be realized if these dimensions are developed from specific bevels, beam sizes and fitting thicknesses.

### Table 10-14B. Clearances for Bolted/Welded Skewed Connections

Table 10-14B is a design aid providing clearance dimensions, beam setbacks and gages for skewed bent double-angle connections and double and single-bent plate bolted/welded connections. Table 10-13B also specifies the dimension A which is added to the fillet weld size, S, to compensate for the root opening for skewed end-plate connections. This table is based conservatively on a gap of 1/8 in. For beam webs beveled to the appropriate skew, values of  $H_1$  for the entire table are valid and A = 0.

### Table 10-14C. Welding Details for Skewed Single Plate Shear Connections

Table 10-14C is a design aid providing weld information for skewed single-plate shear connections. Additionally, this table provides clearances and dimensions for groove-welded single-plate connections without backing bars for skews greater than 30°; refer to AWS D1.1/D1.1M for prequalified welds for both types of joints.

### Table 10-15. Required Length and Thickness for Stiffened Seated Connections to HSS

Table 10-15 is a design aid for stiffened seated connections to HSS. Specific limits are based on the yield-line mechanism limit state of the HSS wall. Some values for small connection lengths, L, and large HSS widths, B, have been reduced to meet the limit state for a line load with a width of 0.4L across the HSS, per AISC Specification Section K1.

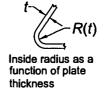
The design procedure for stiffened seated connections to W-shape column webs (Sputo and Ellifritt, 1991) includes a yield limit state based on an analysis by Abolitz and Warner (1965). This has been applied to the HSS wall which is also supported on two edges. However, since the HSS side supports are the same thickness rather than much heavier, as in the case of W-shape column flanges compared to the column web, the equation for rotationally free edge supports has been used instead of fixed edge supports (Abolitz and Warner, 1965).

The strength of the connection is obtained by multiplying the tabulated value for a particular HSS width and stiffener length by the square of the HSS thickness and dividing by the width of the seat. For combinations of B and L that are not listed in Table 10-15, the HSS

does not have sufficient flat width to accommodate a weld to the seat that is 0.2L on each side of the stiffener. Since the required width also depends on the stiffener thickness and the HSS corner radius, the HSS width must be checked even when the values are tabulated. See the tabulated workable flat dimensions for HSS in Part 1.

Table 10-8 is applicable to all member types for stiffened seated connections. The minimum HSS thicknesses associated with the weld strengths of Table 10-8 are given in Table 10-15. If the HSS thickness is less than the minimum tabulated value, the weld strength must be reduced proportionally.

## Table 10-13 Minimum Inside Radius for Cold-Bending<sup>1</sup>



ACTIA Designation <sup>2</sup>		Thickne	ss, t, in.		
ASTM Designation <sup>2</sup>	Up to <sup>3</sup> / <sub>4</sub>	Over 3/4 to 1	Over 1 to 2	Over 2	
A36, A572-42	1½ t	1 <sup>1</sup> / <sub>2</sub> t	1 <sup>1</sup> /2 t	2 <i>t</i>	
A242, A529-50, A529-55, A572-50, A588, A992	1 <sup>1</sup> /2 t	1 <sup>1</sup> / <sub>2</sub> t	2 t	2¹/2 t	
A572-55, A852	1 <sup>1</sup> /2 t	11/2 t	2 <sup>1</sup> / <sub>2</sub> t	3 <i>t</i>	
A572-60, A572-65	1 <sup>1</sup> /2 t	1 <sup>1</sup> / <sub>2</sub> t	3 t	3 <sup>1</sup> /2 t	
A514	1 <sup>3</sup> /4 t	21/4 t	4 <sup>1</sup> /2 t	5 <sup>1</sup> /2 t	

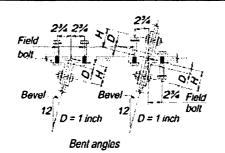
<sup>&</sup>lt;sup>1</sup> Values are for bend lines perpendicular to direction of final rolling. If bend lines are parallel to final rolling direction, multiply values by 1.5.

<sup>&</sup>lt;sup>2</sup> The grade designation follows the dash; where no grade is shown, all grades and/or classes are included.

DESIGN TABLES 10-173

## Table 10-14A Clearances for All-Bolted Skewed Connections

Values given are for webs up to  $\frac{3}{4}$  in. thick, angles up to  $\frac{5}{8}$  in. thick, and bent plates up to  $\frac{1}{2}$  in. thick. Bolts are either  $\frac{7}{8}$ -in. diameter or 1 in. diameter, as noted. Values will be conservative for material thinner than the maximums listed, or for work with smaller bolts, and may be reduced to suit conditions by calculation or layout. For thicker material or larger bolts, check entering, driving, and tightening clearances and increase D and bolt gages as necessary. All dimensions are in inches. Enter bolts as shown.



	Values of <i>H</i> for Various Fastener Combinations									
F	ield Bolts	7/8	1							
S	hop Bolts	7/8	1							
ē	Up to 1	4*	41/4*							
Bevel	Over 1 to 2	4½ 4¾	4 <sup>3</sup> / <sub>8</sub>							
	Over 2 to 3	43/8	43/4							

\*For back-to-back connections, stagger shop and field bolts or increase the 2%-in. field bolt dimension to 31%.

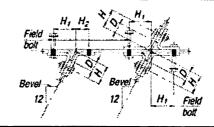
Values of H. H1.	H <sub>2</sub> and D for Various	<b>Bolt Combinations</b>
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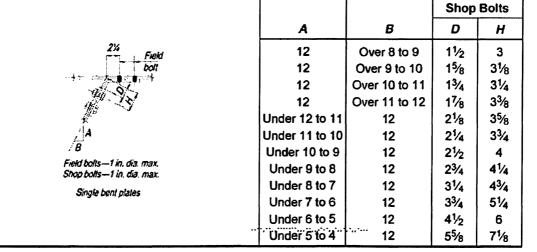
			•						
Fiel	d Fastener		7/8			1			
Sho	p Fastener		7/8			1	-		
Dì	mension	Н	H <sub>1</sub>	H <sub>2</sub>	Н	H <sub>1</sub>	H <sub>2</sub>	D	
	Over 3 to 4	3¾	31/4	21/2	41/4	31⁄4	23/4	11/4	
Ō	Over 4 to 5	3¾	31/2	21/4	41/2	31/2	21/2	11/4	
Bevel	Over 5 to 6	4	33/4	21/4	43/4	3¾	21/4	11/2	
	Over 6 to 7	41/2	4	21/4	5	4	21/4	11/2	
	Over 7 to 8	43/4	41/4	21/4	51/4	41/4	21/4	11/2	



Double bent plates

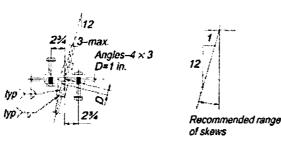
Min. radius of cold bend for A 36 sleef up to % in. thick. For other bends see Table 10-13



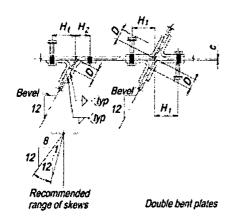


### Table 10-14B Clearances for Bolted/Welded Skewed Connections

Values given are for webs up to  $\frac{3}{4}$  in. thick, angles up to  $\frac{5}{6}$  in. thick, and bent plates up to  $\frac{1}{2}$  in. thick, with bolts 1 in. diameter maximum. Values will be conservative for thinner material and for work with smaller bolts, and may be reduced to suit conditions by calculation or layout. For thicker material or larger bolts, check entering and tightening clearances and increase beam setback D and bolt gages as necessary. Enter bolts as shown. All dimensions are in inches.



Bent angles

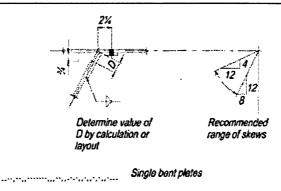




Min. radius of cold bend for A 36 steel up to ½ in. thick. For other bends see Table 10-13

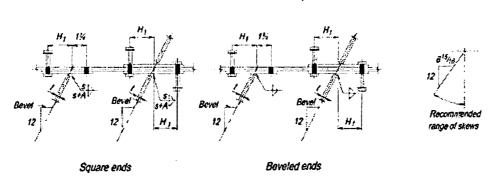
Bevel	D	H <sub>1</sub>	H <sub>2</sub>
Over 3 to 4	c + 5/8	31/4	23/4
Over 4 to 5	$c + \frac{11}{16}$	31/2	21/2
Over 5 to 6	c + 3/4	33/4	21/4
Over 6 to 7	c + 13/16	4	21/4
Over 7 to 8	$c + \frac{7}{8}$	41/4	21/4

$$C = \frac{t_W}{2} + \frac{1}{16}''$$



### Table 10-14B (continued) Clearances for Bolted/Welded Skewed Connections

Values given are for material and bolt sizes noted below. See 'Shear End-Plate Connections" in Part 10 for proportioning these connections. S indicates weld size required for strength, or a size suitable to the thickness of material. When the beam web is cut square, only that portion of the table above the heavy lines is applicable. Dimension A is added to the weld size to compensate for the root opening caused by the skew. When the beam web is beveled to the required skew, values of  $H_1$  for the entire table are valid, and A = 0. In either case, where weld strength is critical, increase the weld size to obtain the required throat dimension. Enter bolts as shown. All dimensions are in inches.



End plates

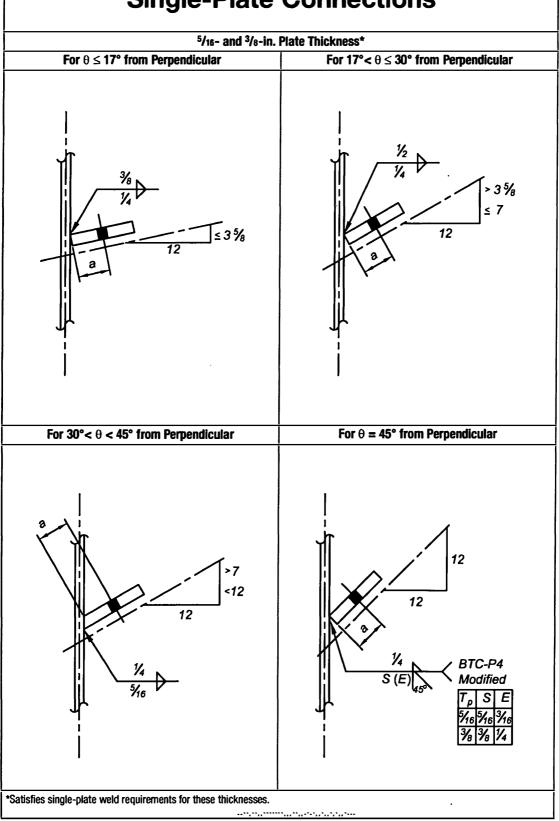
t		1/4	t=	5⁄16	t=	3/8	t=	<sup>7</sup> /16	t=	1/2	$t = \frac{5}{8} \qquad t = \frac{3}{4}$		3/4	
Bevel	<i>H</i> <sub>1</sub>	A	H <sub>1</sub>	A	<i>H</i> <sub>1</sub>	A	H <sub>1</sub>	A	H <sub>1</sub>	A	H <sub>1</sub>	A	H <sub>1</sub>	A
Up to 1%	13/4	0	13⁄4	0	13/4	1/16	13/4	1/16	13/4	1/16	17/8	1/8	17/8	1/8
Over 15% to 21%	13/4	0	13/4	1/16	17/8	1/16	17/8	1/16	17/8	1/8	2	1/8	2	1/8
Over 21/8 to 31/4	17/8	1/16	17/8	1/8	2	1⁄8	2	1/8	2	1/8	21/8	0	21/8	0
Over 31/4 to 43/8	21/8	1/8	21/8	1/8	21/8	1/8	21/8	0	21/4	0	21/4	0	23/8	0
Over 43/8 to 55/8	21/4	1/8	21/4	1/8	23/8	0	23/8	0	<b>2</b> %	0	21/2	0	21/2	0
Over 55% to 615/16	21/2	1/8	21/2	0	21/2	0	21/2	0	25⁄8	0	25/8	0	23/4	0

Bolts: 1/0-in. diameter maximum End Plate thickness: 3/6-in. maximum Supporting web thickness: 3/4-in. maximum

Use of fillet welds is limited to connections with bevels of  $6^{15}/_{16}$  in 12 and less. For greater bevels consider use of double or single bent plates.

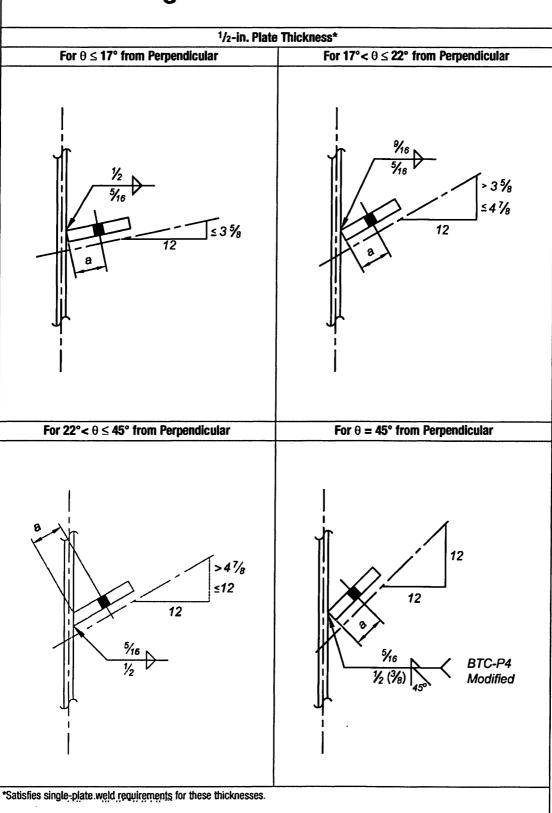
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## Table 10-14C Weld Details for Skewed Single-Plate Connections



DESIGN TABLES 10–177

## Table 10-14C (continued) Weld Details for Skewed Single-Plate Connections



## Table 10-15 Required Length and Thickness for Stiffened Seated Connections to HSS

HSS Wall Strength Factor, $R_uW/t^2$ or $R_aW/t^2$ , kips/in.  HSS Width, $B_i$ in.												
<i>L</i> , In.	5	 i	5.	.5			Γ .	· 7	1 8	B		
•	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRF
6	558	839	545	819	536	805	526	791	525	789	528	79
7	687	1030	664	997	646	971	625	940	615	925	612	92
8			798	1200	771	1160	735	1100	714	1070	704	106
9					911	1370	856	1290	823	1240	804	121
10					1070	1600	990	1490	942	1420	912	137
11							1140	1710	1070	1610	1030	155
12							1300	1960	1210	1820	1160	174
13	3.102								1370	2060	1290	194
14									1540	2310	1440	217
15									1720	2580	1600	241
16											1700	266
17											1960_	294
			***									
											125. } 6.	
			4 0' '		equired H	ISS Thic	kness		UOO TE			
		Weld	d Size, in					Min	<b>1. HSS Th</b> 0.2		, IN.	
			5/ <sub>16</sub>						0.2			
			3/8						0.3			
			7/16						0.3			
	1/2								0.4	48		
			5/8						0.5			

DESIGN TABLES 10–179

## Table 10-15 (continued) Required Length and Thickness for Stiffened Seated Connections to HSS

	I		1100 110	II Streng			tth, <i>B</i> , in					
	1	0	12		14		16		18		20	
<i>L</i> , in.	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRF
6	534	802	552	830	561	843	491	737	437	656	393	590
7	614	922	625	940	644	968	667	1000	594	892	535	80
8	700	1050	704	1060	717	1080	736	1110	759	1140	699	105
9	793	1190	787	1180	794	1190	809	1220	828	1240	851	128
10	893	1340	876	1320	876	1320	885	1330	901	1350	920	138
11	1000	1500	971	1460	962	1450	965	1450	976	1470	993	149
12	1120	1680	1070	1610	1050	1580	1050	1580	1060	1590	1070	160
13	1240	1870	1180	1770	1150	1730	1140	1710	1140	1710	1150	172
14	1370	2070	1290	1940	1250	1880	1230	1850	1220	1840	1230	184
15	1520	2280	1410	2120	1360	2040	1330	1990	1310	1980	1310	197
16	1670	2510	1540	2320	1470	2210	1430	2150	1410	2120	1400	210
17	1830	2760	1680	2520	1590	2390	1540	2310	1510	2260	1490	224
18	2010	3020	1820	2740	1710	2570	1650	2470	1610	2420	1590	238
19	2190	3300	1970	2970	1840	2770	1760	2650	1710	2580	1680	253
<b>2</b> 0	2390	3600	2130	3210	1980	2980	1880	2830	1820	2740	1790	268
21			2300	3460	2120	3190	2010	3020	1940	2910	1890	284
22			2480	3730	2280	3420	2140	3220	2060 -	3090	2000	301
23			2670	4020	2440	3660	2280	3430	2180	3280	2120	318
24			2870	4310	2600	3910	2430	3650	2310	3480	2230	336
25 ⋮			3080	4630	2780	4170	2580	3880	2450	3680	2360	354
26					2960	4450	2740	4110	2590	3890	2480	373
27 :					3150	4730	2900	4360	2730	4110	2610	393
28					3350	5030	3070	4620	2880	4330	2750	413
29 🗄		'			3560	5340	3250	4890	3040	4570	2890	434
30	4. 1%				3770	5660	3440	5160	3200	4810	3040	456
31							3630	5450	3370	5070	3190	479
32							3830	5750	3540	5330	3340	502
	Part (											
		144 1	101 - 1		equired (	HSS Thic	kness		1100 71		•	
		Wei	d Size, in	•				Min	. HSS Th		, in.	
			5/ <sub>16</sub>						0.2			
			<sup>3</sup> /8						0.2			
			<sup>7</sup> / <sub>16</sub>						0.3			
			1/2						0.3 0.4			
			<sup>5</sup> /8						0.4			

## Table 10-15 (continued) Required Length and Thickness for Stiffened Seated Connections to HSS

			HSS Wa	II Stren	gth Facto	r, <i>R<sub>u</sub>W/</i>	t² or R <sub>a</sub> l	W/t², ki <sub>l</sub>	ps/in.			
					,	HSS Wi	ith, <i>B</i> , in		_		·	
		22	2		- 2	6	77777	8	30		32	
<i>L</i> , in.	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
6	357	536	328	492	302	454	281	421	262	393	246	369
7	486	730	446	669	412	618	382	574	357	535	334	502
8	635	953	582	874	537	807	499	749	466	699	437	656
9	804	1210	737	1110	680	1020	632	948	590	885	553	830
10	943	1420	910	1370	840	1260	7,80	1170	728	1090	682	1020
11	1010	1520	1030	1560	1020	1530	944	1420	881	1320	826	1240
12	1080	1630	1100	1660	1130	1690	1120	1690	1050	1570	983	1470
13	1160	1740	1180	1770	1200	1800	1220	1830	1230	1850	1150	1730
14	1240	1860	1250	1880	1270	1910	1290	1940	1310	1970	1330	2010
15	1320	1980	1330	2000	1340	2020	1360	2040	1380	2070	1400	2110
16	1400	2100	1410	2120	1420	2130	1430	2160	1450	2180	1470	2210
17	1490	2230	1490	2240	1500	2250	1510	2270	1530	2290	1540	2320
18	1580	2370	1570	2370	1580	2370	1590	2390	1600	2410	1620	2430
19	1670	2510	1660	2500	1660	2500	1670	2510	1680	2520	1690	2540
20	1760	2650	1750	2630	1750	2630	. 1750	2630	1760	2640	1770	2660
21	1860	2800	1850	2770	1840	2760	1840	2760	1840	2770	1850	2780
22	1960	2950	1940	2920	1930	2900	<sub>3</sub> 1920	2890	1920	2890	1930	2900
23	2070	3110	2040	3070	2020	3040	2010	3030	2010	3020	2010	3030
24	2180	3280	2140	3220	2120	3190	2110	3170	2100	3160	2100	3150
25	2290	3450	2250	3380	2220	3340	2200	3310	2190	3290	2190	3290
26	2410	3620	2360	3540	2320	3490	2300	3450	2280	3430	2280	3420
27	2530	3800	2470	3710	2430	3650	2400	3600	2380	3570	2370	3560
28	2650	3990	2590	3890	2540	3810	2500	3760	2480	3720	2460	3700
29	2780	4180	2700	4060	2650	3980	2610	3920	2580	3870	2560	3840
30	2920	4380	2830	4250	2760	4150	2710	4080	2680	4030	2650	<b>3</b> 990
31	3050	4590	2950	4440	2880	4330	2820	4250	2780	4180	2760	4140
32	3190	4800	.3080	4630	3000	4510	2 40	4420	2890	4350	2860	4300
		L	<u> </u>	R	equired l	HSS Thi			1 92 90020		F100000000 3	
		Weld	d Size, in					Min	. HSS Th	ickness	, in.	
			1/4		.,,				0.2	24		
			5/16						0.2	80		
			3/8						0.3			
			7/ <sub>16</sub>						0.3			
			1/2						0.4	48		
			5/8						0.5	60		

PART 10 REFERENCES 10–181

#### **PART 10 REFERENCES**

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