F_y = 46 ksi
f'_c = 4 ksi

Table 4–15
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS16–HSS14

Shape		HSS16×16×						HSS14×14×					
		1/2		3/8		5/16		5/8		1/2		3/8	
t_{design}, in.		0.465		0.349		0.291		0.581		0.465		0.349	
Steel Wt/ft		103		78.4		65.8		110		89.6		68.2	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	1040	1560	893	1340	820	1230	977	1470	856	1280	732	1100
	6	1030	1540	884	1330	811	1220	964	1450	845	1270	722	1080
	7	1020	1530	881	1320	808	1210	960	1440	841	1260	718	1080
	8	1020	1530	877	1320	804	1210	955	1430	837	1250	714	1070
	9	1010	1520	872	1310	800	1200	949	1420	831	1250	710	1060
	10	1010	1510	868	1300	795	1190	942	1410	826	1240	705	1060
	11	1000	1500	862	1290	790	1190	935	1400	819	1230	699	1050
	12	996	1490	857	1280	785	1180	927	1390	813	1220	693	1040
	13	989	1480	850	1280	779	1170	919	1380	805	1210	687	1030
	14	982	1470	844	1270	773	1160	910	1370	797	1200	680	1020
	15	974	1460	837	1250	766	1150	901	1350	789	1180	673	1010
	16	965	1450	829	1240	759	1140	891	1340	780	1170	665	997
	17	956	1430	821	1230	752	1130	880	1320	771	1160	657	985
	18	947	1420	813	1220	744	1120	869	1300	761	1140	648	972
	19	937	1410	804	1210	736	1100	857	1290	751	1130	639	959
	20	927	1390	795	1190	727	1090	845	1270	740	1110	630	945
	21	916	1370	786	1180	719	1080	833	1250	729	1090	620	931
	22	905	1360	776	1160	709	1060	820	1230	718	1080	611	916
	23	894	1340	766	1150	700	1050	807	1210	706	1060	600	901
	24	882	1320	755	1130	690	1040	793	1190	694	1040	590	885
	25	870	1310	745	1120	680	1020	779	1170	682	1020	579	869
	26	858	1290	734	1100	670	1000	765	1150	669	1000	568	852
	27	845	1270	723	1080	659	989	750	1130	656	985	557	836
	28	832	1250	711	1070	649	973	736	1100	643	965	546	819
	29	819	1230	699	1050	638	957	721	1080	630	945	534	801
	30	805	1210	687	1030	627	940	705	1060	617	925	523	784
	32	778	1170	663	995	604	906	674	1010	589	884	499	748
	34	749	1120	638	957	581	871	643	964	562	843	475	712
	36	720	1080	613	919	557	835	611	917	534	801	451	676
	38	691	1040	587	880	533	799	579	869	506	759	426	639
	40	661	992	561	841	509	763	547	821	478	717	402	603
Properties													
M_n/Ω_b	$\phi_b M_n$ kip-ft	376	566	289	435	243	366	347	521	285	428	219	329
$P_e(KL)^2/10^4$	kip-in.^{2}	44400		37000		33100		32500		28400		23600	
ASD	LRFD												
Ω_c = 2.00	ϕ_c = 0.75												

4

COMPOSITE
HSS14–HSS12

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS14×14×		HSS12×12×									
		5/16		5/8		1/2		3/8		5/16		1/4	
t_{design}, in.		0.291		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft		57.3		93.1		75.9		58.0		48.8		39.4	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	668	1000	790	1180	689	1030	584	876	530	795	475	713
	6	659	988	776	1160	677	1010	573	860	520	780	466	699
	7	656	983	771	1160	672	1010	570	855	517	775	463	695
	8	652	978	765	1150	667	1000	565	848	513	769	459	689
	9	648	971	758	1140	662	993	561	841	508	763	455	683
	10	643	964	751	1130	656	983	555	833	504	755	451	676
	11	638	957	743	1120	649	973	549	824	498	747	446	669
	12	632	948	735	1100	642	962	543	815	492	739	440	661
	13	626	939	726	1090	634	950	536	805	486	729	435	652
	14	620	930	716	1070	625	938	529	794	479	719	429	643
	15	613	919	706	1060	616	925	522	782	472	709	422	633
	16	606	909	695	1040	607	911	513	770	465	698	415	623
	17	598	897	684	1030	597	896	505	758	457	686	408	612
	18	590	885	672	1010	587	881	496	744	449	674	401	601
	19	582	873	660	990	576	865	487	731	441	661	393	589
	20	573	860	647	971	566	848	478	717	432	648	385	578
	21	564	847	634	951	554	831	468	702	423	635	377	565
	22	555	833	621	931	543	814	458	687	414	621	368	553
	23	546	819	607	910	531	796	448	672	405	607	360	540
	24	536	804	593	889	519	778	437	656	395	592	351	526
	25	526	789	579	868	506	759	427	640	385	578	342	513
	26	516	774	564	846	494	740	416	624	375	563	333	500
	27	506	758	549	824	481	721	405	608	365	548	324	486
	28	495	743	535	802	468	702	394	591	355	533	315	472
	29	484	727	520	780	455	683	383	574	345	517	305	458
	30	474	710	505	757	442	663	372	558	335	502	296	444
	32	452	677	475	712	416	624	349	524	314	471	277	416
	34	429	644	444	667	390	585	327	490	294	441	259	388
	36	407	611	414	622	364	546	305	457	273	410	240	361
	38	385	577	385	578	338	507	283	424	254	380	222	334
	40	362	544	356	535	313	470	262	392	234	351	205	307
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	185	278	250	376	206	309	159	239	134	202	109	164
$P_e(KL)^2/10^4$	kip-in.^{2}	21000		19200		16800		14000		12500		10900	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 46 ksi
f'_c = 4 ksi

Table 4-15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS10

Shape		HSS10×10×											
		5/8		1/2		3/8		5/16		1/4		3/16	
t_{design}, in.		0.581		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft		76.1		62.3		47.8		40.3		32.6		24.7	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	616	924	535	802	450	674	406	608	361	541	314	471
	6	600	900	521	782	438	657	395	593	351	527	305	458
	7	594	891	516	774	434	651	391	587	348	522	302	453
	8	588	882	511	766	430	644	387	581	344	516	299	448
	9	581	871	505	757	424	637	383	574	340	509	295	442
	10	573	859	498	747	419	628	377	566	335	502	291	436
	11	564	846	490	736	412	619	372	557	330	495	286	429
	12	555	832	482	724	406	609	365	548	324	486	281	421
	13	545	817	474	711	399	598	359	538	318	477	276	413
	14	534	801	465	697	391	587	352	528	312	468	270	405
	15	523	784	455	683	383	575	345	517	305	458	264	396
	16	511	767	445	668	375	562	337	506	298	448	258	387
	17	499	749	435	652	366	549	329	494	291	437	251	377
	18	487	730	424	636	357	535	321	481	284	426	245	367
	19	474	710	413	620	348	522	312	469	276	414	238	357
	20	460	691	402	603	338	507	304	456	268	402	231	346
	21	447	670	390	585	328	493	295	442	260	390	224	335
	22	433	650	378	568	319	478	286	429	252	378	216	324
	23	419	629	366	550	308	463	277	415	244	366	209	313
	24	405	608	354	532	298	447	267	401	235	353	201	302
	25	391	586	342	513	288	432	258	387	227	341	194	291
	26	377	565	330	495	278	417	249	373	219	328	187	280
	27	362	544	318	477	268	401	239	359	210	315	179	269
	28	348	522	305	458	257	386	230	345	202	303	172	258
	29	334	501	293	440	247	371	221	331	194	290	164	246
	30	320	480	281	422	237	355	212	317	185	278	157	236
	32	292	439	257	386	217	325	193	290	169	253	143	214
	34	266	398	234	351	197	296	176	264	153	230	129	193
	36	240	360	212	318	179	268	159	238	138	207	116	173
	38	215	323	190	286	161	241	143	214	124	186	104	156
	40	194	291	172	258	145	217	129	193	112	168	93.6	140
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	168	252	139	210	108	163	92.0	138	75.0	113	57.0	85.6
$P_e(KL)^2/10^4$	kip-in.^{2}	10200		9030		7620		6770		5880		4910	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4

COMPOSITE
HSS9

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape	HSS9×9×											
	5/8		1/2		3/8		5/16		1/4		3/16	
t_{design}, in.	0.581		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft	67.6		55.5		42.7		36.0		29.2		22.2	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)												
0	534	801	463	694	388	581	348	523	308	463	267	400
6	517	775	448	672	376	563	338	506	299	448	258	387
7	511	766	443	665	371	557	334	501	295	443	255	382
8	504	756	437	656	366	550	329	494	291	437	251	377
9	496	744	431	646	361	542	324	487	287	430	247	371
10	488	732	423	635	355	533	319	479	282	423	243	364
11	479	718	416	624	349	523	313	470	277	415	238	357
12	469	703	407	611	342	513	307	460	271	406	233	350
13	458	687	398	598	334	501	300	450	265	397	228	342
14	447	671	389	583	327	490	293	440	259	388	222	333
15	435	653	379	569	318	478	286	428	252	378	216	324
16	423	635	369	553	310	465	278	417	245	367	210	315
17	411	616	358	537	301	452	270	405	238	357	204	305
18	398	597	347	521	292	438	262	393	230	346	197	296
19	385	577	336	504	283	424	253	380	223	334	190	286
20	372	557	325	487	273	410	245	367	215	323	184	275
21	358	537	313	470	264	395	236	354	207	311	177	265
22	344	517	301	452	254	381	227	341	199	299	170	255
23	331	496	290	434	244	366	218	328	191	287	163	244
24	317	475	278	417	234	351	209	314	184	275	156	234
25	303	455	266	399	224	337	201	301	176	263	149	223
26	289	434	254	381	215	322	192	288	168	252	142	213
27	276	414	243	364	205	307	183	274	160	240	135	202
28	262	394	231	347	195	293	174	261	152	228	128	192
29	249	374	220	329	186	279	166	249	145	217	122	182
30	236	354	208	313	176	265	157	236	137	206	115	173
32	211	317	187	280	158	237	141	211	123	184	102	153
34	187	281	166	249	141	211	125	188	109	163	90.6	136
36	167	250	148	222	126	188	112	168	96.9	145	80.8	121
38	150	225	133	199	113	169	100	150	87.0	131	72.6	109
40	135	203	120	180	102	153	90.5	136	78.5	118	65.5	98.2
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	133	200	111	167	86.8	130	73.8	111	60.2	90.5	45.9	69.0
$P_e(KL)^2/10^4$ kip-in.^{2}	7100		6290		5340		4750		4130		3440	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 46 ksi
f'_c = 4 ksi

Table 4-15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS8

Shape		HSS8×8×									
		5/8		1/2		3/8		5/16		1/4	
t_{design}, in.		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft		59.1		48.7		37.6		31.8		25.8	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	456	683	394	591	329	493	295	442	260	390
	6	437	655	378	568	316	474	283	425	249	374
	7	430	645	373	559	312	467	279	419	246	369
	8	423	634	367	550	306	460	275	412	242	362
	9	414	622	360	539	301	451	269	404	237	356
	10	405	608	352	528	294	442	264	396	232	348
	11	396	593	344	516	288	431	258	387	227	340
	12	385	578	335	502	280	421	251	377	221	331
	13	374	561	326	488	273	409	244	366	215	322
	14	362	544	316	474	265	397	237	356	208	312
	15	350	525	306	458	256	385	230	344	201	302
	16	338	507	295	442	248	372	222	333	195	292
	17	325	488	284	426	239	358	214	321	187	281
	18	312	468	273	410	230	345	206	309	180	270
	19	299	448	262	393	220	331	197	296	173	259
	20	286	428	251	376	211	317	189	284	165	248
	21	272	408	239	359	202	303	181	271	158	237
	22	259	388	228	342	192	289	172	258	150	226
	23	246	368	216	325	183	275	164	246	143	214
	24	233	349	205	308	174	261	155	233	136	203
	25	220	329	194	291	165	247	147	221	128	192
	26	207	310	183	275	156	233	139	209	121	182
	27	194	292	173	259	147	220	131	197	114	171
	28	182	274	162	243	138	207	123	185	107	161
	29	170	255	152	228	130	194	116	174	100	151
	30	159	239	142	213	121	182	108	162	93.9	141
	32	140	210	125	187	106	160	95.1	143	82.5	124
	34	124	186	110	166	94.3	141	84.3	126	73.1	110
	36	111	166	98.6	148	84.1	126	75.2	113	65.2	97.8
	38	99.2	149	88.5	133	75.5	113	67.4	101	58.5	87.8
	40	89.5	134	79.8	120	68.1	102	60.9	91.3	52.8	79.2
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	103	154	86.0	129	67.6	102	57.6	86.6	47.1	70.9
$P_e(KL)^2/10^4$	kip-in.^{2}	4710		4190		3590		3200		2780	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

4

COMPOSITE
HSS8–HSS7

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS8×8×		HSS7×7×							
		3/16		5/8		1/2		3/8		5/16	
t_{design}, in.		0.174		0.581		0.465		0.349		0.291	
Steel Wt/ft		19.6		50.6		41.9		32.5		27.5	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	223	334	381	571	329	494	274	411	244	367
	6	214	321	360	540	312	468	260	389	232	348
	7	211	316	353	529	306	459	255	382	228	342
	8	207	310	344	517	299	448	249	374	223	334
	9	203	304	335	503	291	437	243	365	217	326
	10	198	298	326	488	283	425	236	355	212	317
	11	194	291	315	473	274	411	229	344	205	308
	12	189	283	304	456	265	397	222	332	198	298
	13	183	275	292	439	255	383	214	321	191	287
	14	177	266	280	421	245	367	205	308	184	276
	15	172	257	268	402	235	352	197	295	176	265
	16	166	248	255	383	224	336	188	282	169	253
	17	159	239	243	364	213	319	179	269	161	241
	18	153	229	230	345	202	303	170	255	153	229
	19	146	220	217	325	191	287	161	242	145	217
	20	140	210	204	306	180	270	152	229	137	205
	21	133	200	191	287	169	254	144	215	129	194
	22	127	190	179	269	159	238	135	202	121	182
	23	120	181	167	250	148	223	126	189	114	170
	24	114	171	155	233	138	207	118	177	106	159
	25	108	162	143	215	128	193	110	164	98.9	148
	26	102	152	133	199	119	178	102	152	91.7	137
	27	95.4	143	123	185	110	165	94.1	141	85.0	127
	28	89.5	134	114	172	102	153	87.5	131	79.0	119
	29	83.6	125	107	160	95.4	143	81.6	122	73.7	111
	30	78.1	117	99.6	149	89.1	134	76.2	114	68.8	103
	32	68.7	103	87.6	131	78.3	118	67.0	101	60.5	90.8
	34	60.8	91.2	77.6	116	69.4	104	59.4	89.0	53.6	80.4
	36	54.3	81.4	69.2	104	61.9	92.8	52.9	79.4	47.8	71.7
	38	48.7	73.0	62.1	93.1	55.6	83.3	47.5	71.3	42.9	64.4
	40	43.9	65.9	56.0	84.1	50.1	75.2	42.9	64.3	38.7	58.1

Properties

M_n/Ω_b	$\phi_b M_n$ kip-ft	36.0	54.1	75.9	114	64.1	96.4	50.7	76.2	43.4	65.2
$P_e(KL)^2/10^4$	kip-in.^{2}	2300		2940		2640		2250		2030	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 46 ksi
f'_c = 4 ksi

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS7–HSS6

Shape		HSS7×7×						HSS6×6×			
		1/4		3/16		1/8		5/8		1/2	
t_{design}, in.		0.233		0.174		0.116		0.581		0.465	
Steel Wt/ft		22.4		17.1		11.6		42.1		35.1	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	214	322	183	274	151	226	309	463	267	401
	6	203	305	173	260	142	213	286	428	248	372
	7	200	299	170	255	139	209	278	416	241	362
	8	195	293	166	249	136	204	269	403	234	351
	9	190	286	162	243	132	199	259	388	226	338
	10	185	278	157	236	129	193	248	372	217	325
	11	180	270	152	229	124	186	237	356	207	311
	12	174	261	147	221	120	180	225	338	198	297
	13	168	251	142	213	115	173	213	320	188	281
	14	161	242	136	204	110	166	201	302	177	266
	15	154	232	130	196	105	158	189	283	167	250
	16	148	221	125	187	100	151	176	265	156	235
	17	141	211	119	178	95.3	143	164	246	146	219
	18	134	200	112	169	90.2	135	152	228	136	203
	19	127	190	106	160	85.1	128	140	210	125	188
	20	120	179	100	151	80.0	120	129	193	116	173
	21	113	169	94.4	142	75.0	112	118	176	106	159
	22	106	159	88.5	133	70.1	105	107	161	96.8	145
	23	99.1	149	82.8	124	65.2	97.9	98.0	147	88.5	133
	24	92.5	139	77.1	116	60.6	90.9	90.0	135	81.3	122
	25	86.1	129	71.7	108	55.9	83.9	82.9	124	74.9	112
	26	79.8	120	66.3	99.4	51.7	77.6	76.7	115	69.3	104
	27	74.0	111	61.5	92.2	48.0	71.9	71.1	107	64.2	96.4
	28	68.8	103	57.1	85.7	44.6	66.9	66.1	99.2	59.7	89.6
	29	64.1	96.2	53.3	79.9	41.6	62.4	61.6	92.5	55.7	83.5
	30	59.9	89.9	49.8	74.7	38.8	58.3	57.6	86.4	52.0	78.1
	32	52.7	79.0	43.8	65.6	34.1	51.2	50.6	75.9	45.7	68.6
	34	46.7	70.0	38.8	58.1	30.2	45.4	44.8	67.3	40.5	60.8
	36	41.6	62.4	34.6	51.9	27.0	40.5	40.0	60.0	36.1	54.2
	38	37.4	56.0	31.0	46.5	24.2	36.3				
	40	33.7	50.6	28.0	42.0	21.9	32.8				

Properties

M_n/Ω_b	$\phi_b M_n$ kip-ft	35.6	53.6	27.3	41.0	18.7	28.0	53.2	80.0	45.4	68.3
$P_e(KL)^2/10^4$	kip-in.^{2}	1770		1470		1150		1700		1540	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

4

COMPOSITE HSS6

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS6×6× 3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		27.4		23.3		19.0		14.5		9.85	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	222	333	198	296	172	259	146	219	119	178
	6	206	309	184	276	161	241	136	203	110	165
	7	201	301	179	269	157	235	132	198	107	160
	8	195	292	174	261	152	228	128	192	104	155
	9	188	283	168	252	147	220	124	186	100	150
	10	181	272	162	243	142	212	119	179	96.1	144
	11	174	261	155	233	136	204	114	171	91.9	138
	12	166	249	148	223	130	195	109	164	87.6	131
	13	158	237	141	212	124	185	104	156	83.1	125
	14	149	224	134	201	117	176	98.4	148	78.5	118
	15	141	211	126	189	111	166	92.8	139	73.9	111
	16	132	198	119	178	104	156	87.2	131	69.2	104
	17	124	186	111	167	97.6	146	81.6	122	64.6	96.8
	18	115	173	104	156	91.1	137	76.1	114	60.0	90.0
	19	107	161	96.4	145	84.7	127	70.6	106	55.5	83.2
	20	98.9	148	89.2	134	78.4	118	65.3	98.0	51.1	76.7
	21	91.1	137	82.2	123	72.3	108	60.2	90.3	46.9	70.3
	22	83.3	125	75.4	113	66.4	99.6	55.1	82.6	42.8	64.1
	23	76.2	114	68.9	103	60.7	91.1	50.4	75.6	39.1	58.7
	24	70.0	105	63.3	95.0	55.8	83.7	46.3	69.4	35.9	53.9
	25	64.5	96.8	58.4	87.5	51.4	77.1	42.7	64.0	33.1	49.7
	26	59.7	89.5	54.0	80.9	47.5	71.3	39.4	59.2	30.6	45.9
	27	55.3	83.0	50.0	75.0	44.1	66.1	36.6	54.9	28.4	42.6
	28	51.4	77.2	46.5	69.8	41.0	61.5	34.0	51.0	26.4	39.6
	29	48.0	71.9	43.4	65.1	38.2	57.3	31.7	47.6	24.6	36.9
	30	44.8	67.2	40.5	60.8	35.7	53.5	29.6	44.4	23.0	34.5
	32	39.4	59.1	35.6	53.4	31.4	47.1	26.0	39.1	20.2	30.3
	34	34.9	52.3	31.6	47.3	27.8	41.7	23.1	34.6	17.9	26.9
	36	31.1	46.7	28.1	42.2	24.8	37.2	20.6	30.9	16.0	24.0
	38	27.9	41.9	25.3	37.9	22.2	33.4	18.5	27.7	14.3	21.5
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	36.3	54.6	31.2	46.9	25.7	38.7	19.8	29.8	13.6	20.4
$P_e(KL)^2/10^4$	kip-in.^{2}	1320		1200		1060		876		680	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 4 ksi

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4

COMPOSITE
HSS5½–HSS5

Shape		HSS5½×5½×										HSS5×5×	
		3/8		5/16		1/4		3/16		1/8		1/2	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116		0.465	
Steel Wt/ft		24.9		21.2		17.3		13.2		9.00		28.3	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	197	296	175	263	153	229	129	193	104	156	209	314
	1	197	295	175	263	152	228	128	192	104	155	208	313
	2	195	293	174	261	151	227	127	191	103	154	206	310
	3	193	289	172	258	149	224	126	189	102	152	203	305
	4	190	285	169	253	147	221	124	186	99.8	150	199	298
	5	186	278	165	248	144	216	121	182	97.6	146	193	290
	6	181	271	161	242	140	210	118	177	95.0	142	187	280
	7	175	263	156	234	136	204	114	172	92.0	138	179	269
	8	169	253	151	226	131	197	110	166	88.6	133	171	257
	9	162	243	145	217	126	189	106	159	85.0	127	162	243
	10	155	232	138	207	121	181	101	152	81.1	122	153	229
	11	147	221	132	197	115	172	96.5	145	77.0	115	143	215
	12	139	209	124	187	109	163	91.4	137	72.7	109	133	200
	13	131	196	117	176	103	154	86.1	129	68.4	103	123	185
	14	123	184	110	165	96.4	145	80.8	121	63.9	95.9	113	170
	15	114	171	103	154	90.0	135	75.4	113	59.5	89.3	104	155
	16	106	159	95.3	143	83.7	126	70.1	105	55.1	82.7	94.0	141
	17	97.8	147	88.1	132	77.5	116	64.8	97.2	50.8	76.2	84.8	127
	18	89.9	135	81.1	122	71.3	107	59.6	89.4	46.6	69.9	75.8	114
	19	82.2	123	74.2	111	65.4	98.1	54.6	81.9	42.5	63.8	68.1	102
	20	74.6	112	67.6	101	59.7	89.5	49.8	74.6	38.5	57.8	61.4	92.2
	21	67.7	102	61.3	91.9	54.1	81.2	45.1	67.7	34.9	52.4	55.7	83.6
	22	61.7	92.5	55.9	83.8	49.3	74.0	41.1	61.7	31.8	47.8	50.8	76.2
	23	56.4	84.6	51.1	76.6	45.1	67.7	37.6	56.4	29.1	43.7	46.5	69.7
	24	51.8	77.7	46.9	70.4	41.4	62.2	34.6	51.8	26.8	40.1	42.7	64.0
	25	47.7	71.6	43.3	64.9	38.2	57.3	31.8	47.8	24.7	37.0	39.3	59.0
	26	44.1	66.2	40.0	60.0	35.3	53.0	29.4	44.2	22.8	34.2	36.4	54.5
	27	40.9	61.4	37.1	55.6	32.7	49.1	27.3	41.0	21.1	31.7	33.7	50.6
	28	38.1	57.1	34.5	51.7	30.4	45.7	25.4	38.1	19.7	29.5	31.3	47.0
	29	35.5	53.2	32.1	48.2	28.4	42.6	23.7	35.5	18.3	27.5	29.2	43.8
	30	33.2	49.7	30.0	45.1	26.5	39.8	22.1	33.2	17.1	25.7	27.3	41.0
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	30.0	45.1	25.9	38.9	21.4	32.2	16.5	24.8	11.4	17.1	30.0	45.0
$P_e(KL)^2/10^4$	kip-in.^{2}	981		887		783		654		505		806	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4
COMPOSITE HSS5

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS5×5×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		22.3		19.0		15.6		12.0		8.15	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	173	260	154	231	134	201	112	168	90.0	135
	1	173	259	154	230	133	200	112	168	89.7	135
	2	171	257	152	228	132	198	111	166	88.9	133
	3	169	253	150	225	130	196	109	164	87.6	131
	4	165	248	147	221	128	192	107	161	85.8	129
	5	161	241	143	215	125	187	104	157	83.5	125
	6	156	234	139	208	121	181	101	152	80.9	121
	7	150	225	134	200	116	175	97.6	146	77.8	117
	8	143	215	128	192	111	167	93.5	140	74.4	112
	9	136	204	122	183	106	159	89.1	134	70.8	106
	10	129	193	115	173	101	151	84.4	127	66.9	100
	11	121	182	108	163	94.7	142	79.5	119	62.9	94.4
	12	113	170	101	152	88.7	133	74.4	112	58.8	88.1
	13	105	157	94.3	141	82.6	124	69.3	104	54.6	81.9
	14	96.9	145	87.2	131	76.5	115	64.2	96.3	50.4	75.6
	15	88.9	133	80.1	120	70.4	106	59.1	88.6	46.3	69.4
	16	81.1	122	73.2	110	64.4	96.6	54.1	81.1	42.2	63.3
	17	73.5	110	66.5	99.8	58.6	87.9	49.2	73.8	38.3	57.4
	18	66.1	99.2	60.0	90.1	53.0	79.6	44.6	66.8	34.5	51.7
	19	59.4	89.0	53.9	80.8	47.6	71.5	40.0	60.0	30.9	46.4
	20	53.6	80.3	48.6	73.0	43.0	64.5	36.1	54.2	27.9	41.9
	21	48.6	72.9	44.1	66.2	39.0	58.5	32.8	49.1	25.3	38.0
	22	44.3	66.4	40.2	60.3	35.5	53.3	29.9	44.8	23.1	34.6
	23	40.5	60.8	36.8	55.2	32.5	48.8	27.3	41.0	21.1	31.7
	24	37.2	55.8	33.8	50.7	29.9	44.8	25.1	37.6	19.4	29.1
	25	34.3	51.4	31.1	46.7	27.5	41.3	23.1	34.7	17.9	26.8
	26	31.7	47.5	28.8	43.2	25.4	38.2	21.4	32.1	16.5	24.8
	27	29.4	44.1	26.7	40.0	23.6	35.4	19.8	29.7	15.3	23.0
	28	27.3	41.0	24.8	37.2	21.9	32.9	18.4	27.6	14.2	21.4
	29	25.5	38.2	23.1	34.7	20.5	30.7	17.2	25.8	13.3	19.9
	30	23.8	35.7	21.6	32.4	19.1	28.7	16.1	24.1	12.4	18.6
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	24.3	36.5	21.0	31.6	17.5	26.2	13.5	20.3	9.33	14.0
$P_e(KL)^2/10^4$	kip-in.^{2}	704		639		564		474		367	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 4 ksi

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS4½

Shape		HSS4½×4½×											
		½		3/8		5/16		¼		3/16		1/8	
t_{design}, in.		0.465		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		24.9		19.7		16.9		13.9		10.7		7.30	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	181	272	150	226	134	200	116	174	96.7	145	76.9	115
	1	180	271	150	225	133	200	115	173	96.4	145	76.7	115
	2	178	267	148	222	132	198	114	171	95.4	143	75.8	114
	3	175	262	145	218	129	194	112	168	93.7	141	74.5	112
	4	170	255	142	213	126	189	109	164	91.4	137	72.6	109
	5	164	246	137	206	122	183	106	159	88.6	133	70.3	105
	6	157	236	132	197	117	176	102	153	85.3	128	67.6	101
	7	149	224	125	188	112	168	97.3	146	81.5	122	64.5	96.7
	8	141	211	119	178	106	159	92.3	138	77.3	116	61.1	91.6
	9	132	197	111	167	99.6	149	86.9	130	72.8	109	57.4	86.2
	10	122	183	104	155	92.9	139	81.2	122	68.1	102	53.6	80.5
	11	112	169	95.9	144	86.1	129	75.4	113	63.3	95.0	49.7	74.6
	12	103	154	88.0	132	79.2	119	69.5	104	58.4	87.6	45.8	68.7
	13	92.9	139	80.2	120	72.3	109	63.5	95.3	53.5	80.3	41.8	62.7
	14	83.5	125	72.5	109	65.6	98.4	57.7	86.6	48.7	73.0	37.9	56.9
	15	74.5	112	65.1	97.6	59.0	88.5	52.1	78.1	44.0	66.0	34.2	51.3
	16	65.8	98.7	57.9	86.9	52.7	79.1	46.7	70.0	39.5	59.2	30.6	45.8
	17	58.3	87.4	51.3	76.9	46.7	70.1	41.4	62.1	35.1	52.6	27.1	40.6
	18	52.0	78.0	45.7	68.6	41.7	62.5	36.9	55.4	31.3	46.9	24.2	36.2
	19	46.6	70.0	41.1	61.6	37.4	56.1	33.2	49.7	28.1	42.1	21.7	32.5
	20	42.1	63.1	37.1	55.6	33.8	50.7	29.9	44.9	25.3	38.0	19.6	29.4
	21	38.2	57.3	33.6	50.4	30.6	45.9	27.1	40.7	23.0	34.5	17.8	26.6
	22	34.8	52.2	30.6	45.9	27.9	41.9	24.7	37.1	20.9	31.4	16.2	24.3
	23	31.8	47.7	28.0	42.0	25.5	38.3	22.6	33.9	19.2	28.7	14.8	22.2
	24	29.2	43.8	25.7	38.6	23.5	35.2	20.8	31.2	17.6	26.4	13.6	20.4
	25	26.9	40.4	23.7	35.6	21.6	32.4	19.2	28.7	16.2	24.3	12.5	18.8
	26	24.9	37.4	21.9	32.9	20.0	30.0	17.7	26.6	15.0	22.5	11.6	17.4
	27			20.3	30.5	18.5	27.8	16.4	24.6	13.9	20.9	10.7	16.1
	28					17.2	25.8	15.3	22.9	12.9	19.4	10.0	15.0
	29									12.1	18.1	9.31	14.0
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	23.4	35.2	19.2	28.8	16.7	25.1	13.9	20.9	10.8	16.3	7.50	11.3
$P_e(KL)^2/10^4$	kip-in.^{2}	553		487		444		393		333		258	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4

COMPOSITE
HSS4

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS4×4×											
		1/2		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.465		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		21.5		17.2		14.8		12.2		9.40		6.45	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	154	231	128	193	114	171	98.7	148	82.1	123	64.8	97.2
	1	153	230	128	192	113	170	98.2	147	81.7	123	64.5	96.7
	2	151	226	126	189	112	168	96.9	145	80.6	121	63.6	95.4
	3	147	221	123	184	109	164	94.7	142	78.9	118	62.2	93.3
	4	142	213	119	178	106	159	91.8	138	76.4	115	60.3	90.4
	5	135	203	114	171	101	152	88.1	132	73.4	110	57.9	86.8
	6	128	192	108	162	96.4	145	83.8	126	69.9	105	55.1	82.6
	7	120	180	101	152	90.7	136	79.0	118	66.0	99.0	51.9	77.9
	8	111	166	94.3	141	84.6	127	73.8	111	61.8	92.6	48.5	72.8
	9	101	152	86.9	130	78.1	117	68.3	102	57.3	85.9	44.9	67.4
	10	92.0	138	79.3	119	71.5	107	62.7	94.0	52.6	78.9	41.2	61.9
	11	82.6	124	71.7	108	64.8	97.2	57.0	85.4	47.9	71.9	37.5	56.3
	12	73.3	110	64.2	96.2	58.2	87.3	51.3	76.9	43.3	64.9	33.8	50.7
	13	64.5	96.7	56.9	85.3	51.8	77.7	45.8	68.7	38.7	58.1	30.2	45.3
	14	56.0	83.9	49.9	74.9	45.7	68.5	40.5	60.8	34.3	51.5	26.7	40.1
	15	48.7	73.1	43.5	65.2	39.8	59.8	35.4	53.2	30.1	45.2	23.4	35.1
	16	42.8	64.3	38.2	57.3	35.0	52.5	31.1	46.7	26.5	39.7	20.6	30.9
	17	37.9	56.9	33.9	50.8	31.0	46.5	27.6	41.4	23.5	35.2	18.2	27.3
	18	33.8	50.8	30.2	45.3	27.7	41.5	24.6	36.9	20.9	31.4	16.3	24.4
	19	30.4	45.6	27.1	40.7	24.8	37.2	22.1	33.1	18.8	28.2	14.6	21.9
	20	27.4	41.1	24.5	36.7	22.4	33.6	19.9	29.9	16.9	25.4	13.2	19.8
	21	24.9	37.3	22.2	33.3	20.3	30.5	18.1	27.1	15.4	23.1	11.9	17.9
	22	22.7	34.0	20.2	30.3	18.5	27.8	16.5	24.7	14.0	21.0	10.9	16.3
	23	20.7	31.1	18.5	27.7	16.9	25.4	15.1	22.6	12.8	19.2	10.0	14.9
	24			17.0	25.5	15.6	23.3	13.8	20.8	11.8	17.6	9.15	13.7
	25							12.8	19.1	10.8	16.3	8.43	12.6
	26											7.79	11.7
Properties													
M_n/Ω_b	$\phi_b M_n$ kip-ft	17.7	26.6	14.7	22.1	12.8	19.3	10.8	16.2	8.42	12.7	5.87	8.82
$P_e(KL)^2/10^4$	kip-in.^{2}	360		321		294		262		223		173	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 46 ksi
f'_c = 4 ksi

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS3½

Shape		HSS3½×3½×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		14.6		12.7		10.5		8.13		5.60	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	107	161	95.2	143	82.4	124	68.3	102	53.5	80.2
	1	106	160	94.7	142	81.9	123	67.9	102	53.1	79.7
	2	104	157	92.9	139	80.4	121	66.7	100	52.2	78.3
	3	101	152	90.0	135	78.0	117	64.8	97.2	50.7	76.1
	4	96.6	145	86.2	129	74.8	112	62.2	93.3	48.7	73.0
	5	91.1	137	81.5	122	70.9	106	59.0	88.5	46.2	69.3
	6	84.9	127	76.1	114	66.3	99.5	55.3	83.0	43.3	65.0
	7	78.0	117	70.2	105	61.3	92.0	51.3	76.9	40.2	60.2
	8	70.8	106	63.9	95.9	56.0	84.0	47.0	70.4	36.8	55.2
	9	63.4	95.1	57.5	86.2	50.6	75.9	42.5	63.8	33.3	50.0
	10	56.1	84.1	51.1	76.6	45.1	67.7	38.0	57.0	29.8	44.7
	11	49.0	73.4	44.8	67.2	39.7	59.6	33.6	50.4	26.4	39.6
	12	42.2	63.3	38.8	58.2	34.6	51.9	29.4	44.1	23.1	34.6
	13	35.9	53.9	33.2	49.8	29.7	44.6	25.3	38.0	19.9	29.8
	14	31.0	46.5	28.6	42.9	25.6	38.4	21.8	32.8	17.2	25.7
	15	27.0	40.5	24.9	37.4	22.3	33.5	19.0	28.5	14.9	22.4
	16	23.7	35.6	21.9	32.9	19.6	29.4	16.7	25.1	13.1	19.7
	17	21.0	31.5	19.4	29.1	17.4	26.1	14.8	22.2	11.6	17.5
	18	18.8	28.1	17.3	26.0	15.5	23.2	13.2	19.8	10.4	15.6
	19	16.8	25.2	15.5	23.3	13.9	20.9	11.9	17.8	9.31	14.0
	20	15.2	22.8	14.0	21.0	12.5	18.8	10.7	16.1	8.41	12.6
	21	13.8	20.7	12.7	19.1	11.4	17.1	9.71	14.6	7.62	11.4
	22					10.4	15.6	8.85	13.3	6.95	10.4
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	10.8	16.2	9.50	14.3	8.03	12.1	6.33	9.51	4.44	6.67
$P_e(KL)^2/10^4$	kip-in.^{2}	200		184		164		141		110	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
Ω_c = 2.00	ϕ_c = 0.75										

4

COMPOSITE
HSS3

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS3×3× 3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		12.1		10.5		8.78		6.85		4.75	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	86.7	130	77.3	116	66.9	100	55.4	83.0	43.0	64.5
	1	85.9	129	76.7	115	66.4	99.6	54.9	82.4	42.6	64.0
	2	83.6	125	74.7	112	64.7	97.1	53.6	80.4	41.7	62.5
	3	79.9	120	71.5	107	62.1	93.1	51.5	77.2	40.0	60.1
	4	74.9	112	67.2	101	58.5	87.8	48.6	73.0	37.9	56.8
	5	69.0	103	62.1	93.2	54.3	81.4	45.2	67.9	35.3	52.9
	6	62.3	93.5	56.4	84.6	49.5	74.2	41.4	62.1	32.4	48.6
	7	55.3	83.0	50.4	75.5	44.4	66.6	37.3	55.9	29.2	43.8
	8	48.2	72.3	44.2	66.2	39.1	58.7	33.0	49.5	26.0	38.9
	9	41.3	61.9	38.1	57.1	33.9	50.9	28.8	43.2	22.7	34.1
	10	34.7	52.0	32.2	48.3	28.9	43.4	24.7	37.0	19.5	29.3
	11	28.7	43.0	26.8	40.2	24.2	36.3	20.8	31.2	16.5	24.8
	12	24.1	36.2	22.5	33.8	20.3	30.5	17.5	26.2	13.9	20.9
	13	20.5	30.8	19.2	28.8	17.3	26.0	14.9	22.3	11.8	17.8
	14	17.7	26.6	16.5	24.8	14.9	22.4	12.8	19.3	10.2	15.3
	15	15.4	23.1	14.4	21.6	13.0	19.5	11.2	16.8	8.90	13.3
	16	13.6	20.3	12.7	19.0	11.4	17.2	9.83	14.7	7.82	11.7
	17	12.0	18.0	11.2	16.8	10.1	15.2	8.71	13.1	6.93	10.4
	18			10.0	15.0	9.04	13.6	7.77	11.7	6.18	9.27
	19							6.97	10.5	5.55	8.32
Properties											
M_n/Ω_b / $\phi_b M_n$	kip-ft	7.46	11.2	6.66	10.0	5.69	8.55	4.53	6.81	3.21	4.82
$P_e(KL)^2/10^4$	kip-in.^{2}	114		106		96.2		82.7		65.8	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates *Kl/r* equal to or greater than 200.

F_y = 46 ksi
f'_c = 4 ksi

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

4
COMPOSITE
HSS2 1/2–HSS2 1/4

Shape		HSS2 1/2×2 1/2×								HSS2 1/4×2 1/4×	
		5/16		1/4		3/16		1/8		1/4	
t_{design}, in.		0.291		0.233		0.174		0.116		0.233	
Steel Wt/ft		8.40		7.08		5.57		3.90		6.23	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	60.3	90.4	52.3	78.5	43.3	64.9	33.4	50.1	45.4	68.0
	1	59.5	89.2	51.7	77.5	42.8	64.1	33.0	49.5	44.6	67.0
	2	57.1	85.7	49.8	74.7	41.3	61.9	31.9	47.8	42.6	63.9
	3	53.5	80.2	46.8	70.1	38.9	58.3	30.1	45.2	39.3	59.0
	4	48.8	73.2	42.8	64.3	35.8	53.7	27.8	41.7	35.2	52.8
	5	43.3	65.0	38.3	57.4	32.1	48.2	25.1	37.6	30.5	45.8
	6	37.4	56.2	33.4	50.1	28.2	42.3	22.1	33.2	25.7	38.5
	7	31.5	47.3	28.4	42.6	24.2	36.3	19.1	28.6	20.9	31.4
	8	25.9	38.8	23.5	35.3	20.2	30.3	16.1	24.1	16.5	24.7
	9	20.7	31.0	19.0	28.5	16.5	24.8	13.2	19.8	13.0	19.5
	10	16.7	25.1	15.4	23.1	13.4	20.1	10.7	16.1	10.5	15.8
	11	13.8	20.8	12.7	19.1	11.1	16.6	8.86	13.3	8.70	13.1
	12	11.6	17.4	10.7	16.0	9.29	13.9	7.45	11.2	7.31	11.0
	13	9.91	14.9	9.10	13.6	7.91	11.9	6.35	9.5	6.23	9.35
	14	8.54	12.8	7.84	11.8	6.82	10.2	5.47	8.21		
	15			6.83	10.2	5.94	8.91	4.77	7.15		
	16							4.19	6.28		

Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	4.32	6.49	3.75	5.64	3.03	4.55	2.17	3.27	2.93	4.41
$P_e(KL)^2/10^4$	kip-in.^{2}	55.0		50.5		43.9		35.3		34.6	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
Ω_c = 2.00	ϕ_c = 0.75										

4

COMPOSITE
HSS2¹/₄–HSS2

Table 4–15 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 4 ksi

Shape		HSS2¹/₄×2¹/₄×				HSS2×2×					
		³/₁₆		¹/₈		¹/₄		³/₁₆		¹/₈	
t_{design}, in.		0.174		0.116		0.233		0.174		0.116	
Steel Wt/ft		4.94		3.47		5.38		4.30		3.04	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	37.5	56.3	28.9	43.3	38.6	57.9	32.0	48.0	24.6	36.9
	1	37.0	55.5	28.5	42.7	37.8	56.7	31.4	47.1	24.2	36.2
	2	35.4	53.1	27.3	40.9	35.5	53.3	29.7	44.5	22.9	34.3
	3	32.8	49.2	25.4	38.1	32.0	48.1	26.9	40.4	20.9	31.3
	4	29.6	44.4	23.0	34.5	27.7	41.6	23.5	35.3	18.4	27.6
	5	25.9	38.8	20.2	30.4	23.0	34.5	19.8	29.7	15.6	23.4
	6	22.0	32.9	17.3	26.0	18.3	27.5	16.0	24.0	12.8	19.2
	7	18.1	27.1	14.4	21.6	14.0	21.0	12.5	18.7	10.1	15.2
	8	14.5	21.7	11.6	17.5	10.7	16.1	9.54	14.3	7.77	11.7
	9	11.4	17.1	9.21	13.8	8.47	12.7	7.54	11.3	6.14	9.21
	10	9.25	13.9	7.46	11.2	6.86	10.3	6.11	9.16	4.97	7.46
	11	7.65	11.5	6.17	9.25	5.67	8.50	5.05	7.57	4.11	6.16
	12	6.42	9.64	5.18	7.77			4.24	6.36	3.45	5.18
	13	5.47	8.21	4.42	6.62						
	14			3.81	5.71						
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	2.39	3.60	1.73	2.60	2.21	3.33	1.83	2.75	1.34	2.02
$P_e(KL)^2/10^4$	kip-in.^{2}	30.4		24.5		22.5		20.0		16.3	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5
COMPOSITE
HSS16–HSS14

Shape	HSS16×16×						HSS14×14×					
	1/2		3/8		5/16		5/8		1/2		3/8	
t_{design}, in.	0.465		0.349		0.291		0.581		0.465		0.349	
Steel Wt/ft	103		78.4		65.8		110		89.6		68.2	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	1130	1700	993	1490	921	1380	1050	1570	929	1390	807	1210
6	1120	1680	982	1470	910	1360	1030	1550	916	1370	795	1190
7	1120	1680	978	1470	906	1360	1030	1540	912	1370	791	1190
8	1110	1670	973	1460	902	1350	1020	1530	906	1360	787	1180
9	1110	1660	968	1450	897	1350	1020	1520	900	1350	781	1170
10	1100	1650	962	1440	891	1340	1010	1510	894	1340	775	1160
11	1090	1640	956	1430	885	1330	1000	1500	887	1330	769	1150
12	1090	1630	949	1420	879	1320	991	1490	879	1320	762	1140
13	1080	1620	942	1410	872	1310	982	1470	870	1310	754	1130
14	1070	1600	934	1400	864	1300	972	1460	861	1290	746	1120
15	1060	1590	926	1390	856	1280	961	1440	852	1280	738	1110
16	1050	1580	917	1370	848	1270	950	1430	842	1260	729	1090
17	1040	1560	907	1360	839	1260	938	1410	831	1250	719	1080
18	1030	1540	897	1350	830	1240	926	1390	820	1230	709	1060
19	1020	1530	887	1330	820	1230	913	1370	809	1210	699	1050
20	1010	1510	876	1310	810	1210	900	1350	796	1190	688	1030
21	994	1490	865	1300	799	1200	886	1330	784	1180	677	1020
22	981	1470	854	1280	788	1180	872	1310	771	1160	665	998
23	968	1450	842	1260	777	1170	857	1290	758	1140	654	980
24	955	1430	830	1240	765	1150	842	1260	744	1120	641	962
25	941	1410	817	1230	753	1130	826	1240	731	1100	629	944
26	927	1390	804	1210	741	1110	811	1220	716	1070	616	925
27	912	1370	791	1190	728	1090	795	1190	702	1050	603	905
28	897	1350	778	1170	716	1070	778	1170	687	1030	590	886
29	882	1320	764	1150	703	1050	762	1140	672	1010	577	866
30	867	1300	750	1130	689	1030	745	1120	657	986	564	846
32	835	1250	722	1080	663	994	711	1070	627	940	537	805
34	803	1200	693	1040	635	953	676	1010	596	894	509	764
36	770	1160	663	995	607	911	641	962	564	847	481	722
38	737	1110	633	950	579	868	606	909	533	800	454	681
40	704	1060	603	905	551	826	571	857	502	753	427	640
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	376	566	289	435	243	366	347	521	285	428	219	329
$P_e(KL)^2/10^4$ kip-in.^{2}	45800		38400		34600		33400		29100		24500	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

5

COMPOSITE
HSS14–HSS12

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape	HSS14×14×		HSS12×12×									
	5/16		5/8		1/2		3/8		5/16		1/4	
t_{design}, in.	0.291		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft	57.3		93.1		75.9		58.0		48.8		39.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	744	1120	839	1260	741	1110	638	957	585	878	532	797
6	734	1100	824	1240	727	1090	626	939	574	861	521	781
7	730	1090	818	1230	722	1080	622	933	570	855	517	776
8	725	1090	812	1220	717	1070	617	925	565	848	513	769
9	720	1080	805	1210	710	1070	611	917	560	840	508	762
10	715	1070	797	1200	703	1060	605	908	554	831	502	754
11	708	1060	788	1180	696	1040	598	898	548	822	496	745
12	702	1050	779	1170	688	1030	591	887	541	812	490	735
13	695	1040	769	1150	679	1020	583	875	534	801	483	725
14	687	1030	758	1140	669	1000	575	862	526	789	476	714
15	679	1020	747	1120	659	989	566	849	518	777	468	702
16	670	1010	735	1100	649	973	557	835	509	764	460	690
17	661	992	723	1080	638	957	547	821	500	750	452	677
18	652	978	710	1060	627	940	537	806	491	736	443	664
19	642	963	696	1040	615	922	527	790	481	721	434	650
20	632	948	682	1020	603	904	516	774	471	706	424	636
21	621	932	668	1000	590	885	505	757	460	691	414	622
22	611	916	653	980	577	865	493	740	450	675	404	607
23	599	899	638	957	564	846	482	723	439	658	394	591
24	588	882	623	934	550	825	470	705	428	642	384	576
25	576	864	607	911	536	805	458	687	417	625	373	560
26	564	847	592	887	522	784	446	668	405	608	363	544
27	552	828	576	863	508	763	433	650	394	590	352	528
28	540	810	559	839	494	741	421	631	382	573	341	512
29	527	791	543	815	480	720	408	612	370	556	331	496
30	515	772	527	790	465	698	396	593	359	538	320	480
32	489	734	494	741	437	655	370	556	335	503	298	447
34	464	695	461	692	408	612	345	518	312	468	277	415
36	438	657	429	644	379	569	321	481	289	434	256	383
38	412	618	398	596	351	527	296	444	267	400	235	353
40	386	580	367	550	324	486	273	409	245	368	215	323
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	185	278	250	376	206	309	159	239	134	202	109	164
$P_e(KL)^2/10^4$ kip-in.^{2}	21900		19600		17300		14500		13000		11300	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 46 ksi
f'_c = 5 ksi

Table 4-16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5

COMPOSITE HSS10

Shape		HSS10×10×											
		5/8		1/2		3/8		5/16		1/4		3/16	
t_{design}, in.		0.581		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft		76.1		62.3		47.8		40.3		32.6		24.7	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	649	973	570	854	486	729	443	665	399	599	353	530
	6	631	947	554	832	473	710	431	647	388	582	343	515
	7	625	938	549	824	469	703	427	640	384	576	339	509
	8	618	927	543	815	464	695	422	633	380	569	335	503
	9	610	916	536	804	458	687	417	625	374	562	330	496
	10	602	903	529	793	451	677	411	616	369	553	325	488
	11	592	888	520	781	444	666	404	606	363	544	320	479
	12	582	873	512	767	437	655	397	595	356	534	314	470
	13	571	857	502	753	428	643	389	584	349	524	307	461
	14	560	840	492	738	420	630	381	572	342	513	300	451
	15	548	822	482	723	411	616	373	560	334	501	293	440
	16	535	803	471	706	401	602	364	547	326	489	286	429
	17	522	783	459	689	392	587	355	533	318	477	278	417
	18	508	763	448	671	382	572	346	519	309	464	270	405
	19	494	742	435	653	371	557	336	504	300	450	262	393
	20	480	720	423	634	360	541	326	489	291	437	254	380
	21	465	698	410	615	350	524	316	474	282	423	245	368
	22	451	676	397	596	338	508	306	459	272	409	236	355
	23	436	653	384	576	327	491	296	443	263	394	228	342
	24	420	631	371	557	316	474	285	428	253	380	219	329
	25	405	608	358	537	305	457	275	412	244	365	210	316
	26	390	585	344	517	293	440	264	396	234	351	202	302
	27	375	562	331	497	282	423	254	380	224	337	193	289
	28	359	539	318	477	270	406	243	365	215	322	184	277
	29	344	517	305	457	259	389	233	349	205	308	176	264
	30	329	494	292	437	248	372	223	334	196	294	167	251
	32	300	450	266	399	226	339	202	304	178	267	151	227
	34	272	407	241	361	205	307	183	274	160	240	135	203
	36	244	366	217	325	184	276	164	246	143	215	121	181
	38	219	328	195	292	165	248	147	221	128	193	108	162
	40	198	296	176	263	149	223	133	199	116	174	97.7	147
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	168	252	139	210	108	163	92.0	138	75.0	113	57.0	85.6
$P_e(KL)^2/10^4$	kip-in.^{2}	10400		9230		7830		6980		6090		5130	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

5 COMPOSITE HSS9

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS9×9×											
		5/8		1/2		3/8		5/16		1/4		3/16	
t_{design}, in.		0.581		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft		67.6		55.5		42.7		36.0		29.2		22.2	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	560	840	490	735	417	625	379	568	339	509	299	448
	6	541	812	474	711	403	605	366	549	328	492	288	432
	7	535	802	469	703	398	598	362	542	324	486	284	426
	8	527	791	462	693	393	590	357	535	319	479	280	420
	9	519	779	455	683	387	580	351	527	314	471	275	413
	10	510	765	447	671	380	570	345	517	308	463	270	405
	11	500	750	439	658	373	560	338	507	302	453	264	397
	12	489	734	429	644	365	548	331	497	296	443	258	387
	13	478	717	420	630	357	536	323	485	289	433	252	378
	14	466	699	409	614	348	522	315	473	281	422	245	368
	15	454	680	399	598	339	509	307	460	274	410	238	357
	16	441	661	387	581	330	494	298	447	266	398	231	346
	17	427	641	376	564	320	480	289	434	257	386	223	335
	18	413	620	364	546	310	465	280	420	249	373	216	323
	19	399	599	352	528	299	449	270	406	240	360	208	312
	20	385	578	339	509	289	433	261	391	231	347	200	300
	21	371	556	327	490	278	417	251	376	222	334	192	288
	22	356	534	314	471	268	401	241	362	213	320	184	275
	23	341	512	301	452	257	385	231	347	204	307	175	263
	24	327	490	289	433	246	369	221	332	195	293	167	251
	25	312	468	276	414	235	353	211	317	186	280	159	239
	26	297	446	263	395	224	337	202	302	178	266	151	227
	27	283	425	251	376	214	321	192	288	169	253	144	215
	28	269	403	238	357	203	305	182	273	160	240	136	204
	29	255	382	226	339	193	289	173	259	152	227	128	192
	30	241	362	214	321	183	274	164	245	143	215	121	181
	32	214	322	191	286	163	245	146	218	127	190	107	160
	34	190	285	169	254	144	217	129	193	112	169	94.4	142
	36	169	254	151	226	129	193	115	173	100	150	84.2	126
	38	152	228	135	203	116	173	103	155	90.0	135	75.5	113
	40	137	206	122	183	104	157	93.2	140	81.2	122	68.2	102
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	133	200	111	167	86.8	130	73.8	111	60.2	90.5	45.9	69.0
$P_e(KL)^2/10^4$	kip-in.^{2}	7210		6420		5490		4900		4260		3590	
ASD	LRFD												
Ω_c = 2.00	ϕ_c = 0.75												

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5

COMPOSITE HSS8

Shape		HSS8×8×									
		5/8		1/2		3/8		5/16		1/4	
t_{design}, in.		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft		59.1		48.7		37.6		31.8		25.8	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	475	713	415	623	352	527	318	477	284	426
	6	455	683	398	597	337	506	305	458	272	408
	7	448	672	392	588	332	498	300	451	268	401
	8	440	660	385	578	326	490	295	443	263	394
	9	431	647	378	567	320	480	289	434	258	386
	10	421	632	369	554	313	470	283	425	252	378
	11	411	616	360	541	306	458	276	414	246	368
	12	400	600	351	526	298	446	269	403	239	358
	13	388	582	341	511	289	434	261	392	232	348
	14	376	563	330	495	280	420	253	380	225	337
	15	363	544	319	478	271	406	245	367	217	325
	16	349	524	308	461	261	392	236	354	209	314
	17	336	504	296	444	252	377	227	341	201	301
	18	322	483	284	426	242	362	218	327	193	289
	19	308	462	272	408	232	347	209	313	184	277
	20	294	441	260	390	221	332	199	299	176	264
	21	280	420	248	371	211	317	190	285	168	251
	22	266	398	235	353	201	301	181	271	159	239
	23	252	377	223	335	191	286	172	257	151	226
	24	238	357	211	317	181	271	162	244	143	214
	25	224	336	199	299	171	256	153	230	135	202
	26	211	316	188	282	161	241	145	217	127	190
	27	198	297	177	265	151	227	136	204	119	178
	28	185	278	166	248	142	213	127	191	111	167
	29	173	259	155	232	133	199	119	179	104	156
	30	161	242	144	217	124	186	111	167	96.9	145
	32	142	213	127	190	109	163	97.7	147	85.2	128
	34	126	188	112	169	96.5	145	86.6	130	75.4	113
	36	112	168	100	150	86.1	129	77.2	116	67.3	101
	38	100	151	90.0	135	77.3	116	69.3	104	60.4	90.6
	40	90.7	136	81.2	122	69.7	105	62.6	93.8	54.5	81.8
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	103	154	86.0	129	67.6	102	57.6	86.6	47.1	70.9
$P_e(KL)^2/10^4$	kip-in.^{2}	4770		4260		3660		3280		2870	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE
HSS8–HSS7

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS8×8×		HSS7×7×							
		3/16		5/8		1/2		3/8		5/16	
t_{design}, in.		0.174		0.581		0.465		0.349		0.291	
Steel Wt/ft		19.6		50.6		41.9		32.5		27.5	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	248	372	395	592	345	517	291	436	262	393
	6	237	355	373	559	326	489	275	413	248	372
	7	233	350	365	548	319	479	270	404	243	365
	8	229	343	357	535	312	468	264	395	238	357
	9	224	336	347	520	304	456	257	385	232	348
	10	219	328	337	505	295	443	249	374	225	338
	11	213	320	325	488	286	428	242	362	218	327
	12	207	311	314	471	276	413	233	350	211	316
	13	201	301	301	452	265	398	225	337	203	304
	14	194	291	289	433	254	381	216	323	195	292
	15	187	281	276	413	243	364	206	309	186	279
	16	180	270	262	393	232	347	197	295	178	267
	17	173	259	249	373	220	330	187	281	169	254
	18	166	248	235	353	208	312	177	266	160	241
	19	158	237	222	333	197	295	168	252	152	227
	20	151	226	208	312	185	278	158	237	143	214
	21	143	215	195	293	174	261	148	223	134	202
	22	136	203	182	273	162	244	139	209	126	189
	23	128	192	169	254	151	227	130	195	118	176
	24	121	181	157	236	141	211	121	181	110	164
	25	114	171	145	218	130	195	112	168	102	152
	26	107	160	134	201	120	181	104	155	93.9	141
	27	99.9	150	124	187	112	167	96.1	144	87.1	131
	28	93.1	140	116	173	104	156	89.3	134	81.0	121
	29	86.8	130	108	162	96.8	145	83.3	125	75.5	113
	30	81.1	122	101	151	90.4	136	77.8	117	70.6	106
	32	71.3	107	88.5	133	79.5	119	68.4	103	62.0	93.0
	34	63.2	94.7	78.4	118	70.4	106	60.6	90.9	54.9	82.4
	36	56.3	84.5	69.9	105	62.8	94.2	54.0	81.1	49.0	73.5
	38	50.6	75.8	62.8	94.2	56.4	84.6	48.5	72.8	44.0	66.0
	40	45.6	68.4	56.7	85.0	50.9	76.3	43.8	65.7	39.7	59.5
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	36.0	54.1	75.9	114	64.1	96.4	50.7	76.2	43.4	65.2
$P_e(KL)^2/10^4$	kip-in.^{2}	2400		2980		2680		2300		2090	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5
COMPOSITE
HSS7–HSS6

Shape		HSS7×7×						HSS6×6×			
		1/4		3/16		1/8		5/8		1/2	
t_{design}, in.		0.233		0.174		0.116		0.581		0.465	
Steel Wt/ft		22.4		17.1		11.6		42.1		35.1	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	232	349	201	302	170	255	319	478	278	417
	6	220	330	190	285	160	240	294	441	257	386
	7	216	323	186	279	156	235	286	429	250	375
	8	211	316	182	273	152	229	276	414	242	364
	9	205	308	177	266	148	222	266	399	234	350
	10	199	299	172	258	143	215	255	382	224	336
	11	193	290	166	249	138	207	243	365	214	322
	12	186	279	160	240	133	199	231	346	204	306
	13	179	269	154	231	127	191	218	328	193	290
	14	172	258	147	221	122	182	206	308	182	274
	15	165	247	141	211	116	174	193	289	171	257
	16	157	235	134	201	110	165	180	270	160	240
	17	149	224	127	191	104	156	167	250	149	224
	18	141	212	120	180	97.7	147	154	232	138	208
	19	133	200	113	170	91.8	138	142	213	128	192
	20	126	189	106	160	85.8	129	130	195	118	176
	21	118	177	99.7	150	80.0	120	119	178	107	161
	22	110	166	93.1	140	74.4	112	108	162	97.9	147
	23	103	155	86.7	130	68.9	103	98.8	148	89.6	134
	24	95.9	144	80.4	121	63.4	95.1	90.8	136	82.3	123
	25	88.8	133	74.2	111	58.5	87.7	83.6	125	75.8	114
	26	82.1	123	68.6	103	54.0	81.1	77.3	116	70.1	105
	27	76.2	114	63.6	95.5	50.1	75.2	71.7	108	65.0	97.5
	28	70.8	106	59.2	88.8	46.6	69.9	66.7	100	60.5	90.7
	29	66.0	99.0	55.2	82.7	43.4	65.2	62.2	93.2	56.4	84.5
	30	61.7	92.6	51.5	77.3	40.6	60.9	58.1	87.1	52.7	79.0
	32	54.2	81.3	45.3	68.0	35.7	53.5	51.1	76.6	46.3	69.4
	34	48.0	72.1	40.1	60.2	31.6	47.4	45.2	67.8	41.0	61.5
	36	42.8	64.3	35.8	53.7	28.2	42.3	40.3	60.5	36.6	54.9
	38	38.5	57.7	32.1	48.2	25.3	38.0				
	40	34.7	52.1	29.0	43.5	22.8	34.3				
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	35.6	53.6	27.3	41.0	18.7	28.0	53.2	80.0	45.4	68.3
$P_e(KL)^2/10^4$	kip-in.^{2}	1830		1530		1200		1710		1560	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5 COMPOSITE HSS6

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS6×6×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		27.4		23.3		19.0		14.5		9.85	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	234	351	210	315	185	278	159	239	133	199
	6	217	325	195	292	172	258	148	221	122	183
	7	211	316	190	285	168	251	144	215	119	178
	8	204	307	184	276	162	244	139	209	115	172
	9	197	296	178	266	157	235	134	201	110	166
	10	190	284	171	256	151	226	129	193	106	159
	11	181	272	164	245	144	217	123	185	101	151
	12	173	259	156	234	138	207	117	176	95.8	144
	13	164	246	148	222	131	196	111	167	90.6	136
	14	155	233	140	210	124	186	105	158	85.2	128
	15	146	219	132	198	117	175	98.8	148	79.8	120
	16	137	205	124	185	109	164	92.5	139	74.4	112
	17	128	192	115	173	102	153	86.2	129	69.0	104
	18	119	178	107	161	95.0	142	80.0	120	63.8	95.7
	19	110	165	99.5	149	88.0	132	74.0	111	58.7	88.0
	20	101	152	91.8	138	81.2	122	68.1	102	53.7	80.6
	21	92.9	139	84.3	126	74.6	112	62.4	93.6	48.9	73.3
	22	84.8	127	77.0	115	68.1	102	56.9	85.3	44.5	66.8
	23	77.6	116	70.4	106	62.3	93.5	52.0	78.0	40.7	61.1
	24	71.2	107	64.7	97.0	57.2	85.9	47.8	71.7	37.4	56.1
	25	65.7	98.5	59.6	89.4	52.8	79.1	44.0	66.1	34.5	51.7
	26	60.7	91.0	55.1	82.7	48.8	73.2	40.7	61.1	31.9	47.8
	27	56.3	84.4	51.1	76.6	45.2	67.8	37.8	56.6	29.6	44.3
	28	52.3	78.5	47.5	71.3	42.1	63.1	35.1	52.7	27.5	41.2
	29	48.8	73.2	44.3	66.4	39.2	58.8	32.7	49.1	25.6	38.4
	30	45.6	68.4	41.4	62.1	36.6	55.0	30.6	45.9	23.9	35.9
	32	40.1	60.1	36.4	54.6	32.2	48.3	26.9	40.3	21.0	31.6
	34	35.5	53.2	32.2	48.3	28.5	42.8	23.8	35.7	18.6	28.0
	36	31.7	47.5	28.7	43.1	25.4	38.2	21.2	31.9	16.6	24.9
	38	28.4	42.6	25.8	38.7	22.8	34.2	19.1	28.6	14.9	22.4
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	36.3	54.6	31.2	46.9	25.7	38.7	19.8	29.8	13.6	20.4
$P_e(KL)^2/10^4$	kip-in.^{2}	1350		1220		1080		904		707	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 5 ksi

Table 4-16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5

COMPOSITE
HSS5½–HSS5

Shape	HSS5½×5½×										HSS5×5×	
	3/8		5/16		1/4		3/16		1/8		1/2	
t_{design}, in.	0.349		0.291		0.233		0.174		0.116		0.465	
Steel Wt/ft	24.9		21.2		17.3		13.2		9.00		28.3	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	207	310	186	279	163	245	140	210	116	173	216	324
1	206	310	185	278	163	245	139	209	115	173	215	323
2	205	307	184	276	162	243	138	208	114	172	213	320
3	202	304	182	272	160	240	137	205	113	169	210	315
4	199	298	178	268	157	236	134	201	111	166	205	308
5	194	292	175	262	154	231	131	197	108	162	199	299
6	189	284	170	255	150	224	128	192	105	158	193	289
7	183	275	164	247	145	217	124	186	102	152	185	277
8	176	264	158	238	140	210	119	179	97.6	146	176	264
9	169	253	152	228	134	201	114	171	93.3	140	167	250
10	161	242	145	217	128	192	109	163	88.7	133	157	235
11	153	229	138	206	121	182	103	155	83.9	126	147	220
12	144	216	130	195	115	172	97.5	146	78.9	118	136	204
13	135	203	122	183	108	162	91.6	137	73.9	111	126	189
14	127	190	114	172	101	152	85.6	128	68.8	103	115	173
15	118	177	106	160	94.1	141	79.6	119	63.7	95.5	105	158
16	109	163	98.6	148	87.2	131	73.7	111	58.7	88.0	95.3	143
17	100	150	90.8	136	80.4	121	67.8	102	53.8	80.6	85.7	129
18	91.9	138	83.3	125	73.8	111	62.1	93.2	49.0	73.5	76.5	115
19	83.7	126	76.0	114	67.4	101	56.7	85.0	44.4	66.5	68.7	103
20	75.8	114	68.9	103	61.1	91.7	51.3	76.9	40.0	60.1	62.0	93.0
21	68.7	103	62.5	93.7	55.4	83.2	46.5	69.8	36.3	54.5	56.2	84.3
22	62.6	93.9	56.9	85.4	50.5	75.8	42.4	63.6	33.1	49.6	51.2	76.9
23	57.3	85.9	52.1	78.1	46.2	69.3	38.8	58.2	30.3	45.4	46.9	70.3
24	52.6	78.9	47.8	71.8	42.4	63.7	35.6	53.4	27.8	41.7	43.1	64.6
25	48.5	72.7	44.1	66.1	39.1	58.7	32.8	49.2	25.6	38.4	39.7	59.5
26	44.8	67.3	40.8	61.1	36.2	54.3	30.3	45.5	23.7	35.5	36.7	55.0
27	41.6	62.4	37.8	56.7	33.5	50.3	28.1	42.2	22.0	33.0	34.0	51.0
28	38.7	58.0	35.1	52.7	31.2	46.8	26.2	39.2	20.4	30.6	31.6	47.4
29	36.0	54.1	32.8	49.1	29.1	43.6	24.4	36.6	19.0	28.6	29.5	44.2
30	33.7	50.5	30.6	45.9	27.2	40.7	22.8	34.2	17.8	26.7	27.6	41.3
Properties												
M_n/Ω_b $\phi_b M_n$ kip-ft	30.0	45.1	25.9	38.9	21.4	32.2	16.5	24.8	11.4	17.1	30.0	45.0
$P_e(KL)^2/10^4$ kip-in.^{2}	995		904		804		674		526		815	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

5

COMPOSITE
HSS5

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS5×5×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		22.3		19.0		15.6		12.0		8.15	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	181	272	162	244	143	214	121	182	99.6	149
	1	181	271	162	243	142	213	121	182	99.3	149
	2	179	269	160	241	141	211	120	180	98.4	148
	3	176	264	158	237	139	208	118	177	96.8	145
	4	173	259	155	232	136	204	116	174	94.7	142
	5	168	252	151	226	132	198	113	169	92.0	138
	6	162	243	146	219	128	192	109	163	88.9	133
	7	156	234	140	210	123	185	105	157	85.3	128
	8	149	223	134	201	118	177	100	150	81.4	122
	9	141	212	127	191	112	168	95.2	143	77.1	116
	10	133	200	120	180	106	159	89.9	135	72.6	109
	11	125	188	113	169	99.4	149	84.5	127	68.0	102
	12	117	175	105	158	92.9	139	78.8	118	63.2	94.8
	13	108	162	97.6	146	86.2	129	73.1	110	58.4	87.6
	14	99.4	149	90.0	135	79.5	119	67.4	101	53.6	80.5
	15	91.0	136	82.5	124	73.0	109	61.8	92.7	49.0	73.4
	16	82.7	124	75.1	113	66.5	99.8	56.3	84.5	44.4	66.6
	17	74.8	112	68.0	102	60.3	90.5	51.0	76.5	40.0	60.0
	18	67.0	101	61.1	91.6	54.3	81.4	45.9	68.8	35.7	53.6
	19	60.2	90.3	54.8	82.2	48.7	73.1	41.2	61.7	32.1	48.1
	20	54.3	81.5	49.5	74.2	44.0	65.9	37.1	55.7	29.0	43.4
	21	49.3	73.9	44.9	67.3	39.9	59.8	33.7	50.5	26.3	39.4
	22	44.9	67.3	40.9	61.3	36.3	54.5	30.7	46.1	23.9	35.9
	23	41.1	61.6	37.4	56.1	33.2	49.9	28.1	42.1	21.9	32.8
	24	37.7	56.6	34.4	51.5	30.5	45.8	25.8	38.7	20.1	30.2
	25	34.8	52.1	31.7	47.5	28.1	42.2	23.8	35.7	18.5	27.8
	26	32.1	48.2	29.3	43.9	26.0	39.0	22.0	33.0	17.1	25.7
	27	29.8	44.7	27.2	40.7	24.1	36.2	20.4	30.6	15.9	23.8
	28	27.7	41.6	25.2	37.9	22.4	33.6	19.0	28.4	14.8	22.2
	29	25.8	38.7	23.5	35.3	20.9	31.4	17.7	26.5	13.8	20.7
	30	24.1	36.2	22.0	33.0	19.5	29.3	16.5	24.8	12.9	19.3
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	24.3	36.5	21.0	31.6	17.5	26.2	13.5	20.3	9.33	14.0
$P_e(KL)^2/10^4$	kip-in.^{2}	713		649		577		488		380	
ASD	LRFD										
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5
COMPOSITE
HSS4½

Shape	HSS4½×4½×											
	½		3/8		5/16		¼		3/16		1/8	
t_{design}, in.	0.465		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft	24.9		19.7		16.9		13.9		10.7		7.30	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	186	280	157	235	140	210	123	184	104	156	84.7	127
1	186	279	156	234	140	209	122	183	104	155	84.3	127
2	184	275	154	231	138	207	121	181	103	154	83.4	125
3	180	270	151	227	135	203	119	178	101	151	81.8	123
4	175	262	147	221	132	198	116	174	98.1	147	79.6	119
5	169	253	142	213	128	191	112	168	94.9	142	76.9	115
6	161	242	136	205	122	184	107	161	91.2	137	73.7	111
7	153	230	130	195	117	175	102	154	86.9	130	70.2	105
8	144	216	123	184	110	165	96.9	145	82.3	123	66.2	99.4
9	135	202	115	172	103	155	91.0	137	77.3	116	62.1	93.1
10	125	187	107	160	96.3	144	84.9	127	72.1	108	57.7	86.5
11	114	172	98.5	148	89.0	134	78.5	118	66.7	100	53.2	79.8
12	104	156	90.2	135	81.7	122	72.1	108	61.3	92.0	48.7	73.1
13	94.3	141	81.9	123	74.3	112	65.8	98.7	55.9	83.9	44.3	66.4
14	84.6	127	73.9	111	67.2	101	59.5	89.3	50.7	76.0	39.9	59.9
15	75.2	113	66.1	99.2	60.3	90.4	53.5	80.2	45.6	68.3	35.7	53.6
16	66.3	99.4	58.6	87.9	53.6	80.4	47.7	71.5	40.7	61.0	31.6	47.5
17	58.7	88.1	51.9	77.9	47.5	71.2	42.2	63.4	36.0	54.0	28.0	42.0
18	52.4	78.5	46.3	69.4	42.3	63.5	37.7	56.5	32.1	48.2	25.0	37.5
19	47.0	70.5	41.6	62.3	38.0	57.0	33.8	50.7	28.8	43.2	22.4	33.7
20	42.4	63.6	37.5	56.3	34.3	51.4	30.5	45.8	26.0	39.0	20.3	30.4
21	38.5	57.7	34.0	51.0	31.1	46.6	27.7	41.5	23.6	35.4	18.4	27.6
22	35.1	52.6	31.0	46.5	28.3	42.5	25.2	37.8	21.5	32.2	16.7	25.1
23	32.1	48.1	28.4	42.5	25.9	38.9	23.1	34.6	19.7	29.5	15.3	23.0
24	29.5	44.2	26.0	39.1	23.8	35.7	21.2	31.8	18.1	27.1	14.1	21.1
25	27.1	40.7	24.0	36.0	21.9	32.9	19.5	29.3	16.6	25.0	13.0	19.4
26	25.1	37.6	22.2	33.3	20.3	30.4	18.1	27.1	15.4	23.1	12.0	18.0
27			20.6	30.9	18.8	28.2	16.7	25.1	14.3	21.4	11.1	16.7
28					17.5	26.2	15.6	23.4	13.3	19.9	10.3	15.5
29									12.4	18.6	9.63	14.4

Properties

M_n/Ω_b $\phi_b M_n$ kip-ft	23.4	35.2	19.2	28.8	16.7	25.1	13.9	20.9	10.8	16.3	7.50	11.3
$P_e(KL)^2/10^4$ kip-in.^{2}	557		492		451		400		341		266	

ASD	LRFD	
$\Omega_c = 2.00$	$\phi_c = 0.75$	Note: Heavy line indicates Kl/r equal to or greater than 200.

5

COMPOSITE
HSS4

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS4×4×											
		1/2		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.465		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		21.5		17.2		14.8		12.2		9.40		6.45	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	158	237	133	199	119	178	104	156	87.7	132	70.8	106
	1	157	236	132	198	118	178	103	155	87.3	131	70.5	106
	2	155	232	130	196	117	175	102	153	86.1	129	69.5	104
	3	151	226	127	191	114	171	99.7	149	84.1	126	67.8	102
	4	145	218	123	184	110	165	96.4	145	81.5	122	65.6	98.4
	5	139	208	118	176	105	158	92.4	139	78.1	117	62.8	94.2
	6	131	196	111	167	100	150	87.8	132	74.2	111	59.6	89.4
	7	122	183	104	157	94.0	141	82.6	124	69.9	105	56.0	84.0
	8	113	169	96.9	145	87.4	131	76.9	115	65.2	97.8	52.1	78.2
	9	103	155	89.1	134	80.6	121	71.0	107	60.2	90.4	48.1	72.1
	10	93.4	140	81.1	122	73.5	110	64.9	97.4	55.2	82.7	43.9	65.8
	11	83.7	125	73.1	110	66.5	99.7	58.8	88.3	50.0	75.1	39.7	59.6
	12	74.1	111	65.3	97.9	59.5	89.3	52.8	79.2	45.0	67.5	35.6	53.4
	13	65.0	97.5	57.7	86.6	52.8	79.2	46.9	70.4	40.0	60.1	31.6	47.3
	14	56.3	84.4	50.4	75.6	46.3	69.5	41.3	62.0	35.3	53.0	27.7	41.6
	15	49.0	73.6	43.9	65.9	40.4	60.5	36.0	54.1	30.8	46.3	24.2	36.2
	16	43.1	64.6	38.6	57.9	35.5	53.2	31.7	47.5	27.1	40.7	21.2	31.9
	17	38.2	57.3	34.2	51.3	31.4	47.1	28.1	42.1	24.0	36.0	18.8	28.2
	18	34.1	51.1	30.5	45.8	28.0	42.0	25.0	37.6	21.4	32.1	16.8	25.2
	19	30.6	45.8	27.4	41.1	25.2	37.7	22.5	33.7	19.2	28.8	15.1	22.6
	20	27.6	41.4	24.7	37.1	22.7	34.1	20.3	30.4	17.3	26.0	13.6	20.4
	21	25.0	37.5	22.4	33.6	20.6	30.9	18.4	27.6	15.7	23.6	12.3	18.5
	22	22.8	34.2	20.4	30.6	18.8	28.1	16.8	25.1	14.3	21.5	11.2	16.8
	23	20.9	31.3	18.7	28.0	17.2	25.7	15.3	23.0	13.1	19.7	10.3	15.4
	24			17.2	25.7	15.8	23.6	14.1	21.1	12.0	18.1	9.44	14.2
	25							13.0	19.5	11.1	16.7	8.70	13.0
	26											8.04	12.1
Properties													
M_n/Ω_b	$\phi_b M_n$ kip-ft	17.7	26.6	14.7	22.1	12.8	19.3	10.8	16.2	8.42	12.7	5.87	8.82
$P_e(KL)^2/10^4$	kip-in.^{2}	363		324		298		266		228		179	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5
COMPOSITE
HSS3½

Shape		HSS3½×3½×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		14.6		12.7		10.5		8.13		5.60	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	110	166	98.8	148	86.3	129	72.5	109	58.0	87.0
	1	110	165	98.2	147	85.7	129	72.1	108	57.6	86.4
	2	108	161	96.3	145	84.2	126	70.8	106	56.6	84.9
	3	104	156	93.3	140	81.6	122	68.6	103	54.9	82.3
	4	99.3	149	89.2	134	78.1	117	65.8	98.7	52.6	78.8
	5	93.6	140	84.2	126	73.9	111	62.3	93.4	49.7	74.6
	6	87.0	131	78.5	118	69.0	103	58.2	87.3	46.5	69.7
	7	79.8	120	72.2	108	63.6	95.4	53.8	80.7	42.9	64.4
	8	72.3	108	65.6	98.4	58.0	86.9	49.1	73.7	39.1	58.7
	9	64.6	96.9	58.9	88.3	52.1	78.2	44.3	66.4	35.2	52.9
	10	57.0	85.4	52.1	78.2	46.3	69.5	39.4	59.2	31.4	47.0
	11	49.6	74.4	45.6	68.4	40.7	61.0	34.7	52.1	27.6	41.3
	12	42.5	63.8	39.3	59.0	35.2	52.9	30.2	45.3	23.9	35.9
	13	36.2	54.4	33.5	50.3	30.1	45.2	25.9	38.8	20.5	30.7
	14	31.2	46.9	28.9	43.4	26.0	39.0	22.3	33.4	17.7	26.5
	15	27.2	40.8	25.2	37.8	22.6	34.0	19.4	29.1	15.4	23.1
	16	23.9	35.9	22.1	33.2	19.9	29.8	17.1	25.6	13.5	20.3
	17	21.2	31.8	19.6	29.4	17.6	26.4	15.1	22.7	12.0	18.0
	18	18.9	28.4	17.5	26.2	15.7	23.6	13.5	20.2	10.7	16.0
	19	17.0	25.4	15.7	23.6	14.1	21.2	12.1	18.2	9.59	14.4
	20	15.3	23.0	14.2	21.3	12.7	19.1	10.9	16.4	8.65	13.0
	21	13.9	20.8	12.9	19.3	11.5	17.3	9.91	14.9	7.85	11.8
	22					10.5	15.8	9.03	13.5	7.15	10.7
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	10.8	16.2	9.50	14.3	8.03	12.1	6.33	9.51	4.44	6.67
$P_e(KL)^2/10^4$	kip-in.²	202		186		167		144		114	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
Ω_c = 2.00	ϕ_c = 0.75										

5
COMPOSITE
HSS3

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS3×3×									
		3/8		5/16		1/4		3/16		1/8	
t_{design}, in.		0.349		0.291		0.233		0.174		0.116	
Steel Wt/ft		12.1		10.5		8.78		6.85		4.75	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	88.9	133	79.8	120	69.6	104	58.3	87.5	46.2	69.4
	1	88.1	132	79.1	119	69.0	104	57.8	86.8	45.9	68.8
	2	85.7	129	77.0	115	67.3	101	56.4	84.6	44.7	67.1
	3	81.8	123	73.6	110	64.4	96.7	54.1	81.2	42.9	64.4
	4	76.6	115	69.1	104	60.7	91.0	51.0	76.5	40.5	60.8
	5	70.4	106	63.8	95.7	56.1	84.2	47.3	71.0	37.6	56.4
	6	63.5	95.3	57.8	86.7	51.1	76.6	43.2	64.8	34.3	51.5
	7	56.3	84.4	51.4	77.2	45.6	68.5	38.7	58.1	30.9	46.3
	8	48.9	73.3	45.0	67.5	40.1	60.2	34.2	51.2	27.3	40.9
	9	41.7	62.6	38.6	57.9	34.6	52.0	29.6	44.4	23.7	35.5
	10	34.9	52.4	32.6	48.9	29.4	44.1	25.3	37.9	20.2	30.4
	11	28.9	43.3	27.0	40.5	24.5	36.8	21.2	31.7	17.0	25.5
	12	24.2	36.4	22.7	34.1	20.6	30.9	17.8	26.7	14.3	21.4
	13	20.7	31.0	19.3	29.0	17.5	26.3	15.2	22.7	12.2	18.2
	14	17.8	26.7	16.7	25.0	15.1	22.7	13.1	19.6	10.5	15.7
	15	15.5	23.3	14.5	21.8	13.2	19.8	11.4	17.1	9.13	13.7
	16	13.6	20.5	12.8	19.2	11.6	17.4	10.0	15.0	8.03	12.0
	17	12.1	18.1	11.3	17.0	10.3	15.4	8.86	13.3	7.11	10.7
	18			10.1	15.1	9.15	13.7	7.90	11.9	6.34	9.51
	19							7.09	10.6	5.69	8.54

Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	7.46	11.2	6.66	10.0	5.69	8.55	4.53	6.81	3.21	4.82
$P_e(KL)^2/10^4$	kip-in.^{2}	115		107		97.3		84.1		67.5	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 46 ksi
f'_c = 5 ksi

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

5

COMPOSITE
HSS2^1/2–HSS2^1/4

Shape		HSS2^1/2×2^1/2×								HSS2^1/4×2^1/4×	
		5/16		1/4		3/16		1/8		1/4	
t_{design}, in.		0.291		0.233		0.174		0.116		0.233	
Steel Wt/ft		8.40		7.08		5.57		3.90		6.23	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	61.8	92.7	54.1	81.1	45.2	67.8	35.6	53.3	46.7	70.0
	1	61.0	91.4	53.4	80.1	44.7	67.0	35.1	52.7	45.9	68.9
	2	58.5	87.8	51.4	77.1	43.1	64.6	33.9	50.8	43.8	65.6
	3	54.7	82.1	48.2	72.3	40.5	60.8	31.9	47.9	40.4	60.5
	4	49.8	74.7	44.1	66.1	37.2	55.8	29.4	44.1	36.1	54.1
	5	44.1	66.2	39.3	58.9	33.3	49.9	26.4	39.6	31.2	46.8
	6	38.1	57.1	34.1	51.2	29.1	43.7	23.2	34.7	26.1	39.2
	7	31.9	47.9	28.9	43.3	24.8	37.2	19.8	29.8	21.2	31.7
	8	26.1	39.1	23.8	35.8	20.7	31.0	16.6	24.9	16.6	24.9
	9	20.8	31.2	19.2	28.7	16.7	25.1	13.5	20.3	13.1	19.7
	10	16.8	25.3	15.5	23.3	13.6	20.3	11.0	16.4	10.6	15.9
	11	13.9	20.9	12.8	19.2	11.2	16.8	9.06	13.6	8.77	13.2
	12	11.7	17.5	10.8	16.2	9.41	14.1	7.61	11.4	7.37	11.1
	13	10.0	14.9	9.18	13.8	8.02	12.0	6.49	9.73	6.28	9.42
	14	8.59	12.9	7.91	11.9	6.92	10.4	5.59	8.39		
	15			6.89	10.3	6.03	9.04	4.87	7.31		
	16							4.28	6.42		
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	4.32	6.49	3.75	5.64	3.03	4.55	2.17	3.27	2.93	4.41
$P_e(KL)^2/10^4$	kip-in.^{2}	55.3		51.0		44.5		36.0		34.8	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE
HSS2¼–HSS2

Table 4–16 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Square HSS

F_y = 46 ksi
f'_c = 5 ksi

Shape		HSS2¼×2¼×				HSS2×2×					
		3/16		1/8		1/4		3/16		1/8	
t_{design}, in.		0.174		0.116		0.233		0.174		0.116	
Steel Wt/ft		4.94		3.47		5.38		4.30		3.04	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	39.1	58.6	30.6	45.9	39.6	59.3	33.2	49.8	25.9	38.9
	1	38.5	57.7	30.2	45.2	38.7	58.1	32.5	48.8	25.4	38.2
	2	36.7	55.1	28.8	43.3	36.4	54.5	30.7	46.0	24.0	36.1
	3	34.0	51.1	26.8	40.2	32.7	49.1	27.8	41.7	21.9	32.8
	4	30.6	45.9	24.2	36.2	28.2	42.4	24.2	36.3	19.2	28.8
	5	26.6	40.0	21.2	31.7	23.4	35.1	20.3	30.4	16.2	24.3
	6	22.5	33.8	18.0	27.0	18.5	27.8	16.3	24.5	13.2	19.8
	7	18.4	27.7	14.8	22.3	14.1	21.1	12.6	18.9	10.3	15.5
	8	14.6	21.9	11.9	17.8	10.8	16.2	9.64	14.5	7.90	11.9
	9	11.6	17.3	9.40	14.1	8.52	12.8	7.62	11.4	6.24	9.37
	10	9.36	14.0	7.61	11.4	6.90	10.4	6.17	9.25	5.06	7.59
	11	7.74	11.6	6.29	9.44	5.70	8.53	5.10	7.65	4.18	6.27
	12	6.50	9.75	5.29	7.93			4.28	6.43	3.51	5.27
	13	5.54	8.31	4.50	6.76						
	14			3.88	5.83						
Properties											
M_n/Ω_b / $\phi_b M_n$	kip-ft	2.39	3.60	1.73	2.60	2.21	3.33	1.83	2.75	1.34	2.02
$P_e(KL)^2/10^4$	kip-in.^{2}	30.8		25.1		22.6		20.3		16.6	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS18.000–HSS16.000

Shape		HSS18.000×				HSS16.000×							
		0.500		0.375		0.625		0.500		0.438		0.375	
t_{design}, in.		0.465		0.349		0.581		0.465		0.407		0.349	
Steel Wt/ft		93.5		70.7		103		82.8		72.9		62.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	973	1460	853	1280	920	1380	815	1220	763	1140	710	1060
	6	962	1440	844	1270	908	1360	805	1210	753	1130	700	1050
	7	959	1440	840	1260	904	1360	801	1200	749	1120	696	1040
	8	955	1430	836	1250	899	1350	797	1190	745	1120	692	1040
	9	950	1420	832	1250	893	1340	792	1190	740	1110	688	1030
	10	944	1420	827	1240	887	1330	786	1180	735	1100	683	1020
	11	939	1410	822	1230	881	1320	780	1170	729	1090	677	1020
	12	932	1400	816	1220	874	1310	774	1160	723	1080	671	1010
	13	925	1390	809	1210	866	1300	766	1150	716	1070	665	998
	14	918	1380	803	1200	858	1290	759	1140	709	1060	658	987
	15	910	1370	795	1190	849	1270	751	1130	701	1050	651	976
	16	902	1350	788	1180	840	1260	742	1110	693	1040	643	965
	17	893	1340	780	1170	830	1240	733	1100	684	1030	635	952
	18	884	1330	771	1160	820	1230	724	1090	676	1010	626	940
	19	874	1310	762	1140	809	1210	714	1070	666	999	618	926
	20	864	1300	753	1130	798	1200	704	1060	657	985	608	913
	21	854	1280	744	1120	786	1180	694	1040	647	970	599	898
	22	843	1260	734	1100	774	1160	683	1020	636	954	589	884
	23	832	1250	723	1090	762	1140	672	1010	626	938	579	868
	24	821	1230	713	1070	749	1120	660	990	615	922	568	853
	25	809	1210	702	1050	736	1100	648	973	603	905	558	837
	26	797	1200	691	1040	723	1080	636	955	592	888	547	821
	27	784	1180	680	1020	710	1060	624	936	580	871	536	804
	28	772	1160	668	1000	696	1040	612	918	569	853	525	787
	29	759	1140	656	985	682	1020	599	899	557	835	513	770
	30	746	1120	644	967	668	1000	586	879	544	817	502	753
	32	719	1080	620	930	639	959	560	840	520	779	478	718
	34	691	1040	595	892	610	915	534	801	495	742	455	682
	36	663	995	570	854	580	870	507	761	469	704	431	646
	38	635	953	544	816	551	826	480	720	444	666	407	610
	40	606	910	518	777	521	781	454	680	419	628	383	575
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	300	450	228	343	289	435	235	353	207	312	179	269
$P_e(KL)^2/10^4$	kip-in.^{2}	39700		33000		31200		26800		24500		22200	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

4

COMPOSITE
HSS16.000–
HSS14.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS16.000×				HSS14.000×							
		0.312		0.250		0.625		0.500		0.375		0.312	
t_{design}, in.		0.291		0.233		0.581		0.465		0.349		0.291	
Steel Wt/ft		52.3		42.1		89.4		72.2		54.6		45.7	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	656	984	602	904	760	1140	670	1010	578	868	532	798
	6	647	970	593	890	748	1120	659	988	568	852	522	783
	7	644	965	590	885	743	1120	655	982	565	847	519	778
	8	640	960	587	880	738	1110	650	975	560	841	515	772
	9	635	953	582	874	733	1100	645	968	556	834	510	766
	10	631	946	578	867	726	1090	639	959	551	826	506	758
	11	625	938	573	859	719	1080	633	950	545	817	500	750
	12	620	929	567	851	712	1070	626	939	539	808	494	742
	13	613	920	561	842	703	1060	619	928	532	798	488	732
	14	607	910	555	832	695	1040	611	917	525	788	481	722
	15	600	900	548	822	686	1030	603	904	518	777	474	712
	16	592	889	541	812	676	1010	594	891	510	765	467	701
	17	585	877	534	801	666	999	585	878	502	753	459	689
	18	577	865	526	789	655	983	576	863	493	740	451	677
	19	568	852	518	777	644	966	566	848	484	727	443	664
	20	559	839	509	764	633	949	555	833	475	713	434	651
	21	550	825	501	751	621	931	545	817	466	699	425	638
	22	541	811	492	738	609	913	534	801	456	684	416	624
	23	531	797	483	724	596	894	523	784	446	669	407	610
	24	521	782	473	710	583	875	511	767	436	654	397	595
	25	511	767	464	695	570	856	500	749	426	638	387	581
	26	501	751	454	681	557	836	488	732	415	622	377	566
	27	490	735	444	666	544	816	476	714	404	606	367	551
	28	480	719	434	650	530	795	464	696	394	590	357	536
	29	469	703	423	635	517	775	451	677	383	574	347	521
	30	458	687	413	620	503	754	439	659	372	558	337	505
	32	436	654	392	588	475	712	414	621	350	525	316	474
	34	413	620	371	557	447	670	389	584	328	492	296	444
	36	391	586	350	525	419	629	365	547	306	459	275	413
	38	368	553	329	493	391	587	340	510	285	427	255	383
	40	346	519	308	462	364	547	316	474	264	395	236	354
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	151	226	121	182	220	331	179	268	136	205	115	172
$P_e(KL)^2/10^4$	kip-in.^{2}	19700		17300		19900		17100		14200		12600	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS14.000–HSS10.750

Shape		HSS14.000×		HSS12.750×						HSS10.750×			
		0.250		0.500		0.375		0.250		0.500		0.375	
t_{design}, in.		0.233		0.465		0.349		0.233		0.465		0.349	
Steel Wt/ft		36.7		65.5		49.6		33.4		54.8		41.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	485	727	585	878	502	753	418	626	459	689	390	585
	6	476	714	574	861	492	738	408	612	447	670	379	569
	7	472	709	570	854	488	732	405	607	442	663	375	563
	8	469	703	565	847	484	726	401	602	437	656	371	556
	9	465	697	559	839	479	719	397	595	431	647	366	549
	10	460	690	554	830	474	711	392	588	425	638	360	540
	11	455	682	547	821	468	702	387	581	418	627	354	531
	12	449	674	540	810	462	693	381	572	411	616	348	522
	13	443	665	533	799	455	683	376	563	403	604	341	511
	14	437	655	525	787	448	672	369	554	394	592	334	500
	15	430	645	516	774	441	661	363	544	386	578	326	489
	16	423	635	507	761	433	649	356	533	376	565	318	477
	17	416	624	498	747	425	637	348	522	367	550	310	465
	18	408	612	488	732	416	624	341	511	357	535	301	452
	19	400	600	478	717	407	611	333	499	347	520	292	439
	20	392	588	468	702	398	597	325	487	336	505	283	425
	21	384	575	457	686	389	583	317	475	326	489	274	411
	22	375	562	447	670	379	568	308	462	315	473	265	397
	23	366	549	435	653	369	554	300	449	304	456	256	383
	24	357	535	424	636	359	539	291	436	293	440	246	369
	25	348	522	413	619	349	524	282	423	282	424	237	355
	26	338	508	401	602	339	508	273	410	271	407	227	341
	27	329	494	389	584	329	493	264	396	260	391	218	327
	28	320	479	378	566	318	477	255	383	249	374	208	313
	29	310	465	366	549	308	462	246	369	239	358	199	299
	30	300	451	354	531	297	446	237	356	228	342	190	285
	32	281	422	330	495	277	415	220	329	207	310	172	258
	34	262	393	307	460	256	384	202	303	187	280	155	232
	36	243	365	283	425	236	354	185	278	167	251	138	207
	38	225	337	261	391	217	325	169	253	150	225	124	186
	40	207	311	239	359	198	297	153	229	135	203	112	168
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	92.6	139	147	221	113	169	76.5	115	103	155	79.2	119
$P_e(KL)^2/10^4$	kip-in.^{2}	11000		12600		10400		8020		7110		5880	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4

COMPOSITE
HSS10.750–
HSS10.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape	HSS10.750×		HSS10.000×									
	0.250		0.625		0.500		0.375		0.312		0.250	
t_{design}, in.	0.233		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft	28.1		62.6		50.8		38.6		32.3		26.1	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	319	479	478	716	415	623	351	527	319	478	286	429
6	310	465	462	694	402	603	340	510	308	462	276	414
7	306	460	457	685	397	596	336	504	304	457	272	409
8	302	454	451	676	392	588	331	497	300	450	268	403
9	298	447	444	666	386	579	326	489	295	443	264	396
10	293	440	436	655	380	569	321	481	290	435	259	389
11	288	432	428	642	373	559	314	472	285	427	254	381
12	282	424	420	629	365	547	308	462	279	418	248	373
13	276	415	410	615	357	535	301	451	272	408	242	364
14	270	405	400	601	348	522	294	440	265	398	236	354
15	263	395	390	585	339	509	286	429	258	387	230	344
16	257	385	379	569	330	495	278	417	251	376	223	334
17	249	374	368	552	320	481	270	404	243	365	216	323
18	242	363	357	535	311	466	261	392	235	353	208	313
19	234	352	345	518	300	451	252	379	227	341	201	302
20	227	340	333	500	290	435	244	365	219	329	194	290
21	219	328	321	482	280	419	235	352	211	316	186	279
22	211	316	309	463	269	404	225	338	203	304	178	267
23	203	304	297	445	258	388	216	325	194	291	171	256
24	195	292	284	427	248	372	207	311	186	279	163	245
25	187	280	272	408	237	356	198	297	178	266	155	233
26	179	268	260	390	226	340	189	284	169	254	148	222
27	171	256	248	372	216	324	180	270	161	242	140	211
28	163	245	236	354	206	308	171	257	153	230	133	200
29	155	233	224	336	195	293	163	244	145	218	126	189
30	148	221	212	319	185	278	154	231	137	206	119	178
32	133	199	190	285	166	249	137	206	122	183	105	158
34	118	177	168	253	147	221	122	183	108	162	93.1	140
36	106	158	150	225	131	197	109	163	96.4	145	83.1	125
38	94.7	142	135	202	118	177	97.5	146	86.6	130	74.5	112
40	85.5	128	122	183	106	159	88.0	132	78.1	117	67.3	101

Properties

M_n/Ω_b | $\phi_b M_n$ kip-ft	54.0	81.2	108	163	88.7	133	68.2	102	57.5	86.4	46.6	70.0
$P_e(KL)^2/10^4$ kip-in.^{2}	4490		6390		5590		4620		4100		3530	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE HSS10.000–HSS9.625

Shape		HSS10.000×		HSS9.625×									
		0.188		0.500		0.375		0.312		0.250		0.188	
t_{design}, in.		0.174		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft		19.7		48.8		37.1		31.1		25.1		19.0	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	252	378	394	591	332	499	301	452	270	404	237	355
	6	243	364	380	571	321	481	291	436	260	389	228	342
	7	239	359	376	563	317	475	287	430	256	384	224	337
	8	236	354	370	555	312	468	282	424	252	378	221	331
	9	232	347	364	546	307	461	278	416	248	372	217	325
	10	227	341	358	536	301	452	272	409	243	364	212	318
	11	222	333	350	525	295	443	267	400	238	356	207	311
	12	217	326	343	514	289	433	261	391	232	348	202	303
	13	211	317	334	502	282	423	254	381	226	339	197	295
	14	206	308	326	489	274	412	247	371	220	329	191	286
	15	200	299	317	475	267	400	240	360	213	320	185	277
	16	193	290	307	461	259	388	233	349	206	309	178	268
	17	187	280	298	447	251	376	225	338	199	299	172	258
	18	180	270	288	432	242	363	217	326	192	288	166	248
	19	173	260	278	417	233	350	209	314	185	277	159	238
	20	167	250	267	401	225	337	201	302	177	266	152	228
	21	160	239	257	386	216	324	193	290	170	255	145	218
	22	153	229	247	370	207	311	185	278	163	244	139	208
	23	146	219	236	354	198	297	177	265	155	233	132	198
	24	139	208	226	338	189	284	169	253	148	222	125	188
	25	132	198	215	323	180	270	161	241	140	210	119	178
	26	125	188	205	307	172	257	153	229	133	200	112	168
	27	119	178	195	292	163	244	145	217	126	189	106	159
	28	112	168	184	277	154	231	137	205	119	178	99.5	149
	29	106	158	175	262	146	219	129	194	112	168	93.4	140
	30	99.4	149	165	247	138	207	122	183	105	158	87.3	131
	32	87.4	131	146	219	122	183	107	161	92.5	139	76.8	115
	34	77.4	116	129	194	108	162	95.0	143	81.9	123	68.0	102
	36	69.0	104	115	173	96.2	144	84.7	127	73.1	110	60.7	91.0
	38	62.0	92.9	103	155	86.3	129	76.1	114	65.6	98.4	54.4	81.7
	40	55.9	83.9	93.4	140	77.9	117	68.6	103	59.2	88.8	49.1	73.7
Properties													
M_n/Ω_b / $\phi_b M_n$	kip-ft	35.2	52.9	81.8	123	63.0	94.6	53.2	79.9	43.1	64.8	32.6	49.0
$P_e(KL)^2/10^4$	kip-in.^{2}	2940		4910		4090		3600		3110		2580	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

4

COMPOSITE HSS8.625

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS8.625×											
		0.625		0.500		0.375		0.322		0.250		0.188	
t_{design}, in.		0.581		0.465		0.349		0.300		0.233		0.174	
Steel Wt/ft		53.5		43.4		33.1		28.6		22.4		17.0	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	391	587	339	508	284	426	261	391	228	343	199	299
	6	375	562	324	487	272	408	250	374	218	327	190	285
	7	369	553	319	479	268	402	246	368	214	322	187	280
	8	362	543	314	470	263	395	241	362	210	316	183	274
	9	355	532	307	461	258	387	236	354	206	309	179	268
	10	347	520	300	450	252	378	231	346	201	301	174	261
	11	338	507	293	439	246	368	225	337	196	293	169	254
	12	329	493	285	427	239	358	219	328	190	285	164	246
	13	319	478	276	415	232	348	212	318	184	276	159	238
	14	308	463	268	401	224	336	205	308	178	267	153	230
	15	298	447	258	388	216	325	198	297	171	257	147	221
	16	287	430	249	373	208	313	190	286	165	247	141	212
	17	275	413	239	359	200	300	183	274	158	237	135	202
	18	264	396	229	344	192	288	175	263	151	227	129	193
	19	252	378	219	329	184	275	167	251	144	216	123	184
	20	241	361	209	314	175	263	160	239	137	206	116	174
	21	229	343	199	299	167	250	152	228	130	195	110	165
	22	217	326	189	284	158	237	144	216	123	185	104	156
	23	206	308	179	269	150	225	136	204	116	174	97.7	147
	24	194	291	169	254	141	212	128	193	109	164	91.7	138
	25	183	274	160	240	133	200	121	181	103	154	85.8	129
	26	172	258	150	225	125	188	114	170	96.4	145	80.1	120
	27	161	242	141	211	118	176	106	160	90.0	135	74.5	112
	28	151	226	132	198	110	165	99.3	149	83.8	126	69.2	104
	29	140	211	123	184	102	154	92.6	139	78.1	117	64.6	96.8
	30	131	197	115	172	95.7	144	86.5	130	73.0	109	60.3	90.5
	32	115	173	101	151	84.1	126	76.1	114	64.1	96.2	53.0	79.5
	34	102	153	89.5	134	74.5	112	67.4	101	56.8	85.2	47.0	70.4
	36	91.1	137	79.8	120	66.5	99.7	60.1	90.1	50.7	76.0	41.9	62.8
	38	81.8	123	71.6	107	59.7	89.5	53.9	80.9	45.5	68.2	37.6	56.4
	40	73.8	111	64.6	97.0	53.8	80.8	48.7	73.0	41.0	61.6	33.9	50.9
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	78.9	119	65.0	97.6	50.1	75.3	43.6	65.5	34.4	51.7	26.0	39.2
$P_e(KL)^2/10^4$	kip-in.^{2}	3870		3400		2820		2560		2160		1790	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS7.625–HSS7.500

Shape	HSS7.625×				HSS7.500×							
	0.375		0.328		0.500		0.375		0.312		0.250	
t_{design}, in.	0.349		0.305		0.465		0.349		0.291		0.233	
Steel Wt/ft	29.1		25.6		37.4		28.6		24.0		19.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	239	359	221	331	280	420	234	351	210	315	186	278
6	226	339	209	313	265	397	221	331	198	297	175	262
7	222	333	205	307	259	389	216	324	194	291	171	257
8	217	325	200	300	253	379	211	316	189	284	167	250
9	211	316	195	292	246	369	205	308	184	276	162	243
10	205	307	189	284	239	358	199	299	179	268	157	236
11	198	298	183	274	231	346	193	289	173	259	152	228
12	191	287	177	265	223	334	186	279	167	250	146	219
13	184	276	170	255	214	321	178	268	160	240	140	211
14	177	265	163	244	205	307	171	256	153	230	134	201
15	169	253	156	234	196	293	163	245	146	219	128	192
16	161	241	148	223	186	279	155	233	139	209	122	182
17	153	229	141	211	176	265	147	221	132	198	115	173
18	145	217	134	200	167	250	139	209	125	187	109	163
19	137	205	126	189	157	236	131	197	118	176	102	153
20	129	193	119	178	148	222	123	185	110	166	95.8	144
21	121	181	111	167	138	208	116	173	103	155	89.6	134
22	113	170	104	156	129	194	108	162	96.5	145	83.4	125
23	106	158	97.2	146	120	180	100	151	89.7	135	77.5	116
24	98.2	147	90.3	136	112	167	93.1	140	83.2	125	71.6	107
25	90.9	136	83.6	125	103	154	85.9	129	76.8	115	66.0	99.0
26	84.0	126	77.3	116	95.1	143	79.5	119	71.0	106	61.0	91.5
27	77.9	117	71.7	107	88.2	132	73.7	111	65.8	98.7	56.6	84.9
28	72.4	109	66.6	100	82.0	123	68.5	103	61.2	91.8	52.6	78.9
29	67.5	101	62.1	93.2	76.4	115	63.9	95.8	57.0	85.6	49.0	73.6
30	63.1	94.7	58.0	87.1	71.4	107	59.7	89.5	53.3	80.0	45.8	68.7
32	55.5	83.2	51.0	76.5	62.8	94.2	52.5	78.7	46.9	70.3	40.3	60.4
34	49.1	73.7	45.2	67.8	55.6	83.4	46.5	69.7	41.5	62.3	35.7	53.5
36	43.8	65.7	40.3	60.5	49.6	74.4	41.4	62.2	37.0	55.5	31.8	47.7
38	39.3	59.0	36.2	54.3	44.5	66.8	37.2	55.8	33.2	49.8	28.6	42.8
40	35.5	53.2	32.7	49.0	40.2	60.3	33.6	50.4	30.0	45.0	25.8	38.7
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	38.8	58.2	34.3	51.5	48.3	72.6	37.4	56.3	31.7	47.7	25.8	38.8
$P_e(KL)^2/10^4$ kip-in.^{2}	1870		1710		2120		1760		1570		1350	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

4

COMPOSITE
HSS7.500–
HSS7.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS7.500×		HSS7.000×							
		0.188		0.500		0.375		0.312		0.250	
t_{design}, in.		0.174		0.465		0.349		0.291		0.233	
Steel Wt/ft		14.7		34.7		26.6		22.3		18.0	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	160	241	255	383	212	319	190	285	168	252
	6	151	226	239	359	199	298	178	267	157	235
	7	147	221	233	350	194	291	174	261	153	229
	8	144	215	227	341	189	283	169	254	149	223
	9	139	209	220	330	183	275	164	246	144	216
	10	135	202	213	319	177	265	158	237	139	209
	11	130	195	204	307	170	255	152	228	134	200
	12	125	187	196	294	163	245	146	219	128	192
	13	120	180	187	281	156	234	139	209	122	183
	14	114	171	178	267	148	222	133	199	116	174
	15	109	163	169	253	141	211	126	189	110	165
	16	103	154	159	239	133	199	119	178	104	156
	17	97.2	146	150	225	125	188	112	168	97.5	146
	18	91.5	137	141	211	117	176	105	157	91.3	137
	19	85.8	129	131	197	110	164	98.0	147	85.2	128
	20	80.2	120	122	183	102	153	91.2	137	79.2	119
	21	74.7	112	113	170	94.7	142	84.6	127	73.3	110
	22	69.3	104	105	157	87.5	131	78.2	117	67.6	101
	23	64.1	96.2	96.3	144	80.4	121	71.8	108	62.0	93.0
	24	59.0	88.4	88.4	133	73.9	111	66.0	99.0	56.9	85.4
	25	54.3	81.5	81.5	122	68.1	102	60.8	91.2	52.5	78.7
	26	50.2	75.4	75.4	113	62.9	94.4	56.2	84.3	48.5	72.8
	27	46.6	69.9	69.9	105	58.4	87.6	52.1	78.2	45.0	67.5
	28	43.3	65.0	65.0	97.5	54.3	81.4	48.5	72.7	41.8	62.7
	29	40.4	60.6	60.6	90.9	50.6	75.9	45.2	67.8	39.0	58.5
	30	37.7	56.6	56.6	84.9	47.3	70.9	42.2	63.3	36.4	54.7
	32	33.2	49.7	49.7	74.6	41.6	62.3	37.1	55.7	32.0	48.0
	34	29.4	44.1	44.1	66.1	36.8	55.2	32.9	49.3	28.4	42.6
	36	26.2	39.3	39.3	59.0	32.8	49.3	29.3	44.0	25.3	38.0
	38	23.5	35.3	35.3	52.9	29.5	44.2	26.3	39.5	22.7	34.1
	40	21.2	31.8								
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	19.6	29.4	41.7	62.7	32.4	48.7	27.5	41.3	22.4	33.6
$P_e(KL)^2/10^4$	kip-in.^{2}	1110		1670		1400		1250		1080	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
Ω_c = 2.00	ϕ_c = 0.75										

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4

COMPOSITE
HSS7.000–
HSS6.875

Shape		HSS7.000×				HSS6.875×					
		0.188		0.125		0.500		0.375		0.312	
t_{design}, in.		0.174		0.116		0.465		0.349		0.291	
Steel Wt/ft		13.7		9.19		34.1		26.1		21.9	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	144	217	121	182	249	374	207	311	185	278
	6	135	202	112	168	233	349	194	290	173	260
	7	131	197	109	164	227	341	189	283	169	253
	8	127	191	106	158	221	331	183	275	164	246
	9	123	185	102	153	214	320	178	266	159	238
	10	119	178	97.8	147	206	309	171	257	153	230
	11	114	171	93.5	140	198	297	165	247	147	221
	12	109	163	89.1	134	189	284	158	236	141	212
	13	104	155	84.4	127	181	271	150	225	134	202
	14	98.2	147	79.7	120	172	257	143	214	128	192
	15	92.8	139	74.9	112	162	243	135	203	121	181
	16	87.3	131	70.1	105	153	229	127	191	114	171
	17	81.8	123	65.4	98.1	144	215	120	180	107	160
	18	76.4	115	60.7	91.0	134	201	112	168	100	150
	19	71.0	107	56.1	84.1	125	188	104	157	93.3	140
	20	65.8	98.7	51.6	77.4	116	174	96.9	145	86.6	130
	21	60.7	91.0	47.3	70.9	107	161	89.7	134	80.1	120
	22	55.7	83.6	43.1	64.6	98.9	148	82.6	124	73.8	111
	23	51.0	76.5	39.4	59.1	90.6	136	75.7	114	67.6	101
	24	46.8	70.2	36.2	54.3	83.2	125	69.5	104	62.1	93.1
	25	43.1	64.7	33.4	50.0	76.7	115	64.1	96.1	57.2	85.8
	26	39.9	59.8	30.8	46.3	70.9	106	59.2	88.9	52.9	79.3
	27	37.0	55.5	28.6	42.9	65.7	98.6	54.9	82.4	49.0	73.6
	28	34.4	51.6	26.6	39.9	61.1	91.7	51.1	76.6	45.6	68.4
	29	32.1	48.1	24.8	37.2	57.0	85.5	47.6	71.4	42.5	63.8
	30	30.0	44.9	23.2	34.8	53.3	79.9	44.5	66.7	39.7	59.6
	32	26.3	39.5	20.4	30.5	46.8	70.2	39.1	58.7	34.9	52.4
	34	23.3	35.0	18.0	27.1	41.5	62.2	34.6	52.0	30.9	46.4
	36	20.8	31.2	16.1	24.1	37.0	55.5	30.9	46.3	27.6	41.4
	38	18.7	28.0	14.4	21.7			27.7	41.6	24.8	37.1
	40	16.9	25.3	13.0	19.5						
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	17.0	25.5	11.5	17.3	40.1	60.3	31.2	46.9	26.5	39.8
$P_e(KL)^2/10^4$	kip-in.^{2}	886		685		1570		1310		1170	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

4

COMPOSITE
HSS6.875–
HSS6.625

Table 4–17 (continued)
Available Strength in Axial Compression, kips

Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS6.875×				HSS6.625×					
		0.250		0.188		0.500		0.432		0.375	
t_{design}, in.		0.233		0.174		0.465		0.402		0.349	
Steel Wt/ft		17.7		13.4		32.7		28.6		25.1	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	163	245	140	211	237	356	216	323	197	295
	6	152	229	131	196	220	331	200	300	183	274
	7	149	223	127	191	215	322	195	293	178	267
	8	144	216	123	185	208	312	189	284	173	259
	9	140	209	119	179	201	301	183	274	167	250
	10	135	202	115	172	193	290	176	263	160	241
	11	129	194	110	165	185	277	168	252	154	231
	12	124	185	105	157	176	265	161	241	147	220
	13	118	177	99.7	150	168	251	152	229	139	209
	14	112	168	94.4	142	159	238	144	216	132	198
	15	106	158	89.0	133	149	224	136	204	124	186
	16	99.4	149	83.5	125	140	210	128	191	117	175
	17	93.2	140	78.1	117	131	196	119	179	109	164
	18	87.1	131	72.7	109	122	183	111	166	102	152
	19	81.1	122	67.5	101	113	169	103	154	94.1	141
	20	75.1	113	62.3	93.5	104	156	95	142	86.9	130
	21	69.4	104	57.4	86.0	95.7	144	87.3	131	79.9	120
	22	63.8	95.8	52.5	78.7	87.4	131	79.8	120	73.0	110
	23	58.4	87.6	48.0	72.0	79.9	120	73.0	110	66.8	100
	24	53.6	80.4	44.1	66.1	73.4	110	67.0	101	61.4	92.0
	25	49.4	74.1	40.6	60.9	67.7	101	61.8	92.7	56.5	84.8
	26	45.7	68.5	37.6	56.3	62.6	93.8	57.1	85.7	52.3	78.4
	27	42.4	63.6	34.8	52.2	58.0	87.0	53.0	79.5	48.5	72.7
	28	39.4	59.1	32.4	48.6	53.9	80.9	49.3	73.9	45.1	67.6
	29	36.7	55.1	30.2	45.3	50.3	75.4	45.9	68.9	42.0	63.0
	30	34.3	51.5	28.2	42.3	47.0	70.5	42.9	64.4	39.3	58.9
	32	30.2	45.2	24.8	37.2	41.3	61.9	37.7	56.6	34.5	51.8
	34	26.7	40.1	22.0	32.9	36.6	54.9	33.4	50.1	30.6	45.9
	36	23.8	35.8	19.6	29.4	32.6	48.9	29.8	44.7	27.3	40.9
	38	21.4	32.1	17.6	26.4						
Properties											
M_n/Ω_b $\phi_b M_n$	kip-ft	21.6	32.4	16.4	24.6	37.1	55.7	32.7	49.1	28.8	43.3
$P_e(KL)^2/10^4$	kip-in.^{2}	1010		834		1390		1270		1160	

ASD	LRFD	
$\Omega_c = 2.00$	$\phi_c = 0.75$	Note: Heavy line indicates *Kl/r* equal to or greater than 200.

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS6.625

Shape		HSS6.625×									
		0.312		0.280		0.250		0.188		0.125	
t_{design}, in.		0.291		0.260		0.233		0.174		0.116	
Steel Wt/ft		21.1		19.0		17.0		12.9		8.69	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	176	264	165	247	155	232	133	199	111	166
	6	164	245	153	230	144	216	123	184	102	153
	7	159	239	149	224	140	210	119	179	98.7	148
	8	154	232	144	217	136	203	116	173	95.3	143
	9	149	224	140	209	131	196	111	167	91.6	137
	10	143	215	134	201	126	189	107	160	87.6	131
	11	137	206	129	193	120	181	102	153	83.4	125
	12	131	197	123	184	115	172	97.1	146	79.0	118
	13	125	187	116	175	109	163	92.0	138	74.5	112
	14	118	177	110	165	103	154	86.8	130	69.9	105
	15	111	167	104	156	97.0	145	81.5	122	65.3	97.9
	16	104	156	97.4	146	90.9	136	76.2	114	60.7	91.0
	17	97.4	146	91.0	136	84.9	127	70.9	106	56.2	84.2
	18	90.7	136	84.7	127	78.9	118	65.7	98.5	51.7	77.6
	19	84.0	126	78.5	118	73.1	110	60.6	90.9	47.4	71.1
	20	77.6	116	72.4	109	67.4	101	55.7	83.5	43.3	64.9
	21	71.3	107	66.6	99.8	61.9	92.8	50.9	76.3	39.2	58.8
	22	65.2	97.8	60.8	91.2	56.4	84.7	46.4	69.5	35.7	53.6
	23	59.6	89.5	55.6	83.4	51.6	77.5	42.4	63.6	32.7	49.1
	24	54.8	82.2	51.1	76.6	47.4	71.1	38.9	58.4	30.0	45.1
	25	50.5	75.7	47.1	70.6	43.7	65.6	35.9	53.8	27.7	41.5
	26	46.7	70.0	43.5	65.3	40.4	60.6	33.2	49.8	25.6	38.4
	27	43.3	64.9	40.4	60.5	37.5	56.2	30.8	46.2	23.7	35.6
	28	40.2	60.4	37.5	56.3	34.8	52.3	28.6	42.9	22.1	33.1
	29	37.5	56.3	35.0	52.5	32.5	48.7	26.7	40.0	20.6	30.9
	30	35.1	52.6	32.7	49.0	30.4	45.5	24.9	37.4	19.2	28.8
	32	30.8	46.2	28.7	43.1	26.7	40.0	21.9	32.9	16.9	25.3
	34	27.3	40.9	25.5	38.2	23.6	35.4	19.4	29.1	15.0	22.4
	36	24.3	36.5	22.7	34.1	21.1	31.6	17.3	26.0	13.3	20.0
	38							15.5	23.3	12.0	18.0

Properties

M_n/Ω_b	$\phi_b M_n$ kip-ft	24.5	36.8	22.1	33.2	20.0	30.0	15.2	22.8	10.3	15.5
$P_e(KL)^2/10^4$	kip-in.^{2}	1040		966		897		737		569	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

4

COMPOSITE
HSS6.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape	HSS6.000×											
	0.500		0.375		0.312		0.280		0.250		0.188	
t_{design}, in.	0.465		0.349		0.291		0.260		0.233		0.174	
Steel Wt/ft	29.4		22.5		19.0		17.1		15.4		11.7	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	208	312	172	258	153	230	143	215	134	202	115	172
1	208	311	172	257	153	230	143	214	134	201	114	171
2	206	309	170	256	152	228	142	213	133	200	113	170
3	203	305	168	252	150	225	140	210	131	197	112	168
4	200	300	165	248	147	221	138	206	129	194	110	165
5	195	293	162	242	144	216	135	202	126	189	107	161
6	190	285	157	236	140	210	131	196	123	184	104	156
7	184	276	152	228	136	204	127	190	119	178	101	151
8	177	266	147	220	131	196	122	183	114	172	96.9	145
9	170	254	141	211	125	188	117	176	110	164	92.7	139
10	162	243	134	201	120	179	112	167	105	157	88.3	132
11	153	230	127	191	113	170	106	159	99.2	149	83.6	125
12	145	217	120	180	107	161	100	150	93.6	140	78.7	118
13	136	204	113	169	101	151	93.9	141	87.9	132	73.7	111
14	127	190	105	158	94.1	141	87.8	132	82.2	123	68.7	103
15	118	177	98.1	147	87.5	131	81.7	122	76.4	115	63.7	95.6
16	109	164	90.8	136	81.0	122	75.6	113	70.7	106	58.8	88.1
17	100	150	83.6	125	74.6	112	69.6	104	65.1	97.6	53.9	80.9
18	91.8	138	76.6	115	68.4	103	63.8	95.6	59.6	89.4	49.2	73.8
19	83.6	125	69.9	105	62.3	93.5	58.1	87.2	54.3	81.5	44.7	67.0
20	75.6	113	63.3	94.9	56.4	84.7	52.6	78.9	49.2	73.7	40.3	60.5
21	68.6	103	57.4	86.1	51.2	76.8	47.7	71.6	44.6	66.9	36.6	54.9
22	62.5	93.7	52.3	78.4	46.6	70.0	43.5	65.2	40.6	60.9	33.3	50.0
23	57.2	85.8	47.8	71.7	42.7	64.0	39.8	59.7	37.2	55.8	30.5	45.7
24	52.5	78.8	43.9	65.9	39.2	58.8	36.5	54.8	34.1	51.2	28.0	42.0
25	48.4	72.6	40.5	60.7	36.1	54.2	33.7	50.5	31.5	47.2	25.8	38.7
26	44.7	67.1	37.4	56.1	33.4	50.1	31.1	46.7	29.1	43.6	23.9	35.8
28	38.6	57.9	32.3	48.4	28.8	43.2	26.8	40.3	25.1	37.6	20.6	30.9
30	33.6	50.4	28.1	42.2	25.1	37.6	23.4	35.1	21.8	32.8	17.9	26.9
32	29.5	44.3	24.7	37.1	22.0	33.1	20.6	30.8	19.2	28.8	15.7	23.6
34									17.0	25.5	13.9	20.9

Properties

	0.500		0.375		0.312		0.280		0.250		0.188	
M_n/Ω_b | $\phi_b M_n$ kip-ft	29.9	45.0	23.4	35.2	19.9	29.9	18.0	27.0	16.2	24.4	12.4	18.6
$P_e(KL)^2/10^4$ kip-in.^{2}	994		831		742		691		645		530	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS6.000–
HSS5.563

Shape		HSS6.000×		HSS5.563×									
		0.125		0.500		0.375		0.258		0.188		0.134	
t_{design}, in.		0.116		0.465		0.349		0.240		0.174		0.124	
Steel Wt/ft		7.85		27.1		20.8		14.6		10.8		7.78	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	94.7	142	188	283	155	233	123	184	102	154	86.6	130
	1	94.4	142	188	282	155	232	122	184	102	153	86.4	130
	2	93.6	140	186	279	154	230	121	182	101	152	85.6	128
	3	92.3	138	183	275	151	227	120	179	99.7	150	84.2	126
	4	90.5	136	180	270	148	222	117	176	97.6	146	82.4	124
	5	88.3	132	175	262	144	217	114	171	95.0	143	80.0	120
	6	85.6	128	169	254	140	210	111	166	92.0	138	77.3	116
	7	82.5	124	163	245	135	202	107	160	88.4	133	74.2	111
	8	79.1	119	156	234	129	193	102	153	84.6	127	70.7	106
	9	75.4	113	148	222	123	184	97.1	146	80.4	121	67.0	100
	10	71.5	107	140	210	116	174	91.8	138	75.9	114	63.1	94.6
	11	67.4	101	132	198	109	164	86.4	130	71.3	107	59.0	88.5
	12	63.2	94.8	123	185	102	153	80.8	121	66.5	99.8	54.8	82.3
	13	58.9	88.4	114	172	95.0	143	75.2	113	61.7	92.6	50.7	76.0
	14	54.6	81.9	106	158	87.9	132	69.5	104	56.9	85.4	46.5	69.8
	15	50.3	75.5	96.9	145	80.7	121	63.9	95.8	52.2	78.3	42.4	63.6
	16	46.1	69.2	88.4	133	73.8	111	58.4	87.5	47.5	71.3	38.4	57.6
	17	42.1	63.1	80.2	120	67.0	101	53.0	79.5	43.1	64.6	34.6	51.9
	18	38.1	57.2	72.2	108	60.5	90.8	47.9	71.8	38.7	58.1	30.9	46.4
	19	34.3	51.4	64.8	97.2	54.3	81.5	43.0	64.4	34.7	52.1	27.7	41.6
	20	30.9	46.4	58.5	87.7	49.0	73.5	38.8	58.2	31.4	47.0	25.0	37.6
	21	28.1	42.1	53.1	79.6	44.5	66.7	35.2	52.8	28.4	42.7	22.7	34.1
	22	25.6	38.4	48.3	72.5	40.5	60.8	32.0	48.1	25.9	38.9	20.7	31.0
	23	23.4	35.1	44.2	66.3	37.1	55.6	29.3	44.0	23.7	35.6	18.9	28.4
	24	21.5	32.2	40.6	60.9	34.0	51.1	26.9	40.4	21.8	32.7	17.4	26.1
	25	19.8	29.7	37.4	56.2	31.4	47.1	24.8	37.2	20.1	30.1	16.0	24.0
	26	18.3	27.5	34.6	51.9	29.0	43.5	22.9	34.4	18.6	27.8	14.8	22.2
	28	15.8	23.7	29.8	44.8	25.0	37.5	19.8	29.7	16.0	24.0	12.8	19.2
	30	13.8	20.6	26.0	39.0	21.8	32.7	17.2	25.8	13.9	20.9	11.1	16.7
	32	12.1	18.1									9.78	14.7
	34	10.7	16.1										
Properties													
M_n/Ω_b	$\phi_b M_n$ kip-ft	8.42	12.7	25.4	38.2	19.9	29.9	14.3	21.4	10.6	15.9	7.69	11.6
$P_e(KL)^2/10^4$	kip-in.^{2}	406		769		644		510		412		328	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4

COMPOSITE
HSS5.500–
HSS5.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS5.500×						HSS5.000×					
		0.500		0.375		0.258		0.500		0.375		0.312	
t_{design}, in.		0.465		0.349		0.240		0.465		0.349		0.291	
Steel Wt/ft		26.7		20.5		14.5		24.1		18.5		15.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	186	278	153	230	121	181	164	246	135	202	120	179
	1	185	278	153	229	121	181	163	245	134	201	119	179
	2	183	275	151	227	119	179	161	242	133	199	118	177
	3	181	271	149	223	118	177	158	238	130	196	116	174
	4	177	265	146	219	115	173	154	232	127	191	113	169
	5	172	258	142	213	112	168	149	224	123	185	109	164
	6	166	250	137	206	109	163	143	215	118	177	105	158
	7	160	240	132	198	104	157	137	205	113	169	100	150
	8	153	229	126	190	99.9	150	129	194	107	160	95.0	142
	9	145	218	120	180	95.0	143	121	182	101	151	89.3	134
	10	137	206	114	170	89.8	135	113	170	93.8	141	83.4	125
	11	129	193	107	160	84.4	127	105	157	87.0	130	77.4	116
	12	120	180	99.7	149	78.8	118	96.2	144	80.0	120	71.2	107
	13	111	167	92.5	139	73.1	110	87.7	132	73.1	110	65.1	97.7
	14	103	154	85.4	128	67.5	101	79.4	119	66.3	99.5	59.1	88.6
	15	93.9	141	78.3	117	61.9	92.9	71.3	107	59.7	89.6	53.2	79.9
	16	85.5	128	71.4	107	56.5	84.7	63.6	95.3	53.4	80.1	47.6	71.4
	17	77.4	116	64.7	97.1	51.2	76.8	56.3	84.5	47.3	71.0	42.2	63.4
	18	69.5	104	58.2	87.3	46.1	69.1	50.2	75.3	42.2	63.3	37.7	56.5
	19	62.4	93.5	52.3	78.4	41.3	62.0	45.1	67.6	37.9	56.8	33.8	50.7
	20	56.3	84.4	47.2	70.7	37.3	56.0	40.7	61.0	34.2	51.3	30.5	45.8
	21	51.0	76.6	42.8	64.2	33.8	50.8	36.9	55.3	31.0	46.5	27.7	41.5
	22	46.5	69.8	39.0	58.5	30.8	46.3	33.6	50.4	28.3	42.4	25.2	37.8
	23	42.6	63.8	35.7	53.5	28.2	42.3	30.8	46.1	25.8	38.8	23.1	34.6
	24	39.1	58.6	32.8	49.1	25.9	38.9	28.3	42.4	23.7	35.6	21.2	31.8
	25	36.0	54.0	30.2	45.3	23.9	35.8	26.0	39.1	21.9	32.8	19.5	29.3
	26	33.3	49.9	27.9	41.9	22.1	33.1	24.1	36.1	20.2	30.3	18.1	27.1
	28	28.7	43.1	24.1	36.1	19.0	28.6						
	30			21.0	31.4	16.6	24.9						
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	24.8	37.2	19.4	29.2	13.9	20.9	20.1	30.2	15.9	23.8	13.5	20.4
$P_e(KL)^2/10^4$	kip-in.^{2}	739		619		490		534		449		400	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS5.000–HSS4.500

Shape	HSS5.000×								HSS4.500×			
	0.258		0.250		0.188		0.125		0.375		0.337	
t_{design}, in.	0.240		0.233		0.174		0.116		0.349		0.313	
Steel Wt/ft	13.1		12.7		9.67		6.51		16.5		15.0	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	106	159	104	156	87.7	132	71.3	107	117	176	109	163
1	105	158	104	155	87.4	131	71.0	107	117	175	108	163
2	104	157	102	154	86.4	130	70.2	105	115	173	107	160
3	102	154	101	151	84.9	127	68.8	103	113	169	105	157
4	99.9	150	98.1	147	82.7	124	67.0	100	109	164	101	152
5	96.8	145	95.0	143	80.0	120	64.7	97.0	105	157	97.4	146
6	93.0	140	91.3	137	76.9	115	62.0	92.9	99.7	149	92.7	139
7	88.8	133	87.2	131	73.3	110	58.9	88.3	94.0	141	87.5	131
8	84.1	126	82.6	124	69.4	104	55.5	83.3	87.9	132	81.8	123
9	79.1	119	77.7	117	65.2	97.8	52.0	78.0	81.4	122	75.8	114
10	73.9	111	72.6	109	60.8	91.2	48.3	72.4	74.8	112	69.7	104
11	68.5	103	67.3	101	56.3	84.5	44.5	66.7	68.0	102	63.4	95.1
12	63.1	94.7	62.0	92.9	51.8	77.7	40.7	61.0	61.3	92.0	57.2	85.9
13	57.7	86.5	56.6	85.0	47.3	70.9	36.9	55.3	54.8	82.2	51.2	76.8
14	52.4	78.5	51.4	77.1	42.8	64.2	33.2	49.8	48.6	72.9	45.4	68.1
15	47.2	70.8	46.3	69.5	38.5	57.8	29.6	44.5	42.5	63.8	39.8	59.7
16	42.2	63.3	41.4	62.1	34.4	51.6	26.2	39.3	37.4	56.1	35.0	52.5
17	37.4	56.1	36.7	55.1	30.4	45.7	23.2	34.8	33.1	49.7	31.0	46.5
18	33.4	50.1	32.8	49.2	27.2	40.7	20.7	31.1	29.5	44.3	27.6	41.4
19	30.0	44.9	29.4	44.1	24.4	36.6	18.6	27.9	26.5	39.8	24.8	37.2
20	27.0	40.6	26.5	39.8	22.0	33.0	16.8	25.2	23.9	35.9	22.4	33.6
21	24.5	36.8	24.1	36.1	20.0	29.9	15.2	22.8	21.7	32.6	20.3	30.4
22	22.3	33.5	21.9	32.9	18.2	27.3	13.9	20.8	19.8	29.7	18.5	27.7
23	20.4	30.7	20.1	30.1	16.6	24.9	12.7	19.0	18.1	27.1	16.9	25.4
24	18.8	28.2	18.4	27.7	15.3	22.9	11.6	17.5	16.6	24.9	15.5	23.3
25	17.3	26.0	17.0	25.5	14.1	21.1	10.7	16.1				
26	16.0	24.0	15.7	23.6	13.0	19.5	9.92	14.9				
28	13.8	20.7	13.5	20.3	11.2	16.8	8.56	12.8				
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	11.4	17.1	11.1	16.7	8.50	12.8	5.80	8.72	12.6	19.0	11.5	17.3
$P_e(KL)^2/10^4$ kip-in.^{2}	356		348		289		220		314		294	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

4

COMPOSITE
HSS4.500–
HSS4.000

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 4 ksi

Shape		HSS4.500×						HSS4.000×			
		0.237		0.188		0.125		0.313		0.250	
t_{design}, in.		0.220		0.174		0.116		0.291		0.233	
Steel Wt/ft		10.8		8.67		5.85		12.3		10.0	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	86.7	130	75.4	113	60.7	91.1	88.6	133	76.5	115
	1	86.3	130	75.0	113	60.4	90.7	88.1	132	76.1	114
	2	85.2	128	74.1	111	59.6	89.4	86.7	130	74.8	112
	3	83.3	125	72.4	109	58.2	87.3	84.2	126	72.8	109
	4	80.8	121	70.2	105	56.3	84.5	81.0	121	70.0	105
	5	77.6	116	67.4	101	54.0	80.9	76.9	115	66.5	99.8
	6	73.9	111	64.2	96.3	51.2	76.8	72.3	108	62.5	93.8
	7	69.8	105	60.6	90.9	48.2	72.3	67.2	101	58.1	87.2
	8	65.3	97.9	56.7	85.0	44.9	67.3	61.7	92.5	53.4	80.1
	9	60.6	90.8	52.5	78.8	41.4	62.1	56.0	84.0	48.6	72.8
	10	55.7	83.5	48.3	72.4	37.9	56.8	50.3	75.5	43.6	65.5
	11	50.7	76.1	43.9	65.9	34.3	51.4	44.7	67.0	38.8	58.2
	12	45.8	68.7	39.7	59.5	30.7	46.1	39.2	58.8	34.1	51.1
	13	41.0	61.5	35.5	53.2	27.3	41.0	34.0	51.0	29.6	44.4
	14	36.4	54.5	31.4	47.2	24.0	36.1	29.3	44.0	25.5	38.3
	15	31.9	47.9	27.6	41.4	21.0	31.4	25.5	38.3	22.2	33.3
	16	28.0	42.1	24.2	36.3	18.4	27.6	22.4	33.7	19.5	29.3
	17	24.8	37.3	21.5	32.2	16.3	24.5	19.9	29.8	17.3	26.0
	18	22.2	33.2	19.1	28.7	14.6	21.8	17.7	26.6	15.4	23.2
	19	19.9	29.8	17.2	25.8	13.1	19.6	15.9	23.9	13.9	20.8
	20	17.9	26.9	15.5	23.3	11.8	17.7	14.4	21.5	12.5	18.8
	21	16.3	24.4	14.1	21.1	10.7	16.0	13.0	19.5	11.3	17.0
	22	14.8	22.2	12.8	19.2	9.75	14.6	11.9	17.8	10.3	15.5
	23	13.6	20.4	11.7	17.6	8.92	13.4				
	24	12.5	18.7	10.8	16.2	8.19	12.3				
	25	11.5	17.2	9.92	14.9	7.55	11.3				
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	8.45	12.7	6.83	10.3	4.67	7.02	8.41	12.6	6.94	10.4
$P_e(KL)^2/10^4$	kip-in.^{2}	236		203		156		189		164	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 42 ksi
f'_c = 4 ksi

Table 4–17 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

4
COMPOSITE
HSS4.000

Shape		HSS4.000×									
		0.237		0.226		0.220		0.188		0.125	
t_{design}, in.		0.220		0.210		0.205		0.174		0.116	
Steel Wt/ft		9.53		9.12		8.89		7.66		5.18	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	73.8	111	71.6	107	70.6	106	63.8	95.7	50.9	76.4
	1	73.4	110	71.2	107	70.2	105	63.5	95.2	50.6	75.9
	2	72.1	108	70.0	105	69.0	103	62.4	93.6	49.7	74.6
	3	70.1	105	68.1	102	67.1	101	60.7	91.0	48.3	72.4
	4	67.4	101	65.5	98.2	64.5	96.7	58.3	87.5	46.3	69.5
	5	64.1	96.2	62.3	93.4	61.3	92.0	55.5	83.2	44.0	65.9
	6	60.3	90.4	58.5	87.8	57.7	86.5	52.1	78.2	41.2	61.8
	7	56.0	84.1	54.4	81.6	53.6	80.4	48.5	72.7	38.2	57.3
	8	51.5	77.3	50.0	75.0	49.3	73.9	44.5	66.8	35.0	52.5
	9	46.8	70.2	45.5	68.2	44.8	67.2	40.5	60.7	31.7	47.5
	10	42.1	63.1	40.9	61.3	40.3	60.4	36.4	54.6	28.3	42.5
	11	37.4	56.1	36.3	54.5	35.8	53.7	32.3	48.5	25.0	37.5
	12	32.9	49.3	31.9	47.9	31.5	47.2	28.4	42.6	21.9	32.8
	13	28.6	42.8	27.7	41.6	27.3	41.0	24.7	37.0	18.8	28.3
	14	24.6	36.9	23.9	35.9	23.6	35.3	21.3	31.9	16.3	24.4
	15	21.4	32.2	20.8	31.2	20.5	30.8	18.5	27.8	14.2	21.2
	16	18.8	28.3	18.3	27.5	18.0	27.0	16.3	24.4	12.4	18.7
	17	16.7	25.0	16.2	24.3	16.0	24.0	14.4	21.6	11.0	16.5
	18	14.9	22.3	14.5	21.7	14.2	21.4	12.9	19.3	9.83	14.7
	19	13.4	20.1	13.0	19.5	12.8	19.2	11.5	17.3	8.82	13.2
	20	12.1	18.1	11.7	17.6	11.5	17.3	10.4	15.6	7.96	11.9
	21	10.9	16.4	10.6	15.9	10.5	15.7	9.45	14.2	7.22	10.8
	22	10.0	15.0	9.68	14.5	9.54	14.3	8.61	12.9	6.58	9.87
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	6.60	9.91	6.33	9.51	6.19	9.31	5.34	8.03	3.67	5.51
$P_e(KL)^2/10^4$	kip-in.^{2}	158		154		151		137		105	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE
HSS18.000–
HSS16.000

Table 4–18
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS18.000×				HSS16.000×							
		0.500		0.375		0.625		0.500		0.438		0.375	
t_{design}, in.		0.465		0.349		0.581		0.465		0.407		0.349	
Steel Wt/ft		93.5		70.7		103		82.8		72.9		62.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	1080	1620	965	1450	1000	1500	900	1350	849	1270	797	1200
	6	1070	1600	953	1430	988	1480	888	1330	837	1250	785	1180
	7	1060	1600	949	1420	983	1480	883	1320	832	1250	781	1170
	8	1060	1590	944	1420	978	1470	878	1320	827	1240	776	1160
	9	1050	1580	939	1410	972	1460	872	1310	822	1230	771	1160
	10	1050	1570	933	1400	965	1450	866	1300	815	1220	765	1150
	11	1040	1560	926	1390	957	1440	858	1290	808	1210	758	1140
	12	1030	1550	919	1380	949	1420	851	1280	801	1200	751	1130
	13	1020	1540	911	1370	940	1410	842	1260	793	1190	743	1110
	14	1020	1520	903	1350	930	1400	834	1250	784	1180	735	1100
	15	1010	1510	894	1340	920	1380	824	1240	775	1160	726	1090
	16	997	1500	885	1330	910	1360	814	1220	766	1150	716	1070
	17	987	1480	875	1310	898	1350	804	1210	755	1130	707	1060
	18	976	1460	865	1300	887	1330	793	1190	745	1120	696	1040
	19	964	1450	854	1280	874	1310	781	1170	734	1100	686	1030
	20	952	1430	843	1260	862	1290	769	1150	722	1080	675	1010
	21	940	1410	831	1250	848	1270	757	1140	711	1070	663	995
	22	927	1390	819	1230	835	1250	745	1120	698	1050	651	977
	23	914	1370	807	1210	821	1230	732	1100	686	1030	639	959
	24	901	1350	794	1190	806	1210	718	1080	673	1010	627	940
	25	887	1330	781	1170	792	1190	704	1060	660	990	614	921
	26	873	1310	767	1150	777	1160	691	1040	646	969	601	902
	27	858	1290	754	1130	761	1140	676	1010	633	949	588	882
	28	843	1260	740	1110	746	1120	662	993	619	928	575	862
	29	828	1240	726	1090	730	1090	647	971	605	907	561	842
	30	813	1220	711	1070	714	1070	632	949	591	886	548	822
	32	781	1170	682	1020	681	1020	602	904	562	843	520	780
	34	749	1120	652	978	648	972	572	858	533	799	492	738
	36	717	1080	622	933	615	922	541	812	503	755	464	697
	38	684	1030	592	887	581	872	511	766	474	711	437	655
	40	651	976	561	842	548	822	481	721	445	668	409	614
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	300	450	228	343	289	435	235	353	207	312	179	269
$P_e(KL)^2/10^4$	kip-in.^{2}	41000		34300		32100		27600		25300		23000	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE
HSS16.000–HSS14.000

Shape	HSS16.000×				HSS14.000×							
	0.312		0.250		0.625		0.500		0.375		0.312	
t_{design}, in.	0.291		0.233		0.581		0.465		0.349		0.291	
Steel Wt/ft	52.3		42.1		89.4		72.2		54.6		45.7	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft) 0	745	1120	692	1040	822	1230	734	1100	644	967	599	899
6	733	1100	681	1020	808	1210	721	1080	632	948	587	881
7	729	1090	677	1020	802	1200	716	1070	628	942	583	875
8	725	1090	672	1010	797	1200	711	1070	623	934	578	867
9	719	1080	667	1000	790	1190	705	1060	617	926	573	859
10	713	1070	661	992	783	1170	698	1050	611	917	567	850
11	707	1060	655	982	775	1160	691	1040	604	907	560	841
12	700	1050	648	972	766	1150	683	1020	597	896	553	830
13	692	1040	641	961	757	1140	674	1010	589	884	546	819
14	684	1030	633	949	747	1120	665	998	581	871	538	807
15	675	1010	624	937	737	1110	656	984	572	858	529	794
16	666	1000	616	923	726	1090	646	969	563	844	520	780
17	657	985	606	909	714	1070	635	953	553	830	511	766
18	647	970	597	895	702	1050	624	936	543	814	501	752
19	637	955	587	880	690	1030	613	919	532	799	491	737
20	626	939	576	864	677	1020	601	901	522	782	481	721
21	615	922	565	848	664	995	589	883	510	766	470	705
22	603	905	554	831	650	975	576	864	499	748	459	688
23	592	888	543	814	636	954	563	845	487	731	448	672
24	580	870	531	797	621	932	550	825	475	713	436	654
25	567	851	519	779	607	910	537	805	463	695	425	637
26	555	832	507	761	592	888	523	785	451	676	413	619
27	542	814	495	743	577	866	510	765	438	657	401	602
28	529	794	483	724	562	843	496	744	426	639	389	584
29	517	775	470	706	547	820	482	723	413	620	377	566
30	503	755	458	687	531	797	468	702	400	601	365	548
32	477	715	432	649	500	750	440	660	375	563	341	511
34	450	675	407	610	469	704	412	618	350	525	317	476
36	424	635	382	572	438	657	384	576	325	487	294	440
38	397	596	356	535	408	612	357	535	300	451	271	406
40	371	557	332	498	378	567	330	495	277	415	248	372
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	151	226	121	182	220	331	179	268	136	205	115	172
$P_e(KL)^2/10^4$ kip-in.^{2}	20600		18100		20400		17700		14700		13100	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

5

COMPOSITE
HSS14.000–
HSS10.750

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS14.000×		HSS12.750×						HSS10.750×			
		0.250		0.500		0.375		0.250		0.500		0.375	
t_{design}, in.		0.233		0.465		0.349		0.233		0.465		0.349	
Steel Wt/ft		36.7		65.5		49.6		33.4		54.8		41.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	553	830	637	956	556	835	474	711	495	743	428	642
	6	542	813	624	936	544	816	462	694	481	721	415	623
	7	538	807	619	929	540	810	458	687	476	714	410	616
	8	533	800	614	921	535	802	454	680	470	705	405	608
	9	528	792	608	911	529	794	448	673	464	695	399	599
	10	522	783	601	901	523	784	443	664	456	685	393	589
	11	516	774	593	890	516	774	436	654	449	673	386	579
	12	509	763	585	878	509	763	429	644	440	660	379	568
	13	502	752	577	865	501	751	422	633	431	647	371	556
	14	494	741	568	851	492	739	414	622	422	633	362	543
	15	485	728	558	837	484	725	406	609	412	618	353	530
	16	477	715	548	822	474	711	398	597	402	602	344	516
	17	468	702	537	806	465	697	389	583	391	586	335	502
	18	458	688	526	789	455	682	380	570	380	570	325	487
	19	449	673	515	772	444	666	370	555	368	553	315	472
	20	439	658	503	754	433	650	360	541	357	535	304	456
	21	428	642	491	736	423	634	351	526	345	518	294	441
	22	418	626	478	718	411	617	340	511	333	500	283	425
	23	407	610	466	699	400	600	330	495	321	481	273	409
	24	396	594	453	680	388	583	320	479	309	463	262	393
	25	385	577	440	660	377	565	309	464	297	445	251	377
	26	374	560	427	640	365	547	298	448	285	427	241	361
	27	362	543	414	621	353	529	288	432	272	409	230	345
	28	351	526	400	601	341	512	277	416	260	391	219	329
	29	339	509	387	581	329	494	267	400	248	373	209	313
	30	328	492	374	561	317	476	256	384	237	355	199	298
	32	305	458	347	521	294	440	235	353	214	321	179	268
	34	283	424	321	482	270	406	215	322	192	288	159	239
	36	261	391	296	443	248	372	195	293	171	257	142	213
	38	239	359	271	406	226	339	176	264	153	230	128	191
	40	218	328	247	370	204	307	159	238	139	208	115	173
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	92.6	139	147	221	113	169	76.5	115	103	155	79.2	119
$P_e(KL)^2/10^4$	kip-in.^{2}	11500		13000		10700		8350		7270		6050	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE
HSS10.750–
HSS10.000

Shape		HSS10.750×		HSS10.000×									
		0.250		0.625		0.500		0.375		0.312		0.250	
t_{design}, in.		0.233		0.581		0.465		0.349		0.291		0.233	
Steel Wt/ft		28.1		62.6		50.8		38.6		32.3		26.1	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	359	538	507	760	446	669	384	575	352	528	320	480
	6	347	521	490	735	431	647	370	556	339	509	308	462
	7	343	514	484	726	426	639	366	549	335	502	304	455
	8	338	507	477	716	420	630	360	541	330	495	299	448
	9	333	499	470	704	413	620	355	532	324	487	294	440
	10	327	491	461	692	406	609	348	522	318	477	288	432
	11	321	481	452	678	398	597	341	512	312	468	281	422
	12	314	471	443	664	389	584	333	500	305	457	275	412
	13	307	460	432	649	380	570	325	488	297	446	268	401
	14	299	449	422	632	371	556	317	475	289	434	260	390
	15	291	437	410	615	361	541	308	462	281	421	252	378
	16	283	425	398	598	350	526	299	449	272	408	244	366
	17	275	412	386	579	340	509	290	434	263	395	236	354
	18	266	399	374	561	329	493	280	420	254	382	227	341
	19	257	385	361	542	317	476	270	405	245	368	219	328
	20	248	371	348	522	306	459	260	390	236	354	210	315
	21	238	358	335	502	294	441	250	375	226	339	201	302
	22	229	344	322	483	283	424	240	359	217	325	192	288
	23	220	330	308	463	271	406	229	344	207	311	183	275
	24	210	315	295	443	259	389	219	329	198	296	174	262
	25	201	301	282	423	247	371	209	313	188	282	166	248
	26	192	288	269	403	236	354	199	298	179	268	157	236
	27	182	274	256	383	224	336	189	283	170	254	148	223
	28	173	260	243	364	213	319	179	268	160	241	140	210
	29	164	247	230	345	202	303	169	254	152	227	132	198
	30	156	234	218	326	191	286	160	240	143	214	124	186
	32	139	208	193	290	170	254	141	212	126	189	109	163
	34	123	184	171	257	150	225	125	188	112	167	96.5	145
	36	110	164	153	229	134	201	112	167	99.5	149	86.1	129
	38	98.3	147	137	206	120	180	100	150	89.3	134	77.3	116
	40	88.7	133	124	186	109	163	90.4	136	80.6	121	69.7	105
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	54.0	81.2	108	163	88.7	133	68.2	102	57.5	86.4	46.6	70.0
$P_e(KL)^2/10^4$	kip-in.^{2}	4670		6510		5700		4750		4230		3660	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

5

COMPOSITE
HSS10.000–
HSS9.625

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS10.000×		HSS9.625×									
		0.188		0.500		0.375		0.312		0.250		0.188	
t_{design}, in.		0.174		0.465		0.349		0.291		0.233		0.174	
Steel Wt/ft		19.7		48.8		37.1		31.1		25.1		19.0	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	287	430	422	633	362	543	332	498	301	451	269	404
	6	275	413	407	610	349	523	319	479	289	433	258	386
	7	271	407	402	602	344	516	315	472	285	427	254	380
	8	267	400	395	593	339	508	310	465	280	420	249	374
	9	262	392	389	583	333	500	304	456	275	412	244	366
	10	256	384	381	572	327	490	298	447	269	403	238	358
	11	250	375	373	560	319	479	291	437	263	394	233	349
	12	244	365	365	547	312	468	284	426	256	384	226	339
	13	237	355	355	533	304	456	277	415	249	373	219	329
	14	230	345	346	519	296	443	269	403	241	362	212	319
	15	222	334	336	504	287	430	260	391	234	350	205	308
	16	215	322	325	488	278	417	252	378	226	338	198	296
	17	207	310	315	472	268	402	243	365	217	326	190	285
	18	199	298	304	456	259	388	234	351	209	313	182	273
	19	191	286	292	439	249	373	225	337	200	301	174	261
	20	183	274	281	422	239	359	216	324	192	288	166	249
	21	174	262	270	404	229	344	206	310	183	275	158	237
	22	166	249	258	387	219	329	197	296	174	262	150	225
	23	158	237	247	370	209	314	188	282	166	249	142	213
	24	150	225	235	353	199	299	179	268	157	236	134	202
	25	142	213	224	336	189	284	169	254	149	223	127	190
	26	134	201	212	319	180	269	160	241	141	211	119	179
	27	126	189	201	302	170	255	151	227	132	199	112	168
	28	118	178	190	286	160	241	143	214	124	187	105	157
	29	111	166	180	269	151	227	134	201	117	175	97.4	146
	30	104	156	169	254	142	213	126	189	109	163	91.1	137
	32	91.2	137	149	223	125	188	111	166	95.8	144	80.0	120
	34	80.8	121	132	198	111	166	97.9	147	84.9	127	70.9	106
	36	72.0	108	118	177	98.8	148	87.4	131	75.7	114	63.2	94.8
	38	64.6	97.0	106	158	88.7	133	78.4	118	67.9	102	56.8	85.1
	40	58.3	87.5	95.3	143	80.0	120	70.8	106	61.3	92.0	51.2	76.8
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	35.2	52.9	81.8	123	63.0	94.6	53.2	79.9	43.1	64.8	32.6	49.0
$P_e(KL)^2/10^4$	kip-in.^{2}	3070		5010		4200		3720		3230		2690	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE HSS8.625

Shape	HSS8.625×											
	0.625		0.500		0.375		0.322		0.250		0.188	
t_{design}, in.	0.581		0.465		0.349		0.300		0.233		0.174	
Steel Wt/ft	53.5		43.4		33.1		28.6		22.4		17.0	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	412	618	361	541	308	462	285	427	253	380	225	337
6	394	591	345	517	294	441	272	408	241	361	213	320
7	387	581	339	509	289	434	267	401	237	355	209	314
8	380	570	333	499	284	425	262	393	232	348	205	307
9	372	558	326	489	277	416	256	384	227	340	200	300
10	363	545	318	477	271	406	250	375	221	331	194	291
11	354	531	310	465	264	395	243	365	215	322	188	283
12	344	516	301	452	256	384	236	354	208	312	182	273
13	333	499	292	438	248	372	228	343	201	301	176	263
14	322	483	282	423	240	359	221	331	194	290	169	253
15	310	465	272	408	231	346	212	319	186	279	162	243
16	298	448	261	392	222	333	204	306	178	267	155	232
17	286	429	251	376	213	319	195	293	170	256	147	221
18	274	411	240	360	203	305	187	280	162	244	140	210
19	261	392	229	344	194	291	178	267	154	232	133	199
20	249	373	218	327	184	277	169	253	146	220	125	188
21	236	354	207	311	175	263	160	240	138	208	118	177
22	224	336	196	294	166	249	151	227	130	196	111	166
23	211	317	186	278	156	235	143	214	123	184	104	156
24	199	299	175	262	147	221	134	201	115	173	96.9	145
25	187	281	164	247	138	208	126	189	108	161	90.2	135
26	176	263	154	231	130	194	118	177	100	150	83.5	125
27	164	246	144	216	121	182	110	165	93.1	140	77.4	116
28	153	229	134	202	113	169	102	153	86.5	130	72.0	108
29	142	214	125	188	105	157	95.2	143	80.7	121	67.1	101
30	133	200	117	176	98.1	147	89.0	133	75.4	113	62.7	94.1
32	117	175	103	154	86.2	129	78.2	117	66.3	99.4	55.1	82.7
34	104	155	91.1	137	76.4	115	69.3	104	58.7	88.0	48.8	73.3
36	92.4	139	81.3	122	68.1	102	61.8	92.7	52.4	78.5	43.6	65.3
38	83.0	124	72.9	109	61.1	91.7	55.4	83.2	47.0	70.5	39.1	58.6
40	74.9	112	65.8	98.7	55.2	82.8	50.0	75.1	42.4	63.6	35.3	52.9
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	78.9	119	65.0	97.6	50.1	75.3	43.6	65.5	34.4	51.7	26.0	39.2
$P_e(KL)^2/10^4$ kip-in.^{2}	3930		3460		2890		2640		2230		1860	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

5

COMPOSITE
HSS7.625–
HSS7.500

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape	HSS7.625×				HSS7.500×							
	0.375		0.328		0.500		0.375		0.312		0.250	
t_{design}, in.	0.349		0.305		0.465		0.349		0.291		0.233	
Steel Wt/ft	29.1		25.6		37.4		28.6		24.0		19.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	257	386	239	359	296	445	251	376	228	342	204	306
6	242	364	225	338	279	419	236	354	214	321	191	287
7	237	356	221	331	273	410	231	347	209	314	187	281
8	232	347	215	323	266	400	225	338	204	306	182	273
9	225	338	209	314	259	388	219	329	198	298	177	265
10	218	328	203	304	251	376	212	318	192	288	171	257
11	211	317	196	294	242	363	205	307	185	278	165	247
12	203	305	189	283	233	350	197	296	178	267	158	237
13	195	293	181	272	224	335	189	283	171	256	151	227
14	187	280	173	260	214	321	181	271	163	245	144	217
15	178	267	165	248	204	306	172	258	155	233	137	206
16	170	254	157	236	193	290	163	245	147	221	130	195
17	161	241	149	223	183	275	154	232	139	209	123	184
18	152	228	141	211	173	259	146	219	131	197	115	173
19	143	214	132	199	162	244	137	205	123	185	108	162
20	134	201	124	186	152	228	128	192	115	173	101	151
21	126	188	116	174	142	213	120	180	108	162	93.8	141
22	117	176	108	162	132	199	111	167	100	150	86.9	130
23	109	163	101	151	123	184	103	155	92.7	139	80.3	120
24	101	151	93	140	113	170	95.3	143	85.5	128	73.8	111
25	92.9	139	85.7	129	105	157	87.8	132	78.8	118	68.0	102
26	85.9	129	79.2	119	96.6	145	81.2	122	72.8	109	62.9	94.3
27	79.6	119	73.5	110	89.6	134	75.3	113	67.5	101	58.3	87.4
28	74.0	111	68.3	102	83.3	125	70.0	105	62.8	94.2	54.2	81.3
29	69.0	104	63.7	95.5	77.7	116	65.3	97.9	58.5	87.8	50.5	75.8
30	64.5	96.8	59.5	89.3	72.6	109	61.0	91.5	54.7	82.0	47.2	70.8
32	56.7	85.0	52.3	78.5	63.8	95.7	53.6	80.4	48.1	72.1	41.5	62.2
34	50.2	75.3	46.3	69.5	56.5	84.7	47.5	71.2	42.6	63.9	36.8	55.1
36	44.8	67.2	41.3	62.0	50.4	75.6	42.3	63.5	38.0	57.0	32.8	49.2
38	40.2	60.3	37.1	55.6	45.2	67.8	38.0	57.0	34.1	51.1	29.4	44.1
40	36.3	54.4	33.5	50.2	40.8	61.2	34.3	51.5	30.8	46.2	26.6	39.8
Properties												
M_n/Ω_b $\phi_b M_n$ kip-ft	38.8	58.2	34.3	51.5	48.3	72.6	37.4	56.3	31.7	47.7	25.8	38.8
$P_e(KL)^2/10^4$ kip-in.^{2}	1900		1760		2150		1800		1610		1400	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE
HSS7.500–
HSS7.000

Shape		HSS7.500×		HSS7.000×							
		0.188		0.500		0.375		0.312		0.250	
t_{design}, in.		0.174		0.465		0.349		0.291		0.233	
Steel Wt/ft		14.7		34.7		26.6		22.3		18.0	
Design		P_n/Ω_c	ϕ_cP_n	P_n/Ω_c	ϕ_cP_n	P_n/Ω_c	ϕ_cP_n	P_n/Ω_c	ϕ_cP_n	P_n/Ω_c	ϕ_cP_n
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	180	269	269	404	227	341	206	308	184	275
	6	168	252	251	377	212	318	192	288	171	256
	7	164	246	245	368	207	310	187	280	167	250
	8	159	239	238	357	201	301	182	272	162	242
	9	154	231	231	346	194	292	176	264	156	234
	10	149	223	222	334	188	281	169	254	150	226
	11	143	215	214	320	180	270	163	244	144	216
	12	137	206	204	307	172	258	156	233	138	207
	13	131	196	195	292	164	246	148	222	131	197
	14	124	187	185	278	156	234	141	211	124	186
	15	118	177	175	263	147	221	133	199	117	176
	16	111	167	165	248	139	208	125	188	110	165
	17	105	157	155	232	130	196	117	176	103	155
	18	97.9	147	145	217	122	183	110	165	96.1	144
	19	91.3	137	135	202	114	170	102	153	89.3	134
	20	84.9	127	125	188	105	158	94.7	142	82.6	124
	21	78.6	118	116	174	97.4	146	87.4	131	76.1	114
	22	72.6	109	107	160	89.7	135	80.4	121	69.7	105
	23	66.5	99.8	97.7	147	82.1	123	73.6	110	63.8	95.7
	24	61.1	91.7	89.7	135	75.4	113	67.6	101	58.6	87.9
	25	56.3	84.5	82.7	124	69.5	104	62.3	93.4	54.0	81.0
	26	52.1	78.1	76.4	115	64.2	96.3	57.6	86.4	49.9	74.9
	27	48.3	72.4	70.9	106	59.6	89.3	53.4	80.1	46.3	69.4
	28	44.9	67.4	65.9	98.9	55.4	83.1	49.7	74.5	43.0	64.6
	29	41.9	62.8	61.5	92.2	51.6	77.4	46.3	69.4	40.1	60.2
	30	39.1	58.7	57.4	86.1	48.2	72.4	43.3	64.9	37.5	56.2
	32	34.4	51.6	50.5	75.7	42.4	63.6	38.0	57.0	33.0	49.4
	34	30.5	45.7	44.7	67.1	37.6	56.3	33.7	50.5	29.2	43.8
	36	27.2	40.7	39.9	59.8	33.5	50.3	30.0	45.1	26.0	39.1
	38	24.4	36.6	35.8	53.7	30.1	45.1	27.0	40.4	23.4	35.1
	40	22.0	33.0								
Properties											
M_n/Ω_b / ϕ_bM_n	kip-ft	19.6	29.4	41.7	62.7	32.4	48.7	27.5	41.3	22.4	33.6
$P_e(KL)^2/10^4$	kip-in.^{2}	1160		1700		1430		1280		1110	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE
HSS7.000–
HSS6.875

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS7.000×				HSS6.875×					
		0.188		0.125		0.500		0.375		0.312	
t_{design}, in.		0.174		0.116		0.465		0.349		0.291	
Steel Wt/ft		13.7		9.19		34.1		26.1		21.9	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	161	241	138	207	263	394	221	332	200	300
	6	149	224	127	191	244	367	206	309	186	279
	7	145	218	123	185	238	357	201	301	182	272
	8	141	211	119	179	231	347	195	292	176	264
	9	136	203	114	172	224	335	188	283	170	255
	10	130	195	109	164	215	323	181	272	164	246
	11	125	187	104	156	207	310	174	261	157	236
	12	119	178	98.8	148	197	296	166	249	150	225
	13	113	169	93.2	140	188	282	158	237	143	214
	14	106	159	87.5	131	178	267	150	225	135	203
	15	99.9	150	81.8	123	168	252	142	212	127	191
	16	93.6	140	76.1	114	158	237	133	200	120	180
	17	87.3	131	70.5	106	148	222	125	187	112	168
	18	81.1	122	65.0	97.5	138	207	116	174	104	157
	19	74.9	112	59.6	89.4	128	193	108	162	97.0	146
	20	69.0	104	54.4	81.7	119	178	99.9	150	89.7	135
	21	63.3	94.9	49.4	74.1	110	164	92.1	138	82.6	124
	22	57.7	86.5	45.0	67.5	100	151	84.4	127	75.6	113
	23	52.8	79.1	41.2	61.8	91.9	138	77.2	116	69.2	104
	24	48.5	72.7	37.8	56.7	84.4	127	70.9	106	63.6	95.3
	25	44.7	67.0	34.9	52.3	77.8	117	65.3	98.0	58.6	87.9
	26	41.3	61.9	32.2	48.3	71.9	108	60.4	90.6	54.2	81.2
	27	38.3	57.4	29.9	44.8	66.7	100	56.0	84.0	50.2	75.3
	28	35.6	53.4	27.8	41.7	62.0	93.0	52.1	78.1	46.7	70.0
	29	33.2	49.8	25.9	38.9	57.8	86.7	48.6	72.8	43.5	65.3
	30	31.0	46.5	24.2	36.3	54.0	81.0	45.4	68.1	40.7	61.0
	32	27.3	40.9	21.3	31.9	47.5	71.2	39.9	59.8	35.8	53.6
	34	24.1	36.2	18.8	28.3	42.1	63.1	35.3	53.0	31.7	47.5
	36	21.5	32.3	16.8	25.2	37.5	56.3	31.5	47.3	28.3	42.4
	38	19.3	29.0	15.1	22.6			28.3	42.4	25.4	38.0
	40	17.4	26.2	13.6	20.4						
Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	17.0	25.5	11.5	17.3	40.1	60.3	31.2	46.9	26.5	39.8
$P_e(KL)^2/10^4$	kip-in.^{2}	916		716		1600		1340		1200	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE HSS6.875–HSS6.625

Shape		HSS6.875×				HSS6.625×					
		0.250		0.188		0.500		0.432		0.375	
t_{design}, in.		0.233		0.174		0.465		0.402		0.349	
Steel Wt/ft		17.7		13.4		32.7		28.6		25.1	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	179	268	156	235	249	374	228	342	210	315
	6	166	249	145	217	231	347	211	317	194	292
	7	162	242	141	211	225	337	206	308	189	284
	8	157	235	136	204	218	326	199	299	183	275
	9	151	227	131	197	210	315	192	288	177	265
	10	145	218	126	189	201	302	184	277	170	254
	11	139	209	120	180	193	289	176	264	162	243
	12	133	199	114	171	183	275	168	252	154	231
	13	126	189	108	162	174	261	159	239	146	219
	14	119	179	102	153	164	246	150	225	138	207
	15	112	168	95.6	143	154	231	141	212	130	195
	16	105	158	89.4	134	144	217	132	198	121	182
	17	98.4	148	83.2	125	135	202	123	185	113	170
	18	91.5	137	77.0	116	125	187	114	171	105	157
	19	84.8	127	71.1	107	115	173	106	158	97.0	145
	20	78.3	117	65.2	97.9	106	159	97.2	146	89.2	134
	21	71.9	108	59.6	89.3	97.2	146	89.0	134	81.7	123
	22	65.6	98.5	54.3	81.4	88.6	133	81.1	122	74.4	112
	23	60.1	90.1	49.7	74.5	81.0	122	74.2	111	68.1	102
	24	55.2	82.7	45.6	68.4	74.4	112	68.1	102	62.5	93.8
	25	50.8	76.3	42.0	63.0	68.6	103	62.8	94.2	57.6	86.4
	26	47.0	70.5	38.9	58.3	63.4	95.1	58.1	87.1	53.3	79.9
	27	43.6	65.4	36.0	54.0	58.8	88.2	53.8	80.8	49.4	74.1
	28	40.5	60.8	33.5	50.3	54.7	82.0	50.1	75.1	45.9	68.9
	29	37.8	56.7	31.2	46.8	51.0	76.5	46.7	70.0	42.8	64.2
	30	35.3	53.0	29.2	43.8	47.6	71.4	43.6	65.4	40.0	60.0
	32	31.0	46.5	25.7	38.5	41.9	62.8	38.3	57.5	35.2	52.8
	34	27.5	41.2	22.7	34.1	37.1	55.6	34.0	50.9	31.2	46.7
	36	24.5	36.8	20.3	30.4	33.1	49.6	30.3	45.4	27.8	41.7
	38	22.0	33.0	18.2	27.3						
Properties											
M_n/Ω_b / $\phi_b M_n$	kip-ft	21.6	32.4	16.4	24.6	37.1	55.7	32.7	49.1	28.8	43.3
$P_e(KL)^2/10^4$	kip-in.^{2}	1040		863		1410		1290		1180	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE
HSS6.625

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS6.625×									
		0.312		0.280		0.250		0.188		0.125	
t_{design}, in.		0.291		0.260		0.233		0.174		0.116	
Steel Wt/ft		21.1		19.0		17.0		12.9		8.69	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	190	285	179	268	169	254	148	221	126	189
	6	176	263	165	248	156	234	136	203	115	172
	7	171	256	161	241	152	228	132	197	111	167
	8	165	248	156	233	147	220	127	191	107	160
	9	159	239	150	225	141	212	122	183	102	154
	10	153	229	144	216	136	203	117	175	97.5	146
	11	146	219	137	206	129	194	111	167	92.4	139
	12	139	209	131	196	123	184	105	158	87.1	131
	13	132	198	124	186	116	175	99.4	149	81.7	123
	14	124	186	117	175	110	164	93.4	140	76.3	114
	15	117	175	110	164	103	154	87.2	131	70.8	106
	16	109	164	102	154	96.0	144	81.2	122	65.4	98.1
	17	102	153	95.4	143	89.2	134	75.1	113	60.1	90.1
	18	94.3	141	88.4	133	82.6	124	69.2	104	54.9	82.4
	19	87.1	131	81.6	122	76.1	114	63.5	95.3	50.0	74.9
	20	80.0	120	74.9	112	69.8	105	58.0	87.0	45.1	67.7
	21	73.2	110	68.5	103	63.7	95.5	52.6	78.9	40.9	61.4
	22	66.7	100	62.4	93.6	58.0	87.0	47.9	71.9	37.3	55.9
	23	61.0	91.5	57.1	85.6	53.1	79.6	43.8	65.8	34.1	51.2
	24	56.0	84.1	52.4	78.6	48.7	73.1	40.3	60.4	31.3	47.0
	25	51.6	77.5	48.3	72.4	44.9	67.4	37.1	55.7	28.9	43.3
	26	47.7	71.6	44.7	67.0	41.5	62.3	34.3	51.5	26.7	40.0
	27	44.3	66.4	41.4	62.1	38.5	57.8	31.8	47.7	24.8	37.1
	28	41.2	61.8	38.5	57.8	35.8	53.7	29.6	44.4	23.0	34.5
	29	38.4	57.6	35.9	53.8	33.4	50.1	27.6	41.4	21.5	32.2
	30	35.9	53.8	33.5	50.3	31.2	46.8	25.8	38.7	20.1	30.1
	32	31.5	47.3	29.5	44.2	27.4	41.1	22.7	34.0	17.6	26.4
	34	27.9	41.9	26.1	39.2	24.3	36.4	20.1	30.1	15.6	23.4
	36	24.9	37.4	23.3	34.9	21.7	32.5	17.9	26.8	13.9	20.9
	38							16.1	24.1	12.5	18.7
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	24.5	36.8	22.1	33.2	20.0	30.0	15.2	22.8	10.3	15.5
$P_e(KL)^2/10^4$	kip-in.^{2}	1060		991		922		762		593	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE HSS6.000

Shape		HSS6.000×											
		0.500		0.375		0.312		0.280		0.250		0.188	
t_{design}, in.		0.465		0.349		0.291		0.260		0.233		0.174	
Steel Wt/ft		29.4		22.5		19.0		17.1		15.4		11.7	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	218	327	183	274	164	247	154	232	146	219	126	190
	1	217	326	182	273	164	246	154	231	145	218	126	189
	2	215	323	181	271	163	244	153	229	144	216	125	188
	3	213	319	178	267	161	241	151	226	142	214	123	185
	4	209	313	175	263	158	236	148	222	140	210	121	181
	5	204	306	171	257	154	231	145	217	136	205	118	177
	6	198	297	166	249	150	224	141	211	133	199	114	172
	7	192	287	161	241	145	217	136	204	128	192	110	165
	8	184	276	155	232	139	209	131	196	123	185	106	159
	9	176	264	148	222	133	199	125	187	118	176	101	151
	10	168	252	141	211	127	190	119	178	112	168	95.7	144
	11	159	238	133	200	120	180	112	169	106	159	90.2	135
	12	149	224	125	188	113	169	106	159	99.5	149	84.6	127
	13	140	210	118	176	106	158	99.0	149	93.1	140	78.9	118
	14	131	196	110	164	98.4	148	92.2	138	86.7	130	73.2	110
	15	121	181	102	152	91.2	137	85.4	128	80.3	120	67.5	101
	16	112	167	93.7	141	84.1	126	78.7	118	73.9	111	61.9	92.9
	17	102	154	86.0	129	77.1	116	72.2	108	67.7	102	56.5	84.7
	18	93.4	140	78.5	118	70.4	106	65.8	98.7	61.7	92.6	51.2	76.8
	19	84.8	127	71.3	107	63.8	95.8	59.7	89.5	55.9	83.8	46.1	69.1
	20	76.5	115	64.3	96.5	57.6	86.4	53.8	80.8	50.4	75.7	41.6	62.4
	21	69.4	104	58.4	87.5	52.3	78.4	48.8	73.3	45.7	68.6	37.7	56.6
	22	63.2	94.8	53.2	79.8	47.6	71.4	44.5	66.8	41.7	62.5	34.4	51.6
	23	57.9	86.8	48.6	73.0	43.6	65.4	40.7	61.1	38.1	57.2	31.5	47.2
	24	53.1	79.7	44.7	67.0	40.0	60.0	37.4	56.1	35.0	52.5	28.9	43.3
	25	49.0	73.4	41.2	61.8	36.9	55.3	34.5	51.7	32.3	48.4	26.6	39.9
	26	45.3	67.9	38.1	57.1	34.1	51.1	31.9	47.8	29.8	44.8	24.6	36.9
	28	39.0	58.6	32.8	49.2	29.4	44.1	27.5	41.2	25.7	38.6	21.2	31.8
	30	34.0	51.0	28.6	42.9	25.6	38.4	23.9	35.9	22.4	33.6	18.5	27.7
	32	29.9	44.8	25.1	37.7	22.5	33.8	21.0	31.6	19.7	29.6	16.2	24.4
	34									17.5	26.2	14.4	21.6
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	29.9	45.0	23.4	35.2	19.9	29.9	18.0	27.0	16.2	24.4	12.4	18.6
$P_e(KL)^2/10^4$	kip-in.^{2}	1010		845		757		707		662		546	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

5

COMPOSITE
HSS6.000–
HSS5.563

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape	HSS6.000×		HSS5.563×									
	0.125		0.500		0.375		0.258		0.188		0.134	
t_{design}, in.	0.116		0.465		0.349		0.240		0.174		0.124	
Steel Wt/ft	7.85		27.1		20.8		14.6		10.8		7.78	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft) 0	107	161	196	295	164	246	132	199	113	169	97.2	146
1	107	160	196	294	164	246	132	198	112	168	96.9	145
2	106	159	194	291	162	243	131	196	111	167	95.9	144
3	104	156	191	287	160	240	129	193	109	164	94.2	141
4	102	153	187	281	156	235	126	189	107	160	92.0	138
5	99.2	149	182	273	152	228	123	184	104	156	89.2	134
6	95.9	144	176	264	147	221	119	178	100	151	85.9	129
7	92.2	138	169	254	142	212	114	171	96.3	144	82.1	123
8	88.1	132	162	242	135	203	109	163	91.7	138	78.0	117
9	83.6	125	153	230	128	193	103	155	86.9	130	73.6	110
10	78.9	118	145	217	121	182	97.5	146	81.8	123	68.9	103
11	74.0	111	136	204	114	171	91.4	137	76.5	115	64.2	96.2
12	69.0	104	127	190	106	159	85.2	128	71.0	107	59.3	88.9
13	63.9	95.9	117	176	98.4	148	78.9	118	65.6	98.4	54.4	81.6
14	58.9	88.3	108	162	90.7	136	72.7	109	60.1	90.2	49.6	74.4
15	53.9	80.9	98.9	148	83.1	125	66.5	99.7	54.8	82.2	44.9	67.3
16	49.0	73.6	90.0	135	75.7	113	60.5	90.7	49.6	74.5	40.4	60.5
17	44.3	66.5	81.4	122	68.5	103	54.7	82.0	44.7	67.0	36.0	53.9
18	39.8	59.6	73.0	109	61.5	92.2	49.0	73.5	39.9	59.8	32.1	48.1
19	35.7	53.5	65.5	98.3	55.2	82.7	44.0	66.0	35.8	53.7	28.8	43.2
20	32.2	48.3	59.1	88.7	49.8	74.7	39.7	59.5	32.3	48.4	26.0	39.0
21	29.2	43.8	53.6	80.4	45.2	67.7	36.0	54.0	29.3	43.9	23.6	35.3
22	26.6	39.9	48.9	73.3	41.1	61.7	32.8	49.2	26.7	40.0	21.5	32.2
23	24.4	36.5	44.7	67.1	37.6	56.5	30.0	45.0	24.4	36.6	19.6	29.5
24	22.4	33.6	41.1	61.6	34.6	51.9	27.6	41.3	22.4	33.6	18.0	27.1
25	20.6	30.9	37.8	56.8	31.9	47.8	25.4	38.1	20.7	31.0	16.6	24.9
26	19.1	28.6	35.0	52.5	29.5	44.2	23.5	35.2	19.1	28.7	15.4	23.1
28	16.4	24.6	30.2	45.3	25.4	38.1	20.2	30.4	16.5	24.7	13.3	19.9
30	14.3	21.5	26.3	39.4	22.1	33.2	17.6	26.5	14.4	21.5	11.5	17.3
32	12.6	18.9									10.1	15.2
34	11.1	16.7										
Properties												
M_n/Ω_b | $\phi_b M_n$ kip-ft	8.42	12.7	25.4	38.2	19.9	29.9	14.3	21.4	10.6	15.9	7.69	11.6
$P_e(KL)^2/10^4$ kip-in.^{2}	423		776		654		521		425		341	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates *Kl/r* equal to or greater than 200.

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE
HSS5.500–HSS5.000

Shape	HSS5.500×						HSS5.000×					
	0.500		0.375		0.258		0.500		0.375		0.312	
t_{design}, in.	0.465		0.349		0.240		0.465		0.349		0.291	
Steel Wt/ft	26.7		20.5		14.5		24.1		18.5		15.6	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)												
0	193	290	162	242	130	195	170	255	142	212	127	190
1	193	289	161	242	130	195	169	254	141	212	126	190
2	191	287	160	239	129	193	167	251	139	209	125	187
3	188	282	157	236	127	190	164	246	137	205	123	184
4	184	276	154	231	124	186	160	240	133	200	119	179
5	179	268	150	224	120	181	155	232	129	193	115	173
6	173	259	145	217	116	175	148	222	124	186	111	166
7	166	249	139	208	112	168	141	212	118	177	106	158
8	158	238	133	199	107	160	133	200	111	167	99.8	150
9	150	225	126	189	101	152	125	187	105	157	93.6	140
10	142	212	119	178	95.3	143	116	174	97.3	146	87.2	131
11	133	199	111	167	89.2	134	107	161	90.0	135	80.6	121
12	123	185	103	155	83.0	124	98.4	148	82.5	124	73.9	111
13	114	171	95.8	144	76.7	115	89.5	134	75.1	113	67.3	101
14	105	157	88.1	132	70.5	106	80.7	121	67.9	102	60.8	91.2
15	95.8	144	80.5	121	64.4	96.6	72.3	108	60.9	91.4	54.5	81.8
16	87.0	131	73.1	110	58.4	87.7	64.2	96.2	54.1	81.2	48.5	72.7
17	78.5	118	66.0	99.1	52.7	79.1	56.8	85.2	48.0	71.9	43.0	64.4
18	70.2	105	59.1	88.7	47.1	70.7	50.7	76.0	42.8	64.2	38.3	57.5
19	63.0	94.5	53.1	79.6	42.3	63.5	45.5	68.2	38.4	57.6	34.4	51.6
20	56.9	85.3	47.9	71.8	38.2	57.3	41.1	61.6	34.7	52.0	31.0	46.6
21	51.6	77.4	43.4	65.2	34.6	51.9	37.2	55.9	31.4	47.1	28.2	42.2
22	47.0	70.5	39.6	59.4	31.6	47.3	33.9	50.9	28.6	43.0	25.7	38.5
23	43.0	64.5	36.2	54.3	28.9	43.3	31.0	46.6	26.2	39.3	23.5	35.2
24	39.5	59.2	33.3	49.9	26.5	39.8	28.5	42.8	24.1	36.1	21.6	32.3
25	36.4	54.6	30.7	46.0	24.4	36.7	26.3	39.4	22.2	33.3	19.9	29.8
26	33.7	50.5	28.3	42.5	22.6	33.9	24.3	36.4	20.5	30.8	18.4	27.5
28	29.0	43.5	24.4	36.7	19.5	29.2						
30			21.3	31.9	17.0	25.5						
Properties												
M_n/Ω_b / $\phi_b M_n$ kip-ft	24.8	37.2	19.4	29.2	13.9	20.9	20.1	30.2	15.9	23.8	13.5	20.4
$P_e(KL)^2/10^4$ kip-in.^{2}	747		629		501		540		455		408	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

5

COMPOSITE
HSS5.000–
HSS4.500

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS5.000×								HSS4.500×			
		0.258		0.250		0.188		0.125		0.375		0.337	
t_{design}, in.		0.240		0.233		0.174		0.116		0.349		0.313	
Steel Wt/ft		13.1		12.7		9.67		6.51		16.5		15.0	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	113	170	112	167	95.8	144	79.8	120	123	184	114	172
	1	113	170	111	167	95.4	143	79.4	119	122	183	114	171
	2	112	168	110	165	94.3	141	78.4	118	120	180	112	169
	3	110	165	108	162	92.5	139	76.8	115	118	176	110	165
	4	107	160	105	158	90.0	135	74.6	112	114	171	106	159
	5	103	155	102	152	86.9	130	71.8	108	109	164	102	153
	6	99.1	149	97.4	146	83.3	125	68.6	103	104	156	96.9	145
	7	94.3	141	92.8	139	79.2	119	64.9	97.4	97.6	146	91.2	137
	8	89.1	134	87.7	131	74.7	112	60.9	91.4	91.0	137	85.1	128
	9	83.6	125	82.2	123	69.9	105	56.7	85.1	84.1	126	78.7	118
	10	77.8	117	76.5	115	64.9	97.4	52.4	78.5	77.0	116	72.0	108
	11	71.9	108	70.7	106	59.8	89.8	47.9	71.9	69.9	105	65.4	98.1
	12	65.9	98.9	64.8	97.2	54.7	82.1	43.5	65.3	62.8	94.2	58.8	88.1
	13	60.0	90.0	59.0	88.4	49.7	74.5	39.2	58.7	55.9	83.9	52.3	78.5
	14	54.2	81.3	53.2	79.9	44.7	67.1	34.9	52.4	49.3	74.0	46.2	69.3
	15	48.6	72.9	47.7	71.6	39.9	59.9	30.9	46.4	43.1	64.6	40.3	60.5
	16	43.1	64.7	42.4	63.6	35.3	53.0	27.2	40.7	37.8	56.8	35.4	53.2
	17	38.2	57.3	37.5	56.3	31.3	47.0	24.1	36.1	33.5	50.3	31.4	47.1
	18	34.1	51.1	33.5	50.2	27.9	41.9	21.5	32.2	29.9	44.8	28.0	42.0
	19	30.6	45.9	30.1	45.1	25.1	37.6	19.3	28.9	26.8	40.3	25.1	37.7
	20	27.6	41.4	27.1	40.7	22.6	33.9	17.4	26.1	24.2	36.3	22.7	34.0
	21	25.0	37.6	24.6	36.9	20.5	30.8	15.8	23.7	22.0	33.0	20.6	30.9
	22	22.8	34.2	22.4	33.6	18.7	28.0	14.4	21.6	20.0	30.0	18.8	28.1
	23	20.9	31.3	20.5	30.8	17.1	25.7	13.1	19.7	18.3	27.5	17.2	25.7
	24	19.2	28.8	18.8	28.3	15.7	23.6	12.1	18.1	16.8	25.2	15.8	23.6
	25	17.7	26.5	17.4	26.0	14.5	21.7	11.1	16.7				
	26	16.3	24.5	16.1	24.1	13.4	20.1	10.3	15.4				
	28	14.1	21.1	13.8	20.8	11.5	17.3	8.87	13.3				
Properties													
M_n/Ω_b | $\phi_b M_n$	kip-ft	11.4	17.1	11.1	16.7	8.50	12.8	5.80	8.72	12.6	19.0	11.5	17.3
$P_e(KL)^2/10^4$	kip-in.^{2}	363		356		297		229		318		298	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.											
$\Omega_c = 2.00$	$\phi_c = 0.75$												

F_y = 42 ksi
f'_c = 5 ksi

Table 4–18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

5
COMPOSITE
HSS4.500–
HSS4.000

Shape		HSS4.500×						HSS4.000×			
		0.237		0.188		0.125		0.313		0.250	
t_{design}, in.		0.220		0.174		0.116		0.291		0.233	
Steel Wt/ft		10.8		8.67		5.85		12.3		10.0	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	92.9	139	81.8	123	67.5	101	93.0	139	81.2	122
	1	92.4	139	81.4	122	67.2	101	92.5	139	80.7	121
	2	91.2	137	80.3	120	66.2	99.3	90.8	136	79.3	119
	3	89.1	134	78.4	118	64.5	96.8	88.2	132	77.0	116
	4	86.2	129	75.9	114	62.3	93.4	84.7	127	73.9	111
	5	82.7	124	72.7	109	59.5	89.2	80.3	120	70.1	105
	6	78.5	118	69.0	104	56.2	84.4	75.3	113	65.8	98.6
	7	73.9	111	64.9	97.4	52.6	79.0	69.8	105	60.9	91.4
	8	69.0	103	60.5	90.7	48.8	73.2	63.9	95.8	55.8	83.7
	9	63.7	95.6	55.8	83.7	44.7	67.1	57.8	86.7	50.5	75.8
	10	58.3	87.5	51.0	76.6	40.6	60.9	51.7	77.6	45.2	67.8
	11	52.9	79.3	46.2	69.3	36.5	54.8	45.7	68.6	40.0	60.0
	12	47.5	71.3	41.5	62.2	32.5	48.7	40.0	60.0	34.9	52.4
	13	42.3	63.5	36.9	55.3	28.6	42.9	34.4	51.7	30.1	45.2
	14	37.3	56.0	32.5	48.7	24.9	37.3	29.7	44.5	26.0	38.9
	15	32.6	48.9	28.3	42.4	21.7	32.5	25.9	38.8	22.6	33.9
	16	28.6	42.9	24.9	37.3	19.1	28.6	22.7	34.1	19.9	29.8
	17	25.4	38.0	22.0	33.0	16.9	25.3	20.1	30.2	17.6	26.4
	18	22.6	33.9	19.6	29.5	15.1	22.6	18.0	26.9	15.7	23.6
	19	20.3	30.4	17.6	26.4	13.5	20.3	16.1	24.2	14.1	21.1
	20	18.3	27.5	15.9	23.9	12.2	18.3	14.6	21.8	12.7	19.1
	21	16.6	24.9	14.4	21.7	11.1	16.6	13.2	19.8	11.5	17.3
	22	15.1	22.7	13.2	19.7	10.1	15.1	12.0	18.0	10.5	15.8
	23	13.9	20.8	12.0	18.0	9.22	13.8				
	24	12.7	19.1	11.1	16.6	8.47	12.7				
	25	11.7	17.6	10.2	15.3	7.81	11.7				

Properties											
M_n/Ω_b	$\phi_b M_n$ kip-ft	8.45	12.7	6.83	10.3	4.67	7.02	8.41	12.6	6.94	10.4
$P_e(KL)^2/10^4$	kip-in.^{2}	240		209		160		192		167	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

5

COMPOSITE HSS4.000

Table 4-18 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Round HSS

F_y = 42 ksi
f'_c = 5 ksi

Shape		HSS4.000× 0.237		HSS4.000× 0.226		HSS4.000× 0.220		HSS4.000× 0.188		HSS4.000× 0.125	
t_{design}, in.		0.220		0.210		0.205		0.174		0.116	
Steel Wt/ft		9.53		9.12		8.89		7.66		5.18	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	78.5	118	76.4	115	75.4	113	68.8	103	56.2	84.3
	1	78.0	117	76.0	114	74.9	112	68.4	103	55.9	83.8
	2	76.7	115	74.6	112	73.6	110	67.2	101	54.8	82.2
	3	74.5	112	72.5	109	71.5	107	65.2	97.8	53.1	79.7
	4	71.5	107	69.6	104	68.6	103	62.6	93.9	50.8	76.3
	5	67.8	102	66.0	99.0	65.1	97.6	59.3	89.0	48.0	72.1
	6	63.6	95.3	61.9	92.8	61.0	91.5	55.6	83.4	44.8	67.3
	7	58.9	88.3	57.3	86.0	56.5	84.8	51.5	77.2	41.3	62.0
	8	53.9	80.9	52.5	78.7	51.7	77.6	47.1	70.6	37.6	56.4
	9	48.8	73.2	47.5	71.2	46.8	70.2	42.6	63.9	33.8	50.7
	10	43.7	65.5	42.5	63.7	41.9	62.8	38.1	57.1	30.0	45.0
	11	38.6	57.9	37.5	56.3	37.0	55.5	33.6	50.4	26.3	39.4
	12	33.7	50.6	32.8	49.2	32.3	48.5	29.3	44.0	22.8	34.1
	13	29.1	43.6	28.3	42.4	27.9	41.8	25.2	37.8	19.4	29.2
	14	25.1	37.6	24.4	36.6	24.0	36.0	21.8	32.6	16.8	25.2
	15	21.8	32.8	21.2	31.8	20.9	31.4	19.0	28.4	14.6	21.9
	16	19.2	28.8	18.7	28.0	18.4	27.6	16.7	25.0	12.8	19.3
	17	17.0	25.5	16.5	24.8	16.3	24.4	14.8	22.1	11.4	17.1
	18	15.2	22.7	14.7	22.1	14.5	21.8	13.2	19.7	10.1	15.2
	19	13.6	20.4	13.2	19.8	13.0	19.6	11.8	17.7	9.10	13.7
	20	12.3	18.4	11.9	17.9	11.8	17.7	10.7	16.0	8.22	12.3
	21	11.1	16.7	10.8	16.2	10.7	16.0	9.67	14.5	7.45	11.2
	22	10.2	15.2	9.87	14.8	9.73	14.6	8.81	13.2	6.79	10.2

Properties

M_n/Ω_b	$\phi_b M_n$ kip-ft	6.60	9.91	6.33	9.51	6.19	9.31	5.34	8.03	3.67	5.51
$P_e(KL)^2/10^4$	kip-in.^{2}	161		157		154		140		108	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 35 ksi
f'_c = 4 ksi

Table 4–19
Available Strength in Axial Compression, kips
Concrete Filled Pipe

4

COMPOSITE PIPE 12–PIPE 8

Shape		Pipe 12				Pipe 10				Pipe 8			
		XS		Std		XS		Std		XXS		XS	
Wall Thickness, in.		0.465		0.349		0.465		0.340		0.816		0.465	
Steel Wt/ft		65.5		49.6		54.8		40.5		72.5		43.4	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	523	784	455	682	407	610	346	519	423	635	297	445
	6	513	770	446	669	397	595	337	506	407	611	286	429
	7	510	765	443	665	393	590	334	501	401	602	282	423
	8	506	759	440	659	389	584	330	495	395	593	278	416
	9	502	753	436	654	385	577	326	489	388	582	273	409
	10	497	746	431	647	380	570	322	483	380	570	267	401
	11	492	738	427	640	374	561	317	476	372	558	261	392
	12	486	729	421	632	368	553	312	468	363	544	255	383
	13	480	720	416	624	362	543	306	459	353	530	249	373
	14	474	711	410	615	355	533	300	451	343	515	242	362
	15	467	701	404	606	348	523	294	441	333	499	234	351
	16	460	690	397	596	341	511	288	432	322	483	227	340
	17	452	678	390	586	333	500	281	421	311	466	219	328
	18	444	667	383	575	325	488	274	411	299	449	211	317
	19	436	655	376	564	317	476	267	400	288	431	203	304
	20	428	642	368	552	309	463	259	389	276	414	195	292
	21	419	629	360	541	300	450	252	378	264	396	187	280
	22	410	616	352	528	291	437	244	366	252	378	178	267
	23	401	602	344	516	282	424	236	355	240	361	170	255
	24	392	588	336	503	273	410	228	343	229	343	162	243
	25	382	574	327	491	264	397	221	331	217	325	154	231
	26	373	559	318	478	255	383	213	319	205	308	146	218
	27	363	545	310	464	246	369	205	307	194	291	138	207
	28	353	530	301	451	237	355	197	295	183	275	130	195
	29	343	515	292	438	228	342	189	283	172	258	122	184
	30	333	500	283	424	219	328	181	271	161	242	115	172
	32	313	470	265	398	201	301	166	248	142	213	101	151
	34	293	440	247	371	183	275	150	226	126	189	89.5	134
	36	274	410	230	345	166	250	136	204	112	168	79.8	120
	38	254	381	212	319	150	225	122	183	101	151	71.6	107
	40	235	353	196	294	135	203	110	165	90.8	136	64.6	97.0
Properties													
M_n/Ω_b $\phi_b M_n$	kip-ft	123	184	93.8	141	86.0	129	64.4	96.8	87.2	131	54.1	81.4
$P_e(KL)^2/10^4$	kip-in.^{2}	12600		10400		7110		5790		4770		3400	
ASD	LRFD												
$\Omega_c = 2.00$	$\phi_c = 0.75$												

4

COMPOSITE
PIPE 8–PIPE 5

Table 4–19 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

F_y = 35 ksi
f'_c = 4 ksi

Shape		Pipe 8		Pipe 6						Pipe 5	
		Std		XXS		XS		Std		XXS	
Wall Thickness, in.		0.300		0.805		0.403		0.261		0.699	
Steel Wt/ft		28.6		53.2		28.6		19.0		38.6	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (KL) (ft)	0	233	350	295	442	188	283	147	220	213	320
	6	224	337	276	414	177	265	138	206	194	291
	7	221	332	269	404	173	259	134	202	187	281
	8	218	326	262	393	168	252	131	196	180	270
	9	214	320	254	380	163	245	127	190	172	258
	10	209	314	245	367	158	236	122	184	163	245
	11	204	307	235	353	152	228	118	177	155	232
	12	199	299	226	338	146	219	113	169	145	218
	13	194	291	215	323	139	209	108	162	136	204
	14	188	282	205	307	133	199	103	154	127	190
	15	182	273	194	291	126	189	97.4	146	117	176
	16	176	264	183	275	119	179	92.0	138	108	162
	17	170	255	172	259	112	169	86.6	130	98.9	148
	18	163	245	162	242	106	158	81.2	122	90.2	135
	19	157	235	151	226	98.8	148	75.9	114	81.6	122
	20	150	226	140	210	92.2	138	70.7	106	73.7	110
	21	144	216	130	195	85.7	129	65.6	98.4	66.8	100
	22	137	206	120	180	79.3	119	60.6	91.0	60.9	91.3
	23	130	196	110	165	73.2	110	55.8	83.6	55.7	83.5
	24	124	186	101	152	67.2	101	51.2	76.8	51.1	76.7
	25	117	176	93.2	140	61.9	92.9	47.2	70.8	47.1	70.7
	26	111	166	86.2	129	57.2	85.9	43.6	65.4	43.6	65.4
	27	105	157	79.9	120	53.1	79.6	40.5	60.7	40.4	60.6
	28	98.5	148	74.3	112	49.4	74.0	37.6	56.4	37.6	56.4
	29	92.5	139	69.3	104	46.0	69.0	35.1	52.6	35.0	52.5
	30	86.5	130	64.8	97.1	43.0	64.5	32.8	49.2		
	32	76.1	114	56.9	85.4	37.8	56.7	28.8	43.2		
	34	67.4	101	50.4	75.6	33.5	50.2	25.5	38.3		
	36	60.1	90.1			29.9	44.8	22.8	34.1		
	38	53.9	80.9								
	40	48.7	73.0								
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	36.3	54.6	47.9	72.0	27.3	41.0	18.5	27.8	29.1	43.7
$P_e(KL)^2/10^4$	kip-in.^{2}	2560		1920		1270		969		968	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 35 ksi
f'_c = 4 ksi

Table 4–19 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

4
COMPOSITE
PIPE 5–PIPE 4

Shape		Pipe 5				Pipe 4					
		XS		Std		XXS		XS		Std	
Wall Thickness, in.		0.349		0.241		0.628		0.315		0.221	
Steel Wt/ft		20.8		14.6		27.6		15.0		10.8	
Design		P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD	P_n/Ω_c ASD	$\phi_c P_n$ LRFD
Effective length (*KL*) (ft)	0	135	203	109	164	149	224	94.8	142	76.6	115
	6	124	185	99.4	149	129	193	82.5	124	66.5	99.8
	7	120	179	96.1	144	122	183	78.4	118	63.2	94.8
	8	115	173	92.5	139	115	172	74.0	111	59.6	89.4
	9	110	165	88.5	133	107	161	69.3	104	55.8	83.7
	10	105	158	84.3	126	99.0	148	64.4	96.6	51.8	77.7
	11	99.6	149	79.9	120	90.8	136	59.3	89.0	47.7	71.6
	12	94.0	141	75.3	113	82.6	124	54.3	81.4	43.6	65.5
	13	88.2	132	70.6	106	74.5	112	49.3	73.9	39.6	59.4
	14	82.4	124	65.8	98.8	66.7	100	44.4	66.6	35.6	53.4
	15	76.5	115	61.1	91.7	59.2	88.8	39.7	59.5	31.8	47.7
	16	70.7	106	56.4	84.6	52.1	78.1	35.1	52.7	28.1	42.2
	17	65.1	97.6	51.8	77.7	46.1	69.2	31.1	46.7	24.9	37.4
	18	59.5	89.3	47.4	71.0	41.1	61.7	27.7	41.6	22.2	33.3
	19	54.2	81.3	43.1	64.6	36.9	55.4	24.9	37.3	19.9	29.9
	20	49.0	73.5	38.9	58.3	33.3	50.0	22.5	33.7	18.0	27.0
	21	44.4	66.6	35.3	52.9	30.2	45.3	20.4	30.6	16.3	24.5
	22	40.5	60.7	32.1	48.2	27.5	41.3	18.6	27.9	14.9	22.3
	23	37.0	55.6	29.4	44.1	25.2	37.8	17.0	25.5	13.6	20.4
	24	34.0	51.0	27.0	40.5			15.6	23.4	12.5	18.7
	25	31.3	47.0	24.9	37.3					11.5	17.3
	26	29.0	43.5	23.0	34.5						
	27	26.9	40.3	21.3	32.0						
	28	25.0	37.5	19.8	29.8						
	29	23.3	34.9	18.5	27.7						
	30	21.8	32.7	17.3	25.9						
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	16.6	24.9	11.9	17.9	16.6	24.9	9.65	14.5	7.07	10.6
$P_e(KL)^2/10^4$	kip-in.^{2}	644		511		438		295		236	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 4–19 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

COMPOSITE
PIPE 3½–PIPE 3

F_y = 35 ksi
f'_c = 4 ksi

Shape		Pipe 3½				Pipe 3					
		XS		Std		XXS		XS		Std	
Wall Thickness, in.		0.296		0.211		0.559		0.280		0.201	
Steel Wt/ft		12.5		9.12		18.6		10.3		7.58	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	77.5	116	63.0	94.5	98.8	148	62.4	93.6	50.7	76.1
	6	65.0	97.5	52.8	79.2	76.8	115	49.6	74.3	40.3	60.4
	7	61.0	91.5	49.5	74.3	70.2	105	45.6	68.4	37.1	55.6
	8	56.6	85.0	46.0	69.0	63.2	94.8	41.4	62.1	33.7	50.5
	9	52.1	78.2	42.3	63.5	56.1	84.2	37.1	55.7	30.2	45.3
	10	47.5	71.2	38.5	57.8	49.2	73.7	32.9	49.3	26.7	40.1
	11	42.8	64.2	34.7	52.1	42.5	63.7	28.7	43.1	23.4	35.1
	12	38.3	57.4	31.0	46.5	36.1	54.1	24.8	37.2	20.2	30.2
	13	33.8	50.8	27.4	41.1	30.7	46.1	21.1	31.7	17.2	25.8
	14	29.6	44.4	24.0	36.0	26.5	39.8	18.2	27.3	14.8	22.2
	15	25.8	38.7	20.9	31.3	23.1	34.6	15.9	23.8	12.9	19.4
	16	22.7	34.0	18.4	27.5	20.3	30.4	14.0	20.9	11.4	17.0
	17	20.1	30.1	16.3	24.4	18.0	27.0	12.4	18.5	10.1	15.1
	18	17.9	26.9	14.5	21.8			11.0	16.5	8.97	13.5
	19	16.1	24.1	13.0	19.5			9.89	14.8	8.05	12.1
	20	14.5	21.8	11.8	17.6						
	21	13.2	19.7	10.7	16.0						
	22			9.71	14.6						
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	7.11	10.7	5.30	7.96	8.55	12.8	5.08	7.64	3.83	5.75
$P_e(KL)^2/10^4$	kip-in.^{2}	190		154		170		117		95.5	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 35 ksi
f'_c = 5 ksi

Table 4–20
Available Strength in Axial Compression, kips
Concrete Filled Pipe

5

COMPOSITE
PIPE 12–PIPE 8

Shape	Pipe 12				Pipe 10				Pipe 8			
	XS		Std		XS		Std		XXS		XS	
Wall Thickness, in.	0.465		0.349		0.465		0.340		0.816		0.465	
Steel Wt/ft	65.5		49.6		54.8		40.5		72.5		43.4	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)												
0	575	862	509	763	443	664	384	576	441	662	319	479
6	564	846	499	748	431	647	373	560	424	636	307	460
7	560	840	495	742	427	641	369	554	418	627	302	453
8	555	833	491	736	423	634	365	548	411	617	297	446
9	550	825	486	729	417	626	360	541	403	605	292	437
10	545	817	481	721	412	617	355	533	395	593	285	428
11	539	808	475	712	405	608	349	524	386	579	279	418
12	532	798	469	703	398	598	343	515	376	565	272	408
13	525	788	462	693	391	587	337	505	366	549	264	397
14	517	776	455	683	384	575	330	494	355	533	257	385
15	510	764	448	671	375	563	322	483	344	516	248	373
16	501	752	440	660	367	551	315	472	333	499	240	360
17	492	739	431	647	358	537	307	460	321	481	231	347
18	483	725	423	634	349	524	298	448	308	463	223	334
19	474	711	414	621	340	510	290	435	296	444	214	320
20	464	696	405	607	330	495	281	422	284	425	205	307
21	454	681	396	593	320	481	273	409	271	407	195	293
22	444	665	386	579	311	466	264	395	259	388	186	279
23	433	650	376	564	300	451	255	382	246	369	177	266
24	422	634	366	549	290	435	246	368	234	350	168	252
25	411	617	356	534	280	420	236	355	221	332	159	239
26	400	601	346	519	270	405	227	341	209	314	150	226
27	389	584	336	503	259	389	218	327	197	296	142	213
28	378	567	325	488	249	374	209	313	186	278	133	200
29	367	550	315	472	239	358	200	300	174	261	125	188
30	355	533	304	457	229	343	191	286	163	244	117	176
32	332	499	284	425	209	313	173	260	143	215	103	154
34	310	465	263	395	190	285	157	235	127	190	91.1	137
36	287	431	243	364	171	257	140	210	113	170	81.3	122
38	266	398	223	335	153	230	126	189	102	152	72.9	109
40	244	366	204	306	139	208	114	170	91.6	137	65.8	98.7
Properties												
M_n/Ω_b / $\phi_b M_n$ kip-ft	123	184	93.8	141	86.0	129	64.4	96.8	87.2	131	54.1	81.4
$P_e(KL)^2/10^4$ kip-in.^{2}	13000		10700		7270		5960		4810		3460	

ASD	LRFD
$\Omega_c = 2.00$	$\phi_c = 0.75$

5

COMPOSITE PIPE 8–PIPE 5

Table 4–20 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

F_y = 35 ksi
f'_c = 5 ksi

Shape		Pipe 8		Pipe 6						Pipe 5	
		Std		XXS		XS		Std		XXS	
Wall Thickness, in.		0.300		0.805		0.403		0.261		0.699	
Steel Wt/ft		28.6		53.2		28.6		19.0		38.6	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	257	386	304	456	201	302	161	241	220	329
	6	247	370	284	426	188	282	150	225	199	299
	7	243	365	277	416	183	275	146	219	192	288
	8	239	358	269	404	178	267	142	213	184	277
	9	234	351	261	391	173	259	137	206	176	264
	10	229	343	251	377	167	250	132	198	167	251
	11	223	335	242	362	160	240	127	191	158	237
	12	217	326	231	347	153	230	121	182	148	223
	13	211	316	220	331	146	220	116	173	139	208
	14	204	306	209	314	139	209	110	165	129	193
	15	197	296	198	297	132	198	104	156	119	179
	16	190	286	187	280	124	187	97.6	146	109	164
	17	183	275	175	263	117	175	91.5	137	100	150
	18	176	263	164	246	109	164	85.5	128	90.9	136
	19	168	252	153	229	102	153	79.5	119	82.1	123
	20	161	241	142	213	94.9	142	73.7	111	74.1	111
	21	153	230	131	197	87.9	132	68.0	102	67.2	101
	22	145	218	121	182	81.1	122	62.5	93.8	61.2	91.8
	23	138	207	111	166	74.3	112	57.2	85.8	56.0	84.0
	24	130	196	102	153	68.3	102	52.5	78.8	51.4	77.1
	25	123	185	93.8	141	62.9	94.4	48.4	72.6	47.4	71.1
	26	116	174	86.7	130	58.2	87.3	44.8	67.1	43.8	65.7
	27	109	163	80.4	121	53.9	80.9	41.5	62.3	40.6	61.0
	28	102	153	74.8	112	50.2	75.2	38.6	57.9	37.8	56.7
	29	95.2	143	69.7	105	46.8	70.1	36.0	54.0	35.2	52.8
	30	89.0	133	65.1	97.7	43.7	65.5	33.6	50.4		
	32	78.2	117	57.3	85.9	38.4	57.6	29.5	44.3		
	34	69.3	104	50.7	76.1	34.0	51.0	26.2	39.3		
	36	61.8	92.7			30.3	45.5	23.3	35.0		
	38	55.5	83.2								
	40	50.0	75.1								
Properties											
M_n/Ω_b $\phi_b M_n$	kip-ft	36.3	54.6	47.9	72.0	27.3	41.0	18.5	27.8	29.1	43.7
$P_e(KL)^2/10^4$	kip-in.^{2}	2640		1930		1290		994		973	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

F_y = 35 ksi
f'_c = 5 ksi

Table 4–20 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

5

COMPOSITE
PIPE 5–PIPE 4

Shape		Pipe 5				Pipe 4					
		XS		Std		XXS		XS		Std	
Wall Thickness, in.		0.349		0.241		0.628		0.315		0.221	
Steel Wt/ft		20.8		14.6		27.6		15.0		10.8	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (*KL*) (ft)	0	144	216	119	178	153	230	100	151	82.7	124
	6	131	197	108	161	132	198	86.8	130	71.3	107
	7	127	190	104	156	125	187	82.3	124	67.5	101
	8	122	182	99.6	149	117	176	77.5	116	63.5	95.2
	9	116	174	95.1	143	109	164	72.3	109	59.2	88.8
	10	111	166	90.3	135	101	151	67.0	100	54.7	82.1
	11	105	157	85.2	128	92.2	138	61.5	92.3	50.2	75.2
	12	98.3	147	80.0	120	83.7	126	56.1	84.1	45.6	68.4
	13	92.0	138	74.7	112	75.3	113	50.7	76.0	41.1	61.7
	14	85.6	128	69.4	104	67.3	101	45.4	68.2	36.8	55.2
	15	79.3	119	64.1	96.2	59.5	89.2	40.4	60.6	32.6	49.0
	16	73.0	109	58.9	88.3	52.3	78.4	35.6	53.4	28.7	43.1
	17	66.9	100	53.8	80.7	46.3	69.5	31.5	47.3	25.4	38.1
	18	60.9	91.4	48.9	73.3	41.3	62.0	28.1	42.2	22.7	34.0
	19	55.1	82.7	44.1	66.1	37.1	55.6	25.2	37.9	20.4	30.5
	20	49.7	74.6	39.8	59.7	33.5	50.2	22.8	34.2	18.4	27.6
	21	45.1	67.7	36.1	54.1	30.4	45.5	20.7	31.0	16.7	25.0
	22	41.1	61.7	32.9	49.3	27.7	41.5	18.8	28.2	15.2	22.8
	23	37.6	56.4	30.1	45.1	25.3	38.0	17.2	25.8	13.9	20.8
	24	34.5	51.8	27.6	41.4			15.8	23.7	12.8	19.1
	25	31.8	47.8	25.5	38.2					11.8	17.6
	26	29.4	44.2	23.5	35.3						
	27	27.3	40.9	21.8	32.7						
	28	25.4	38.1	20.3	30.4						
	29	23.7	35.5	18.9	28.4						
	30	22.1	33.2	17.7	26.5						
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	16.6	24.9	11.9	17.9	16.6	24.9	9.65	14.5	7.07	10.6
$P_e(KL)^2/10^4$	kip-in.^{2}	654		523		439		300		242	
ASD	LRFD	Note: Heavy line indicates *Kl/r* equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

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COMPOSITE
PIPE 3½–PIPE 3

Table 4–20 (continued)
Available Strength in Axial Compression, kips
Concrete Filled Pipe

F_y = 35 ksi
f'_c = 5 ksi

Shape		Pipe 3½				Pipe 3					
		XS		Std		XXS		XS		Std	
Wall Thickness, in.		0.296		0.211		0.559		0.280		0.201	
Steel Wt/ft		12.5		9.12		18.6		10.3		7.58	
Design		P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length (KL) (ft)	0	81.9	123	67.8	102	101	151	65.7	98.5	54.3	81.5
	6	68.1	102	56.2	84.4	78.1	117	51.6	77.5	42.6	63.9
	7	63.7	95.6	52.6	78.8	71.2	107	47.3	71.0	39.0	58.5
	8	59.0	88.5	48.6	72.9	64.0	96.1	42.8	64.3	35.3	52.9
	9	54.1	81.2	44.5	66.8	56.8	85.1	38.2	57.4	31.5	47.2
	10	49.1	73.6	40.3	60.5	49.6	74.4	33.7	50.5	27.7	41.5
	11	44.1	66.1	36.2	54.2	42.7	64.1	29.3	43.9	24.0	36.0
	12	39.2	58.8	32.1	48.1	36.2	54.3	25.1	37.6	20.5	30.8
	13	34.5	51.7	28.2	42.3	30.8	46.3	21.4	32.1	17.5	26.2
	14	30.0	45.0	24.4	36.7	26.6	39.9	18.4	27.6	15.1	22.6
	15	26.1	39.2	21.3	31.9	23.2	34.8	16.1	24.1	13.1	19.7
	16	23.0	34.4	18.7	28.1	20.4	30.5	14.1	21.2	11.6	17.3
	17	20.3	30.5	16.6	24.9	18.0	27.1	12.5	18.7	10.2	15.3
	18	18.1	27.2	14.8	22.2			11.1	16.7	9.13	13.7
	19	16.3	24.4	13.3	19.9			10.0	15.0	8.19	12.3
	20	14.7	22.0	12.0	18.0						
	21	13.3	20.0	10.9	16.3						
	22			9.90	14.8						
Properties											
M_n/Ω_b | $\phi_b M_n$	kip-ft	7.11	10.7	5.30	7.96	8.55	12.8	5.08	7.64	3.83	5.75
$P_e(KL)^2/10^4$	kip-in.^{2}	193		157		171		119		97.1	
ASD	LRFD	Note: Heavy line indicates Kl/r equal to or greater than 200.									
$\Omega_c = 2.00$	$\phi_c = 0.75$										

Table 4–21
Stiffness Reduction Factor τ_a

ASD $\frac{P_a}{A_g}$ / LRFD $\frac{P_u}{A_g}$	F_y, ksi: 35 ASD	35 LRFD	36 ASD	36 LRFD	42 ASD	42 LRFD	46 ASD	46 LRFD	50 ASD	50 LRFD
45	–	–	–	–	–	–	–	–	–	–
44	–	–	–	–	–	–	–	–	–	0.0599
43	–	–	–	–	–	–	–	–	–	0.118
42	–	–	–	–	–	–	–	–	–	0.175
41	–	–	–	–	–	–	–	0.0262	–	0.231
40	–	–	–	–	–	–	–	0.0905	–	0.285
39	–	–	–	–	–	–	–	0.153	–	0.338
38	–	–	–	–	–	–	–	0.214	–	0.389
37	–	–	–	–	–	0.0570	–	0.274	–	0.438
36	–	–	–	–	–	0.127	–	0.331	–	0.486
35	–	–	–	–	–	0.194	–	0.387	–	0.532
34	–	–	–	–	–	0.260	–	0.441	–	0.577
33	–	–	–	–	–	0.323	–	0.492	–	0.620
32	–	–	–	0.0334	–	0.384	–	0.542	–	0.660
31	–	0.0429	–	0.115	–	0.443	–	0.590	–	0.699
30	–	0.127	–	0.194	–	0.500	–	0.636	–	0.736
29	–	0.207	–	0.270	–	0.554	–	0.679	0.0842	0.771
28	–	0.285	–	0.344	–	0.606	–	0.720	0.171	0.804
27	–	0.360	–	0.414	–	0.655	0.0534	0.759	0.254	0.835
26	–	0.431	–	0.481	–	0.701	0.148	0.796	0.334	0.863
25	–	0.500	–	0.545	0.0162	0.745	0.240	0.830	0.410	0.890
24	–	0.564	–	0.606	0.122	0.786	0.327	0.861	0.483	0.913
23	–	0.626	–	0.663	0.223	0.823	0.410	0.890	0.552	0.934
22	–	0.683	–	0.716	0.319	0.858	0.489	0.915	0.617	0.953
21	–	0.736	0.0695	0.766	0.410	0.890	0.563	0.938	0.678	0.969
20	0.122	0.786	0.189	0.811	0.496	0.917	0.633	0.957	0.734	0.982
19	0.242	0.831	0.303	0.853	0.577	0.942	0.698	0.974	0.786	0.992
18	0.356	0.871	0.410	0.890	0.652	0.962	0.757	0.986	0.833	0.998
17	0.462	0.907	0.510	0.922	0.721	0.979	0.811	0.996	0.875	1.00
16	0.561	0.937	0.603	0.949	0.784	0.991	0.860	1.00	0.912	↓
15	0.652	0.962	0.687	0.971	0.840	0.999	0.902	↓	0.943	↓
14	0.734	0.982	0.764	0.988	0.888	1.00	0.937	↓	0.968	↓
13	0.807	0.995	0.831	0.998	0.929	↓	0.965	↓	0.987	↓
12	0.870	1.00	0.888	1.00	0.962	↓	0.986	↓	0.998	↓
11	0.922	↓	0.935	↓	0.985	↓	0.999	↓	1.00	↓
10	0.962	↓	0.971	↓	0.999	↓	1.00	↓	↓	↓
9	0.989	↓	0.993	↓	1.00	↓	↓	↓	↓	↓
8	1.00	↓	1.00	↓	↓	↓	↓	↓	↓	↓
7	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
6	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

– Indicates stiffness reduction factor is not applicable because the required strength exceeds the available strength for $Kl/r = 0$.

Table 4–22
Available Critical Stress for Compression Members

$F_y = 35$ksi			$F_y = 36$ksi			$F_y = 42$ksi			$F_y = 46$ksi			$F_y = 50$ksi		
$\frac{Kl}{r}$	F_{cr}/Ω_c ksi	$\phi_c F_{cr}$ ksi	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi	$\phi_c F_{cr}$ ksi	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi	$\phi_c F_{cr}$ ksi	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi	$\phi_c F_{cr}$ ksi	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi	$\phi_c F_{cr}$ ksi
	ASD	**LRFD**		**ASD**	**LRFD**		**ASD**	**LRFD**		**ASD**	**LRFD**		**ASD**	**LRFD**
1	**21.0**	31.5	1	**21.6**	32.4	1	**25.1**	37.8	1	**27.5**	41.4	1	**29.9**	45.0
2	**21.0**	31.5	2	**21.6**	32.4	2	**25.1**	37.8	2	**27.5**	41.4	2	**29.9**	45.0
3	**20.9**	31.5	3	**21.5**	32.4	3	**25.1**	37.8	3	**27.5**	41.4	3	**29.9**	45.0
4	**20.9**	31.5	4	**21.5**	32.4	4	**25.1**	37.8	4	**27.5**	41.4	4	**29.9**	44.9
5	**20.9**	31.5	5	**21.5**	32.4	5	**25.1**	37.7	5	**27.5**	41.3	5	**29.9**	44.9
6	**20.9**	31.4	6	**21.5**	32.3	6	**25.1**	37.7	6	**27.5**	41.3	6	**29.9**	44.9
7	**20.9**	31.4	7	**21.5**	32.3	7	**25.1**	37.7	7	**27.5**	41.3	7	**29.8**	44.8
8	**20.9**	31.4	8	**21.5**	32.3	8	**25.1**	37.7	8	**27.4**	41.2	8	**29.8**	44.8
9	**20.9**	31.4	9	**21.5**	32.3	9	**25.0**	37.6	9	**27.4**	41.2	9	**29.8**	44.7
10	**20.9**	31.3	10	**21.4**	32.2	10	**25.0**	37.6	10	**27.4**	41.1	10	**29.7**	44.7
11	**20.8**	31.3	11	**21.4**	32.2	11	**25.0**	37.5	11	**27.3**	41.1	11	**29.7**	44.6
12	**20.8**	31.3	12	**21.4**	32.2	12	**24.9**	37.5	12	**27.3**	41.0	12	**29.6**	44.5
13	**20.8**	31.2	13	**21.4**	32.1	13	**24.9**	37.4	13	**27.2**	40.9	13	**29.6**	44.4
14	**20.7**	31.2	14	**21.3**	32.1	14	**24.8**	37.3	14	**27.2**	40.9	14	**29.5**	44.4
15	**20.7**	31.1	15	**21.3**	32.0	15	**24.8**	37.3	15	**27.1**	40.8	15	**29.5**	44.3
16	**20.7**	31.1	16	**21.3**	32.0	16	**24.8**	37.2	16	**27.1**	40.7	16	**29.4**	44.2
17	**20.7**	31.0	17	**21.2**	31.9	17	**24.7**	37.1	17	**27.0**	40.6	17	**29.3**	44.1
18	**20.6**	31.0	18	**21.2**	31.9	18	**24.7**	37.1	18	**27.0**	40.5	18	**29.2**	43.9
19	**20.6**	30.9	19	**21.2**	31.8	19	**24.6**	37.0	19	**26.9**	40.4	19	**29.2**	43.8
20	**20.5**	30.9	20	**21.1**	31.7	20	**24.5**	36.9	20	**26.8**	40.3	20	**29.1**	43.7
21	**20.5**	30.8	21	**21.1**	31.7	21	**24.5**	36.8	21	**26.7**	40.2	21	**29.0**	43.6
22	**20.4**	30.7	22	**21.0**	31.6	22	**24.4**	36.7	22	**26.7**	40.1	22	**28.9**	43.4
23	**20.4**	30.7	23	**21.0**	31.5	23	**24.3**	36.6	23	**26.6**	40.0	23	**28.8**	43.3
24	**20.3**	30.6	24	**20.9**	31.4	24	**24.3**	36.5	24	**26.5**	39.8	24	**28.7**	43.1
25	**20.3**	30.5	25	**20.9**	31.4	25	**24.2**	36.4	25	**26.4**	39.7	25	**28.6**	43.0
26	**20.2**	30.4	26	**20.8**	31.3	26	**24.1**	36.3	26	**26.3**	39.6	26	**28.5**	42.8
27	**20.2**	30.3	27	**20.7**	31.2	27	**24.0**	36.1	27	**26.2**	39.4	27	**28.4**	42.7
28	**20.1**	30.3	28	**20.7**	31.1	28	**24.0**	36.0	28	**26.1**	39.3	28	**28.3**	42.5
29	**20.1**	30.2	29	**20.6**	31.0	29	**23.9**	35.9	29	**26.0**	39.1	29	**28.2**	42.3
30	**20.0**	30.1	30	**20.6**	30.9	30	**23.8**	35.8	30	**25.9**	39.0	30	**28.0**	42.1
31	**20.0**	30.0	31	**20.5**	30.8	31	**23.7**	35.6	31	**25.8**	38.8	31	**27.9**	41.9
32	**19.9**	29.9	32	**20.4**	30.7	32	**23.6**	35.5	32	**25.7**	38.6	32	**27.8**	41.8
33	**19.8**	29.8	33	**20.4**	30.6	33	**23.5**	35.4	33	**25.6**	38.5	33	**27.7**	41.6
34	**19.8**	29.7	34	**20.3**	30.5	34	**23.4**	35.2	34	**25.5**	38.3	34	**27.5**	41.4
35	**19.7**	29.6	35	**20.2**	30.4	35	**23.3**	35.1	35	**25.4**	38.1	35	**27.4**	41.2
36	**19.6**	29.5	36	**20.1**	30.3	36	**23.2**	34.9	36	**25.2**	37.9	36	**27.2**	40.9
37	**19.5**	29.4	37	**20.1**	30.1	37	**23.1**	34.8	37	**25.1**	37.8	37	**27.1**	40.7
38	**19.5**	29.3	38	**20.0**	30.0	38	**23.0**	34.6	38	**25.0**	37.6	38	**26.9**	40.5
39	**19.4**	29.1	39	**19.9**	29.9	39	**22.9**	34.4	39	**24.9**	37.4	39	**26.8**	40.3
40	**19.3**	29.0	40	**19.8**	29.8	40	**22.8**	34.3	40	**24.7**	37.2	40	**26.6**	40.0

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

Table 4–22 (continued)
Available Critical Stress for Compression Members

	F_y = 35ksi			F_y = 36ksi			F_y = 42ksi			F_y = 46ksi			F_y = 50ksi	
$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD
41	**19.2**	28.9	41	**19.7**	29.7	41	**22.7**	34.1	41	**24.6**	37.0	41	**26.5**	39.8
42	**19.2**	28.8	42	**19.6**	29.5	42	**22.6**	33.9	42	**24.5**	36.8	42	**26.3**	39.5
43	**19.1**	28.7	43	**19.6**	29.4	43	**22.5**	33.7	43	**24.3**	36.6	43	**26.2**	39.3
44	**19.0**	28.5	44	**19.5**	29.3	44	**22.3**	33.6	44	**24.2**	36.3	44	**26.0**	39.1
45	**18.9**	28.4	45	**19.4**	29.1	45	**22.2**	33.4	45	**24.0**	36.1	45	**25.8**	38.8
46	**18.8**	28.3	46	**19.3**	29.0	46	**22.1**	33.2	46	**23.9**	35.9	46	**25.6**	38.5
47	**18.7**	28.1	47	**19.2**	28.9	47	**22.0**	33.0	47	**23.8**	35.7	47	**25.5**	38.3
48	**18.6**	28.0	48	**19.1**	28.7	48	**21.8**	32.8	48	**23.6**	35.4	48	**25.3**	38.0
49	**18.5**	27.9	49	**19.0**	28.5	49	**21.7**	32.6	49	**23.4**	35.2	49	**25.1**	37.7
50	**18.4**	27.7	50	**18.9**	28.4	50	**21.6**	32.4	50	**23.3**	35.0	50	**24.9**	37.5
51	**18.3**	27.6	51	**18.8**	28.3	51	**21.4**	32.2	51	**23.1**	34.8	51	**24.8**	37.2
52	**18.3**	27.4	52	**18.7**	28.1	52	**21.3**	32.0	52	**23.0**	34.5	52	**24.6**	36.9
53	**18.2**	27.3	53	**18.6**	28.0	53	**21.2**	31.8	53	**22.8**	34.3	53	**24.4**	36.7
54	**18.1**	27.1	54	**18.5**	27.8	54	**21.0**	31.6	54	**22.6**	34.0	54	**24.2**	36.4
55	**18.0**	27.0	55	**18.4**	27.6	55	**20.9**	31.4	55	**22.5**	33.8	55	**24.0**	36.1
56	**17.9**	26.8	56	**18.3**	27.5	56	**20.7**	31.2	56	**22.3**	33.5	56	**23.8**	35.8
57	**17.7**	26.7	57	**18.2**	27.3	57	**20.6**	31.0	57	**22.1**	33.3	57	**23.6**	35.5
58	**17.6**	26.5	58	**18.1**	27.1	58	**20.5**	30.7	58	**22.0**	33.0	58	**23.4**	35.2
59	**17.5**	26.4	59	**17.9**	27.0	59	**20.3**	30.5	59	**21.8**	32.8	59	**23.2**	34.9
60	**17.4**	26.2	60	**17.8**	26.8	60	**20.2**	30.3	60	**21.6**	32.5	60	**23.0**	34.6
61	**17.3**	26.0	61	**17.7**	26.6	61	**20.0**	30.1	61	**21.4**	32.2	61	**22.8**	34.3
62	**17.2**	25.9	62	**17.6**	26.5	62	**19.9**	29.9	62	**21.3**	32.0	62	**22.6**	34.0
63	**17.1**	25.7	63	**17.5**	26.3	63	**19.7**	29.6	63	**21.1**	31.7	63	**22.4**	33.7
64	**17.0**	25.5	64	**17.4**	26.1	64	**19.6**	29.4	64	**20.9**	31.4	64	**22.2**	33.4
65	**16.9**	25.4	65	**17.3**	25.9	65	**19.4**	29.2	65	**20.7**	31.2	65	**22.0**	33.0
66	**16.8**	25.2	66	**17.1**	25.8	66	**19.2**	28.9	66	**20.5**	30.9	66	**21.8**	32.7
67	**16.7**	25.0	67	**17.0**	25.6	67	**19.1**	28.7	67	**20.4**	30.6	67	**21.6**	32.4
68	**16.5**	24.9	68	**16.9**	25.4	68	**18.9**	28.5	68	**20.2**	30.3	68	**21.4**	32.1
69	**16.4**	24.7	69	**16.8**	25.2	69	**18.8**	28.2	69	**20.0**	30.1	69	**21.1**	31.8
70	**16.3**	24.5	70	**16.7**	25.0	70	**18.6**	28.0	70	**19.8**	29.8	70	**20.9**	31.4
71	**16.2**	24.3	71	**16.5**	24.8	71	**18.5**	27.7	71	**19.6**	29.5	71	**20.7**	31.1
72	**16.1**	24.2	72	**16.4**	24.7	72	**18.3**	27.5	72	**19.4**	29.2	72	**20.5**	30.8
73	**16.0**	24.0	73	**16.3**	24.5	73	**18.1**	27.2	73	**19.2**	28.9	73	**20.3**	30.5
74	**15.8**	23.8	74	**16.2**	24.3	74	**18.0**	27.0	74	**19.1**	28.6	74	**20.1**	30.2
75	**15.7**	23.6	75	**16.0**	24.1	75	**17.8**	26.8	75	**18.9**	28.4	75	**19.8**	29.8
76	**15.6**	23.4	76	**15.9**	23.9	76	**17.6**	26.5	76	**18.7**	28.1	76	**19.6**	29.5
77	**15.5**	23.3	77	**15.8**	23.7	77	**17.5**	26.3	77	**18.5**	27.8	77	**19.4**	29.2
78	**15.4**	23.1	78	**15.6**	23.5	78	**17.3**	26.0	78	**18.3**	27.5	78	**19.2**	28.8
79	**15.2**	22.9	79	**15.5**	23.3	79	**17.1**	25.8	79	**18.1**	27.2	79	**19.0**	28.5
80	**15.1**	22.7	80	**15.4**	23.1	80	**17.0**	25.5	80	**17.9**	26.9	80	**18.8**	28.2

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

Table 4–22 (continued)
Available Critical Stress for Compression Members

$F_y = 35$ksi			$F_y = 36$ksi			$F_y = 42$ksi			$F_y = 46$ksi			$F_y = 50$ksi		
$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD
81	**15.0**	22.5	81	**15.3**	22.9	81	**16.8**	25.3	81	**17.7**	26.6	81	**18.5**	27.9
82	**14.9**	22.3	82	**15.1**	22.7	82	**16.6**	25.0	82	**17.5**	26.3	82	**18.3**	27.5
83	**14.7**	22.1	83	**15.0**	22.5	83	**16.5**	24.8	83	**17.3**	26.0	83	**18.1**	27.2
84	**14.6**	22.0	84	**14.9**	22.3	84	**16.3**	24.5	84	**17.1**	25.8	84	**17.9**	26.9
85	**14.5**	21.8	85	**14.7**	22.1	85	**16.1**	24.3	85	**16.9**	25.5	85	**17.7**	26.5
86	**14.4**	21.6	86	**14.6**	22.0	86	**16.0**	24.0	86	**16.7**	25.2	86	**17.4**	26.2
87	**14.2**	21.4	87	**14.5**	21.8	87	**15.8**	23.7	87	**16.6**	24.9	87	**17.2**	25.9
88	**14.1**	21.2	88	**14.3**	21.6	88	**15.6**	23.5	88	**16.4**	24.6	88	**17.0**	25.5
89	**14.0**	21.0	89	**14.2**	21.4	89	**15.5**	23.2	89	**16.2**	24.3	89	**16.8**	25.2
90	**13.8**	20.8	90	**14.1**	21.2	90	**15.3**	23.0	90	**16.0**	24.0	90	**16.6**	24.9
91	**13.7**	20.6	91	**13.9**	21.0	91	**15.1**	22.7	91	**15.8**	23.7	91	**16.3**	24.6
92	**13.6**	20.4	92	**13.8**	20.8	92	**15.0**	22.5	92	**15.6**	23.4	92	**16.1**	24.2
93	**13.5**	20.2	93	**13.7**	20.5	93	**14.8**	22.2	93	**15.4**	23.1	93	**15.9**	23.9
94	**13.3**	20.0	94	**13.5**	20.3	94	**14.6**	22.0	94	**15.2**	22.8	94	**15.7**	23.6
95	**13.2**	19.9	95	**13.4**	20.1	95	**14.4**	21.7	95	**15.0**	22.6	95	**15.5**	23.3
96	**13.1**	19.7	96	**13.3**	19.9	96	**14.3**	21.5	96	**14.8**	22.3	96	**15.3**	22.9
97	**13.0**	19.5	97	**13.1**	19.7	97	**14.1**	21.2	97	**14.6**	22.0	97	**15.0**	22.6
98	**12.8**	19.3	98	**13.0**	19.5	98	**13.9**	21.0	98	**14.4**	21.7	98	**14.8**	22.3
99	**12.7**	19.1	99	**12.9**	19.3	99	**13.8**	20.7	99	**14.2**	21.4	99	**14.6**	22.0
100	**12.6**	18.9	100	**12.7**	19.1	100	**13.6**	20.5	100	**14.1**	21.1	100	**14.4**	21.7
101	**12.4**	18.7	101	**12.6**	18.9	101	**13.4**	20.2	101	**13.9**	20.8	101	**14.2**	21.3
102	**12.3**	18.5	102	**12.5**	18.7	102	**13.3**	20.0	102	**13.7**	20.6	102	**14.0**	21.0
103	**12.2**	18.3	103	**12.3**	18.5	103	**13.1**	19.7	103	**13.5**	20.3	103	**13.8**	20.7
104	**12.1**	18.1	104	**12.2**	18.3	104	**12.9**	19.5	104	**13.3**	20.0	104	**13.6**	20.4
105	**11.9**	17.9	105	**12.1**	18.1	105	**12.8**	19.2	105	**13.1**	19.7	105	**13.4**	20.1
106	**11.8**	17.7	106	**11.9**	17.9	106	**12.6**	19.0	106	**12.9**	19.4	106	**13.2**	19.8
107	**11.7**	17.5	107	**11.8**	17.7	107	**12.4**	18.7	107	**12.8**	19.2	107	**13.0**	19.5
108	**11.5**	17.3	108	**11.7**	17.5	108	**12.3**	18.5	108	**12.6**	18.9	108	**12.8**	19.2
109	**11.4**	17.2	109	**11.5**	17.3	109	**12.1**	18.2	109	**12.4**	18.6	109	**12.6**	18.9
110	**11.3**	17.0	110	**11.4**	17.1	110	**12.0**	18.0	110	**12.2**	18.3	110	**12.4**	18.6
111	**11.2**	16.8	111	**11.3**	16.9	111	**11.8**	17.7	111	**12.0**	18.1	111	**12.2**	18.3
112	**11.0**	16.6	112	**11.1**	16.7	112	**11.6**	17.5	112	**11.8**	17.8	112	**12.0**	18.0
113	**10.9**	16.4	113	**11.0**	16.5	113	**11.5**	17.3	113	**11.7**	17.5	113	**11.8**	17.7
114	**10.8**	16.2	114	**10.9**	16.3	114	**11.3**	17.0	114	**11.5**	17.3	114	**11.6**	17.4
115	**10.7**	16.0	115	**10.7**	16.2	115	**11.2**	16.8	115	**11.3**	17.0	115	**11.4**	17.1
116	**10.5**	15.8	116	**10.6**	16.0	116	**11.0**	16.5	116	**11.1**	16.7	116	**11.2**	16.8
117	**10.4**	15.6	117	**10.5**	15.8	117	**10.8**	16.3	117	**11.0**	16.5	117	**11.0**	16.5
118	**10.3**	15.5	118	**10.4**	15.6	118	**10.7**	16.1	118	**10.8**	16.2	118	**10.8**	16.2
119	**10.2**	15.3	119	**10.2**	15.4	119	**10.5**	15.8	119	**10.6**	16.0	119	**10.6**	16.0
120	**10.0**	15.1	120	**10.1**	15.2	120	**10.4**	15.6	120	**10.4**	15.7	120	**10.4**	15.7

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

Table 4–22 (continued)
Available Critical Stress for Compression Members

F_y = 35ksi			F_y = 36ksi			F_y = 42ksi			F_y = 46ksi			F_y = 50ksi		
$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD
121	9.91	14.9	121	10.0	15.0	121	10.2	15.4	121	10.3	15.4	121	10.3	15.4
122	9.79	14.7	122	9.85	14.8	122	10.1	15.2	122	10.1	15.2	122	10.1	15.2
123	9.67	14.5	123	9.72	14.6	123	9.93	14.9	123	9.94	14.9	123	9.94	14.9
124	9.55	14.3	124	9.59	14.4	124	9.78	14.7	124	9.78	14.7	124	9.78	14.7
125	9.43	14.2	125	9.47	14.2	125	9.62	14.5	125	9.62	14.5	125	9.62	14.5
126	9.31	14.0	126	9.35	14.0	126	9.47	14.2	126	9.47	14.2	126	9.47	14.2
127	9.19	13.8	127	9.22	13.9	127	9.32	14.0	127	9.32	14.0	127	9.32	14.0
128	9.07	13.6	128	9.10	13.7	128	9.17	13.8	128	9.17	13.8	128	9.17	13.8
129	8.95	13.4	129	8.98	13.5	129	9.03	13.6	129	9.03	13.6	129	9.03	13.6
130	8.83	13.3	130	8.86	13.3	130	8.89	13.4	130	8.89	13.4	130	8.89	13.4
131	8.71	13.1	131	8.73	13.1	131	8.76	13.2	131	8.76	13.2	131	8.76	13.2
132	8.60	12.9	132	8.61	12.9	132	8.63	13.0	132	8.63	13.0	132	8.63	13.0
133	8.48	12.7	133	8.49	12.8	133	8.50	12.8	133	8.50	12.8	133	8.50	12.8
134	8.37	12.6	134	8.37	12.6	134	8.37	12.6	134	8.37	12.6	134	8.37	12.6
135	8.25	12.4	135	8.25	12.4	135	8.25	12.4	135	8.25	12.4	135	8.25	12.4
136	8.13	12.2	136	8.13	12.2	136	8.13	12.2	136	8.13	12.2	136	8.13	12.2
137	8.01	12.0	137	8.01	12.0	137	8.01	12.0	137	8.01	12.0	137	8.01	12.0
138	7.89	11.9	138	7.89	11.9	138	7.89	11.9	138	7.89	11.9	138	7.89	11.9
139	7.78	11.7	139	7.78	11.7	139	7.78	11.7	139	7.78	11.7	139	7.78	11.7
140	7.67	11.5	140	7.67	11.5	140	7.67	11.5	140	7.67	11.5	140	7.67	11.5
141	7.56	11.4	141	7.56	11.4	141	7.56	11.4	141	7.56	11.4	141	7.56	11.4
142	7.45	11.2	142	7.45	11.2	142	7.45	11.2	142	7.45	11.2	142	7.45	11.2
143	7.35	11.0	143	7.35	11.0	143	7.35	11.0	143	7.35	11.0	143	7.35	11.0
144	7.25	10.9	144	7.25	10.9	144	7.25	10.9	144	7.25	10.9	144	7.25	10.9
145	7.15	10.7	145	7.15	10.7	145	7.15	10.7	145	7.15	10.7	145	7.15	10.7
146	7.05	10.6	146	7.05	10.6	146	7.05	10.6	146	7.05	10.6	146	7.05	10.6
147	6.96	10.5	147	6.96	10.5	147	6.96	10.5	147	6.96	10.5	147	6.96	10.5
148	6.86	10.3	148	6.86	10.3	148	6.86	10.3	148	6.86	10.3	148	6.86	10.3
149	6.77	10.2	149	6.77	10.2	149	6.77	10.2	149	6.77	10.2	149	6.77	10.2
150	6.68	10.0	150	6.68	10.0	150	6.68	10.0	150	6.68	10.0	150	6.68	10.0
151	6.59	9.91	151	6.59	9.91	151	6.59	9.91	151	6.59	9.91	151	6.59	9.91
152	6.51	9.78	152	6.51	9.78	152	6.51	9.78	152	6.51	9.78	152	6.51	9.78
153	6.42	9.65	153	6.42	9.65	153	6.42	9.65	153	6.42	9.65	153	6.42	9.65
154	6.34	9.53	154	6.34	9.53	154	6.34	9.53	154	6.34	9.53	154	6.34	9.53
155	6.26	9.40	155	6.26	9.40	155	6.26	9.40	155	6.26	9.40	155	6.26	9.40
156	6.18	9.28	156	6.18	9.28	156	6.18	9.28	156	6.18	9.28	156	6.18	9.28
157	6.10	9.17	157	6.10	9.17	157	6.10	9.17	157	6.10	9.17	157	6.10	9.17
158	6.02	9.05	158	6.02	9.05	158	6.02	9.05	158	6.02	9.05	158	6.02	9.05
159	5.95	8.94	159	5.95	8.94	159	5.95	8.94	159	5.95	8.94	159	5.95	8.94
160	5.87	8.82	160	5.87	8.82	160	5.87	8.82	160	5.87	8.82	160	5.87	8.82

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

Table 4–22 (continued)
Available Critical Stress for Compression Members

F_y = 35ksi			F_y = 36ksi			F_y = 42ksi			F_y = 46ksi			F_y = 50ksi		
$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD	$\frac{Kl}{r}$	F_{cr}/Ω_c ksi ASD	$\phi_c F_{cr}$ ksi LRFD
161	**5.80**	8.72	161	**5.80**	8.72	161	**5.80**	8.72	161	**5.80**	8.72	161	**5.80**	8.72
162	**5.73**	8.61	162	**5.73**	8.61	162	**5.73**	8.61	162	**5.73**	8.61	162	**5.73**	8.61
163	**5.66**	8.50	163	**5.66**	8.50	163	**5.66**	8.50	163	**5.66**	8.50	163	**5.66**	8.50
164	**5.59**	8.40	164	**5.59**	8.40	164	**5.59**	8.40	164	**5.59**	8.40	164	**5.59**	8.40
165	**5.52**	8.30	165	**5.52**	8.30	165	**5.52**	8.30	165	**5.52**	8.30	165	**5.52**	8.30
166	**5.45**	8.20	166	**5.45**	8.20	166	**5.45**	8.20	166	**5.45**	8.20	166	**5.45**	8.20
167	**5.39**	8.10	167	**5.39**	8.10	167	**5.39**	8.10	167	**5.39**	8.10	167	**5.39**	8.10
168	**5.33**	8.00	168	**5.33**	8.00	168	**5.33**	8.00	168	**5.33**	8.00	168	**5.33**	8.00
169	**5.25**	7.89	169	**5.25**	7.89	169	**5.25**	7.89	169	**5.25**	7.89	169	**5.25**	7.89
170	**5.20**	7.82	170	**5.20**	7.82	170	**5.20**	7.82	170	**5.20**	7.82	170	**5.20**	7.82
171	**5.14**	7.73	171	**5.14**	7.73	171	**5.14**	7.73	171	**5.14**	7.73	171	**5.14**	7.73
172	**5.08**	7.64	172	**5.08**	7.64	172	**5.08**	7.64	172	**5.08**	7.64	172	**5.08**	7.64
173	**5.02**	7.55	173	**5.02**	7.55	173	**5.02**	7.55	173	**5.02**	7.55	173	**5.02**	7.55
174	**4.96**	7.46	174	**4.96**	7.46	174	**4.96**	7.46	174	**4.96**	7.46	174	**4.96**	7.46
175	**4.91**	7.38	175	**4.91**	7.38	175	**4.91**	7.38	175	**4.91**	7.38	175	**4.91**	7.38
176	**4.85**	7.29	176	**4.85**	7.29	176	**4.85**	7.29	176	**4.85**	7.29	176	**4.85**	7.29
177	**4.80**	7.21	177	**4.80**	7.21	177	**4.80**	7.21	177	**4.80**	7.21	177	**4.80**	7.21
178	**4.74**	7.13	178	**4.74**	7.13	178	**4.74**	7.13	178	**4.74**	7.13	178	**4.74**	7.13
179	**4.69**	7.05	179	**4.69**	7.05	179	**4.69**	7.05	179	**4.69**	7.05	179	**4.69**	7.05
180	**4.64**	6.97	180	**4.64**	6.97	180	**4.64**	6.97	180	**4.64**	6.97	180	**4.64**	6.97
181	**4.59**	6.90	181	**4.59**	6.90	181	**4.59**	6.90	181	**4.59**	6.90	181	**4.59**	6.90
182	**4.54**	6.82	182	**4.54**	6.82	182	**4.54**	6.82	182	**4.54**	6.82	182	**4.54**	6.82
183	**4.49**	6.75	183	**4.49**	6.75	183	**4.49**	6.75	183	**4.49**	6.75	183	**4.49**	6.75
184	**4.44**	6.67	184	**4.44**	6.67	184	**4.44**	6.67	184	**4.44**	6.67	184	**4.44**	6.67
185	**4.39**	6.60	185	**4.39**	6.60	185	**4.39**	6.60	185	**4.39**	6.60	185	**4.39**	6.60
186	**4.34**	6.53	186	**4.34**	6.53	186	**4.34**	6.53	186	**4.34**	6.53	186	**4.34**	6.53
187	**4.30**	6.46	187	**4.30**	6.46	187	**4.30**	6.46	187	**4.30**	6.46	187	**4.30**	6.46
188	**4.25**	6.39	188	**4.25**	6.39	188	**4.25**	6.39	188	**4.25**	6.39	188	**4.25**	6.39
189	**4.21**	6.32	189	**4.21**	6.32	189	**4.21**	6.32	189	**4.21**	6.32	189	**4.21**	6.32
190	**4.16**	6.26	190	**4.16**	6.26	190	**4.16**	6.26	190	**4.16**	6.26	190	**4.16**	6.26
191	**4.12**	6.19	191	**4.12**	6.19	191	**4.12**	6.19	191	**4.12**	6.19	191	**4.12**	6.19
192	**4.08**	6.13	192	**4.08**	6.13	192	**4.08**	6.13	192	**4.08**	6.13	192	**4.08**	6.13
193	**4.04**	6.06	193	**4.04**	6.06	193	**4.04**	6.06	193	**4.04**	6.06	193	**4.04**	6.06
194	**3.99**	6.00	194	**3.99**	6.00	194	**3.99**	6.00	194	**3.99**	6.00	194	**3.99**	6.00
195	**3.95**	5.94	195	**3.95**	5.94	195	**3.95**	5.94	195	**3.95**	5.94	195	**3.95**	5.94
196	**3.91**	5.88	196	**3.91**	5.88	196	**3.91**	5.88	196	**3.91**	5.88	196	**3.91**	5.88
197	**3.87**	5.82	197	**3.87**	5.82	197	**3.87**	5.82	197	**3.87**	5.82	197	**3.87**	5.82
198	**3.83**	5.76	198	**3.83**	5.76	198	**3.83**	5.76	198	**3.83**	5.76	198	**3.83**	5.76
199	**3.80**	5.70	199	**3.80**	5.70	199	**3.80**	5.70	199	**3.80**	5.70	199	**3.80**	5.70
200	**3.76**	5.65	200	**3.76**	5.65	200	**3.76**	5.65	200	**3.76**	5.65	200	**3.76**	5.65

ASD	LRFD
$\Omega_c = 1.67$	$\phi_c = 0.90$

PART 5

DESIGN OF TENSION MEMBERS

SCOPE

The specification requirements and other design considerations summarized in this Part apply to the design of members subject to static axial tension. For fatigue applications, see AISC Specification Appendix 3. For the design of members subject to eccentric tension or combined tension and flexure, see Part 6. For tension members that are part of a seismic force resisting system in which the seismic response modification factor, *R*, is taken greater than 3, the requirements in the AISC *Seismic Provisions for Structural Steel Buildings* also apply. The AISC *Seismic Provisions for Structural Steel Buildings* is available in Part 6 of the AISC *Seismic Design Manual* from the American Institute of Steel Construction, Inc. at www.aisc.org.

GROSS AREA, NET AREA, AND EFFECTIVE NET AREA

In the determination of the available strength of a tension member, the gross area, A_g, is needed for the tensile yielding limit state and the effective net area, A_e, is needed for the tensile rupture limit state.

Gross Area

The gross area, A_g, is determined as specified in AISC Specification Section D3.1.

Effective Net Area

The effective net area, A_e, is determined by multiplying the net area, A_n, by the shear lag coefficient, U, where A_n is determined for tension members per AISC Specification Section D3 and U is determined from AISC Specification Table D3.1. Shear lag parameters are illustrated in AISC Commentary Figure C-D3.1.

TENSILE STRENGTH

The limit-state of tensile yielding will control the available tensile strength over tensile rupture when the following relationship is satisfied:

LRFD	ASD
$0.9F_yA_g \le 0.75F_uA_e$	$\dfrac{F_yA_g}{1.67} \le \dfrac{F_uA_e}{2}$

These expressions are both reduced to:

$$\frac{A_e}{A_g} \ge 1.2\frac{F_y}{F_u}$$

Otherwise, the limit-state of tensile rupture will control over tensile yielding.

Yielding Limit State

The available tensile strength due to tensile yielding, which must equal or exceed the required strength, P_u or P_a, is determined for tension members, per AISC Specification Section D2(a), using Equation D2-1.

Rupture Limit State

The available tensile strength due to tensile rupture, which must equal or exceed the required strength, P_u or P_a, is determined for tension members, per AISC Specification Section D2(b) using Equation D2-2.

OTHER SPECIFICATION REQUIREMENTS AND DESIGN CONSIDERATIONS

Special Requirements for Heavy Shapes and Plates

For tension members with complete-joint-penetration groove welded joints and made from heavy shapes with a flange thickness exceeding 2 in. or built-up sections consisting of plates with a thickness exceeding 2 in., see AISC Specification Sections A3.1c and Section A3.1d.

Slenderness

Tension member slenderness, L/r, should preferably be limited to a maximum of 300 per the User Note in AISC Specification Section D1. The intent of this recommendation is explained in the corresponding Commentary.

STEEL TENSION MEMBER SELECTION TABLES

Available tensile strengths for various types of tension members (see individual descriptions below) are given in Tables 5–1 through 5–8 for the limit states of tensile yielding and tensile rupture. In each case, the tabulated values for available tensile rupture strength are based upon the assumption that $A_e = 0.75A_g$, which is arbitrarily selected as a value that is practical to achieve with typical end connections. Such consideration of the effective net area during the design of the member will simplify the design of its end connections, which can be difficult to configure and costly if tension members are selected based upon available tensile yielding strength only, without considering the reduction in strength due to the connection.

When $A_e > 0.75A_g$, either the tabulated values for available tensile rupture strength can be used conservatively or the available tensile rupture strength can be calculated based upon the actual value of A_e. When $A_e < 0.75A_g$, the tabulated values of the available tensile rupture strength cannot be used, but rather, must be calculated based upon the actual value of A_e.

Table 5–1. W-Shapes

Available strengths in axial tension are given for W-shapes with $F_y = 50$ ksi and $F_u = 65$ ksi (ASTM A992). Note that tensile rupture will control over tensile yielding given for W-shapes with $F_y = 50$ ksi and $F_u = 65$ ksi when $A_e/A_g < 0.923$. Otherwise, tensile yielding will control over tensile rupture.

Table 5–2. Single Angles

Available strengths in axial tension are given for single angles with F_y = 36 ksi and F_u = 58 ksi (ASTM A36). Note that tensile rupture will control over tensile yielding given for single angles with F_y = 36 ksi and F_u = 58 ksi when $A_e/A_g < 0.745$. Otherwise, tensile yielding will control over tensile rupture.

Table 5–3. WT-Shapes

Table 5–3 is similar to Table 5–1, except it covers WT-shapes with F_y = 50 ksi and F_u = 65 ksi (ASTM A992).

Table 5–4. Rectangular HSS

Available strengths in axial tension are given for rectangular HSS with F_y = 46 ksi and F_u = 58 ksi (ASTM A500 Grade B). Note that tensile rupture will control over tensile yielding given for rectangular HSS with F_y = 46 ksi and F_u = 58 ksi when $A_e/A_g < 0.952$. Otherwise, tensile yielding will control over tensile rupture.

Table 5–5. Square HSS

Table 5–3 is similar to Table 5–1, except it covers square HSS with F_y = 46 ksi and F_u = 58 ksi (ASTM A500 Grade B).

Table 5–6. Round HSS

Available strengths in axial tension are given for ASTM A500 round HSS with F_y = 42 ksi and F_u = 58 ksi (ASTM A500 Grade B). Note that tensile rupture will control over tensile yielding given for round HSS with F_y = 42 ksi and F_u = 58 ksi when $A_e/A_g < 0.869$. Otherwise, tensile yielding will control over tensile rupture.

Table 5–7. Steel Pipe

Available strengths in axial tension are given for steel pipe with F_y = 35 ksi and F_u = 60 ksi (ASTM A53 grade B). Note that tensile rupture will control over tensile yielding given for steel pipe with F_y = 35 ksi and F_u = 60 ksi when $A_e/A_g < 0.700$. Otherwise, tensile yielding will control over tensile rupture.

Table 5–8. Double Angles

Available strengths in axial tension are given for double angles with F_y = 36 ksi and F_u = 58 ksi (ASTM A36). Note that tensile rupture will control over tensile yielding given for double angles with F_y = 36 ksi and F_u = 58 ksi when $A_e/A_g < 0.745$. Otherwise, tensile yielding will control over tensile rupture.

F_y = 50 ksi
F_u = 65 ksi

Table 5-1
Available Strength in Axial Tension
W Shapes

W44–W40

Shape	Gross Area, A_g	A_e = $0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
W44×335	98.5	73.9	2950	4430	2400	3600
×290	85.4	64.1	2560	3840	2080	3120
×262	76.9	57.7	2300	3460	1880	2810
×230	67.7	50.8	2030	3050	1650	2480
W40×593[h]	174	131	5210	7830	4260	6390
×503[h]	148	111	4430	6660	3610	5410
×431[h]	127	95.3	3800	5720	3100	4650
×397[h]	117	87.8	3500	5270	2850	4280
×372[h]	109	81.8	3260	4910	2660	3990
×362[h]	107	80.3	3200	4820	2610	3910
×324	95.3	71.5	2850	4290	2320	3490
×297	87.4	65.6	2620	3930	2130	3200
×277	81.4	61.0	2440	3660	1980	2970
×249	73.3	55.0	2190	3300	1790	2680
×215	63.4	47.6	1900	2850	1550	2320
×199	58.5	43.9	1750	2630	1430	2140
W40×392[h]	115	86.3	3440	5180	2800	4210
×331[h]	97.5	73.1	2920	4390	2380	3560
×327[h]	96.0	72.0	2870	4320	2340	3510
×294	86.3	64.7	2580	3880	2100	3150
×278	82.0	61.5	2460	3690	2000	3000
×264	77.6	58.2	2320	3490	1890	2840
×235	69.0	51.8	2070	3110	1680	2530
×211	62.0	46.5	1860	2790	1510	2270
×183	53.3	40.0	1600	2400	1300	1950
×167	49.2	36.9	1470	2210	1200	1800
×149	43.8	32.8	1310	1970	1070	1600

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

W36–W33

Table 5–1 (continued)
Available Strength in Axial Tension
W Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
W36×800[h]	236	177	7070	10600	5750	8630
×652[h]	192	144	5750	8640	4680	7020
×529[h]	156	117	4670	7020	3800	5700
×487[h]	143	107.0	4280	6440	3480	5220
×441[h]	130	97.5	3890	5850	3170	4750
×395[h]	116	87.0	3470	5220	2830	4240
×361[h]	106.0	79.5	3170	4770	2580	3880
×330	97.0	72.8	2900	4370	2370	3550
×302	88.8	66.6	2660	4000	2160	3250
×282	82.9	62.2	2480	3730	2020	3030
×262	77.0	57.8	2310	3470	1880	2820
×247	72.5	54.4	2170	3260	1770	2650
×231	68.1	51.1	2040	3060	1660	2490
W36×256	75.4	56.6	2260	3390	1840	2760
×232	68.1	51.1	2040	3060	1660	2490
×210	61.8	46.3	1850	2780	1500	2260
×194	57.0	42.7	1710	2560	1390	2080
×182	53.6	40.2	1600	2410	1310	1960
×170	50.1	37.6	1500	2250	1220	1830
×160	47.0	35.3	1410	2120	1150	1720
×150	44.2	33.2	1320	1990	1080	1620
×135	39.7	29.8	1190	1790	968	1450
W33×387[h]	114	85.5	3410	5130	2780	4170
×354[h]	104	78.0	3110	4680	2540	3800
×318	93.6	70.2	2800	4210	2280	3420
×291	85.7	64.3	2570	3860	2090	3130
×263	77.5	58.1	2320	3490	1890	2830
×241	71.0	53.3	2130	3200	1730	2600
×221	65.2	48.9	1950	2930	1590	2380
×201	59.2	44.4	1770	2660	1440	2160

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5-1 (continued)
Available Strength in Axial Tension
W Shapes

W33–W27

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding		Rupture	
			kips		kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
W33×169	49.5	37.1	**1480**	2230	**1210**	1810
×152	44.8	33.6	**1340**	2020	**1090**	1640
×141	41.6	31.2	**1250**	1870	**1010**	1520
×130	38.3	28.7	**1150**	1720	**933**	1400
×118	34.7	26.0	**1040**	1560	**845**	1270
W30×391[h]	115	86.3	**3440**	5180	**2800**	4210
×357[h]	105	78.8	**3140**	4730	**2560**	3840
×326[h]	95.8	71.8	**2870**	4310	**2330**	3500
×292	85.9	64.4	**2570**	3870	**2090**	3140
×261	76.9	57.7	**2300**	3460	**1880**	2810
×235	69.2	51.9	**2070**	3110	**1690**	2530
×211	62.2	46.7	**1860**	2800	**1520**	2280
×191	56.3	42.2	**1690**	2530	**1370**	2060
×173	51.0	38.3	**1530**	2300	**1240**	1870
W30×148	43.5	32.6	**1300**	1960	**1060**	1590
×132	38.9	29.2	**1160**	1750	**949**	1420
×124	36.5	27.4	**1090**	1640	**891**	1340
×116	34.2	25.7	**1020**	1540	**835**	1250
×108	31.7	23.8	**949**	1430	**773**	1160
×99	29.1	21.8	**871**	1310	**709**	1060
×90	26.4	19.8	**790**	1190	**644**	965
W27×539[h]	159	119	**4760**	7160	**3870**	5800
×368[h]	108	81.0	**3230**	4860	**2630**	3950
×336[h]	98.9	74.2	**2960**	4450	**2410**	3620
×307[h]	90.4	67.8	**2710**	4070	**2200**	3310
×281	82.9	62.2	**2480**	3730	**2020**	3030
×258	76.0	57.0	**2280**	3420	**1850**	2780
×235	69.4	52.1	**2080**	3120	**1690**	2540
×217	64.0	48.0	**1920**	2880	**1560**	2340
×194	57.2	42.9	**1710**	2570	**1390**	2090
×178	52.5	39.4	**1570**	2360	**1280**	1920
×161	47.6	35.7	**1430**	2140	**1160**	1740
×146	43.1	32.3	**1290**	1940	**1050**	1570

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

Table 5–1 (continued)
Available Strength in Axial Tension
W Shapes

W27–W21

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	A_e = 0.75A_g	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
W27×129	37.8	28.4	1130	1700	923	1380
×114	33.5	25.1	1000	1510	816	1220
×102	30.0	22.5	898	1350	731	1100
×94	27.7	20.8	829	1250	676	1010
×84	24.8	18.6	743	1120	605	907
W24×370^h	109	81.8	3260	4910	2660	3990
×335^h	98.4	73.8	2950	4430	2400	3600
×306^h	89.8	67.4	2690	4040	2190	3290
×279^h	82.0	61.5	2460	3690	2000	3000
×250	73.5	55.1	2200	3310	1790	2690
×229	67.2	50.4	2010	3020	1640	2460
×207	60.7	45.5	1820	2730	1480	2220
×192	56.3	42.2	1690	2530	1370	2060
×176	51.7	38.8	1550	2330	1260	1890
×162	47.7	35.8	1430	2150	1160	1750
×146	43.0	32.3	1290	1940	1050	1570
×131	38.5	28.9	1150	1730	939	1410
×117	34.4	25.8	1030	1550	839	1260
×104	30.6	22.9	916	1380	744	1120
W24×103	30.3	22.7	907	1360	738	1110
×94	27.7	20.8	829	1250	676	1010
×84	24.7	18.5	740	1110	601	902
×76	22.4	16.8	671	1010	546	819
×68	20.1	15.1	602	905	491	736
×62	18.2	13.6	545	819	442	663
×55	16.2	12.1	485	729	393	590
W21×201	59.2	44.4	1770	2660	1440	2160
×182	53.6	40.2	1600	2410	1310	1960
×166	48.8	36.6	1460	2200	1190	1780
×147	43.2	32.4	1290	1940	1050	1580
×132	38.8	29.1	1160	1750	946	1420
×122	35.9	26.9	1070	1620	874	1310
×111	32.7	24.5	979	1470	796	1190
×101	29.8	22.3	892	1340	725	1090

Limit State	ASD	LRFD
Yielding	Ω_t = 1.67	ϕ_t = 0.90
Rupture	Ω_t = 2.00	ϕ_t = 0.75

^{h} Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5–1 (continued)
Available Strength in Axial Tension
W Shapes

W21–W18

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
W21×93	27.3	20.5	**817**	1230	**666**	999
×83	24.3	18.2	**728**	1090	**592**	887
×73	21.5	16.1	**644**	968	**523**	785
×68	20.0	15.0	**599**	900	**488**	731
×62	18.3	13.7	**548**	824	**445**	668
×55	16.2	12.1	**485**	729	**393**	590
×48	14.1	10.6	**422**	634	**345**	517
W21×57	16.7	12.5	**500**	752	**406**	609
×50	14.7	11.0	**440**	662	**358**	536
×44	13.0	9.75	**389**	585	**317**	475
W18×311	91.6	68.7	**2740**	4120	**2230**	3350
×283[h]	83.3	62.5	**2490**	3750	**2030**	3050
×258[h]	75.9	56.9	**2270**	3420	**1850**	2770
×234[h]	68.8	51.6	**2060**	3100	**1680**	2520
×211[h]	62.1	46.6	**1860**	2790	**1510**	2270
×192	56.4	42.3	**1690**	2540	**1370**	2060
×175	51.3	38.5	**1540**	2310	**1250**	1880
×158	46.3	34.7	**1390**	2080	**1130**	1690
×143	42.1	31.6	**1260**	1890	**1030**	1540
×130	38.2	28.7	**1140**	1720	**933**	1400
×119	35.1	26.3	**1050**	1580	**855**	1280
×106	31.1	23.3	**931**	1400	**757**	1140
×97	28.5	21.4	**853**	1280	**696**	1040
×86	25.3	19.0	**757**	1140	**618**	926
×76	22.3	16.7	**668**	1000	**543**	814
W18×71	20.8	15.6	**623**	936	**507**	761
×65	19.1	14.3	**572**	860	**465**	697
×60	17.6	13.2	**527**	792	**429**	644
×55	16.2	12.1	**485**	729	**393**	590
×50	14.7	11.0	**440**	662	**358**	536
W18×46	13.5	10.1	**404**	608	**328**	492
×40	11.8	8.85	**353**	531	**288**	431
×35	10.3	7.73	**308**	463	**251**	377

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

W16–W14

Table 5-1 (continued)
Available Strength in Axial Tension
W Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
W16×100	29.5	22.1	883	1330	718	1080
×89	26.2	19.7	784	1180	640	960
×77	22.6	17.0	677	1020	553	829
×67	19.7	14.8	590	887	481	722
W16×57	16.8	12.6	503	756	410	614
×50	14.7	11.0	440	662	358	536
×45	13.3	9.98	398	599	324	487
×40	11.8	8.85	353	531	288	431
×36	10.6	7.95	317	477	258	388
W16×31	9.13	6.85	273	411	223	334
×26	7.68	5.76	230	346	187	281
W14×730	215	161	6440	9680	5230	7850
×665[h]	196	147	5870	8820	4780	7170
×605[h]	178	134	5330	8010	4360	6530
×550[h]	162	122	4850	7290	3970	5950
×500[h]	147	110	4400	6620	3580	5360
×455[h]	134	101	4010	6030	3280	4920
×426[h]	125	93.8	3740	5630	3050	4570
×398[h]	117	87.8	3500	5270	2850	4280
×370[h]	109	81.8	3260	4910	2660	3990
×34[h]	101	75.8	3020	4550	2460	3700
×311[h]	91.4	68.6	2740	4110	2230	3340
×283[h]	83.3	62.5	2490	3750	2030	3050
×257[h]	75.6	56.7	2260	3400	1840	2760
×233	68.5	51.4	2050	3080	1670	2510
×211	62.0	46.5	1860	2790	1510	2270
×193	56.8	42.6	1700	2560	1380	2080
×176	51.8	38.9	1550	2330	1260	1900
×159	46.7	35.0	1400	2100	1140	1710
×145	42.7	32.0	1280	1920	1040	1560

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5-1 (continued)
Available Strength in Axial Tension
W Shapes

W14–W12

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
W14×132	38.8	29.1	**1160**	1750	**946**	1420
×120	35.3	26.5	**1060**	1590	**861**	1290
×109	32.0	24.0	**958**	1440	**780**	1170
×99	29.1	21.8	**871**	1310	**709**	1060
×90	26.5	19.9	**793**	1190	**647**	970
W14×82	24.0	18.0	**719**	1080	**585**	878
×74	21.8	16.4	**653**	981	**533**	800
×68	20.0	15.0	**599**	900	**488**	731
×61	17.9	13.4	**536**	805	**436**	653
W14×53	15.6	11.7	**467**	702	**380**	570
×48	14.1	10.6	**422**	634	**345**	517
×43	12.6	9.45	**377**	567	**307**	461
W14×38	11.2	8.40	**335**	504	**273**	410
×34	10.0	7.50	**299**	450	**244**	366
×30	8.85	6.64	**265**	398	**216**	324
W14×26	7.69	5.77	**230**	346	**188**	281
×22	6.49	4.87	**194**	292	**158**	237
W12×336	98.8	74.1	**2960**	4450	**2410**	3610
×305[h]	89.6	67.2	**2680**	4030	**2180**	3280
×279[h]	81.9	61.4	**2450**	3690	**2000**	2990
×252[h]	74.0	55.5	**2220**	3330	**1800**	2710
×230[h]	67.7	50.8	**2030**	3050	**1650**	2480
×210[h]	61.8	46.3	**1850**	2780	**1500**	2260
×190	55.8	41.9	**1670**	2510	**1360**	2040
×170	50.0	37.5	**1500**	2250	**1220**	1830
×152	44.7	33.5	**1340**	2010	**1090**	1630
×136	39.9	29.9	**1190**	1800	**972**	1460
×120	35.3	26.5	**1060**	1590	**861**	1290
×106	31.2	23.4	**934**	1400	**761**	1140
×96	28.2	21.2	**844**	1270	**689**	1030
×87	25.6	19.2	**766**	1150	**624**	936
×79	23.2	17.4	**695**	1040	**566**	848
×72	21.1	15.8	**632**	949	**514**	770
×65	19.1	14.3	**572**	860	**465**	697

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

W12–W10

Table 5–1 (continued)
Available Strength in Axial Tension
W Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
W12×58	17.0	12.8	**509**	765	**416**	624
×53	15.6	11.7	**467**	702	**380**	570
W12×50	14.6	10.9	**437**	657	**354**	531
×45	13.1	9.83	**392**	590	**319**	479
×40	11.7	8.78	**350**	527	**285**	428
W12×35	10.3	7.73	**308**	463	**251**	377
×30	8.79	6.59	**263**	396	**214**	321
×26	7.65	5.74	**229**	344	**187**	280
W12×22	6.48	4.86	**194**	292	**158**	237
×19	5.57	4.18	**167**	251	**136**	204
×16	4.71	3.53	**141**	212	**115**	172
×14	4.16	3.12	**125**	187	**101**	152
W10×112	32.9	24.7	**985**	1480	**803**	1200
×100	29.4	22.0	**880**	1320	**715**	1070
×88	25.9	19.4	**775**	1170	**631**	946
×77	22.6	17.0	**677**	1020	**553**	829
×68	20.0	15.0	**599**	900	**488**	731
×60	17.6	13.2	**527**	792	**429**	644
×54	15.8	11.9	**473**	711	**387**	580
×49	14.4	10.8	**431**	648	**351**	527
W10×45	13.3	9.98	**398**	599	**324**	487
×39	11.5	8.63	**344**	518	**280**	421
×33	9.71	7.28	**291**	437	**237**	355
W10×30	8.84	6.63	**265**	398	**215**	323
×26	7.61	5.71	**228**	342	**186**	278
×22	6.49	4.87	**194**	292	**158**	237
W10×19	5.62	4.22	**168**	253	**137**	206
×17	4.99	3.74	**149**	225	**122**	182
×15	4.41	3.31	**132**	198	**108**	161
×12	3.54	2.66	**106**	159	**86.5**	130

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5-1 (continued)
Available Strength in Axial Tension
W Shapes

W8

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
W8×67	19.7	14.8	590	887	481	722
×58	17.1	12.8	512	770	416	624
×48	14.1	10.6	422	634	345	517
×40	11.7	8.78	350	527	285	428
×35	10.3	7.73	308	463	251	377
×31	9.12	6.84	273	410	222	333
W8×28	8.24	6.18	247	371	201	301
×24	7.08	5.31	212	319	173	259
W8×21	6.16	4.62	184	277	150	225
×18	5.26	3.94	157	237	128	192
W8×15	4.44	3.33	133	200	108	162
×13	3.84	2.88	115	173	93.6	140
×10	2.96	2.22	88.6	133	72.2	108

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

Table 5-2
Available Strength in Axial Tension
Angles

L8–L6

F_y = 36 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
L8×8×1 1/8	16.7	12.5	360	541	363	544
×1	15.0	11.3	323	486	328	492
×7/8	13.2	9.90	285	428	287	431
×3/4	11.4	8.55	246	369	248	372
×5/8	9.61	7.21	207	311	209	314
×9/16	8.68	6.51	187	281	189	283
×1/2	7.75	5.81	167	251	168	253
L8×6×1	13.0	9.75	280	421	283	424
×7/8	11.5	8.63	248	373	250	375
×3/4	9.94	7.46	214	322	216	325
×5/8	8.36	6.27	180	271	182	273
×9/16	7.56	5.67	163	245	164	247
×1/2	6.75	5.06	146	219	147	220
×7/16	5.93	4.45	128	192	129	194
L8×4×1	11.0	8.25	237	356	239	359
×7/8	9.73	7.30	210	315	212	318
×3/4	8.44	6.33	182	273	184	275
×5/8	7.11	5.33	153	230	155	232
×9/16	6.43	4.82	139	208	140	210
×1/2	5.75	4.31	124	186	125	187
×7/16	5.06	3.80	109	164	110	165
L7×4×3/4	7.69	5.77	166	249	167	251
×5/8	6.48	4.86	140	210	141	211
×1/2	5.25	3.94	113	170	114	171
×7/16	4.62	3.47	99.6	150	101	151
×3/8	3.98	2.99	85.8	129	86.7	130
L6×6×1	11.0	8.25	237	356	239	359
×7/8	9.75	7.31	210	316	212	318
×3/4	8.46	6.34	182	274	184	276
×5/8	7.13	5.35	154	231	155	233
×9/16	6.45	4.84	139	209	140	211
×1/2	5.77	4.33	124	187	126	188
×7/16	5.08	3.81	110	165	110	166
×3/8	4.38	3.29	94.4	142	95.4	143
×5/16	3.67	2.75	79.1	119	79.8	120

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

F_y = 36 ksi
F_u = 58 ksi

Table 5–2 (continued)
Available Strength in Axial Tension
Angles

L6–L5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
L6×4×7/8	7.98	5.99	172	259	174	261
×3/4	6.94	5.21	150	225	151	[illegible]
×5/8	5.86	4.39	126	190	127	[illegible]
×9/16	5.31	3.98	114	172	115	[illegible]
×1/2	4.75	3.56	102	154	103	[illegible]
×7/16	4.18	3.14	90.1	135	91.1	[illegible]
×3/8	3.61	2.71	77.8	117	78.6	[illegible]
×5/16	3.03	2.27	65.3	98.2	65.8	[illegible]
L6×3½×1/2	4.50	3.38	97.0	146	98.0	[illegible]
×3/8	3.42	2.57	73.7	111	74.5	[illegible]
×5/16	2.87	2.15	61.9	93.0	62.4	[illegible]
L5×5×7/8	7.98	5.99	172	259	174	261
×3/4	6.94	5.21	150	225	151	[illegible]
×5/8	5.86	4.39	126	190	127	[illegible]
×1/2	4.75	3.56	102	154	103	[illegible]
×7/16	4.18	3.14	90.1	135	91.1	[illegible]
×3/8	3.61	2.71	77.8	117	78.6	[illegible]
×5/16	3.03	2.27	65.3	98.2	65.8	[illegible]
L5×3½×3/4	5.81	4.36	125	188	126	[illegible]
×5/8	4.92	3.69	106	159	107	[illegible]
×1/2	4.00	3.00	86.2	130	87.0	[illegible]
×3/8	3.05	2.29	65.7	98.8	66.4	[illegible]
×5/16	2.56	1.92	55.2	82.9	55.7	[illegible]
×1/4	2.06	1.55	44.4	66.7	45.0	[illegible]
L5×3×1/2	3.75	2.81	80.8	122	81.5	122
×7/16	3.31	2.48	71.4	107	71.9	[illegible]
×3/8	2.86	2.15	61.7	92.7	62.4	[illegible]
×5/16	2.40	1.80	51.7	77.8	52.2	[illegible]
×1/4	1.94	1.46	41.8	62.9	42.3	[illegible]

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

Table 5–2 (continued)
Available Strength in Axial Tension
Angles

F_y = 36 ksi
F_u = 58 ksi

L4–L3½

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
L4×4×3/4	5.44	4.08	117	176	118	177
×5/8	4.61	3.46	99.4	149	100	151
×1/2	3.75	2.81	80.8	122	81.5	122
×7/16	3.31	2.48	71.4	107	71.9	108
×3/8	2.86	2.15	61.7	92.7	62.4	93.5
×5/16	2.40	1.80	51.7	77.8	52.2	78.3
×1/4	1.94	1.46	41.8	62.9	42.3	63.5
L4×3½×1/2	3.50	2.63	75.4	113	76.3	114
×3/8	2.67	2.00	57.6	86.5	58.0	87.0
×5/16	2.25	1.69	48.5	72.9	49.0	73.5
×1/4	1.81	1.36	39.0	58.6	39.4	59.2
L4×3×5/8	3.89	2.92	83.9	126	84.7	127
×1/2	3.25	2.44	70.1	105	70.8	106
×3/8	2.48	1.86	53.5	80.4	53.9	80.9
×5/16	2.09	1.57	45.1	67.7	45.5	68.3
×1/4	1.69	1.27	36.4	54.8	36.8	55.2
L3½×3½×1/2	3.25	2.44	70.1	105	70.8	106
×7/16	2.87	2.15	61.9	93.0	62.4	93.5
×3/8	2.48	1.86	53.5	80.4	53.9	80.9
×5/16	2.09	1.57	45.1	67.7	45.5	68.3
×1/4	1.69	1.27	36.4	54.8	36.8	55.2
L3½×3×1/2	3.00	2.25	64.7	97.2	65.3	97.9
×7/16	2.65	1.99	57.1	85.9	57.7	86.6
×3/8	2.30	1.73	49.6	74.5	50.2	75.3
×5/16	1.93	1.45	41.6	62.5	42.1	63.1
×1/4	1.56	1.17	33.6	50.5	33.9	50.9
×1/2	2.75	2.06	59.3	89.1	59.7	89.6
×3/8	2.11	1.58	45.5	68.4	45.8	68.7
×5/16	1.78	1.34	38.4	57.7	38.9	58.3
×1/4	1.44	1.08	31.0	46.7	31.3	47.0

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

Table 5-2 (continued) Available Strength in Axial Tension

Angles

F_y = 36 ksi
F_u = 58 ksi

L3–L2

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
L3×3×1/2	2.75	2.06	59.3	89.1	59.7	89.6
×7/16	2.43	1.82	52.4	78.7	52.8	79.2
×3/8	2.11	1.58	45.5	68.4	45.8	68.7
×5/16	1.78	1.34	38.4	57.7	38.9	58.3
×1/4	1.44	1.08	31.0	46.7	31.3	47.0
×3/16	1.09	0.818	23.5	35.3	23.7	35.6
L3×2 1/2×1/2	2.50	1.88	53.9	81.0	54.5	81.8
×7/16	2.21	1.66	47.6	71.6	48.1	72.2
×3/8	1.92	1.44	41.4	62.2	41.8	62.6
×5/16	1.67	1.25	36.0	54.1	36.3	54.4
×1/4	1.31	0.983	28.2	42.4	28.5	42.8
×3/16	1.00	0.747	21.5	32.3	21.7	32.5
L3×2×1/2	2.25	1.69	48.5	72.9	49.0	73.5
×3/8	1.73	1.30	37.3	56.1	37.7	56.6
×5/16	1.46	1.10	31.5	47.3	31.9	47.9
×1/4	1.19	0.892	25.7	38.6	25.9	38.8
×3/16	0.902	0.676	19.4	29.2	19.6	29.4
L2 1/2×2 1/2×1/2	2.25	1.69	48.5	72.9	49.0	73.5
×3/8	1.73	1.30	37.3	56.1	37.7	56.6
×5/16	1.46	1.10	31.5	47.3	31.9	47.9
×1/4	1.19	0.892	25.7	38.6	25.9	38.8
×3/16	0.900	0.675	19.4	29.2	19.6	29.4
L2 1/2×2×3/8	1.55	1.16	33.4	50.2	33.6	50.5
×5/16	1.31	0.983	28.2	42.4	28.5	42.8
×1/4	1.06	0.795	22.9	34.3	23.1	34.6
×3/16	0.809	0.607	17.4	26.2	17.6	26.4
L2 1/2×1 1/2×1/4	0.938	0.704	20.2	30.4	20.4	30.6
×3/16	0.715	0.536	15.4	23.2	15.5	23.3
L2×2×3/8	1.36	1.02	29.3	44.1	29.6	44.4
×5/16	1.15	0.863	24.8	37.3	25.0	37.5
×1/4	0.938	0.704	20.2	30.4	20.4	30.6
×3/16	0.715	0.536	15.4	23.2	15.5	23.3
×1/8	0.484	0.363	10.4	15.7	10.5	15.8

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

WT22–WT20

Table 5–3
Available Strength in Axial Tension
WT Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
WT22×167.5	49.2	36.9	**1470**	2210	**1200**	1800
×145	42.7	32.0	**1280**	1920	**1040**	1560
×131	38.4	28.8	**1150**	1730	**936**	1400
×115	33.8	25.4	**1010**	1520	**826**	1240
WT20×296.5[h]	87.2	65.4	**2610**	3920	**2130**	3190
×251.5[h]	73.9	55.4	**2210**	3330	**1800**	2700
×215.5[h]	63.4	47.6	**1900**	2850	**1550**	2320
×198.5[h]	58.4	43.8	**1750**	2630	**1420**	2140
×186[h]	54.6	41.0	**1630**	2460	**1330**	2000
×181[h]	53.3	40.0	**1600**	2400	**1300**	1950
×162	47.7	35.8	**1430**	2150	**1160**	1750
×148.5	43.7	32.8	**1310**	1970	**1070**	1600
×138.5	40.7	30.5	**1220**	1830	**991**	1490
×124.5	36.7	27.5	**1100**	1650	**894**	1340
×107.5	31.7	23.8	**949**	1430	**773**	1160
×99.5	29.2	21.9	**874**	1310	**712**	1070
WT20×196[h]	57.6	43.2	**1720**	2590	**1400**	2110
×165.5[h]	48.7	36.5	**1460**	2190	**1190**	1780
×163.5[h]	48.0	36.0	**1440**	2160	**1170**	1760
×147	43.1	32.3	**1290**	1940	**1050**	1570
×139	41.0	30.8	**1230**	1850	**1000**	1500
×132	38.8	29.1	**1160**	1750	**946**	1420
×117.5	34.5	25.9	**1030**	1550	**842**	1260
×105.5	31.0	23.3	**928**	1400	**757**	1140
×91.5	26.7	20.0	**799**	1200	**650**	975
×83.5	24.6	18.5	**737**	1110	**601**	902
×74.5	21.9	16.4	**656**	985	**533**	800

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

WT18–WT16.5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
WT18×400^h	118	88.5	3530	5310	2880	4310
×326^h	96.1	72.1	2880	4320	2340	3510
×264.5^h	77.8	58.3	2330	3500	1890	2840
×243.5^h	71.7	53.8	2150	3230	1750	2620
×220.5^h	64.9	48.7	1940	2920	1580	2370
×197.5^h	58.2	43.7	1740	2620	1420	2130
×180.5^h	53.0	39.8	1590	2390	1290	1940
×165	48.5	36.4	1450	2180	1180	1770
×151	44.4	33.3	1330	2000	1080	1620
×141	41.5	31.1	1240	1870	1010	1520
×131	38.5	28.9	1150	1730	939	1410
×123.5	36.3	27.2	1090	1630	884	1330
×115.5	34.0	25.5	1020	1530	829	1240
WT18×128	37.7	28.3	1130	1700	920	1380
×116	34.1	25.6	1020	1530	832	1250
×105	30.9	23.2	925	1390	754	1130
×97	28.5	21.4	853	1280	696	1040
×91	26.8	20.1	802	1210	653	980
×85	25.0	18.8	749	1130	611	917
×80	23.5	17.6	704	1060	572	858
×75	22.1	16.6	662	995	540	809
×67.5	19.9	14.9	596	896	484	726
WT16.5×193.5^h	57.0	42.7	1710	2560	1390	2080
×177^h	52.1	39.1	1560	2340	1270	1910
×159	46.8	35.1	1400	2110	1140	1710
×145.5	42.8	32.1	1280	1930	1040	1560
×131.5	38.7	29.0	1160	1740	942	1410
×120.5	35.5	26.6	1060	1600	865	1300
×110.5	32.6	24.5	976	1470	796	1190
×100.5	29.6	22.2	886	1330	722	1080

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

^h Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

WT16.5–WT13.5

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
WT16.5×84.5	24.8	18.6	743	1120	605	907
×76	22.4	16.8	671	1010	546	819
×70.5	20.8	15.6	623	936	507	761
×65	19.2	14.4	575	864	468	702
×59	17.3	13.0	518	778	423	634
WT15×195.5[h]	57.6	43.2	1720	2590	1400	2110
×178.5[h]	52.5	39.4	1570	2360	1280	1920
×163[h]	47.9	35.9	1430	2160	1170	1750
×146	42.9	32.2	1280	1930	1050	1570
×130.5	38.4	28.8	1150	1730	936	1400
×117.5	34.6	25.9	1040	1560	842	1260
×105.5	31.1	23.3	931	1400	757	1140
×95.5	28.1	21.1	841	1260	686	1030
×86.5	25.5	19.1	763	1150	621	931
WT15×74	21.7	16.3	650	977	530	795
×66	19.4	14.6	581	873	475	712
×62	18.2	13.6	545	819	442	663
×58	17.1	12.8	512	770	416	624
×54	15.9	11.9	476	716	387	580
×49.5	14.5	10.9	434	652	354	531
×45	13.2	9.90	395	594	322	483
WT13.5×269.5[h]	79.3	59.5	2370	3570	1930	2900
×184[h]	54.2	40.7	1620	2440	1320	1980
×168[h]	49.5	37.1	1480	2230	1210	1810
×153.5[h]	45.2	33.9	1350	2030	1100	1650
×140.5	41.4	31.1	1240	1860	1010	1520
×129	38.0	28.5	1140	1710	926	1390
×117.5	34.7	26.0	1040	1560	845	1270
×108.5	32.0	24.0	958	1440	780	1170
×97	28.6	21.5	856	1290	699	1050
×89	26.2	19.7	784	1180	640	960
×80.5	23.8	17.9	713	1070	582	873
×73	21.6	16.2	647	972	527	790

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

WT13.5–WT10.5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
WT13.5×64.5	18.9	14.2	**566**	850	**462**	692
×57	16.8	12.6	**503**	756	**410**	614
×51	15.0	11.3	**449**	675	**367**	551
×47	13.8	10.4	**413**	621	**338**	507
×42	12.4	9.30	**371**	558	**302**	453
WT12×185[h]	54.4	40.8	**1630**	2450	**1330**	1990
×167.5[h]	49.2	36.9	**1470**	2210	**1200**	1800
×153[h]	44.9	33.7	**1340**	2020	**1100**	1640
×139.5[h]	41.0	30.8	**1230**	1850	**1000**	1500
×125	36.8	27.6	**1100**	1660	**897**	1350
×114.5	33.6	25.2	**1010**	1510	**819**	1230
×103.5	30.4	22.8	**910**	1370	**741**	1110
×96	28.1	21.1	**841**	1260	**686**	1030
×88	25.8	19.4	**772**	1160	**631**	946
×81	23.9	17.9	**716**	1080	**582**	873
×73	21.5	16.1	**644**	968	**523**	785
×65.5	19.3	14.5	**578**	869	**471**	707
×58.5	17.2	12.9	**515**	774	**419**	629
×52	15.3	11.5	**458**	689	**374**	561
WT12×51.5	15.1	11.3	**452**	680	**367**	551
×47	13.8	10.4	**413**	621	**338**	507
×42	12.4	9.30	**371**	558	**302**	453
×38	11.2	8.40	**335**	504	**273**	410
×34	10.0	7.50	**299**	450	**244**	366
WT12×31	9.11	6.83	**273**	410	**222**	333
×27.5	8.10	6.08	**243**	365	**198**	296
WT10.5×100.5	29.6	22.2	**886**	1330	**722**	1080
×91	26.8	20.1	**802**	1210	**653**	980
×83	24.4	18.3	**731**	1100	**595**	892
×73.5	21.6	16.2	**647**	972	**527**	790
×66	19.4	14.6	**581**	873	**475**	712
×61	17.9	13.4	**536**	805	**436**	653
×55.5	16.3	12.2	**488**	734	**397**	595
×50.5	14.9	11.2	**446**	670	**364**	546

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

WT10.5–WT9

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
WT10.5×46.5	13.7	10.3	**410**	617	**335**	502
×41.5	12.2	9.15	**365**	549	**297**	446
×36.5	10.7	8.02	**320**	481	**261**	391
×34	10.0	7.50	**299**	450	**244**	366
×31	9.13	6.85	**273**	411	**223**	334
×27.5	8.10	6.08	**243**	365	**198**	296
×24	7.07	5.30	**212**	318	**172**	258
WT10.5×28.5	8.37	6.28	**251**	377	**204**	306
×25	7.36	5.52	**220**	331	**179**	269
×22	6.49	4.87	**194**	292	**158**	237
WT9×155.5[h]	45.8	34.4	**1370**	2060	**1120**	1680
×141.5[h]	41.6	31.2	**1250**	1870	**1010**	1520
×129[h]	37.9	28.4	**1130**	1710	**923**	1380
×117[h]	34.4	25.8	**1030**	1550	**839**	1260
×105.5	31.1	23.3	**931**	1400	**757**	1140
×96	28.2	21.2	**844**	1270	**689**	1030
×87.5	25.7	19.3	**769**	1160	**627**	941
×79	23.2	17.4	**695**	1040	**566**	848
×71.5	21.0	15.8	**629**	945	**514**	770
×65	19.1	14.3	**572**	860	**465**	697
×59.5	17.5	13.1	**524**	788	**426**	639
×53	15.6	11.7	**467**	702	**380**	570
×48.5	14.3	10.7	**428**	644	**348**	522
×43	12.7	9.52	**380**	572	**309**	464
×38	11.2	8.40	**335**	504	**273**	410
WT9×35.5	10.4	7.80	**311**	468	**254**	380
×32.5	9.55	7.16	**286**	430	**233**	349
×30	8.82	6.62	**264**	397	**215**	323
×27.5	8.10	6.08	**243**	365	**198**	296
×25	7.33	5.50	**219**	330	**179**	268
WT9×23	6.77	5.08	**203**	305	**165**	248
×20	5.88	4.41	**176**	265	**143**	215
×17.5	5.15	3.86	**154**	232	**125**	188

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

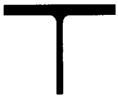
WT8–WT7

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
WT8×50	14.7	11.0	**440**	662	**358**	536
×44.5	13.1	9.83	**392**	590	**319**	479
×38.5	11.3	8.48	**338**	509	**276**	413
×33.5	9.84	7.38	**295**	443	**240**	360
WT8×28.5	8.39	6.29	**251**	378	**204**	307
×25	7.37	5.53	**221**	332	**180**	270
×22.5	6.63	4.97	**199**	298	**162**	242
×20	5.89	4.42	**176**	265	**144**	215
×18	5.29	3.97	**158**	238	**129**	194
WT8×15.5	4.56	3.42	**137**	205	**111**	167
×13	3.84	2.88	**115**	173	**93.6**	140
WT7×365[h]	107	80.3	**3200**	4820	**2610**	3910
×332.5[h]	97.8	73.3	**2930**	4400	**2380**	3570
×302.5[h]	88.9	66.7	**2660**	4000	**2170**	3250
×275[h]	80.9	60.7	**2420**	3640	**1970**	2960
×250[h]	73.5	55.1	**2200**	3310	**1790**	2690
×227.5[h]	66.9	50.2	**2000**	3010	**1630**	2450
×213[h]	62.6	47.0	**1870**	2820	**1530**	2290
×199[h]	58.5	43.9	**1750**	2630	**1430**	2140
×185[h]	54.4	40.8	**1630**	2450	**1330**	1990
×171[h]	50.3	37.7	**1510**	2260	**1230**	1840
×155.5[h]	45.7	34.3	**1370**	2060	**1110**	1670
×141.5[h]	41.6	31.2	**1250**	1870	**1010**	1520
×128.5	37.8	28.4	**1130**	1700	**923**	1380
×116.5	34.2	25.7	**1020**	1540	**835**	1250
×105.5	31.0	23.3	**928**	1400	**757**	1140
×96.5	28.4	21.3	**850**	1280	**692**	1040
×88	25.9	19.4	**775**	1170	**631**	946
×79.5	23.4	17.6	**701**	1050	**572**	858
×72.5	21.3	16.0	**638**	959	**520**	780

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.



WT7–WT6

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
WT7×66	19.4	14.6	**581**	873	**475**	712
×60	17.7	13.3	**530**	797	**432**	648
×54.5	16.0	12.0	**479**	720	**390**	585
×49.5	14.6	10.9	**437**	657	**354**	531
×45	13.2	9.90	**395**	594	**322**	483
WT7×41	12.0	9.00	**359**	540	**293**	439
×37	10.9	8.18	**326**	491	**266**	399
×34	9.99	7.49	**299**	450	**243**	365
×30.5	8.96	6.72	**268**	403	**218**	328
WT7×26.5	7.80	5.85	**234**	351	**190**	285
×24	7.07	5.30	**212**	318	**172**	258
×21.5	6.31	4.73	**189**	284	**154**	231
WT7×19	5.58	4.19	**167**	251	**136**	204
×17	5.00	3.75	**150**	225	**122**	183
×15	4.42	3.32	**132**	199	**108**	162
WT7×13	3.85	2.89	**115**	173	**93.9**	141
×11	3.25	2.44	**97.3**	146	**79.3**	119
WT6×168[h]	49.4	37.1	**1480**	2220	**1210**	1810
×152.5[h]	44.8	33.6	**1340**	2020	**1090**	1640
×139.5[h]	41.0	30.8	**1230**	1850	**1000**	1500
×126[h]	37.0	27.8	**1110**	1670	**904**	1360
×115[h]	33.9	25.4	**1010**	1530	**826**	1240
×105	30.9	23.2	**925**	1390	**754**	1130
×95	27.9	20.9	**835**	1260	**679**	1020
×85	25.0	18.8	**749**	1130	**611**	917
×76	22.4	16.8	**671**	1010	**546**	819
×68	20.0	15.0	**599**	900	**488**	731
×60	17.6	13.2	**527**	792	**429**	644
×53	15.6	11.7	**467**	702	**380**	570
×48	14.1	10.6	**422**	634	**345**	517
×43.5	12.8	9.60	**383**	576	**312**	468
×39.5	11.6	8.70	**347**	522	**283**	424
×36	10.6	7.95	**317**	477	**258**	388
×32.5	9.54	7.15	**286**	429	**232**	349

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

[h] Flange thickness is greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 50 ksi
F_u = 65 ksi

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

WT6–WT5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
WT6×29	8.52	6.39	255	383	208	312
×26.5	7.78	5.84	233	350	190	285
WT6×25	7.30	5.48	219	329	178	267
×22.5	6.56	4.92	196	295	160	240
×20	5.84	4.38	175	263	142	214
WT6×17.5	5.17	3.88	155	233	126	189
×15	4.40	3.30	132	198	107	161
×13	3.82	2.87	114	172	93.3	140
WT6×11	3.24	2.43	97.0	146	79.0	118
×9.5	2.79	2.09	83.5	126	67.9	102
×8	2.36	1.77	70.7	106	57.5	86.3
×7	2.08	1.56	62.3	93.6	50.7	76.1
WT5×56	16.5	12.4	494	743	403	605
×50	14.7	11.0	440	662	358	536
×44	12.9	9.68	386	581	315	472
×38.5	11.3	8.48	338	509	276	413
×34	9.99	7.49	299	450	243	365
×30	8.82	6.62	264	397	215	323
×27	7.91	5.93	237	356	193	289
×24.5	7.21	5.41	216	324	176	264
WT5×22.5	6.63	4.97	199	298	162	242
×19.5	5.73	4.30	172	258	140	210
×16.5	4.85	3.64	145	218	118	177
WT5×15	4.42	3.32	132	199	108	162
×13	3.81	2.86	114	171	93.0	139
×11	3.24	2.43	97.0	146	79.0	118
WT5×9.5	2.81	2.11	84.1	126	68.6	103
×8.5	2.50	1.88	74.9	113	61.1	91.6
×7.5	2.21	1.66	66.2	99.5	54.0	80.9
×6	1.77	1.33	53.0	79.7	43.2	64.8

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

WT4

Table 5–3 (continued)
Available Strength in Axial Tension
WT Shapes

F_y = 50 ksi
F_u = 65 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
WT4×33.5	9.84	7.38	295	443	240	360
×29	8.54	6.41	256	384	208	312
×24	7.05	5.29	211	317	172	258
×20	5.87	4.40	176	264	143	215
×17.5	5.14	3.86	154	231	125	188
×15.5	4.56	3.42	137	205	111	167
WT4×14	4.12	3.09	123	185	100	151
×12	3.54	2.66	106	159	86.5	130
WT4×10.5	3.08	2.31	92.2	139	75.1	113
×9	2.63	1.97	78.7	118	64.0	96.0
WT4×7.5	2.22	1.67	66.5	99.9	54.3	81.4
×6.5	1.92	1.44	57.5	86.4	46.8	70.2
×5	1.48	1.11	44.3	66.6	36.1	54.1

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.923A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–4
Available Strength in Axial Tension
Rectangular HSS

HSS20–HSS16

Shape	Gross Area, A_g	A_e = $0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS20×12×5/8	35.0	26.3	**964**	1450	**763**	1140
×1/2	28.3	21.2	**780**	1170	**615**	922
×3/8	21.5	16.1	**592**	890	**467**	700
×5/16	18.1	13.6	**499**	749	**394**	592
HSS20×8×5/8	30.3	22.7	**835**	1250	**658**	987
×1/2	24.6	18.5	**678**	1020	**537**	805
×3/8	18.7	14.0	**515**	774	**406**	609
×5/16	15.7	11.8	**432**	650	**342**	513
HSS20×4×1/2	20.9	15.7	**576**	865	**455**	683
×3/8	16.0	12.0	**441**	662	**348**	522
×5/16	13.4	10.1	**369**	555	**293**	439
×1/4	10.8	8.10	**297**	447	**235**	352
HSS18×6×5/8	25.7	19.3	**708**	1060	**560**	840
×1/2	20.9	15.7	**576**	865	**455**	683
×3/8	16.0	12.0	**441**	662	**348**	522
×5/16	13.4	10.1	**369**	555	**293**	439
×1/4	10.8	8.10	**297**	447	**235**	352
HSS16×12×5/8	30.3	22.7	**835**	1250	**658**	987
×1/2	24.6	18.5	**678**	1020	**537**	805
×3/8	18.7	14.0	**515**	774	**406**	609
×5/16	15.7	11.8	**432**	650	**342**	513
HSS16×8×5/8	25.7	19.3	**708**	1060	**560**	840
×1/2	20.9	15.7	**576**	865	**455**	683
×3/8	16.0	12.0	**441**	662	**348**	522
×1/4	10.8	8.10	**297**	447	**235**	352
HSS16×4×5/8	21.0	15.8	**578**	869	**458**	687
×1/2	17.2	12.9	**474**	712	**374**	561
×3/8	13.2	9.90	**364**	546	**287**	431
×5/16	11.1	8.32	**306**	460	**241**	362
×1/4	8.96	6.72	**247**	371	**195**	292
×3/16	6.76	5.07	**186**	280	**147**	221

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

HSS14–HSS12

Table 5-4 (continued)
Available Strength in Axial Tension
Rectangular HSS

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS14×10×5/8	25.7	19.3	708	1060	560	840
×1/2	20.9	15.7	576	865	455	683
×3/8	16.0	12.0	441	662	348	522
×5/16	13.4	10.1	369	555	293	439
×1/4	10.8	8.10	297	447	235	352
HSS14×6×5/8	21.0	15.8	578	869	458	687
×1/2	17.2	12.9	474	712	374	561
×3/8	13.2	9.90	364	546	287	431
×5/16	11.1	8.32	306	460	241	362
×1/4	8.96	6.72	247	371	195	292
×3/16	6.76	5.07	186	280	147	221
HSS14×4×5/8	18.7	14.0	515	774	406	609
×1/2	15.3	11.5	421	633	334	500
×3/8	11.8	8.85	325	489	257	385
×5/16	9.92	7.44	273	411	216	324
×1/4	8.03	6.02	221	332	175	262
×3/16	6.06	4.55	167	251	132	198
HSS12×10×1/2	19.0	14.3	523	787	415	622
×3/8	14.6	10.9	402	604	316	474
×5/16	12.2	9.15	336	505	265	398
×1/4	9.90	7.43	273	410	215	323
HSS12×8×5/8	21.0	15.8	578	869	458	687
×1/2	17.2	12.9	474	712	374	561
×3/8	13.2	9.90	364	546	287	431
×5/16	11.1	8.32	306	460	241	362
×1/4	8.96	6.72	247	371	195	292
×3/16	6.76	5.07	186	280	147	221
HSS12×6×5/8	18.7	14.0	515	774	406	609
×1/2	15.3	11.5	421	633	334	500
×3/8	11.8	8.85	325	489	257	385
×5/16	9.92	7.44	273	411	216	324
×1/4	8.03	6.02	221	332	175	262
×3/16	6.06	4.55	167	251	132	198

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

HSS12–HSS10

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding, kips		Rupture, kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS12×4×5/8	16.4	12.3	**452**	679	**357**	535
×1/2	13.5	10.1	**372**	559	**293**	439
×3/8	10.4	7.80	**286**	431	**226**	339
×5/16	8.76	6.57	**241**	363	**191**	286
×1/4	7.10	5.33	**196**	294	**155**	232
×3/16	5.37	4.03	**148**	222	**117**	175
HSS12×3 1/2×3/8	10.0	7.50	**275**	414	**218**	326
×5/16	8.46	6.34	**233**	350	**184**	276
HSS12×3×5/16	8.17	6.13	**225**	338	**178**	267
×1/4	6.63	4.97	**183**	274	**144**	216
×3/16	5.02	3.76	**138**	208	**109**	164
HSS12×2×5/16	7.59	5.69	**209**	314	**165**	248
×1/4	6.17	4.63	**170**	255	**134**	201
×3/16	4.67	3.50	**129**	193	**102**	152
HSS10×8×5/8	18.7	14.0	**515**	774	**406**	609
×1/2	15.3	11.5	**421**	633	**334**	500
×3/8	11.8	8.85	**325**	489	**257**	385
×5/16	9.92	7.44	**273**	411	**216**	324
×1/4	8.03	6.02	**221**	332	**175**	262
×3/16	6.06	4.55	**167**	251	**132**	198
HSS10×6×5/8	16.4	12.3	**452**	679	**357**	535
×1/2	13.5	10.1	**372**	559	**293**	439
×3/8	10.4	7.80	**286**	431	**226**	339
×5/16	8.76	6.57	**241**	363	**191**	286
×1/4	7.10	5.33	**196**	294	**155**	232
×3/16	5.37	4.03	**148**	222	**117**	175
HSS10×5×3/8	9.67	7.25	**266**	400	**210**	315
×5/16	8.17	6.13	**225**	338	**178**	267
×1/4	6.63	4.97	**183**	274	**144**	216
×3/16	5.02	3.76	**138**	208	**109**	164

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

HSS10–HSS9

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS10×4×5/8	14.0	10.5	**386**	580	**305**	457
×1/2	11.6	8.70	**320**	480	**252**	378
×3/8	8.97	6.73	**247**	371	**195**	293
×5/16	7.59	5.69	**209**	314	**165**	248
×1/4	6.17	4.63	**170**	255	**134**	201
×3/16	4.67	3.50	**129**	193	**102**	152
×1/8	3.16	2.37	**87.0**	131	**68.7**	103
HSS10×3 1/2×1/2	11.1	8.32	**306**	460	**241**	362
×3/8	8.62	6.47	**237**	357	**188**	281
×5/16	7.30	5.48	**201**	302	**159**	238
×1/4	5.93	4.45	**163**	246	**129**	194
×3/16	4.50	3.38	**124**	186	**98.0**	147
×1/8	3.04	2.28	**83.7**	126	**66.1**	99.2
HSS10×3×3/8	8.27	6.20	**228**	342	**180**	270
×5/16	7.01	5.26	**193**	290	**153**	229
×1/4	5.70	4.27	**157**	236	**124**	186
×3/16	4.32	3.24	**119**	179	**94.0**	141
×1/8	2.93	2.20	**80.7**	121	**63.8**	95.7
HSS10×2×3/8	7.58	5.69	**209**	314	**165**	248
×5/16	6.43	4.82	**177**	266	**140**	210
×1/4	5.24	3.93	**144**	217	**114**	171
×3/16	3.98	2.99	**110**	165	**86.7**	130
×1/8	2.70	2.03	**74.4**	112	**58.9**	88.3
HSS9×7×5/8	16.4	12.3	**452**	679	**357**	535
×1/2	13.5	10.1	**372**	559	**293**	439
×3/8	10.4	7.80	**286**	431	**226**	339
×5/16	8.76	6.57	**241**	363	**191**	286
×1/4	7.10	5.33	**196**	294	**155**	232
×3/16	5.37	4.03	**148**	222	**117**	175

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

HSS9–HSS8

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
HSS9×5×5/8	14.0	10.5	**386**	580	**305**	457
×1/2	11.6	8.70	**320**	480	**252**	378
×3/8	8.97	6.73	**247**	371	**195**	293
×5/16	7.59	5.69	**209**	314	**165**	248
×1/4	6.17	4.63	**170**	255	**134**	201
×3/16	4.67	3.50	**129**	193	**102**	152
HSS9×3×1/2	9.74	7.30	**268**	403	**212**	318
×3/8	7.58	5.69	**209**	314	**165**	248
×5/16	6.43	4.82	**177**	266	**140**	210
×1/4	5.24	3.93	**144**	217	**114**	171
×3/16	3.98	2.99	**110**	165	**86.7**	130
HSS8×6×5/8	14.0	10.5	**386**	580	**305**	457
×1/2	11.6	8.70	**320**	480	**252**	378
×3/8	8.97	6.73	**247**	371	**195**	293
×5/16	7.59	5.69	**209**	314	**165**	248
×1/4	6.17	4.63	**170**	255	**134**	201
×3/16	4.67	3.50	**129**	193	**102**	152
HSS8×4×5/8	11.7	8.78	**322**	484	**255**	382
×1/2	9.74	7.30	**268**	403	**212**	318
×3/8	7.58	5.69	**209**	314	**165**	248
×5/16	6.43	4.82	**177**	266	**140**	210
×1/4	5.24	3.93	**144**	217	**114**	171
×3/16	3.98	2.99	**110**	165	**86.7**	130
×1/8	2.70	2.03	**74.4**	112	**58.9**	88.3
HSS8×3×1/2	8.81	6.61	**243**	365	**192**	288
×3/8	6.88	5.16	**190**	285	**150**	224
×5/16	5.85	4.39	**161**	242	**127**	191
×1/4	4.77	3.58	**131**	197	**104**	156
×3/16	3.63	2.72	**100**	150	**78.9**	118
×1/8	2.46	1.85	**67.8**	102	**53.7**	80.5

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

HSS8–HSS6

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS8×2×3/8	6.18	4.63	170	256	134	201
×5/16	5.26	3.94	145	218	114	171
×1/4	4.30	3.22	118	178	93.4	140
×3/16	3.28	2.46	90.3	136	71.3	107
×1/8	2.23	1.67	61.4	92.3	48.4	72.6
HSS7×5×1/2	9.74	7.30	268	403	212	318
×3/8	7.58	5.69	209	314	165	248
×5/16	6.43	4.82	177	266	140	210
×1/4	5.24	3.93	144	217	114	171
×3/16	3.98	2.99	110	165	86.7	130
×1/8	2.70	2.03	74.4	112	58.9	88.3
HSS7×4×1/2	8.81	6.61	243	365	192	288
×3/8	6.88	5.16	190	285	150	224
×5/16	5.85	4.39	161	242	127	191
×1/4	4.77	3.58	131	197	104	156
×3/16	3.63	2.72	100	150	78.9	118
×1/8	2.46	1.85	67.8	102	53.7	80.5
HSS7×3×1/2	7.88	5.91	217	326	171	257
×3/8	6.18	4.63	170	256	134	201
×5/16	5.26	3.94	145	218	114	171
×1/4	4.30	3.22	118	178	93.4	140
×3/16	3.28	2.46	90.3	136	71.3	107
×1/8	2.23	1.67	61.4	92.3	48.4	72.6
HSS7×2×1/4	3.84	2.88	106	159	83.5	125
×3/16	2.93	2.20	80.7	121	63.8	95.7
×1/8	2.00	1.50	55.1	82.8	43.5	65.3
HSS6×5×1/2	8.81	6.61	243	365	192	288
×3/8	6.88	5.16	190	285	150	224
×5/16	5.85	4.39	161	242	127	191
×1/4	4.77	3.58	131	197	104	156
×3/16	3.63	2.72	100	150	78.9	118
×1/8	2.46	1.85	67.8	102	53.7	80.5

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

HSS6–HSS5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding (kips)		Rupture (kips)	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS6×4×1/2	7.88	5.91	217	326	171	257
×3/8	6.18	4.63	170	256	134	201
×5/16	5.26	3.94	145	218	114	171
×1/4	4.30	3.22	118	178	93.4	140
×3/16	3.28	2.46	90.3	136	71.3	107
×1/8	2.23	1.67	61.4	92.3	48.4	72.6
HSS6×3×1/2	6.95	5.21	191	288	151	227
×3/8	5.48	4.11	151	227	119	179
×5/16	4.68	3.51	129	194	102	153
×1/4	3.84	2.88	106	159	83.5	125
×3/16	2.93	2.20	80.7	121	63.8	95.7
×1/8	2.00	1.50	55.1	82.8	43.5	65.3
HSS6×2×3/8	4.78	3.58	132	198	104	156
×5/16	4.10	3.08	113	170	89.3	134
×1/4	3.37	2.53	92.8	140	73.4	110
×3/16	2.58	1.94	71.1	107	56.3	84.4
×1/8	1.77	1.33	48.8	73.3	38.6	57.9
HSS5×4×1/2	6.95	5.21	191	288	151	227
×3/8	5.48	4.11	151	227	119	179
×5/16	4.68	3.51	129	194	102	153
×1/4	3.84	2.88	106	159	83.5	125
×3/16	2.93	2.20	80.7	121	63.8	95.7
×1/8	2.00	1.50	55.1	82.8	43.5	65.3
HSS5×3×1/2	6.02	4.51	166	249	131	196
×3/8	4.78	3.58	132	198	104	156
×5/16	4.10	3.08	113	170	89.3	134
×1/4	3.37	2.53	92.8	140	73.4	110
×3/16	2.58	1.94	71.1	107	56.3	84.4
×1/8	1.77	1.33	48.8	73.3	38.6	57.9
HSS5×2½×1/4	3.14	2.36	86.5	130	68.4	103
×3/16	2.41	1.81	66.4	99.8	52.5	78.7
×1/8	1.65	1.24	45.4	68.3	36.0	53.9

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

Table 5-4 (continued)
Available Strength in Axial Tension
Rectangular HSS

HSS5–HSS3½

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS5×2×3/8	4.09	3.07	**113**	169	**89.0**	134
×5/16	3.52	2.64	**97.0**	146	**76.6**	115
×1/4	2.91	2.18	**80.2**	120	**63.2**	94.8
×3/16	2.24	1.68	**61.7**	92.7	**48.7**	73.1
×1/8	1.54	1.16	**42.4**	63.8	**33.6**	50.5
HSS4×3×3/8	4.09	3.07	**113**	169	**89.0**	134
×5/16	3.52	2.64	**97.0**	146	**76.6**	115
×1/4	2.91	2.18	**80.2**	120	**63.2**	94.8
×3/16	2.24	1.68	**61.7**	92.7	**48.7**	73.1
×1/8	1.54	1.16	**42.4**	63.8	**33.6**	50.5
HSS4×2½×3/8	3.74	2.81	**103**	155	**81.5**	122
×5/16	3.23	2.42	**89.0**	134	**70.2**	105
×1/4	2.67	2.00	**73.5**	111	**58.0**	87.0
×3/16	2.06	1.55	**56.7**	85.3	**45.0**	67.4
×1/8	1.42	1.07	**39.1**	58.8	**31.0**	46.5
HSS4×2×3/8	3.39	2.54	**93.4**	140	**73.7**	110
×5/16	2.94	2.21	**81.0**	122	**64.1**	96.1
×1/4	2.44	1.83	**67.2**	101	**53.1**	79.6
×3/16	1.89	1.42	**52.1**	78.2	**41.2**	61.8
×1/8	1.30	0.975	**35.8**	53.8	**28.3**	42.4
HSS3½×2½×3/8	3.39	2.54	**93.4**	140	**73.7**	110
×5/16	2.94	2.21	**81.0**	122	**64.1**	96.1
×1/4	2.44	1.83	**67.2**	101	**53.1**	79.6
×3/16	1.89	1.42	**52.1**	78.2	**41.2**	61.8
×1/8	1.30	0.975	**35.8**	53.8	**28.3**	42.4
HSS3½×2×1/4	2.21	1.66	**60.9**	91.5	**48.1**	72.2
×3/16	1.71	1.28	**47.1**	70.8	**37.1**	55.7
×1/8	1.19	0.892	**32.8**	49.3	**25.9**	38.8
×1/4	1.97	1.48	**54.3**	81.6	**42.9**	64.4
×3/16	1.54	1.16	**42.4**	63.8	**33.6**	50.5
×1/8	1.07	0.803	**29.5**	44.3	**23.3**	34.9

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–4 (continued)
Available Strength in Axial Tension
Rectangular HSS

HSS3–HSS2

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS3×2$^1/_2$×$^5/_{16}$	2.64	1.98	**72.7**	109	**57.4**	86.1
×$^1/_4$	2.21	1.66	**60.9**	91.5	**48.1**	72.2
×$^3/_{16}$	1.71	1.28	**47.1**	70.8	**37.1**	55.7
×$^1/_8$	1.19	0.892	**32.8**	49.3	**25.9**	38.8
HSS3×2×$^5/_{16}$	2.35	1.76	**64.7**	97.3	**51.0**	76.6
×$^1/_4$	1.97	1.48	**54.3**	81.6	**42.9**	64.4
×$^3/_{16}$	1.54	1.16	**42.4**	63.8	**33.6**	50.5
×$^1/_8$	1.07	0.803	**29.5**	44.3	**23.3**	34.9
HSS3×1$^1/_2$×$^1/_4$	1.74	1.30	**47.9**	72.0	**37.7**	56.6
×$^3/_{16}$	1.37	1.03	**37.7**	56.7	**29.9**	44.8
HSS3×1×$^1/_8$	0.956	0.717	**26.3**	39.6	**20.8**	31.2
×$^3/_{16}$	1.19	0.892	**32.8**	49.3	**25.9**	38.8
×$^1/_8$	0.840	0.630	**23.1**	34.8	**18.3**	27.4
HSS2$^1/_2$×2×$^1/_4$	1.74	1.30	**47.9**	72.0	**37.7**	56.6
×$^3/_{16}$	1.37	1.03	**37.7**	56.7	**29.9**	44.8
×$^1/_8$	0.956	0.717	**26.3**	39.6	**20.8**	31.2
HSS2$^1/_2$×1$^1/_2$×$^1/_4$	1.51	1.13	**41.6**	62.5	**32.8**	49.2
×$^3/_{16}$	1.19	0.892	**32.8**	49.3	**25.9**	38.8
×$^1/_8$	0.840	0.630	**23.1**	34.8	**18.3**	27.4
HSS2$^1/_2$×1×$^3/_{16}$	1.02	0.765	**28.1**	42.2	**22.2**	33.3
×$^1/_8$	0.724	0.543	**19.9**	30.0	**15.7**	23.6
HSS2$^1/_4$×2×$^3/_{16}$	1.28	0.960	**35.3**	53.0	**27.8**	41.8
×$^1/_8$	0.898	0.674	**24.7**	37.2	**19.5**	29.3
HSS2×1$^1/_2$×$^3/_{16}$	1.02	0.765	**28.1**	42.2	**22.2**	33.3
×$^1/_8$	0.724	0.543	**19.9**	30.0	**15.7**	23.6
HSS2×1×$^3/_{16}$	0.845	0.634	**23.3**	35.0	**18.4**	27.6
×$^1/_8$	0.608	0.456	**16.7**	25.2	**13.2**	19.8

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

HSS16–HSS8

Table 5–5
Available Strength in Axial Tension
Square HSS

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS16×16×5/8	35.0	26.3	964	1450	763	1140
×1/2	28.3	21.2	780	1170	615	922
×3/8	21.5	16.1	592	890	467	700
×5/16	18.1	13.6	499	749	394	592
HSS14×14×5/8	30.3	22.7	835	1250	658	987
×1/2	24.6	18.5	678	1020	537	805
×3/8	18.7	14.0	515	774	406	609
×5/16	15.7	11.8	432	650	342	513
HSS12×12×5/8	25.7	19.3	708	1060	560	840
×1/2	20.9	15.7	576	865	455	683
×3/8	16.0	12.0	441	662	348	522
×5/16	13.4	10.1	369	555	293	439
×1/4	10.8	8.10	297	447	235	352
×3/16	8.15	6.11	224	337	177	266
HSS10×10×5/8	21.0	15.8	578	869	458	687
×1/2	17.2	12.9	474	712	374	561
×3/8	13.2	9.90	364	546	287	431
×5/16	11.1	8.32	306	460	241	362
×1/4	8.96	6.72	247	371	195	292
×3/16	6.76	5.07	186	280	147	221
HSS9×9×5/8	18.7	14.0	515	774	406	609
×1/2	15.3	11.5	421	633	334	500
×3/8	11.8	8.85	325	489	257	385
×5/16	9.92	7.44	273	411	216	324
×1/4	8.03	6.02	221	332	175	262
×3/16	6.06	4.55	167	251	132	198
×1/8	4.09	3.07	113	169	89.0	134
HSS8×8×5/8	16.4	12.3	452	679	357	535
×1/2	13.5	10.1	372	559	293	439
×3/8	10.4	7.80	286	431	226	339
×5/16	8.76	6.57	241	363	191	286
×1/4	7.10	5.33	196	294	155	232
×3/16	5.37	4.03	148	222	117	175
×1/8	3.62	2.71	99.7	150	78.6	118

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 46 ksi
F_u = 58 ksi

Table 5–5 (continued)
Available Strength in Axial Tension
Square HSS

HSS7–HSS4½

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS7×7×5/8	14.0	10.5	386	580	305	457
×1/2	11.6	8.70	320	480	252	378
×3/8	8.97	6.73	247	371	195	293
×5/16	7.59	5.69	209	314	165	248
×1/4	6.17	4.63	170	255	134	201
×3/16	4.67	3.50	129	193	102	152
×1/8	3.16	2.37	87.0	131	68.7	103
HSS6×6×5/8	11.7	8.78	322	484	255	382
×1/2	9.74	7.30	268	403	212	318
×3/8	7.58	5.69	209	314	165	248
×5/16	6.43	4.82	177	266	140	210
×1/4	5.24	3.93	144	217	114	171
×3/16	3.98	2.99	110	165	86.7	130
×1/8	2.70	2.03	74.4	112	58.9	88.3
HSS5½×5½×3/8	6.88	5.16	190	285	150	224
×5/16	5.85	4.39	161	242	127	191
×1/4	4.77	3.58	131	197	104	156
×3/16	3.63	2.72	100	150	78.9	118
×1/8	2.46	1.85	67.8	102	53.7	80.5
HSS5×5×1/2	7.88	5.91	217	326	171	257
×3/8	6.18	4.63	170	256	134	201
×5/16	5.26	3.94	145	218	114	171
×1/4	4.30	3.22	118	178	93.4	140
×3/16	3.28	2.46	90.3	136	71.3	107
×1/8	2.23	1.67	61.4	92.3	48.4	72.6
HSS4½×4½×1/2	6.95	5.21	191	288	151	227
×3/8	5.48	4.11	151	227	119	179
×5/16	4.68	3.51	129	194	102	153
×1/4	3.84	2.88	106	159	83.5	125
×3/16	2.93	2.20	80.7	121	63.8	95.7
×1/8	2.00	1.50	55.1	82.8	43.5	65.3

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

HSS4–HSS2

Table 5–5 (continued)
Available Strength in Axial Tension
Square HSS

F_y = 46 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding (kips) P_n/Ω_t	Yielding (kips) $\phi_t P_n$	Rupture (kips) P_n/Ω_t	Rupture (kips) $\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
HSS4×4×1/2	6.02	4.51	**166**	249	**131**	196
×3/8	4.78	3.58	**132**	198	**104**	156
×5/16	4.10	3.08	**113**	170	**89.3**	134
×1/4	3.37	2.53	**92.8**	140	**73.4**	110
×3/16	2.58	1.94	**71.1**	107	**56.3**	84.4
×1/8	1.77	1.33	**48.8**	73.3	**38.6**	57.9
HSS3 1/2×3 1/2×3/8	4.09	3.07	**113**	169	**89.0**	134
×5/16	3.52	2.64	**97.0**	146	**76.6**	115
×1/4	2.91	2.18	**80.2**	120	**63.2**	94.8
×3/16	2.24	1.68	**61.7**	92.7	**48.7**	73.1
×1/8	1.54	1.16	**42.4**	63.8	**33.6**	50.5
HSS3×3×3/8	3.39	2.54	**93.4**	140	**73.7**	110
×5/16	2.94	2.21	**81.0**	122	**64.1**	96.1
×1/4	2.44	1.83	**67.2**	101	**53.1**	79.6
×3/16	1.89	1.42	**52.1**	78.2	**41.2**	61.8
×1/8	1.30	0.975	**35.8**	53.8	**28.3**	42.4
HSS2 1/2×2 1/2×5/16	2.35	1.76	**64.7**	97.3	**51.0**	76.6
×1/4	1.97	1.48	**54.3**	81.6	**42.9**	64.4
×3/16	1.54	1.16	**42.4**	63.8	**33.6**	50.5
×1/8	1.07	0.803	**29.5**	44.3	**23.3**	34.9
HSS2 1/4×2 1/4×1/4	1.74	1.30	**47.9**	72.0	**37.7**	56.6
×3/16	1.37	1.03	**37.7**	56.7	**29.9**	44.8
×1/8	0.956	0.717	**26.3**	39.6	**20.8**	31.2
HSS2×2×1/4	1.51	1.13	**41.6**	62.5	**32.8**	49.2
×3/16	1.19	0.892	**32.8**	49.3	**25.9**	38.8
×1/8	0.840	0.630	**23.1**	34.8	**18.3**	27.4

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.952A_g$.

F_y = 42 ksi
F_u = 58 ksi

Table 5–6
Available Strength in Axial Tension
Round HSS

HSS20.000–HSS10.000

Shape	Gross Area, A_g	A_e = $0.75A_g$	Yielding (kips) P_n/Ω_t	Yielding (kips) $\phi_t P_n$	Rupture (kips) P_n/Ω_t	Rupture (kips) $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS20.000×0.375	21.5	16.1	**541**	813	**467**	700
HSS18.000×0.500	25.6	19.2	**644**	968	**557**	835
×0.375	19.4	14.6	**488**	733	**423**	635
HSS16.000×0.625	28.1	21.1	**707**	1060	**612**	918
×0.500	22.7	17.0	**571**	858	**493**	740
×0.438	19.9	14.9	**500**	752	**432**	648
×0.375	17.2	12.9	**433**	650	**374**	561
×0.312	14.4	10.8	**362**	544	**313**	470
×0.250	11.5	8.63	**289**	435	**250**	375
HSS14.000×0.625	24.5	18.4	**616**	926	**534**	800
×0.500	19.8	14.9	**498**	748	**432**	648
×0.375	15.0	11.3	**377**	567	**328**	492
×0.312	12.5	9.38	**314**	473	**272**	408
×0.250	10.1	7.58	**254**	382	**220**	330
HSS12.750×0.500	17.9	13.4	**450**	677	**389**	583
×0.375	13.6	10.2	**342**	514	**296**	444
×0.250	9.16	6.87	**230**	346	**199**	299
HSS10.750×0.500	15.0	11.3	**377**	567	**328**	492
×0.375	11.4	8.55	**287**	431	**248**	372
×0.250	7.70	5.78	**194**	291	**168**	251
HSS10.000×0.625	17.2	12.9	**433**	650	**374**	561
×0.500	13.9	10.4	**350**	525	**302**	452
×0.375	10.6	7.95	**267**	401	**231**	346
×0.312	8.88	6.66	**223**	336	**193**	290
×0.250	7.15	5.36	**180**	270	**155**	233
×0.188	5.37	4.03	**135**	203	**117**	175

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.869A_g$.

HSS9.625–
HSS6.875

Table 5–6 (continued)
Available Strength in Axial Tension
Round HSS

F_y = 42 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
HSS9.625×0.500	13.4	10.1	337	507	293	439
×0.375	10.2	7.65	257	386	222	333
×0.312	8.53	6.40	215	322	186	278
×0.250	6.87	5.15	173	260	149	224
×0.188	5.17	3.88	130	195	113	169
HSS8.625×0.625	14.7	11.0	370	556	319	479
×0.500	11.9	8.92	299	450	259	388
×0.375	9.07	6.80	228	343	197	296
×0.322	7.85	5.89	197	297	171	256
×0.250	6.14	4.60	154	232	133	200
×0.188	4.62	3.47	116	175	101	151
HSS7.625×0.375	7.98	5.99	201	302	174	261
×0.328	7.01	5.26	176	265	153	229
HSS7.500×0.500	10.3	7.73	259	389	224	336
×0.375	7.84	5.88	197	296	171	256
×0.312	6.59	4.94	166	249	143	215
×0.250	5.32	3.99	134	201	116	174
×0.188	4.00	3.00	101	151	87.0	131
HSS7.000×0.500	9.55	7.16	240	361	208	311
×0.375	7.29	5.47	183	276	159	238
×0.312	6.13	4.60	154	232	133	200
×0.250	4.95	3.71	124	187	108	161
×0.188	3.73	2.80	93.8	141	81.2	122
×0.125	2.51	1.88	63.1	94.9	54.5	81.8
HSS6.875×0.500	9.36	7.02	235	354	204	305
×0.375	7.16	5.37	180	271	156	234
×0.312	6.02	4.51	151	228	131	196
×0.250	4.86	3.64	122	184	106	158
×0.188	3.66	2.75	92.0	138	79.8	120

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.869A_g$.

F_y = 42 ksi
F_u = 58 ksi

Table 5–6 (continued)
Available Strength in Axial Tension
Round HSS

HSS6.625–HSS5.000

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding (kips)		Rupture (kips)	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS6.625×0.500	9.00	6.75	226	340	196	294
×0.432	7.86	5.90	198	297	171	257
×0.375	6.88	5.16	173	260	150	224
×0.312	5.79	4.34	146	219	126	189
×0.280	5.20	3.90	131	197	113	170
×0.250	4.68	3.51	118	177	102	153
×0.188	3.53	2.65	88.8	133	76.9	115
×0.125	2.37	1.78	59.6	89.6	51.6	77.4
HSS6.000×0.500	8.09	6.07	203	306	176	264
×0.375	6.20	4.65	156	234	135	202
×0.312	5.22	3.92	131	197	114	171
×0.280	4.69	3.52	118	177	102	153
×0.250	4.22	3.17	106	160	91.9	138
×0.188	3.18	2.39	80.0	120	69.3	104
×0.125	2.14	1.61	53.8	80.9	46.7	70.0
HSS5.563×0.500	7.45	5.59	187	282	162	243
×0.375	5.72	4.29	144	216	124	187
×0.258	4.01	3.01	101	152	87.3	131
×0.188	2.95	2.21	74.2	112	64.1	96.1
×0.134	2.12	1.59	53.3	80.1	46.1	69.2
HSS5.500×0.500	7.36	5.52	185	278	160	240
×0.375	5.65	4.24	142	214	123	184
×0.258	3.97	2.98	99.8	150	86.4	130
×0.500	6.62	4.97	166	250	144	216
HSS5.000×0.375	5.10	3.82	128	193	111	166
×0.312	4.30	3.22	108	163	93.4	140
×0.258	3.59	2.69	90.3	136	78.0	117
×0.250	3.49	2.62	87.8	132	76.0	114
×0.188	2.64	1.98	66.4	99.8	57.4	86.1
×0.125	1.78	1.34	44.8	67.3	38.9	58.3

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.869A_g$.

HSS4.500–
HSS2.500

Table 5–6 (continued)
Available Strength in Axial Tension
Round HSS

F_y = 42 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
HSS4.500×0.375	4.55	3.41	**114**	172	**98.9**	148
×0.337	4.12	3.09	**104**	156	**89.6**	134
×0.237	2.96	2.22	**74.4**	112	**64.4**	96.6
×0.188	2.36	1.77	**59.4**	89.2	**51.3**	77.0
×0.125	1.60	1.20	**40.2**	60.5	**34.8**	52.2
HSS4.000×0.313	3.39	2.54	**85.3**	128	**73.7**	110
×0.250	2.76	2.07	**69.4**	104	**60.0**	90.0
×0.237	2.61	1.96	**65.6**	98.7	**56.8**	85.3
×0.226	2.50	1.88	**62.9**	94.5	**54.5**	81.8
×0.220	2.44	1.83	**61.4**	92.2	**53.1**	79.6
×0.188	2.09	1.57	**52.6**	79.0	**45.5**	68.3
×0.125	1.42	1.07	**35.7**	53.7	**31.0**	46.5
HSS3.500×0.313	2.93	2.20	**73.7**	111	**63.8**	95.7
×0.300	2.82	2.11	**70.9**	107	**61.2**	91.8
×0.250	2.39	1.79	**60.1**	90.3	**51.9**	77.9
×0.216	2.08	1.56	**52.3**	78.6	**45.2**	67.9
×0.203	1.97	1.48	**49.5**	74.5	**42.9**	64.4
×0.188	1.82	1.36	**45.8**	68.8	**39.4**	59.2
×0.125	1.23	0.923	**30.9**	46.5	**26.8**	40.2
HSS3.000×0.250	2.03	1.52	**51.1**	76.7	**44.1**	66.1
×0.216	1.77	1.33	**44.5**	66.9	**38.6**	57.9
×0.203	1.67	1.25	**42.0**	63.1	**36.3**	54.4
×0.188	1.54	1.16	**38.7**	58.2	**33.6**	50.5
×0.152	1.27	0.953	**31.9**	48.0	**27.6**	41.5
×0.134	1.12	0.840	**28.2**	42.3	**24.4**	36.5
×0.125	1.05	0.788	**26.4**	39.7	**22.9**	34.3
HSS2.875×0.250	1.93	1.45	**48.5**	73.0	**42.1**	63.1
×0.203	1.59	1.19	**40.0**	60.1	**34.5**	51.8
×0.188	1.48	1.11	**37.2**	55.9	**32.2**	48.3
×0.125	1.01	0.758	**25.4**	38.2	**22.0**	33.0
HSS2.500×0.250	1.66	1.25	**41.7**	62.7	**36.3**	54.4
×0.188	1.27	0.953	**31.9**	48.0	**27.6**	41.5
×0.125	0.869	0.652	**21.9**	32.8	**18.9**	28.4

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.869A_g$.

F_y = 42 ksi
F_u = 58 ksi

Table 5–6 (continued)
Available Strength in Axial Tension
Round HSS

HSS2.375–
HSS1.660

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding (kips)		Rupture (kips)	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
HSS2.375×0.250	1.57	1.18	**39.5**	59.3	**34.2**	51.3
×0.218	1.39	1.04	**35.0**	52.5	**30.2**	45.2
×0.188	1.20	0.900	**30.2**	45.4	**26.1**	39.1
×0.154	1.00	0.750	**25.1**	37.8	**21.8**	32.6
×0.125	0.823	0.617	**20.7**	31.1	**17.9**	26.8
HSS1.900×0.188	0.943	0.707	**23.7**	35.6	**20.5**	30.8
×0.145	0.749	0.562	**18.8**	28.3	**16.3**	24.4
×0.120	0.624	0.468	**15.7**	23.6	**13.6**	20.4
HSS1.660×0.140	0.625	0.469	**15.7**	23.6	**13.6**	20.4

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.869A_g$.

PIPE12–
PIPE1½

Table 5–7
Available Strength in Axial Tension
Pipe

F_y = 35 ksi
F_u = 60 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
Pipe 12 X-Strong	17.9	13.4	375	564	402	603
Std	13.6	10.2	285	428	306	459
Pipe 10 X-Strong	15.0	11.3	314	473	339	509
Std	11.1	8.32	233	350	250	374
Pipe 8 XX-Strong	20.0	15.0	419	630	450	675
X-Strong	11.9	8.92	249	375	268	401
Std	7.85	5.89	165	247	177	265
Pipe 6 XX-Strong	14.7	11.0	308	463	330	495
X-Strong	7.88	5.91	165	248	177	266
Std	5.22	3.92	109	164	118	176
Pipe 5 XX-Strong	10.7	8.02	224	337	241	361
X-Strong	5.72	4.29	120	180	129	193
Std	4.03	3.02	84.5	127	90.6	136
Pipe 4 XX-Strong	7.64	5.73	160	241	172	258
X-Strong	4.14	3.10	86.8	130	93.0	140
Std	2.97	2.23	62.2	93.6	66.9	100
Pipe 3½ X-Strong	3.44	2.58	72.1	108	77.4	116
Std	2.51	1.88	52.6	79.1	56.4	84.6
Pipe 3 XX-Strong	5.16	3.87	108	163	116	174
X-Strong	2.83	2.12	59.3	89.1	63.6	95.4
Std	2.08	1.56	43.6	65.5	46.8	70.2
Pipe 2½ XX-Strong	3.81	2.86	79.9	120	85.8	129
X-Strong	2.11	1.58	44.2	66.5	47.4	71.1
Std	1.59	1.19	33.3	50.1	35.7	53.6
Pipe 2 XX-Strong	2.51	1.88	52.6	79.1	56.4	84.6
X-Strong	1.39	1.04	29.1	43.8	31.2	46.8
Std	1.00	0.750	21.0	31.5	22.5	33.8
Pipe 1½ X-Strong	1.00	0.750	21.0	31.5	22.5	33.8
Std	0.750	0.563	15.7	23.6	16.9	25.3

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.700A_g$.

F_y = 35 ksi
F_u = 60 ksi

Table 5–7 (continued)
Available Strength in Axial Tension
Pipe

PIPE1¼–PIPE½

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
Pipe 1¼ X-Strong	0.830	0.623	17.4	26.1	18.7	28.0
Std	0.620	0.465	13.0	19.5	14.0	20.9
Pipe 1 X-Strong	0.600	0.450	12.6	18.9	13.5	20.3
Std	0.460	0.345	9.64	14.5	10.4	15.5
Pipe ¾ X-Strong	0.410	0.308	8.59	12.9	9.24	13.9
Std	0.310	0.232	6.50	9.77	6.96	10.4
Pipe ½ X-Strong	0.300	0.225	6.29	9.45	6.75	10.1
Std	0.230	0.173	4.82	7.24	5.19	7.79

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.700A_g$.

2L8–2L6

Table 5–8
Available Strength in Axial Tension
Double Angles

F_y = 36 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
2L8×8×1 1/8	33.4	25	**720**	1080	**725**	1090
×1	30.0	22.5	**647**	972	**653**	979
×7/8	26.4	19.8	**569**	855	**574**	861
×3/4	22.8	17.1	**491**	739	**496**	744
×5/8	19.2	14.4	**414**	622	**418**	626
×9/16	17.4	13.0	**375**	564	**377**	566
×1/2	15.5	11.6	**334**	502	**336**	505
2L8×6×1	26.0	19.5	**560**	842	**566**	848
×7/8	23.0	17.3	**496**	745	**502**	753
×3/4	19.9	14.9	**429**	645	**432**	648
×5/8	16.7	12.5	**360**	541	**363**	544
×9/16	15.1	11.3	**326**	489	**328**	492
×1/2	13.5	10.1	**291**	437	**293**	439
×7/16	11.9	8.92	**257**	386	**259**	388
2L8×4×1	22.0	16.5	**474**	713	**479**	718
×7/8	19.5	14.6	**420**	632	**423**	635
×3/4	16.9	12.7	**364**	548	**368**	552
×5/8	14.2	10.6	**306**	460	**307**	461
×9/16	12.9	9.68	**278**	418	**281**	421
×1/2	11.5	8.63	**248**	373	**250**	375
×7/16	10.1	7.58	**218**	327	**220**	330
2L7×4×3/4	15.4	11.6	**332**	499	**336**	505
×5/8	13.0	9.75	**280**	421	**283**	424
×1/2	10.5	7.88	**226**	340	**229**	343
×7/16	9.24	6.93	**199**	299	**201**	301
×3/8	7.96	5.97	**172**	258	**173**	260
2L6×6×1	22.0	16.5	**474**	713	**479**	718
×7/8	19.5	14.6	**420**	632	**423**	635
×3/4	16.9	12.7	**364**	548	**368**	552
×5/8	14.3	10.7	**308**	463	**310**	465
×9/16	12.9	9.68	**278**	418	**281**	421
×1/2	11.5	8.63	**248**	373	**250**	375
×7/16	10.2	7.65	**220**	330	**222**	333
×3/8	8.76	6.57	**189**	284	**191**	286
×5/16	7.34	5.51	**158**	238	**160**	240

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

F_y = 36 ksi
F_u = 58 ksi

Table 5–8 (continued)
Available Strength in Axial Tension
Double Angles

2L6–2L5

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips		Rupture kips	
			P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
2L6×4×7/8	16.0	12.0	**345**	518	**348**	522
×3/4	13.9	10.4	**300**	450	**302**	452
×5/8	11.7	8.78	**252**	379	**255**	382
×9/16	10.6	7.95	**229**	343	**231**	346
×1/2	9.50	7.13	**205**	308	**207**	310
×7/16	8.36	6.27	**180**	271	**182**	273
×3/8	7.22	5.42	**156**	234	**157**	236
×5/16	6.05	4.54	**130**	196	**132**	197
2L6×3½×1/2	9.00	6.75	**194**	292	**196**	294
×3/8	6.84	5.13	**147**	222	**149**	223
×5/16	5.74	4.31	**124**	186	**125**	187
2L5×5×7/8	16.0	12.0	**345**	518	**348**	522
×3/4	13.9	10.4	**300**	450	**302**	452
×5/8	11.7	8.78	**252**	379	**255**	382
×1/2	9.50	7.13	**205**	308	**207**	310
×7/16	8.36	6.27	**180**	271	**182**	273
×3/8	7.22	5.42	**156**	234	**157**	236
×5/16	6.06	4.55	**131**	196	**132**	198
2L5×3½×3/4	11.6	8.70	**250**	376	**252**	378
×5/8	9.84	7.38	**212**	319	**214**	321
×1/2	8.01	6.01	**173**	260	**174**	261
×3/8	6.10	4.57	**131**	198	**133**	199
×5/16	5.12	3.84	**110**	166	**111**	167
×1/4	4.12	3.09	**88.8**	133	**89.6**	134
2L5×3×1/2	7.51	5.63	**162**	243	**163**	245
×7/16	6.62	4.97	**143**	214	**144**	216
×3/8	5.73	4.30	**124**	186	**125**	187
×5/16	4.80	3.60	**103**	156	**104**	157
×1/4	3.88	2.91	**83.6**	126	**84.4**	127

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

2L4–2L3½

Table 5–8 (continued)
Available Strength in Axial Tension
Double Angles

F_y = 36 ksi
F_u = 58 ksi

Shape	Gross Area, A_g	A_e = $0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.²	in.²	ASD	LRFD	ASD	LRFD
2L4×4×¾	10.9	8.18	235	353	237	356
×⅝	9.21	6.91	199	298	200	301
×½	7.49	5.62	161	243	163	244
×7/16	6.62	4.97	143	214	144	216
×⅜	5.72	4.29	123	185	124	187
×5/16	4.80	3.60	103	156	104	157
×¼	3.88	2.91	83.6	126	84.4	127
2L4×3½×½	7.01	5.26	151	227	153	229
×⅜	5.34	4.00	115	173	116	174
×5/16	4.50	3.38	97.0	146	98.0	147
×¼	3.62	2.71	78.0	117	78.6	118
2L4×3×⅝	7.78	5.84	168	252	169	254
×½	6.50	4.88	140	211	142	212
×⅜	4.96	3.72	107	161	108	162
×5/16	4.18	3.14	90.1	135	91.1	137
×¼	3.38	2.54	72.9	110	73.7	110
2L3½×3½×½	6.50	4.88	140	211	142	212
×7/16	5.74	4.31	124	186	125	187
×⅜	4.96	3.72	107	161	108	162
×5/16	4.18	3.14	90.1	135	91.1	137
×¼	3.38	2.54	72.9	110	73.7	110
2L3½×3×½	6.00	4.50	129	194	131	196
×7/16	5.30	3.98	114	172	115	173
×⅜	4.60	3.45	99.2	149	100	150
×5/16	3.86	2.90	83.2	125	84.1	126
×¼	3.12	2.34	67.3	101	67.9	102
2L3½×2½×½	5.50	4.13	119	178	120	180
×⅜	4.22	3.17	91.0	137	91.9	138
×5/16	3.56	2.67	76.7	115	77.4	116
×¼	2.88	2.16	62.1	93.3	62.6	94.0

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

F_y = 36 ksi
F_u = 58 ksi

Table 5–8 (continued)
Available Strength in Axial Tension
Double Angles

2L3–2L2

Shape	Gross Area, A_g	$A_e = 0.75A_g$	Yielding kips P_n/Ω_t	Yielding kips $\phi_t P_n$	Rupture kips P_n/Ω_t	Rupture kips $\phi_t P_n$
	in.^{2}	in.^{2}	ASD	LRFD	ASD	LRFD
2L3×3×1/2	5.50	4.13	119	178	120	180
×7/16	4.86	3.64	105	157	106	158
×3/8	4.22	3.17	91.0	137	91.9	138
×5/16	3.55	2.66	76.5	115	77.1	116
×1/4	2.87	2.15	61.9	93.0	62.4	93.5
×3/16	2.18	1.64	47.0	70.6	47.6	71.3
2L3×2 1/2×1/2	5.00	3.75	108	162	109	163
×7/16	4.42	3.32	95.3	143	96.3	144
×3/8	3.84	2.88	82.8	124	83.5	125
×5/16	3.34	2.51	72.0	108	72.8	109
×1/4	2.62	1.97	56.5	84.9	57.1	85.7
×3/16	1.99	1.49	42.9	64.5	43.2	64.8
2L3×2×1/2	4.50	3.38	97.0	146	98.0	147
×3/8	3.46	2.59	74.6	112	75.1	113
×5/16	2.92	2.19	62.9	94.6	63.5	95.3
×1/4	2.38	1.79	51.3	77.1	51.9	77.9
×3/16	1.80	1.35	38.8	58.3	39.2	58.7
2L2 1/2×2 1/2×1/2	4.50	3.38	97.0	146	98.0	147
×3/8	3.47	2.60	74.8	112	75.4	113
×5/16	2.93	2.20	63.2	94.9	63.8	95.7
×1/4	2.37	1.78	51.1	76.8	51.6	77.4
×3/16	1.80	1.35	38.8	58.3	39.2	58.7
2L2 1/2×2×3/8	3.10	2.33	66.8	100	67.6	101
×5/16	2.62	1.97	56.5	84.9	57.1	85.7
×1/4	2.12	1.59	45.7	68.7	46.1	69.2
×3/16	1.62	1.22	34.9	52.5	35.4	53.1
2L2 1/2×1 1/2×1/4	1.88	1.41	40.5	60.9	40.9	61.3
×3/16	1.43	1.07	30.8	46.3	31.0	46.5
2L2×2×3/8	2.72	2.04	58.6	88.1	59.2	88.7
×5/16	2.30	1.73	49.6	74.5	50.2	75.3
×1/4	1.88	1.41	40.5	60.9	40.9	61.3
×3/16	1.43	1.07	30.8	46.3	31.0	46.5
×1/8	0.968	0.726	20.9	31.4	21.1	31.6

Limit State	ASD	LRFD
Yielding	$\Omega_t = 1.67$	$\phi_t = 0.90$
Rupture	$\Omega_t = 2.00$	$\phi_t = 0.75$

Note: Tensile rupture on the effective net area will control over tensile yielding on the gross area unless the tension member is selected so that an end connection can be configured with $A_e \geq 0.745A_g$.

PART 6

DESIGN OF MEMBERS SUBJECT TO COMBINED LOADING

SCOPE

The specification requirements and other design considerations summarized in this Part apply to the design of members subject to combined loading. For the design of members subject to axial tension only, see Part 5. For the design of members subject to axial compression only, see Part 4. For the design of members subject to uniaxial flexure only, see Part 3. For members that are part of a seismic force resisting system in which the seismic response modification factor, R, is taken greater than 3, the requirements in the AISC *Seismic Provisions for Structural Steel Buildings* also apply. The AISC *Seismic Provisions for Structural Steel Buildings* is available in Part 6 of the AISC *Seismic Design Manual* from the American Institute of Steel Construction, Inc. at www.aisc.org.

COMPACT, NON-COMPACT, AND SLENDER-ELEMENT CROSS-SECTIONS

Based upon the types of load transmitted by the member, the discussions of width-thickness ratios in Part 4 for compression members and Part 3 for flexural members apply to the design of members subject to combined loading.

MEMBERS SUBJECT TO COMBINED AXIAL COMPRESSION AND FLEXURE

The interaction of the combined effects of the required strengths (axial compression and bending moment) must satisfy the unity check as follows:

1. For doubly symmetric and singly symmetric members, per AISC Specification Section H1.1.
2. For unsymmetric and other members, per AISC Specification Section H2.

MEMBERS SUBJECT TO COMBINED AXIAL TENSION AND FLEXURE

The interaction of the combined effects of the required strengths (axial tension and bending moment) must satisfy the unity check as follows:

1. For doubly symmetric and singly symmetric members, per AISC Specification Section H1.2.
2. For unsymmetric and other members, per AISC Specification Section H2.

MEMBERS SUBJECT TO COMBINED TORSION, FLEXURE, SHEAR, AND/OR AXIAL FORCE

The interaction of the combined effects of the required strengths (torsion, bending moment, shear force, and/or axial force) must satisfy the requirements of AISC Specification Section H3.

See also AISC Design Guide No. 9 *Torsional Analysis of Structural Steel Members*.

COMPOSITE MEMBERS SUBJECT TO COMBINED AXIAL COMPRESSION AND FLEXURE

For the design of composite members subject to combined axial compression and flexure, see AISC Specification Section I4.

OTHER SPECIFICATION REQUIREMENTS AND DESIGN CONSIDERATIONS

Based upon the types of load transmitted by the member, the specification requirements and design considerations given in Part 5 for tension members, Part 4 for compression members, and Part 3 for flexural members apply to the design of members subject to combined loading.

STEEL BEAM-COLUMN SELECTION TABLES

Table 6–1. W-Shapes in Combined Axial and Bending

The determination of the adequacy of W-shapes subject to combined axial and bending loads is facilitated by the use of this table. The AISC Specification Equations to check the adequacy of W-shapes with F_y = 50 ksi (ASTM A992) subject to combined axial force and flexure can be determined using the values of p, b_x, b_y, t_r and t_y, tabulated in Table 6-1. These variables are defined as follows:

	LRFD	ASD
Axial Compression	$p = \dfrac{1}{\phi_c P_n}$, $(\text{kips})^{-1}$	$p = \dfrac{\Omega_c}{P_n}$, $(\text{kips})^{-1}$
Strong Axis Bending	$b_x = \dfrac{8}{9\phi_b M_{nx}}$, $(\text{kip-ft})^{-1}$	$b_x = \dfrac{8\Omega_b}{9M_{nx}}$, $(\text{kip-ft})^{-1}$
Weak Axis Bending	$b_y = \dfrac{8}{9\phi_b M_{ny}}$, $(\text{kip-ft})^{-1}$	$b_y = \dfrac{8\Omega_b}{9M_{ny}}$, $(\text{kip-ft})^{-1}$
Tension Rupture	$t_r = \dfrac{1}{\phi_t 0.75 F_u A_g}$, $(\text{kips})^{-1}$	$t_r = \dfrac{\Omega_t}{0.75 F_u A_g}$, $(\text{kips})^{-1}$
Tension Yielding	$t_y = \dfrac{1}{\phi_c F_y A_g}$, $(\text{kips})^{-1}$	$t_y = \dfrac{\Omega}{F_y A_g}$, $(\text{kips})^{-1}$

Table 6-1 is normally used with iteration to determine an appropriate shape. After selecting a trial shape, the sum of the load ratios reveals if that trial shape is close (a sum nearly equal to 1.0), conservative (a sum less than 1.0), or unconservative (a sum greater than 1.0). When the trial shape is unconservative and axial effects dominate, the second trial shape should be one with a larger value of p. Similarly, when X-X axis or Y-Y axis flexural effects dominate, the second trial shape should be one with a larger value of b_x or b_y, respectively. This process can be repeated until an acceptable shape is determined.

An alternative approach for the initial selection of members may be found in Aminmansour (2000).

Combined Compression and Flexure

In this case, the compressive component of the combined force is accounted for by selecting the proper value of p based on the larger of the effective length for compression buckling about the Y-Y axis $(KL)_y$ and the effective length for compression buckling about the X-X axis $(KL)_{y\,eq}$, as described in Part 4. The tabulated values can be used directly, as the slenderness of the cross section is accounted for.

The bending component of the combined force is accounted for by selecting the proper value of b_x based on the unbraced length L_b, as described in Part 3. Because unbraced length is not a factor in weak-axis bending, a single value of b_y applies for any given W-shape.

When $P_r/P_c \geq 0.2$, the tabulated values of p, b_x, and b_y can be used as follows to solve the modified form of AISC Specification Equation H1-1a:

$$pP_r + b_x M_{rx} + b_y M_{ry} \leq 1.0$$

When $P_r/P_c < 0.2$, the tabulated values of p, b_x, and b_y can be used as follows to solve the modified form of AISC Specification Equation H1-1b:

$$\tfrac{1}{2}pP_r + \tfrac{9}{8}(b_x M_{rx} + b_y M_{ry}) \leq 1.0$$

The tabulated values of b_x and b_y assume that $C_b = 1.0$. These values may be modified in accordance with AISC Specification Section F1.

For further information, see Aminmansour (2000).

Combined Tension and Flexure

In this case, the axial component of the combined force is accounted for by selecting the larger value of t_y *or* t_r, for the critical case of available tension yield or available tension rupture strength, as described in Part 5. It is important to note that the tabulated values for t_r are based upon the assumption that $A_e = 0.75A_g$, which is arbitrarily selected as a value that is practical to achieve with typical end connections. When $A_e > 0.75A_g$, the tabulated values for t_r can be used conservatively. When $A_e < 0.75A_g$, the tabulated values of t_r cannot be used, but rather, must be calculated based upon the actual value of A_e.

The bending component of the combined force is accounted for by selecting the proper value of b_x for the unbraced length L_b, as described in Part 3. Because unbraced length is not a factor in weak-axis bending, a single value of b_y applies for any given W-shape.

When $P_r/P_c \geq 0.2$, the tabulated values of t_y, t_r, b_x, and b_y can be used as follows to solve the modified form of AISC Specification Equation H1-1a:

$$(t_y \text{ or } t_r)\, P_r + b_x M_{rx} + b_y M_{ry} \leq 1.0$$

When $P_r/P_c < 0.2$, the tabulated values of p, b_x, and b_y can be used as follows to solve the modified form of AISC Specification Equation H1-1b:

$$\tfrac{1}{2}(t_y \text{ or } t_r)\, P_r + \tfrac{9}{8}(b_x M_{rx} + b_y M_{ry}) \leq 1.0$$

The tabulated values of b_x and b_y assume that $C_b = 1.0$. These values may be modified in accordance with AISC Specification Sections F1 and H1.2.

PART 6 REFERENCES

Aminmansour, A., 2000, "A New Approach for Design of Steel Beam-Columns," *Engineering Journal*, Vol. 37, No. 2, (2nd Qtr.), pp. 41-72, AISC, Chicago, IL.

F_y = 50 ksi

Table 6–1
Combined Axial and Bending
W Shapes

W44

Shape		W44×											
		335[c]				290[c]				262[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.345	0.230	0.220	0.146	0.417	0.278	0.253	0.168	0.476	0.317	0.281	0.187
	11	0.378	0.251	0.220	0.146	0.454	0.302	0.253	0.168	0.518	0.344	0.281	0.187
	12	0.384	0.256	0.220	0.146	0.462	0.307	0.253	0.168	0.526	0.350	0.281	0.187
	13	0.393	0.261	0.222	0.148	0.470	0.313	0.255	0.170	0.536	0.356	0.284	0.189
	14	0.402	0.267	0.225	0.150	0.480	0.319	0.259	0.173	0.546	0.363	0.289	0.192
	15	0.412	0.274	0.229	0.152	0.490	0.326	0.264	0.175	0.557	0.371	0.294	0.196
	16	0.423	0.282	0.233	0.155	0.501	0.333	0.268	0.178	0.570	0.379	0.299	0.199
	17	0.435	0.290	0.236	0.157	0.514	0.342	0.273	0.181	0.584	0.389	0.304	0.203
	18	0.449	0.299	0.240	0.160	0.527	0.351	0.277	0.184	0.599	0.399	0.310	0.206
	19	0.463	0.308	0.244	0.162	0.542	0.361	0.282	0.188	0.616	0.410	0.316	0.210
	20	0.479	0.319	0.248	0.165	0.559	0.372	0.287	0.191	0.634	0.422	0.322	0.214
	22	0.515	0.343	0.257	0.171	0.597	0.397	0.298	0.198	0.676	0.450	0.335	0.223
	24	0.558	0.371	0.266	0.177	0.644	0.428	0.309	0.206	0.727	0.484	0.348	0.232
	26	0.608	0.405	0.275	0.183	0.702	0.467	0.321	0.214	0.788	0.524	0.363	0.242
	28	0.668	0.444	0.286	0.190	0.770	0.513	0.334	0.223	0.862	0.574	0.380	0.253
	30	0.738	0.491	0.297	0.198	0.852	0.567	0.349	0.232	0.954	0.635	0.397	0.264
	32	0.822	0.547	0.310	0.206	0.948	0.631	0.365	0.243	1.06	0.708	0.417	0.278
	34	0.923	0.614	0.323	0.215	1.06	0.708	0.382	0.254	1.20	0.796	0.439	0.292
	36	1.04	0.689	0.338	0.225	1.19	0.794	0.401	0.267	1.34	0.892	0.466	0.310
	38	1.15	0.767	0.354	0.235	1.33	0.885	0.429	0.285	1.49	0.994	0.508	0.338
	40	1.28	0.850	0.377	0.251	1.47	0.981	0.463	0.308	1.66	1.10	0.550	0.366
	42	1.41	0.937	0.405	0.269	1.62	1.08	0.498	0.331	1.83	1.21	0.593	0.394
	44	1.55	1.03	0.432	0.287	1.78	1.19	0.533	0.355	2.00	1.33	0.636	0.423
	46	1.69	1.12	0.459	0.306	1.95	1.30	0.569	0.378	2.19	1.46	0.679	0.452
	48	1.84	1.22	0.487	0.324	2.12	1.41	0.604	0.402	2.38	1.59	0.723	0.481
	50	2.00	1.33	0.514	0.342	2.30	1.53	0.640	0.426	2.59	1.72	0.767	0.510

Other Constants and Properties

	335 ASD	335 LRFD	290 ASD	290 LRFD	262 ASD	262 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.51	1.00	1.74	1.16	1.96	1.30
$t_y \times 10^3$ (kips)$^{-1}$	0.339	0.226	0.390	0.260	0.434	0.289
$t_r \times 10^3$ (kips)$^{-1}$	0.417	0.278	0.480	0.320	0.534	0.356
r_x/r_y	5.10		5.10		5.10	

[c] Shape is slender for compression with F_y = 50 ksi.

W44–W40

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W44×				W40×							
		230[c]				593[h]				503[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.558	0.371	0.324	0.215	0.192	0.128	0.129	0.0859	0.226	0.150	0.154	0.103
	11	0.605	0.403	0.324	0.215	0.210	0.139	0.129	0.0859	0.247	0.165	0.154	0.103
	12	0.615	0.409	0.324	0.215	0.213	0.142	0.129	0.0859	0.252	0.168	0.154	0.103
	13	0.626	0.417	0.329	0.219	0.217	0.144	0.129	0.0859	0.257	0.171	0.154	0.103
	14	0.638	0.424	0.335	0.223	0.221	0.147	0.130	0.0863	0.262	0.174	0.155	0.103
	15	0.651	0.433	0.341	0.227	0.226	0.150	0.131	0.0870	0.268	0.178	0.157	0.104
	16	0.666	0.443	0.347	0.231	0.231	0.154	0.132	0.0877	0.274	0.182	0.159	0.105
	17	0.682	0.454	0.354	0.235	0.237	0.158	0.133	0.0884	0.281	0.187	0.160	0.107
	18	0.700	0.465	0.360	0.240	0.243	0.162	0.134	0.0892	0.289	0.192	0.162	0.108
	19	0.719	0.478	0.367	0.244	0.250	0.166	0.135	0.0899	0.297	0.198	0.163	0.109
	20	0.740	0.492	0.375	0.249	0.257	0.171	0.136	0.0907	0.306	0.204	0.165	0.110
	22	0.789	0.525	0.390	0.260	0.273	0.182	0.139	0.0923	0.326	0.217	0.168	0.112
	24	0.847	0.563	0.407	0.271	0.292	0.194	0.141	0.0939	0.350	0.233	0.172	0.114
	26	0.917	0.610	0.425	0.283	0.314	0.209	0.144	0.0956	0.377	0.251	0.176	0.117
	28	1.00	0.667	0.445	0.296	0.340	0.226	0.146	0.0973	0.410	0.273	0.180	0.119
	30	1.11	0.736	0.468	0.311	0.370	0.246	0.149	0.0991	0.448	0.298	0.184	0.122
	32	1.23	0.821	0.492	0.327	0.405	0.269	0.152	0.101	0.492	0.327	0.188	0.125
	34	1.39	0.925	0.519	0.345	0.446	0.297	0.155	0.103	0.544	0.362	0.192	0.128
	36	1.56	1.04	0.567	0.377	0.494	0.329	0.158	0.105	0.606	0.403	0.197	0.131
	38	1.74	1.16	0.620	0.413	0.551	0.366	0.161	0.107	0.675	0.449	0.202	0.134
	40	1.92	1.28	0.674	0.448	0.610	0.406	0.164	0.109	0.748	0.498	0.207	0.138
	42	2.12	1.41	0.728	0.485	0.673	0.448	0.168	0.112	0.825	0.549	0.212	0.141
	44	2.33	1.55	0.784	0.521	0.738	0.491	0.171	0.114	0.906	0.603	0.218	0.145
	46	2.55	1.69	0.839	0.558	0.807	0.537	0.175	0.116	0.990	0.659	0.224	0.149
	48	2.77	1.84	0.896	0.596	0.879	0.585	0.179	0.119	1.08	0.717	0.231	0.153
	50	3.01	2.00	0.953	0.634	0.953	0.634	0.183	0.122	1.17	0.778	0.237	0.158

Other Constants and Properties

	W44×230 ASD	W44×230 LRFD	W40×593 ASD	W40×593 LRFD	W40×503 ASD	W40×503 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.27	1.51	0.741	0.493	0.904	0.602
$t_y \times 10^3$ (kips)$^{-1}$	0.492	0.328	0.192	0.128	0.225	0.150
$t_r \times 10^3$ (kips)$^{-1}$	0.606	0.404	0.236	0.157	0.278	0.185
r_x/r_y	5.10		4.47		4.52	

[c] Shape is slender for compression with F_y = 50 ksi.

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

$F_y = 50$ ksi

Table 6–1 (continued) Combined Axial and Bending W Shapes

W40

Shape	W40× 431[h]				W40× 397[h]				W40× 392[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.263	0.175	0.182	0.121	0.285	0.190	0.198	0.132	0.290	0.193	0.208	0.139
11	0.289	0.193	0.182	0.121	0.314	0.209	0.198	0.132	0.349	0.232	0.213	0.142
12	0.295	0.196	0.182	0.121	0.320	0.213	0.198	0.132	0.361	0.240	0.217	0.144
13	0.301	0.200	0.182	0.121	0.327	0.217	0.198	0.132	0.375	0.249	0.220	0.146
14	0.307	0.204	0.184	0.122	0.334	0.222	0.201	0.133	0.391	0.260	0.223	0.148
15	0.314	0.209	0.186	0.124	0.341	0.227	0.203	0.135	0.408	0.271	0.227	0.151
16	0.322	0.214	0.188	0.125	0.350	0.233	0.205	0.137	0.428	0.284	0.230	0.153
17	0.330	0.220	0.190	0.127	0.359	0.239	0.208	0.138	0.449	0.299	0.234	0.156
18	0.340	0.226	0.193	0.128	0.369	0.246	0.211	0.140	0.474	0.315	0.238	0.158
19	0.350	0.233	0.195	0.130	0.380	0.253	0.213	0.142	0.501	0.333	0.241	0.161
20	0.361	0.240	0.197	0.131	0.392	0.261	0.216	0.144	0.531	0.354	0.245	0.163
22	0.386	0.257	0.202	0.134	0.419	0.279	0.222	0.147	0.603	0.401	0.254	0.169
24	0.415	0.276	0.207	0.138	0.451	0.300	0.227	0.151	0.693	0.461	0.263	0.175
26	0.449	0.299	0.212	0.141	0.488	0.325	0.234	0.156	0.808	0.538	0.273	0.181
28	0.489	0.325	0.218	0.145	0.532	0.354	0.240	0.160	0.937	0.623	0.283	0.188
30	0.536	0.356	0.224	0.149	0.584	0.388	0.247	0.165	1.08	0.716	0.295	0.196
32	0.591	0.393	0.230	0.153	0.644	0.429	0.255	0.169	1.22	0.814	0.307	0.204
34	0.656	0.436	0.237	0.157	0.715	0.476	0.263	0.175	1.38	0.919	0.320	0.213
36	0.734	0.488	0.243	0.162	0.801	0.533	0.271	0.180	1.55	1.03	0.335	0.223
38	0.818	0.544	0.251	0.167	0.892	0.594	0.280	0.186	1.73	1.15	0.351	0.233
40	0.906	0.603	0.259	0.172	0.989	0.658	0.289	0.193	1.91	1.27	0.372	0.247
42	0.999	0.665	0.267	0.178	1.09	0.725	0.300	0.199	2.11	1.40	0.393	0.262
44	1.10	0.729	0.276	0.184	1.20	0.796	0.311	0.207	2.31	1.54	0.415	0.276
46	1.20	0.797	0.285	0.190	1.31	0.870	0.322	0.215				
48	1.30	0.868	0.296	0.197	1.42	0.947	0.339	0.225				
50	1.42	0.942	0.309	0.205	1.55	1.03	0.356	0.237				

Other Constants and Properties

	431[h] ASD	431[h] LRFD	397[h] ASD	397[h] LRFD	392[h] ASD	392[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.09	0.723	1.19	0.790	1.71	1.14
$t_y \times 10^3$ (kips)$^{-1}$	0.263	0.175	0.285	0.190	0.290	0.193
$t_r \times 10^3$ (kips)$^{-1}$	0.323	0.215	0.351	0.234	0.357	0.238
r_x/r_y	4.55		4.56		6.10	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W40

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W40×											
		372[h]				362[h]				331[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	**0.306**	0.204	**0.212**	0.141	**0.312**	0.208	**0.217**	0.145	**0.343**	0.228	**0.249**	0.166
	11	**0.338**	0.225	**0.212**	0.141	**0.344**	0.229	**0.217**	0.145	**0.416**	0.276	**0.257**	0.171
	12	**0.344**	0.229	**0.212**	0.141	**0.351**	0.233	**0.217**	0.145	**0.431**	0.287	**0.262**	0.174
	13	**0.352**	0.234	**0.213**	0.142	**0.358**	0.238	**0.218**	0.145	**0.449**	0.298	**0.266**	0.177
	14	**0.359**	0.239	**0.215**	0.143	**0.366**	0.244	**0.221**	0.147	**0.468**	0.312	**0.271**	0.180
	15	**0.368**	0.245	**0.218**	0.145	**0.375**	0.249	**0.224**	0.149	**0.490**	0.326	**0.276**	0.184
	16	**0.377**	0.251	**0.221**	0.147	**0.384**	0.256	**0.227**	0.151	**0.515**	0.343	**0.281**	0.187
	17	**0.388**	0.258	**0.224**	0.149	**0.395**	0.263	**0.230**	0.153	**0.543**	0.361	**0.287**	0.191
	18	**0.399**	0.265	**0.227**	0.151	**0.406**	0.270	**0.233**	0.155	**0.574**	0.382	**0.292**	0.194
	19	**0.411**	0.273	**0.230**	0.153	**0.419**	0.278	**0.236**	0.157	**0.609**	0.405	**0.298**	0.198
	20	**0.424**	0.282	**0.233**	0.155	**0.432**	0.287	**0.239**	0.159	**0.648**	0.431	**0.304**	0.202
	22	**0.454**	0.302	**0.239**	0.159	**0.463**	0.308	**0.246**	0.164	**0.741**	0.493	**0.317**	0.211
	24	**0.489**	0.326	**0.246**	0.164	**0.498**	0.332	**0.253**	0.168	**0.858**	0.571	**0.331**	0.220
	26	**0.531**	0.353	**0.254**	0.169	**0.541**	0.360	**0.261**	0.174	**1.01**	0.669	**0.346**	0.230
	28	**0.579**	0.385	**0.261**	0.174	**0.590**	0.393	**0.269**	0.179	**1.17**	0.776	**0.363**	0.241
	30	**0.637**	0.424	**0.269**	0.179	**0.648**	0.431	**0.278**	0.185	**1.34**	0.891	**0.381**	0.253
	32	**0.704**	0.468	**0.278**	0.185	**0.717**	0.477	**0.287**	0.191	**1.52**	1.01	**0.401**	0.267
	34	**0.784**	0.521	**0.287**	0.191	**0.798**	0.531	**0.297**	0.197	**1.72**	1.14	**0.425**	0.283
	36	**0.879**	0.585	**0.297**	0.198	**0.895**	0.596	**0.307**	0.204	**1.93**	1.28	**0.457**	0.304
	38	**0.979**	0.652	**0.308**	0.205	**0.998**	0.664	**0.319**	0.212	**2.15**	1.43	**0.488**	0.325
	40	**1.09**	0.722	**0.319**	0.213	**1.11**	0.735	**0.331**	0.220	**2.38**	1.58	**0.519**	0.346
	42	**1.20**	0.796	**0.332**	0.221	**1.22**	0.811	**0.344**	0.229	**2.62**	1.75	**0.551**	0.366
	44	**1.31**	0.874	**0.345**	0.230	**1.34**	0.890	**0.359**	0.239				
	46	**1.44**	0.955	**0.364**	0.242	**1.46**	0.973	**0.380**	0.253				
	48	**1.56**	1.04	**0.384**	0.256	**1.59**	1.06	**0.401**	0.267				
	50	**1.70**	1.13	**0.404**	0.269	**1.73**	1.15	**0.422**	0.281				
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		**1.29**		0.856		**1.32**		0.878		**2.10**		1.40	
$t_y \times 10^3$ (kips)$^{-1}$		**0.306**		0.204		**0.312**		0.208		**0.342**		0.228	
$t_r \times 10^3$ (kips)$^{-1}$		**0.377**		0.251		**0.384**		0.256		**0.422**		0.281	
r_x/r_y		4.58				4.58				6.19			

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W40

Shape	W40× 327[h]				W40× 324				W40× 297[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	**0.348**	0.232	**0.253**	0.168	**0.350**	0.233	**0.244**	0.162	**0.385**	0.256	**0.268**	0.178
11	**0.421**	0.280	**0.261**	0.174	**0.387**	0.257	**0.244**	0.162	**0.423**	0.281	**0.268**	0.178
12	**0.437**	0.291	**0.265**	0.177	**0.394**	0.262	**0.244**	0.162	**0.431**	0.287	**0.268**	0.178
13	**0.455**	0.302	**0.270**	0.180	**0.403**	0.268	**0.245**	0.163	**0.440**	0.293	**0.270**	0.179
14	**0.474**	0.316	**0.275**	0.183	**0.412**	0.274	**0.249**	0.165	**0.451**	0.300	**0.274**	0.182
15	**0.497**	0.331	**0.280**	0.186	**0.421**	0.280	**0.252**	0.168	**0.462**	0.307	**0.278**	0.185
16	**0.522**	0.347	**0.285**	0.190	**0.432**	0.288	**0.256**	0.170	**0.474**	0.315	**0.282**	0.188
17	**0.550**	0.366	**0.290**	0.193	**0.444**	0.296	**0.259**	0.172	**0.487**	0.324	**0.286**	0.190
18	**0.581**	0.387	**0.296**	0.197	**0.457**	0.304	**0.263**	0.175	**0.502**	0.334	**0.291**	0.193
19	**0.616**	0.410	**0.302**	0.201	**0.471**	0.314	**0.267**	0.178	**0.518**	0.344	**0.295**	0.196
20	**0.655**	0.436	**0.308**	0.205	**0.487**	0.324	**0.271**	0.180	**0.535**	0.356	**0.300**	0.200
22	**0.748**	0.498	**0.321**	0.213	**0.521**	0.347	**0.279**	0.186	**0.574**	0.382	**0.310**	0.206
24	**0.865**	0.576	**0.335**	0.223	**0.562**	0.374	**0.288**	0.192	**0.620**	0.413	**0.320**	0.213
26	**1.01**	0.674	**0.350**	0.233	**0.611**	0.406	**0.298**	0.198	**0.674**	0.449	**0.332**	0.221
28	**1.18**	0.782	**0.367**	0.244	**0.667**	0.444	**0.308**	0.205	**0.738**	0.491	**0.344**	0.229
30	**1.35**	0.898	**0.385**	0.256	**0.734**	0.488	**0.318**	0.212	**0.814**	0.542	**0.357**	0.237
32	**1.54**	1.02	**0.406**	0.270	**0.813**	0.541	**0.330**	0.220	**0.903**	0.601	**0.371**	0.247
34	**1.73**	1.15	**0.430**	0.286	**0.906**	0.603	**0.343**	0.228	**1.01**	0.673	**0.386**	0.257
36	**1.94**	1.29	**0.462**	0.308	**1.02**	0.676	**0.356**	0.237	**1.13**	0.754	**0.403**	0.268
38	**2.17**	1.44	**0.494**	0.329	**1.13**	0.753	**0.371**	0.247	**1.26**	0.840	**0.421**	0.280
40	**2.40**	1.60	**0.526**	0.350	**1.25**	0.835	**0.386**	0.257	**1.40**	0.931	**0.444**	0.296
42	**2.65**	1.76	**0.558**	0.371	**1.38**	0.920	**0.407**	0.271	**1.54**	1.03	**0.476**	0.317
44					**1.52**	1.01	**0.433**	0.288	**1.69**	1.13	**0.508**	0.338
46					**1.66**	1.10	**0.460**	0.306	**1.85**	1.23	**0.539**	0.359
48					**1.81**	1.20	**0.486**	0.324	**2.02**	1.34	**0.571**	0.380
50					**1.96**	1.30	**0.513**	0.341	**2.19**	1.45	**0.603**	0.401
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.12**		1.41		**1.49**		0.992		**1.66**		1.10	
$t_y \times 10^3$ (kips)$^{-1}$	**0.348**		0.232		**0.350**		0.233		**0.381**		0.254	
$t_r \times 10^3$ (kips)$^{-1}$	**0.428**		0.285		**0.431**		0.287		**0.470**		0.313	
r_x/r_y	6.20				4.58				4.60			

[c] Shape is slender for compression with F_y = 50 ksi.

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W40

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W40×											
	294				278				277[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.387	0.258	0.281	0.187	0.407	0.271	0.299	0.199	0.425	0.283	0.285	0.190
11	0.471	0.313	0.291	0.194	0.498	0.331	0.312	0.207	0.463	0.308	0.285	0.190
12	0.489	0.325	0.296	0.197	0.517	0.344	0.318	0.211	0.471	0.313	0.285	0.190
13	0.509	0.339	0.302	0.201	0.539	0.359	0.324	0.216	0.479	0.319	0.287	0.191
14	0.532	0.354	0.308	0.205	0.564	0.375	0.331	0.220	0.489	0.325	0.291	0.193
15	0.557	0.371	0.314	0.209	0.592	0.394	0.338	0.225	0.499	0.332	0.295	0.196
16	0.586	0.390	0.321	0.214	0.623	0.414	0.345	0.229	0.510	0.340	0.300	0.199
17	0.618	0.411	0.328	0.218	0.658	0.438	0.352	0.234	0.523	0.348	0.305	0.203
18	0.654	0.435	0.335	0.223	0.697	0.464	0.360	0.240	0.537	0.357	0.309	0.206
19	0.695	0.462	0.342	0.228	0.741	0.493	0.369	0.245	0.552	0.367	0.314	0.209
20	0.740	0.492	0.350	0.233	0.791	0.526	0.377	0.251	0.570	0.379	0.320	0.213
22	0.848	0.564	0.366	0.244	0.909	0.605	0.396	0.263	0.611	0.406	0.330	0.220
24	0.984	0.655	0.384	0.256	1.06	0.705	0.416	0.277	0.659	0.438	0.342	0.228
26	1.15	0.768	0.404	0.269	1.24	0.828	0.439	0.292	0.715	0.476	0.355	0.236
28	1.34	0.891	0.426	0.284	1.44	0.960	0.464	0.309	0.781	0.520	0.368	0.245
30	1.54	1.02	0.451	0.300	1.66	1.10	0.493	0.328	0.860	0.572	0.383	0.255
32	1.75	1.16	0.482	0.320	1.88	1.25	0.535	0.356	0.952	0.633	0.398	0.265
34	1.97	1.31	0.521	0.347	2.13	1.42	0.579	0.386	1.06	0.706	0.415	0.276
36	2.21	1.47	0.561	0.373	2.38	1.59	0.624	0.415	1.19	0.792	0.434	0.289
38	2.47	1.64	0.600	0.400	2.66	1.77	0.669	0.445	1.33	0.882	0.454	0.302
40	2.73	1.82	0.640	0.426	2.94	1.96	0.713	0.475	1.47	0.978	0.485	0.322
42	3.01	2.00	0.679	0.452	3.25	2.16	0.758	0.504	1.62	1.08	0.520	0.346
44									1.78	1.18	0.555	0.369
46									1.94	1.29	0.591	0.393
48									2.12	1.41	0.626	0.417
50									2.30	1.53	0.662	0.440
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.38		1.58		2.56		1.70		1.75		1.16	
$t_y \times 10^3$ (kips)$^{-1}$	0.387		0.258		0.407		0.271		0.410		0.273	
$t_r \times 10^3$ (kips)$^{-1}$	0.476		0.317		0.501		0.334		0.504		0.336	
r_x/r_y	6.24				6.27				4.58			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W40

Shape		W40×											
		264				249[c]				235[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.431	0.287	0.315	0.210	0.484	0.322	0.318	0.212	0.505	0.336	0.353	0.235
	11	0.526	0.350	0.329	0.219	0.526	0.350	0.318	0.212	0.596	0.397	0.368	0.245
	12	0.547	0.364	0.335	0.223	0.535	0.356	0.318	0.212	0.616	0.410	0.376	0.250
	13	0.570	0.379	0.342	0.228	0.544	0.362	0.320	0.213	0.639	0.425	0.384	0.256
	14	0.596	0.397	0.349	0.233	0.555	0.369	0.325	0.217	0.667	0.444	0.393	0.261
	15	0.625	0.416	0.357	0.238	0.567	0.377	0.331	0.220	0.699	0.465	0.402	0.267
	16	0.658	0.438	0.365	0.243	0.580	0.386	0.336	0.224	0.735	0.489	0.411	0.274
	17	0.695	0.463	0.373	0.248	0.594	0.395	0.342	0.227	0.776	0.516	0.421	0.280
	18	0.737	0.490	0.382	0.254	0.609	0.405	0.347	0.231	0.822	0.547	0.432	0.287
	19	0.784	0.521	0.391	0.260	0.626	0.417	0.353	0.235	0.873	0.581	0.443	0.294
	20	0.836	0.556	0.401	0.267	0.645	0.429	0.359	0.239	0.930	0.619	0.454	0.302
	22	0.961	0.639	0.421	0.280	0.687	0.457	0.372	0.248	1.07	0.710	0.479	0.319
	24	1.12	0.745	0.444	0.295	0.738	0.491	0.386	0.257	1.24	0.825	0.507	0.337
	26	1.32	0.875	0.469	0.312	0.801	0.533	0.401	0.267	1.46	0.968	0.538	0.358
	28	1.53	1.01	0.498	0.331	0.877	0.583	0.417	0.278	1.69	1.12	0.574	0.382
	30	1.75	1.16	0.533	0.355	0.966	0.643	0.435	0.289	1.94	1.29	0.630	0.419
	32	1.99	1.33	0.583	0.388	1.07	0.713	0.454	0.302	2.20	1.47	0.690	0.459
	34	2.25	1.50	0.632	0.421	1.20	0.797	0.475	0.316	2.49	1.66	0.751	0.500
	36	2.52	1.68	0.682	0.454	1.34	0.894	0.498	0.331	2.79	1.86	0.812	0.540
	38	2.81	1.87	0.731	0.486	1.50	0.996	0.530	0.353	3.11	2.07	0.873	0.581
	40	3.11	2.07	0.780	0.519	1.66	1.10	0.573	0.381	3.44	2.29	0.934	0.621
	42	3.43	2.28	0.830	0.552	1.83	1.22	0.616	0.410	3.80	2.53	0.994	0.662
	44					2.01	1.34	0.659	0.439				
	46					2.19	1.46	0.703	0.468				
	48					2.39	1.59	0.746	0.497				
	50					2.59	1.72	0.790	0.526				

Other Constants and Properties

	264		249[c]		235[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.70	1.80	1.96	1.30	3.02	2.01
$t_y \times 10^3$ (kips)$^{-1}$	0.431	0.287	0.455	0.303	0.483	0.322
$t_r \times 10^3$ (kips)$^{-1}$	0.530	0.353	0.560	0.373	0.596	0.397
r_x/r_y	6.27		4.59		6.26	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W40

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W40×											
	215[c]				211[c]				199[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	**0.579**	0.385	**0.370**	0.246	**0.579**	0.385	**0.393**	0.262	**0.633**	0.421	**0.410**	0.273
11	**0.629**	0.418	**0.370**	0.246	**0.682**	0.454	**0.412**	0.274	**0.688**	0.458	**0.410**	0.273
12	**0.639**	0.425	**0.370**	0.246	**0.705**	0.469	**0.422**	0.281	**0.700**	0.466	**0.410**	0.273
13	**0.650**	0.432	**0.373**	0.248	**0.730**	0.486	**0.432**	0.287	**0.712**	0.474	**0.416**	0.277
14	**0.662**	0.440	**0.379**	0.252	**0.760**	0.505	**0.442**	0.294	**0.726**	0.483	**0.423**	0.282
15	**0.675**	0.449	**0.385**	0.256	**0.793**	0.527	**0.453**	0.301	**0.742**	0.493	**0.431**	0.287
16	**0.690**	0.459	**0.392**	0.261	**0.831**	0.553	**0.464**	0.309	**0.759**	0.505	**0.439**	0.292
17	**0.707**	0.470	**0.399**	0.265	**0.874**	0.581	**0.476**	0.317	**0.777**	0.517	**0.447**	0.297
18	**0.724**	0.482	**0.406**	0.270	**0.925**	0.616	**0.489**	0.325	**0.797**	0.531	**0.455**	0.303
19	**0.744**	0.495	**0.413**	0.275	**0.984**	0.655	**0.503**	0.334	**0.820**	0.545	**0.464**	0.309
20	**0.765**	0.509	**0.421**	0.280	**1.05**	0.699	**0.517**	0.344	**0.844**	0.562	**0.473**	0.315
22	**0.814**	0.541	**0.437**	0.291	**1.21**	0.804	**0.548**	0.364	**0.900**	0.599	**0.493**	0.328
24	**0.872**	0.580	**0.455**	0.303	**1.41**	0.940	**0.583**	0.388	**0.968**	0.644	**0.514**	0.342
26	**0.941**	0.626	**0.474**	0.315	**1.66**	1.10	**0.622**	0.414	**1.05**	0.698	**0.537**	0.357
28	**1.02**	0.681	**0.494**	0.329	**1.92**	1.28	**0.679**	0.452	**1.15**	0.763	**0.563**	0.374
30	**1.12**	0.747	**0.517**	0.344	**2.21**	1.47	**0.753**	0.501	**1.27**	0.842	**0.590**	0.393
32	**1.25**	0.829	**0.542**	0.360	**2.51**	1.67	**0.827**	0.551	**1.41**	0.940	**0.621**	0.413
34	**1.39**	0.928	**0.569**	0.378	**2.83**	1.89	**0.902**	0.600	**1.59**	1.06	**0.655**	0.436
36	**1.56**	1.04	**0.604**	0.402	**3.18**	2.11	**0.978**	0.651	**1.78**	1.19	**0.716**	0.476
38	**1.74**	1.16	**0.659**	0.438	**3.54**	2.36	**1.05**	0.701	**1.99**	1.32	**0.782**	0.521
40	**1.93**	1.28	**0.714**	0.475	**3.92**	2.61	**1.13**	0.751	**2.20**	1.46	**0.850**	0.565
42	**2.13**	1.42	**0.770**	0.512					**2.43**	1.61	**0.918**	0.611
44	**2.34**	1.55	**0.827**	0.550					**2.66**	1.77	**0.988**	0.657
46	**2.55**	1.70	**0.884**	0.588					**2.91**	1.94	**1.06**	0.704
48	**2.78**	1.85	**0.941**	0.626					**3.17**	2.11	**1.13**	0.751
50	**3.02**	2.01	**0.999**	0.665					**3.44**	2.29	**1.20**	0.798
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.28**		1.52		**3.39**		2.26		**2.60**		1.73	
$t_y \times 10^3$ (kips)$^{-1}$	**0.527**		0.351		**0.537**		0.358		**0.570**		0.380	
$t_r \times 10^3$ (kips)$^{-1}$	**0.648**		0.432		**0.662**		0.441		**0.702**		0.468	
r_x/r_y	4.58				6.29				4.64			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W40

Shape	W40×											
	183[c]				167[c]				149[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.702	0.467	0.460	0.306	0.769	0.512	0.514	0.342	0.882	0.587	0.596	0.396
11	0.823	0.548	0.485	0.322	0.909	0.605	0.548	0.364	1.05	0.701	0.644	0.429
12	0.850	0.565	0.497	0.330	0.940	0.626	0.562	0.374	1.09	0.726	0.663	0.441
13	0.880	0.585	0.509	0.339	0.976	0.649	0.577	0.384	1.14	0.755	0.682	0.454
14	0.914	0.608	0.522	0.348	1.02	0.676	0.593	0.395	1.19	0.789	0.703	0.468
15	0.953	0.634	0.536	0.357	1.06	0.707	0.610	0.406	1.24	0.828	0.725	0.483
16	0.996	0.663	0.551	0.367	1.11	0.742	0.628	0.418	1.31	0.872	0.749	0.498
17	1.05	0.696	0.566	0.377	1.17	0.782	0.648	0.431	1.39	0.924	0.774	0.515
18	1.10	0.734	0.583	0.388	1.24	0.828	0.668	0.444	1.48	0.984	0.801	0.533
19	1.17	0.777	0.600	0.399	1.32	0.880	0.690	0.459	1.58	1.05	0.830	0.552
20	1.24	0.826	0.619	0.412	1.41	0.941	0.713	0.474	1.70	1.13	0.861	0.573
22	1.43	0.948	0.659	0.438	1.65	1.10	0.764	0.508	2.02	1.34	0.930	0.619
24	1.67	1.11	0.705	0.469	1.95	1.30	0.823	0.548	2.40	1.60	1.03	0.683
26	1.96	1.30	0.762	0.507	2.29	1.52	0.921	0.613	2.82	1.88	1.18	0.783
28	2.27	1.51	0.858	0.571	2.65	1.76	1.04	0.692	3.27	2.17	1.33	0.887
30	2.61	1.74	0.955	0.636	3.05	2.03	1.16	0.773	3.75	2.50	1.49	0.994
32	2.97	1.97	1.05	0.702	3.46	2.31	1.29	0.855	4.27	2.84	1.66	1.10
34	3.35	2.23	1.15	0.768	3.91	2.60	1.41	0.939	4.82	3.21	1.82	1.21
36	3.76	2.50	1.26	0.836	4.38	2.92	1.54	1.02	5.40	3.59	1.99	1.33
38	4.18	2.78	1.36	0.904	4.89	3.25	1.67	1.11	6.02	4.01	2.17	1.44
40	4.64	3.09	1.46	0.972	5.41	3.60	1.80	1.19				

Other Constants and Properties

	183[c]		167[c]		149[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	4.03	2.68	4.69	3.12	5.74	3.82
$t_y \times 10^3$ (kips)$^{-1}$	0.626	0.417	0.678	0.452	0.761	0.507
$t_r \times 10^3$ (kips)$^{-1}$	0.770	0.513	0.834	0.556	0.936	0.624
r_x/r_y	6.31		6.38		6.55	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W36

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W36× 800[h]				W36× 652[h]				W36× 529[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	**ASD**	LRFD	**ASD**	LRFD	**ASD**	LRFD	**ASD**	LRFD	**ASD**	LRFD	**ASD**	LRFD
0	**0.142**	0.094	**0.0976**	0.0649	**0.174**	0.116	**0.122**	0.0815	**0.214**	0.142	**0.153**	0.102
11	**0.152**	0.101	**0.0976**	0.0649	**0.188**	0.125	**0.122**	0.0815	**0.232**	0.154	**0.153**	0.102
12	**0.154**	0.103	**0.0976**	0.0649	**0.190**	0.127	**0.122**	0.0815	**0.235**	0.157	**0.153**	0.102
13	**0.156**	0.104	**0.0976**	0.0649	**0.193**	0.129	**0.122**	0.0815	**0.239**	0.159	**0.153**	0.102
14	**0.159**	0.106	**0.0976**	0.0649	**0.197**	0.131	**0.122**	0.0815	**0.244**	0.162	**0.153**	0.102
15	**0.162**	0.108	**0.0977**	0.0650	**0.200**	0.133	**0.123**	0.0817	**0.248**	0.165	**0.154**	0.102
16	**0.165**	0.110	**0.0982**	0.0653	**0.204**	0.136	**0.124**	0.0823	**0.253**	0.169	**0.155**	0.103
17	**0.168**	0.112	**0.0987**	0.0657	**0.208**	0.139	**0.124**	0.0828	**0.259**	0.172	**0.157**	0.104
18	**0.171**	0.114	**0.0992**	0.0660	**0.213**	0.142	**0.125**	0.0833	**0.265**	0.176	**0.158**	0.105
19	**0.175**	0.117	**0.0997**	0.0664	**0.218**	0.145	**0.126**	0.0839	**0.272**	0.181	**0.159**	0.106
20	**0.179**	0.119	**0.100**	0.0667	**0.223**	0.149	**0.127**	0.0845	**0.279**	0.185	**0.160**	0.107
22	**0.188**	0.125	**0.101**	0.0674	**0.236**	0.157	**0.129**	0.0856	**0.294**	0.196	**0.163**	0.109
24	**0.199**	0.132	**0.102**	0.0682	**0.250**	0.166	**0.130**	0.0868	**0.313**	0.208	**0.166**	0.110
26	**0.211**	0.140	**0.104**	0.0689	**0.266**	0.177	**0.132**	0.0880	**0.334**	0.222	**0.169**	0.112
28	**0.225**	0.150	**0.105**	0.0697	**0.284**	0.189	**0.134**	0.0892	**0.359**	0.239	**0.172**	0.114
30	**0.241**	0.160	**0.106**	0.0705	**0.306**	0.203	**0.136**	0.0905	**0.387**	0.258	**0.175**	0.117
32	**0.259**	0.173	**0.107**	0.0713	**0.330**	0.220	**0.138**	0.0918	**0.420**	0.279	**0.178**	0.119
34	**0.280**	0.187	**0.108**	0.0721	**0.359**	0.239	**0.140**	0.0932	**0.458**	0.305	**0.182**	0.121
36	**0.305**	0.203	**0.110**	0.0730	**0.392**	0.261	**0.142**	0.0946	**0.502**	0.334	**0.185**	0.123
38	**0.332**	0.221	**0.111**	0.0738	**0.430**	0.286	**0.144**	0.0960	**0.554**	0.369	**0.189**	0.126
40	**0.365**	0.243	**0.112**	0.0747	**0.475**	0.316	**0.147**	0.0975	**0.614**	0.409	**0.193**	0.128
42	**0.402**	0.268	**0.114**	0.0756	**0.524**	0.348	**0.149**	0.0990	**0.677**	0.450	**0.197**	0.131
44	**0.441**	0.294	**0.115**	0.0766	**0.575**	0.382	**0.151**	0.101	**0.743**	0.494	**0.201**	0.134
46	**0.482**	0.321	**0.117**	0.0775	**0.628**	0.418	**0.154**	0.102	**0.812**	0.540	**0.205**	0.137
48	**0.525**	0.349	**0.118**	0.0785	**0.684**	0.455	**0.156**	0.104	**0.884**	0.588	**0.210**	0.140
50	**0.570**	0.379	**0.119**	0.0795	**0.742**	0.494	**0.159**	0.106	**0.960**	0.638	**0.215**	0.143

Other Constants and Properties

	800[h] ASD	800[h] LRFD	652[h] ASD	652[h] LRFD	529[h] ASD	529[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**0.479**	0.319	**0.613**	0.408	**0.785**	0.522
$t_y \times 10^3$ (kips)$^{-1}$	**0.141**	0.0940	**0.174**	0.116	**0.213**	0.142
$t_r \times 10^3$ (kips)$^{-1}$	**0.174**	0.116	**0.213**	0.142	**0.263**	0.175
r_x/r_y	3.93		3.95		4.00	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W36

Shape		W36× 487[h]				W36× 441[h]				W36× 395[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.234	0.155	0.167	0.111	0.257	0.171	0.187	0.124	0.288	0.192	0.208	0.139
	11	0.253	0.169	0.167	0.111	0.279	0.186	0.187	0.124	0.313	0.208	0.208	0.139
	12	0.257	0.171	0.167	0.111	0.284	0.189	0.187	0.124	0.318	0.212	0.208	0.139
	13	0.262	0.174	0.167	0.111	0.288	0.192	0.187	0.124	0.324	0.216	0.208	0.139
	14	0.266	0.177	0.167	0.111	0.294	0.196	0.187	0.124	0.330	0.220	0.209	0.139
	15	0.272	0.181	0.169	0.112	0.300	0.199	0.189	0.125	0.337	0.224	0.211	0.141
	16	0.277	0.185	0.170	0.113	0.306	0.204	0.190	0.127	0.344	0.229	0.213	0.142
	17	0.284	0.189	0.172	0.114	0.313	0.208	0.192	0.128	0.352	0.234	0.216	0.144
	18	0.290	0.193	0.173	0.115	0.321	0.213	0.194	0.129	0.361	0.240	0.218	0.145
	19	0.298	0.198	0.175	0.116	0.329	0.219	0.196	0.130	0.371	0.247	0.221	0.147
	20	0.306	0.203	0.176	0.117	0.338	0.225	0.198	0.132	0.381	0.253	0.223	0.148
	22	0.323	0.215	0.180	0.120	0.358	0.238	0.202	0.135	0.404	0.269	0.228	0.152
	24	0.344	0.229	0.183	0.122	0.381	0.254	0.206	0.137	0.431	0.287	0.234	0.155
	26	0.368	0.245	0.187	0.124	0.408	0.272	0.211	0.140	0.462	0.307	0.239	0.159
	28	0.395	0.263	0.190	0.127	0.440	0.293	0.215	0.143	0.498	0.331	0.245	0.163
	30	0.427	0.284	0.194	0.129	0.476	0.317	0.220	0.147	0.540	0.359	0.251	0.167
	32	0.465	0.309	0.198	0.132	0.518	0.345	0.225	0.150	0.589	0.392	0.258	0.171
	34	0.508	0.338	0.202	0.135	0.567	0.377	0.231	0.153	0.646	0.430	0.265	0.176
	36	0.558	0.371	0.207	0.138	0.624	0.415	0.236	0.157	0.713	0.474	0.272	0.181
	38	0.617	0.410	0.211	0.141	0.693	0.461	0.242	0.161	0.792	0.527	0.279	0.186
	40	0.684	0.455	0.216	0.144	0.767	0.511	0.248	0.165	0.878	0.584	0.288	0.191
	42	0.754	0.501	0.221	0.147	0.846	0.563	0.255	0.169	0.968	0.644	0.296	0.197
	44	0.827	0.550	0.226	0.150	0.928	0.618	0.261	0.174	1.06	0.707	0.305	0.203
	46	0.904	0.601	0.232	0.154	1.01	0.675	0.268	0.179	1.16	0.772	0.315	0.209
	48	0.984	0.655	0.237	0.158	1.10	0.735	0.276	0.184	1.26	0.841	0.325	0.216
	50	1.07	0.711	0.243	0.162	1.20	0.798	0.284	0.189	1.37	0.913	0.336	0.224

Other Constants and Properties

	487[h] ASD	487[h] LRFD	441[h] ASD	441[h] LRFD	395[h] ASD	395[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	0.865	0.575	0.968	0.644	1.10	0.729
$t_y \times 10^3$ (kips)$^{-1}$	0.233	0.155	0.257	0.171	0.288	0.192
$t_r \times 10^3$ (kips)$^{-1}$	0.287	0.191	0.315	0.210	0.354	0.236
r_x/r_y	3.99		4.01		4.05	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

W36

F_y = 50 ksi

Shape	W36×											
	361[h]				330				302			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	**0.315**	0.210	**0.230**	0.153	**0.344**	0.229	**0.253**	0.168	**0.376**	0.250	**0.278**	0.185
11	**0.343**	0.228	**0.230**	0.153	**0.376**	0.250	**0.253**	0.168	**0.410**	0.273	**0.278**	0.185
12	**0.349**	0.232	**0.230**	0.153	**0.382**	0.254	**0.253**	0.168	**0.417**	0.278	**0.278**	0.185
13	**0.355**	0.236	**0.230**	0.153	**0.389**	0.259	**0.253**	0.168	**0.425**	0.283	**0.278**	0.185
14	**0.362**	0.241	**0.231**	0.154	**0.397**	0.264	**0.254**	0.169	**0.433**	0.288	**0.280**	0.186
15	**0.370**	0.246	**0.234**	0.155	**0.405**	0.269	**0.257**	0.171	**0.442**	0.294	**0.284**	0.189
16	**0.378**	0.251	**0.236**	0.157	**0.414**	0.275	**0.260**	0.173	**0.452**	0.301	**0.287**	0.191
17	**0.387**	0.257	**0.239**	0.159	**0.424**	0.282	**0.264**	0.175	**0.463**	0.308	**0.291**	0.194
18	**0.397**	0.264	**0.242**	0.161	**0.435**	0.289	**0.267**	0.178	**0.475**	0.316	**0.295**	0.196
19	**0.407**	0.271	**0.245**	0.163	**0.446**	0.297	**0.270**	0.180	**0.488**	0.325	**0.299**	0.199
20	**0.419**	0.279	**0.248**	0.165	**0.459**	0.305	**0.274**	0.182	**0.502**	0.334	**0.303**	0.202
22	**0.444**	0.296	**0.254**	0.169	**0.488**	0.324	**0.281**	0.187	**0.533**	0.355	**0.312**	0.208
24	**0.474**	0.316	**0.260**	0.173	**0.521**	0.347	**0.289**	0.192	**0.570**	0.379	**0.321**	0.214
26	**0.509**	0.339	**0.267**	0.178	**0.560**	0.372	**0.297**	0.198	**0.612**	0.407	**0.331**	0.220
28	**0.550**	0.366	**0.275**	0.183	**0.605**	0.402	**0.306**	0.204	**0.662**	0.440	**0.341**	0.227
30	**0.597**	0.397	**0.282**	0.188	**0.657**	0.437	**0.315**	0.210	**0.720**	0.479	**0.352**	0.234
32	**0.652**	0.434	**0.290**	0.193	**0.718**	0.478	**0.325**	0.216	**0.787**	0.524	**0.364**	0.242
34	**0.716**	0.477	**0.299**	0.199	**0.790**	0.526	**0.335**	0.223	**0.866**	0.576	**0.376**	0.250
36	**0.791**	0.526	**0.308**	0.205	**0.873**	0.581	**0.346**	0.230	**0.958**	0.637	**0.390**	0.259
38	**0.880**	0.586	**0.317**	0.211	**0.973**	0.647	**0.358**	0.238	**1.07**	0.710	**0.404**	0.269
40	**0.976**	0.649	**0.328**	0.218	**1.08**	0.717	**0.371**	0.247	**1.18**	0.787	**0.419**	0.279
42	**1.08**	0.716	**0.339**	0.225	**1.19**	0.791	**0.384**	0.256	**1.30**	0.867	**0.436**	0.290
44	**1.18**	0.785	**0.350**	0.233	**1.30**	0.868	**0.399**	0.265	**1.43**	0.952	**0.457**	0.304
46	**1.29**	0.858	**0.363**	0.241	**1.43**	0.948	**0.417**	0.277	**1.56**	1.04	**0.485**	0.323
48	**1.40**	0.935	**0.376**	0.250	**1.55**	1.03	**0.441**	0.293	**1.70**	1.13	**0.514**	0.342
50	**1.52**	1.01	**0.396**	0.263	**1.68**	1.12	**0.464**	0.309	**1.85**	1.23	**0.542**	0.361

Other Constants and Properties

	361 ASD	361 LRFD	330 ASD	330 LRFD	302 ASD	302 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**1.22**	0.809	**1.34**	0.894	**1.48**	0.984
$t_y \times 10^3$ (kips)$^{-1}$	**0.315**	0.210	**0.344**	0.229	**0.375**	0.250
$t_r \times 10^3$ (kips)$^{-1}$	**0.387**	0.258	**0.423**	0.282	**0.462**	0.308
r_x/r_y	4.05		4.05		4.03	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W36

Shape		W36× 282[c]				W36× 262[c]				W36× 256			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	**0.404**	0.269	**0.299**	0.199	**0.441**	0.294	**0.324**	0.215	**0.443**	0.295	**0.343**	0.228
	11	**0.440**	0.293	**0.299**	0.199	**0.477**	0.318	**0.324**	0.215	**0.531**	0.354	**0.353**	0.235
	12	**0.447**	0.298	**0.299**	0.199	**0.485**	0.323	**0.324**	0.215	**0.550**	0.366	**0.360**	0.239
	13	**0.455**	0.303	**0.299**	0.199	**0.493**	0.328	**0.324**	0.215	**0.571**	0.380	**0.366**	0.244
	14	**0.465**	0.309	**0.302**	0.201	**0.502**	0.334	**0.327**	0.218	**0.595**	0.396	**0.374**	0.249
	15	**0.474**	0.316	**0.306**	0.203	**0.513**	0.341	**0.332**	0.221	**0.621**	0.413	**0.381**	0.254
	16	**0.485**	0.323	**0.310**	0.206	**0.525**	0.349	**0.337**	0.224	**0.651**	0.433	**0.389**	0.259
	17	**0.497**	0.331	**0.314**	0.209	**0.538**	0.358	**0.342**	0.227	**0.684**	0.455	**0.397**	0.264
	18	**0.510**	0.339	**0.319**	0.212	**0.552**	0.367	**0.347**	0.231	**0.720**	0.479	**0.405**	0.270
	19	**0.524**	0.349	**0.323**	0.215	**0.568**	0.378	**0.352**	0.234	**0.761**	0.507	**0.414**	0.276
	20	**0.539**	0.359	**0.328**	0.218	**0.585**	0.389	**0.357**	0.238	**0.807**	0.537	**0.423**	0.282
	22	**0.573**	0.381	**0.338**	0.225	**0.622**	0.414	**0.369**	0.245	**0.916**	0.609	**0.443**	0.295
	24	**0.613**	0.408	**0.348**	0.232	**0.666**	0.443	**0.381**	0.253	**1.05**	0.699	**0.465**	0.309
	26	**0.659**	0.439	**0.359**	0.239	**0.718**	0.478	**0.394**	0.262	**1.22**	0.814	**0.488**	0.325
	28	**0.713**	0.475	**0.371**	0.247	**0.778**	0.518	**0.408**	0.271	**1.42**	0.944	**0.515**	0.342
	30	**0.776**	0.516	**0.384**	0.255	**0.848**	0.564	**0.423**	0.281	**1.63**	1.08	**0.544**	0.362
	32	**0.850**	0.565	**0.397**	0.264	**0.930**	0.619	**0.439**	0.292	**1.85**	1.23	**0.581**	0.386
	34	**0.935**	0.622	**0.412**	0.274	**1.03**	0.683	**0.456**	0.303	**2.09**	1.39	**0.630**	0.419
	36	**1.04**	0.690	**0.427**	0.284	**1.14**	0.759	**0.475**	0.316	**2.35**	1.56	**0.679**	0.452
	38	**1.16**	0.768	**0.444**	0.296	**1.27**	0.846	**0.495**	0.329	**2.61**	1.74	**0.729**	0.485
	40	**1.28**	0.852	**0.462**	0.308	**1.41**	0.937	**0.517**	0.344	**2.90**	1.93	**0.778**	0.517
	42	**1.41**	0.939	**0.482**	0.321	**1.55**	1.03	**0.551**	0.367	**3.19**	2.12	**0.827**	0.550
	44	**1.55**	1.03	**0.514**	0.342	**1.70**	1.13	**0.590**	0.392	**3.50**	2.33	**0.876**	0.583
	46	**1.69**	1.13	**0.546**	0.364	**1.86**	1.24	**0.628**	0.418				
	48	**1.84**	1.23	**0.579**	0.385	**2.03**	1.35	**0.667**	0.443				
	50	**2.00**	1.33	**0.612**	0.407	**2.20**	1.46	**0.705**	0.469				
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		**1.60**		1.06		**1.75**		1.16		**2.60**		1.73	
$t_y \times 10^3$ (kips)$^{-1}$		**0.402**		0.268		**0.434**		0.289		**0.443**		0.295	
$t_r \times 10^3$ (kips)$^{-1}$		**0.495**		0.330		**0.533**		0.355		**0.545**		0.363	
r_x/r_y		4.05				4.07				5.62			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W36

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W36×											
		247[c]				232[c]				231[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	**0.474**	0.316	**0.346**	0.230	**0.497**	0.331	**0.381**	0.253	**0.512**	0.341	**0.370**	0.246
	11	**0.513**	0.341	**0.346**	0.230	**0.590**	0.393	**0.394**	0.262	**0.553**	0.368	**0.370**	0.246
	12	**0.521**	0.346	**0.346**	0.230	**0.612**	0.407	**0.402**	0.267	**0.562**	0.374	**0.370**	0.246
	13	**0.529**	0.352	**0.346**	0.230	**0.636**	0.423	**0.410**	0.273	**0.571**	0.38	**0.370**	0.246
	14	**0.539**	0.359	**0.350**	0.233	**0.662**	0.441	**0.419**	0.279	**0.582**	0.387	**0.375**	0.249
	15	**0.549**	0.366	**0.355**	0.236	**0.693**	0.461	**0.428**	0.284	**0.593**	0.394	**0.381**	0.253
	16	**0.561**	0.373	**0.360**	0.240	**0.726**	0.483	**0.437**	0.291	**0.605**	0.403	**0.387**	0.257
	17	**0.574**	0.382	**0.366**	0.243	**0.764**	0.508	**0.447**	0.297	**0.619**	0.412	**0.393**	0.261
	18	**0.588**	0.391	**0.372**	0.247	**0.806**	0.536	**0.457**	0.304	**0.634**	0.422	**0.399**	0.265
	19	**0.604**	0.402	**0.377**	0.251	**0.853**	0.568	**0.468**	0.311	**0.65**	0.433	**0.406**	0.270
	20	**0.622**	0.414	**0.384**	0.255	**0.906**	0.603	**0.479**	0.319	**0.668**	0.444	**0.412**	0.274
	22	**0.663**	0.441	**0.396**	0.264	**1.03**	0.686	**0.503**	0.335	**0.710**	0.473	**0.426**	0.284
	24	**0.710**	0.473	**0.410**	0.273	**1.19**	0.789	**0.530**	0.353	**0.762**	0.507	**0.442**	0.294
	26	**0.766**	0.510	**0.424**	0.282	**1.39**	0.922	**0.560**	0.372	**0.823**	0.547	**0.458**	0.305
	28	**0.831**	0.553	**0.440**	0.293	**1.61**	1.07	**0.593**	0.395	**0.893**	0.594	**0.475**	0.316
	30	**0.907**	0.603	**0.457**	0.304	**1.84**	1.23	**0.632**	0.421	**0.976**	0.650	**0.494**	0.329
	32	**0.995**	0.662	**0.475**	0.316	**2.10**	1.40	**0.692**	0.461	**1.07**	0.714	**0.515**	0.342
	34	**1.10**	0.731	**0.494**	0.329	**2.37**	1.58	**0.753**	0.501	**1.19**	0.790	**0.537**	0.357
	36	**1.22**	0.814	**0.516**	0.343	**2.66**	1.77	**0.813**	0.541	**1.32**	0.881	**0.561**	0.373
	38	**1.36**	0.907	**0.539**	0.359	**2.96**	1.97	**0.874**	0.581	**1.48**	0.982	**0.588**	0.391
	40	**1.51**	1.01	**0.569**	0.379	**3.28**	2.18	**0.934**	0.621	**1.64**	1.09	**0.631**	0.419
	42	**1.67**	1.11	**0.612**	0.407	**3.61**	2.41	**0.994**	0.662	**1.80**	1.20	**0.679**	0.452
	44	**1.83**	1.22	**0.655**	0.436					**1.98**	1.32	**0.728**	0.484
	46	**2.00**	1.33	**0.699**	0.465					**2.16**	1.44	**0.777**	0.517
	48	**2.18**	1.45	**0.743**	0.494					**2.36**	1.57	**0.827**	0.550
	50	**2.36**	1.57	**0.786**	0.523					**2.56**	1.70	**0.876**	0.583

Other Constants and Properties

	247 ASD	247 LRFD	232 ASD	232 LRFD	231 ASD	231 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**1.88**	1.25	**2.92**	1.94	**2.02**	1.35
$t_y \times 10^3$ (kips)$^{-1}$	**0.459**	0.306	**0.489**	0.326	**0.489**	0.326
$t_r \times 10^3$ (kips)$^{-1}$	**0.566**	0.377	**0.603**	0.402	**0.603**	0.402
r_x/r_y	4.06		5.65		4.07	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W36

Shape		W36× 210[c]				W36× 194[c]				W36× 182[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.556	0.370	0.428	0.285	0.618	0.411	0.464	0.309	0.669	0.445	0.496	0.330
	11	0.654	0.435	0.445	0.296	0.726	0.483	0.485	0.322	0.783	0.521	0.519	0.345
	12	0.679	0.451	0.455	0.302	0.749	0.498	0.496	0.330	0.808	0.538	0.531	0.353
	13	0.706	0.470	0.465	0.309	0.776	0.516	0.507	0.337	0.836	0.556	0.544	0.362
	14	0.737	0.490	0.475	0.316	0.806	0.536	0.519	0.345	0.869	0.578	0.557	0.371
	15	0.771	0.513	0.486	0.323	0.841	0.560	0.532	0.354	0.905	0.602	0.571	0.380
	16	0.810	0.539	0.498	0.331	0.884	0.588	0.545	0.363	0.947	0.630	0.586	0.390
	17	0.854	0.568	0.510	0.339	0.932	0.620	0.559	0.372	0.995	0.662	0.601	0.400
	18	0.902	0.600	0.523	0.348	0.986	0.656	0.574	0.382	1.05	0.700	0.617	0.411
	19	0.956	0.636	0.536	0.357	1.05	0.696	0.589	0.392	1.12	0.744	0.635	0.422
	20	1.02	0.677	0.550	0.366	1.11	0.741	0.605	0.403	1.19	0.792	0.653	0.434
	22	1.16	0.773	0.581	0.386	1.28	0.848	0.641	0.426	1.36	0.908	0.693	0.461
	24	1.34	0.894	0.615	0.409	1.48	0.984	0.681	0.453	1.58	1.05	0.738	0.491
	26	1.57	1.05	0.653	0.434	1.73	1.15	0.726	0.483	1.86	1.24	0.789	0.525
	28	1.83	1.21	0.697	0.463	2.01	1.34	0.784	0.522	2.15	1.43	0.867	0.577
	30	2.10	1.39	0.766	0.509	2.31	1.54	0.871	0.580	2.47	1.65	0.965	0.642
	32	2.38	1.59	0.841	0.560	2.63	1.75	0.960	0.638	2.81	1.87	1.06	0.708
	34	2.69	1.79	0.917	0.610	2.96	1.97	1.05	0.698	3.18	2.11	1.16	0.775
	36	3.02	2.01	0.994	0.661	3.32	2.21	1.14	0.757	3.56	2.37	1.27	0.842
	38	3.36	2.24	1.07	0.712	3.70	2.46	1.23	0.817	3.97	2.64	1.37	0.910
	40	3.73	2.48	1.15	0.763	4.10	2.73	1.32	0.877	4.40	2.93	1.47	0.978
	42	4.11	2.73	1.22	0.814	4.52	3.01	1.41	0.937	4.85	3.23	1.57	1.05

Other Constants and Properties

	210 ASD	210 LRFD	194 ASD	194 LRFD	182 ASD	182 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	3.33	2.22	3.65	2.43	3.93	2.61
$t_y \times 10^3$ (kips)$^{-1}$	0.540	0.360	0.585	0.390	0.623	0.415
$t_r \times 10^3$ (kips)$^{-1}$	0.663	0.442	0.720	0.480	0.765	0.510
r_x/r_y	5.66		5.70		5.69	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W36

F_y = 50 ksi

Shape		W36×											
		170[c]				160[c]				150[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.731	0.486	0.533	0.355	0.790	0.526	0.571	0.380	0.853	0.568	0.613	0.408
	11	0.855	0.569	0.559	0.372	0.925	0.615	0.601	0.400	0.999	0.665	0.648	0.431
	12	0.882	0.587	0.573	0.381	0.954	0.635	0.616	0.410	1.03	0.686	0.665	0.442
	13	0.913	0.607	0.587	0.390	0.987	0.657	0.632	0.420	1.07	0.710	0.683	0.454
	14	0.947	0.63	0.602	0.400	1.03	0.682	0.648	0.431	1.11	0.737	0.701	0.466
	15	0.987	0.657	0.617	0.411	1.07	0.711	0.666	0.443	1.16	0.769	0.721	0.480
	16	1.03	0.687	0.634	0.422	1.12	0.744	0.684	0.455	1.21	0.804	0.741	0.493
	17	1.08	0.721	0.651	0.433	1.17	0.781	0.704	0.468	1.27	0.845	0.763	0.508
	18	1.14	0.76	0.670	0.445	1.24	0.823	0.724	0.482	1.34	0.891	0.787	0.523
	19	1.21	0.804	0.689	0.458	1.31	0.871	0.746	0.496	1.42	0.945	0.811	0.540
	20	1.29	0.857	0.709	0.472	1.39	0.927	0.769	0.512	1.51	1.01	0.838	0.557
	22	1.48	0.984	0.755	0.502	1.60	1.07	0.821	0.546	1.74	1.16	0.896	0.596
	24	1.72	1.15	0.806	0.536	1.88	1.25	0.879	0.585	2.05	1.36	0.963	0.641
	26	2.02	1.34	0.864	0.575	2.20	1.47	0.952	0.634	2.40	1.60	1.06	0.707
	28	2.34	1.56	0.966	0.643	2.55	1.70	1.08	0.716	2.78	1.85	1.20	0.800
	30	2.69	1.79	1.08	0.717	2.93	1.95	1.20	0.799	3.20	2.13	1.35	0.895
	32	3.06	2.04	1.19	0.792	3.34	2.22	1.33	0.885	3.64	2.42	1.49	0.993
	34	3.46	2.30	1.31	0.868	3.77	2.51	1.46	0.972	4.10	2.73	1.64	1.09
	36	3.88	2.58	1.42	0.946	4.22	2.81	1.59	1.06	4.60	3.06	1.79	1.19
	38	4.32	2.87	1.54	1.02	4.70	3.13	1.73	1.15	5.13	3.41	1.95	1.29
	40	4.78	3.18	1.66	1.10	5.21	3.47	1.86	1.24	5.68	3.78	2.10	1.40
	42	5.28	3.51	1.77	1.18								

Other Constants and Properties

	170[c]		160[c]		150[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	4.25	2.83	4.61	3.07	5.02	3.34
$t_y \times 10^3$ (kips)$^{-1}$	0.666	0.444	0.708	0.472	0.753	0.502
$t_r \times 10^3$ (kips)$^{-1}$	0.819	0.546	0.872	0.581	0.927	0.618
r_x/r_y	5.73		5.76		5.79	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

W36–W33

Shape	W36× 135[c]				W33× 387[h]				W33× 354[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.971	0.646	0.700	0.466	0.293	0.195	0.228	0.152	0.321	0.214	0.251	0.167
11	1.14	0.761	0.749	0.498	0.320	0.213	0.228	0.152	0.352	0.234	0.251	0.167
12	1.18	0.787	0.769	0.512	0.326	0.217	0.228	0.152	0.358	0.238	0.251	0.167
13	1.23	0.816	0.791	0.526	0.332	0.221	0.228	0.152	0.365	0.243	0.251	0.167
14	1.28	0.849	0.814	0.542	0.339	0.225	0.230	0.153	0.372	0.248	0.253	0.168
15	1.33	0.887	0.838	0.558	0.346	0.230	0.232	0.155	0.380	0.253	0.256	0.170
16	1.40	0.931	0.864	0.575	0.354	0.236	0.235	0.156	0.389	0.259	0.259	0.172
17	1.47	0.981	0.892	0.593	0.363	0.241	0.237	0.158	0.399	0.266	0.261	0.174
18	1.56	1.04	0.921	0.613	0.372	0.248	0.239	0.159	0.410	0.273	0.264	0.176
19	1.66	1.10	0.953	0.634	0.383	0.255	0.242	0.161	0.421	0.280	0.267	0.178
20	1.77	1.18	0.986	0.656	0.394	0.262	0.244	0.163	0.434	0.289	0.270	0.180
22	2.07	1.37	1.06	0.706	0.419	0.279	0.250	0.166	0.462	0.308	0.277	0.184
24	2.45	1.63	1.15	0.764	0.449	0.299	0.255	0.170	0.495	0.330	0.283	0.188
26	2.88	1.91	1.31	0.872	0.483	0.322	0.261	0.174	0.534	0.355	0.290	0.193
28	3.34	2.22	1.49	0.990	0.524	0.348	0.267	0.178	0.579	0.386	0.298	0.198
30	3.83	2.55	1.67	1.11	0.571	0.380	0.273	0.182	0.632	0.421	0.305	0.203
32	4.36	2.90	1.86	1.24	0.626	0.416	0.280	0.186	0.694	0.462	0.313	0.208
34	4.92	3.27	2.05	1.36	0.690	0.459	0.287	0.191	0.767	0.510	0.322	0.214
36	5.51	3.67	2.24	1.49	0.766	0.510	0.294	0.196	0.854	0.568	0.331	0.220
38	6.14	4.09	2.44	1.62	0.854	0.568	0.302	0.201	0.951	0.633	0.340	0.226
40					0.946	0.629	0.310	0.206	1.05	0.701	0.350	0.233
42					1.04	0.694	0.318	0.212	1.16	0.773	0.361	0.240
44					1.14	0.762	0.327	0.218	1.28	0.848	0.372	0.248
46					1.25	0.832	0.337	0.224	1.39	0.927	0.384	0.256
48					1.36	0.906	0.347	0.231	1.52	1.01	0.397	0.264
50					1.48	0.984	0.358	0.238	1.65	1.10	0.412	0.274

Other Constants and Properties

	W36×135 ASD	W36×135 LRFD	W33×387 ASD	W33×387 LRFD	W33×354 ASD	W33×354 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	5.97	3.97	1.14	0.760	1.26	0.841
$t_y \times 10^3$ (kips)$^{-1}$	0.839	0.559	0.293	0.195	0.321	0.214
$t_r \times 10^3$ (kips)$^{-1}$	1.03	0.688	0.360	0.240	0.395	0.263
r_x/r_y	5.88		3.87		3.88	

[c] Shape is slender for compression with F_y = 50 ksi.

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W33

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W33×											
		318				291				263			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.357	0.237	0.281	0.187	0.390	0.259	0.307	0.204	0.431	0.287	0.343	0.228
	11	0.391	0.260	0.281	0.187	0.428	0.285	0.307	0.204	0.474	0.315	0.343	0.228
	12	0.398	0.265	0.281	0.187	0.436	0.290	0.307	0.204	0.483	0.321	0.343	0.228
	13	0.406	0.270	0.281	0.187	0.445	0.296	0.307	0.204	0.492	0.328	0.343	0.228
	14	0.415	0.276	0.283	0.189	0.454	0.302	0.311	0.207	0.503	0.335	0.348	0.231
	15	0.424	0.282	0.287	0.191	0.464	0.309	0.315	0.210	0.515	0.342	0.352	0.234
	16	0.434	0.289	0.290	0.193	0.476	0.316	0.319	0.212	0.527	0.351	0.357	0.238
	17	0.445	0.296	0.294	0.196	0.488	0.325	0.323	0.215	0.541	0.360	0.362	0.241
	18	0.457	0.304	0.297	0.198	0.501	0.334	0.328	0.218	0.556	0.370	0.367	0.244
	19	0.470	0.313	0.301	0.200	0.516	0.343	0.332	0.221	0.573	0.381	0.373	0.248
	20	0.485	0.322	0.305	0.203	0.532	0.354	0.336	0.224	0.590	0.393	0.378	0.252
	22	0.517	0.344	0.313	0.208	0.568	0.378	0.346	0.230	0.631	0.420	0.390	0.259
	24	0.554	0.369	0.321	0.214	0.610	0.406	0.356	0.237	0.678	0.451	0.402	0.267
	26	0.599	0.398	0.330	0.220	0.659	0.439	0.366	0.244	0.733	0.488	0.415	0.276
	28	0.650	0.433	0.339	0.226	0.717	0.477	0.378	0.251	0.798	0.531	0.429	0.285
	30	0.710	0.473	0.349	0.232	0.785	0.522	0.390	0.259	0.875	0.582	0.443	0.295
	32	0.781	0.520	0.360	0.239	0.864	0.575	0.402	0.268	0.964	0.642	0.459	0.306
	34	0.864	0.575	0.371	0.247	0.958	0.637	0.416	0.277	1.07	0.712	0.476	0.317
	36	0.964	0.641	0.382	0.254	1.07	0.712	0.430	0.286	1.20	0.796	0.495	0.329
	38	1.07	0.715	0.395	0.263	1.19	0.793	0.446	0.297	1.33	0.887	0.514	0.342
	40	1.19	0.792	0.408	0.272	1.32	0.879	0.463	0.308	1.48	0.983	0.536	0.356
	42	1.31	0.873	0.423	0.281	1.46	0.969	0.481	0.320	1.63	1.08	0.562	0.374
	44	1.44	0.958	0.438	0.291	1.60	1.06	0.501	0.333	1.79	1.19	0.599	0.398
	46	1.57	1.05	0.455	0.302	1.75	1.16	0.531	0.353	1.95	1.30	0.635	0.423
	48	1.71	1.14	0.478	0.318	1.90	1.27	0.561	0.373	2.13	1.42	0.672	0.447
	50	1.86	1.24	0.503	0.335	2.06	1.37	0.590	0.393	2.31	1.54	0.709	0.472

Other Constants and Properties

	318		291		263	
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.43	0.948	1.58	1.05	1.76	1.17
$t_y \times 10^3$ (kips)$^{-1}$	0.356	0.237	0.389	0.259	0.431	0.287
$t_r \times 10^3$ (kips)$^{-1}$	0.438	0.292	0.479	0.319	0.530	0.353
r_x/r_y	3.91		3.91		3.91	

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W33

Shape		W33×										
		241[c]				221[c]				201[c]		
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.472	0.314	0.379	0.252	0.523	0.348	0.416	0.277	0.587	0.391	0.461	0.307
	11	0.519	0.345	0.379	0.252	0.569	0.379	0.416	0.277	0.640	0.425	0.461	0.307
	12	0.528	0.351	0.379	0.252	0.579	0.385	0.416	0.277	0.650	0.433	0.461	0.307
	13	0.539	0.359	0.380	0.253	0.590	0.392	0.418	0.278	0.662	0.440	0.464	0.309
	14	0.551	0.366	0.386	0.257	0.602	0.400	0.424	0.282	0.675	0.449	0.471	0.314
	15	0.564	0.375	0.391	0.260	0.616	0.410	0.431	0.286	0.689	0.459	0.479	0.319
	16	0.578	0.385	0.397	0.264	0.632	0.420	0.437	0.291	0.705	0.469	0.487	0.324
	17	0.594	0.395	0.403	0.268	0.649	0.432	0.444	0.296	0.723	0.481	0.495	0.329
	18	0.610	0.406	0.409	0.272	0.668	0.444	0.451	0.300	0.742	0.494	0.504	0.335
	19	0.629	0.418	0.416	0.276	0.688	0.458	0.459	0.305	0.763	0.508	0.512	0.341
	20	0.649	0.432	0.422	0.281	0.711	0.473	0.467	0.310	0.787	0.524	0.521	0.347
	22	0.694	0.462	0.436	0.290	0.761	0.506	0.483	0.321	0.844	0.561	0.541	0.360
	24	0.747	0.497	0.450	0.300	0.821	0.546	0.500	0.333	0.911	0.606	0.561	0.373
	26	0.810	0.539	0.466	0.310	0.891	0.593	0.519	0.345	0.990	0.658	0.583	0.388
	28	0.883	0.588	0.483	0.321	0.973	0.647	0.539	0.358	1.08	0.720	0.607	0.404
	30	0.970	0.645	0.501	0.333	1.07	0.711	0.560	0.373	1.19	0.793	0.633	0.421
	32	1.07	0.713	0.520	0.346	1.18	0.787	0.584	0.388	1.32	0.879	0.662	0.440
	34	1.19	0.792	0.541	0.360	1.32	0.878	0.609	0.405	1.48	0.982	0.693	0.461
	36	1.33	0.888	0.564	0.375	1.48	0.984	0.637	0.424	1.66	1.10	0.727	0.484
	38	1.49	0.989	0.589	0.392	1.65	1.10	0.667	0.444	1.84	1.23	0.781	0.519
	40	1.65	1.10	0.619	0.412	1.83	1.21	0.718	0.478	2.04	1.36	0.844	0.562
	42	1.82	1.21	0.663	0.441	2.01	1.34	0.772	0.513	2.25	1.50	0.908	0.604
	44	1.99	1.33	0.708	0.471	2.21	1.47	0.825	0.549	2.47	1.65	0.973	0.647
	46	2.18	1.45	0.753	0.501	2.41	1.61	0.878	0.584	2.70	1.80	1.04	0.691
	48	2.37	1.58	0.797	0.531	2.63	1.75	0.932	0.620	2.94	1.96	1.10	0.734
	50	2.57	1.71	0.842	0.560	2.85	1.90	0.986	0.656	3.19	2.12	1.17	0.778

Other Constants and Properties

	241[c] ASD	241[c] LRFD	221[c] ASD	221[c] LRFD	201[c] ASD	201[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.96	1.30	2.17	1.45	2.42	1.61
$t_y \times 10^3$ (kips)$^{-1}$	0.470	0.313	0.512	0.341	0.563	0.375
$t_r \times 10^3$ (kips)$^{-1}$	0.578	0.385	0.630	0.420	0.693	0.462
r_x/r_y	3.90		3.93		3.93	

[c] Shape is slender for compression with F_y = 50 ksi.

W33

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W33× 169[c]				W33× 152[c]				W33× 141[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**
0	**0.720**	0.479	**0.566**	0.377	**0.812**	0.540	**0.637**	0.424	**0.890**	0.592	**0.693**	0.461
11	**0.851**	0.567	**0.594**	0.396	**0.960**	0.638	**0.672**	0.447	**1.05**	0.701	**0.735**	0.489
12	**0.880**	0.586	**0.608**	0.405	**0.992**	0.660	**0.689**	0.459	**1.09**	0.724	**0.754**	0.502
13	**0.913**	0.607	**0.623**	0.414	**1.03**	0.684	**0.707**	0.470	**1.13**	0.752	**0.774**	0.515
14	**0.950**	0.632	**0.638**	0.425	**1.07**	0.712	**0.725**	0.482	**1.18**	0.783	**0.795**	0.529
15	**0.992**	0.660	**0.654**	0.435	**1.12**	0.744	**0.745**	0.495	**1.23**	0.818	**0.818**	0.544
16	**1.04**	0.692	**0.671**	0.446	**1.17**	0.780	**0.765**	0.509	**1.29**	0.859	**0.841**	0.560
17	**1.10**	0.730	**0.689**	0.458	**1.24**	0.822	**0.787**	0.523	**1.36**	0.905	**0.866**	0.576
18	**1.16**	0.775	**0.707**	0.471	**1.31**	0.869	**0.810**	0.539	**1.44**	0.958	**0.893**	0.594
19	**1.24**	0.825	**0.727**	0.484	**1.39**	0.926	**0.834**	0.555	**1.53**	1.02	**0.921**	0.613
20	**1.32**	0.881	**0.748**	0.498	**1.49**	0.990	**0.860**	0.572	**1.64**	1.09	**0.951**	0.633
22	**1.52**	1.01	**0.794**	0.528	**1.72**	1.14	**0.917**	0.610	**1.91**	1.27	**1.02**	0.677
24	**1.78**	1.19	**0.845**	0.562	**2.02**	1.34	**0.981**	0.653	**2.25**	1.50	**1.09**	0.727
26	**2.09**	1.39	**0.904**	0.601	**2.37**	1.58	**1.06**	0.708	**2.64**	1.76	**1.21**	0.807
28	**2.43**	1.62	**0.997**	0.663	**2.75**	1.83	**1.20**	0.797	**3.06**	2.04	**1.37**	0.910
30	**2.79**	1.85	**1.10**	0.735	**3.16**	2.10	**1.33**	0.887	**3.51**	2.34	**1.53**	1.01
32	**3.17**	2.11	**1.21**	0.808	**3.59**	2.39	**1.47**	0.978	**4.00**	2.66	**1.69**	1.12
34	**3.58**	2.38	**1.32**	0.881	**4.06**	2.70	**1.61**	1.07	**4.51**	3.00	**1.85**	1.23
36	**4.01**	2.67	**1.44**	0.955	**4.55**	3.03	**1.75**	1.16	**5.06**	3.37	**2.01**	1.34
38	**4.47**	2.97	**1.55**	1.03	**5.07**	3.37	**1.89**	1.26	**5.64**	3.75	**2.18**	1.45
40	**4.95**	3.30	**1.66**	1.10	**5.61**	3.74	**2.03**	1.35	**6.25**	4.16	**2.35**	1.56

Other Constants and Properties

	169[c] ASD	169[c] LRFD	152[c] ASD	152[c] LRFD	141[c] ASD	141[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**4.22**	2.81	**4.82**	3.21	**5.33**	3.54
$t_y \times 10^3$ (kips)$^{-1}$	**0.674**	0.449	**0.746**	0.497	**0.803**	0.535
$t_r \times 10^3$ (kips)$^{-1}$	**0.828**	0.552	**0.917**	0.611	**0.987**	0.658
r_x/r_y	5.48		5.47		5.51	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates *Kl/r* equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W33–W30

Shape		W33×								W30×			
		130[c]				118[c]				391[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.982	0.653	0.763	0.508	1.11	0.739	0.858	0.571	0.290	0.193	0.246	0.163
	11	1.16	0.774	0.814	0.542	1.32	0.880	0.926	0.616	0.319	0.212	0.246	0.163
	12	1.20	0.801	0.836	0.557	1.37	0.911	0.952	0.633	0.325	0.216	0.246	0.163
	13	1.25	0.832	0.860	0.572	1.42	0.947	0.980	0.652	0.331	0.221	0.246	0.164
	14	1.30	0.867	0.884	0.588	1.49	0.988	1.01	0.672	0.339	0.225	0.248	0.165
	15	1.36	0.907	0.911	0.606	1.56	1.04	1.04	0.693	0.346	0.230	0.250	0.166
	16	1.43	0.952	0.938	0.624	1.64	1.09	1.08	0.715	0.355	0.236	0.252	0.168
	17	1.51	1.00	0.968	0.644	1.73	1.15	1.11	0.739	0.364	0.242	0.255	0.169
	18	1.60	1.06	0.999	0.665	1.84	1.22	1.15	0.765	0.374	0.249	0.257	0.171
	19	1.70	1.13	1.03	0.687	1.97	1.31	1.19	0.792	0.385	0.256	0.259	0.172
	20	1.82	1.21	1.07	0.711	2.11	1.41	1.24	0.822	0.397	0.264	0.262	0.174
	22	2.13	1.42	1.15	0.764	2.48	1.65	1.33	0.888	0.424	0.282	0.267	0.177
	24	2.52	1.68	1.24	0.825	2.96	1.97	1.48	0.982	0.456	0.303	0.272	0.181
	26	2.96	1.97	1.41	0.938	3.47	2.31	1.69	1.13	0.493	0.328	0.277	0.184
	28	3.43	2.28	1.59	1.06	4.02	2.68	1.92	1.28	0.536	0.357	0.282	0.188
	30	3.94	2.62	1.78	1.19	4.62	3.07	2.15	1.43	0.587	0.391	0.288	0.192
	32	4.48	2.98	1.97	1.31	5.26	3.50	2.39	1.59	0.647	0.430	0.294	0.196
	34	5.06	3.37	2.17	1.44	5.93	3.95	2.64	1.75	0.717	0.477	0.300	0.200
	36	5.67	3.78	2.37	1.58	6.65	4.43	2.88	1.92	0.802	0.533	0.307	0.204
	38	6.32	4.21	2.57	1.71	7.41	4.93	3.13	2.08	0.893	0.594	0.314	0.209
	40									0.990	0.658	0.321	0.213
	42									1.09	0.726	0.328	0.218
	44									1.20	0.797	0.336	0.224
	46									1.31	0.871	0.344	0.229
	48									1.43	0.948	0.353	0.235
	50									1.55	1.03	0.362	0.241
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		5.99		3.98		6.94		4.62		1.15		0.765	
$t_y \times 10^3$ (kips)$^{-1}$		0.870		0.580		0.962		0.641		0.290		0.193	
$t_r \times 10^3$ (kips)$^{-1}$		1.07		0.714		1.18		0.789		0.357		0.238	
r_x/r_y		5.52				5.60				3.65			

[c] Shape is slender for compression with F_y = 50 ksi.

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W30

F_y = 50 ksi

Shape		W30×											
		357[h]				326[h]				292			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.318	0.212	0.270	0.180	0.349	0.232	0.299	0.199	0.389	0.259	0.336	0.224
	11	0.350	0.233	0.270	0.180	0.385	0.256	0.299	0.199	0.430	0.286	0.336	0.224
	12	0.357	0.237	0.270	0.180	0.392	0.261	0.299	0.199	0.438	0.291	0.336	0.224
	13	0.364	0.242	0.270	0.180	0.400	0.266	0.300	0.200	0.447	0.297	0.337	0.225
	14	0.372	0.247	0.273	0.182	0.409	0.272	0.303	0.202	0.457	0.304	0.341	0.227
	15	0.380	0.253	0.275	0.183	0.419	0.278	0.307	0.204	0.468	0.311	0.345	0.230
	16	0.390	0.259	0.278	0.185	0.429	0.286	0.310	0.206	0.480	0.319	0.349	0.232
	17	0.400	0.266	0.281	0.187	0.441	0.293	0.313	0.208	0.493	0.328	0.353	0.235
	18	0.412	0.274	0.284	0.189	0.454	0.302	0.316	0.211	0.508	0.338	0.358	0.238
	19	0.424	0.282	0.287	0.191	0.467	0.311	0.320	0.213	0.523	0.348	0.362	0.241
	20	0.437	0.291	0.290	0.193	0.482	0.321	0.323	0.215	0.540	0.360	0.366	0.244
	22	0.467	0.311	0.296	0.197	0.517	0.344	0.331	0.220	0.579	0.385	0.376	0.250
	24	0.503	0.334	0.302	0.201	0.557	0.370	0.338	0.225	0.624	0.415	0.385	0.256
	26	0.544	0.362	0.308	0.205	0.604	0.402	0.346	0.230	0.678	0.451	0.396	0.263
	28	0.593	0.395	0.315	0.210	0.659	0.439	0.355	0.236	0.741	0.493	0.406	0.270
	30	0.650	0.433	0.322	0.214	0.724	0.482	0.364	0.242	0.815	0.542	0.418	0.278
	32	0.718	0.478	0.330	0.219	0.801	0.533	0.373	0.248	0.902	0.600	0.430	0.286
	34	0.797	0.530	0.338	0.225	0.892	0.593	0.383	0.255	1.01	0.670	0.443	0.295
	36	0.892	0.594	0.346	0.230	1.00	0.665	0.393	0.261	1.13	0.751	0.456	0.304
	38	0.994	0.662	0.354	0.236	1.11	0.741	0.404	0.269	1.26	0.837	0.471	0.313
	40	1.10	0.733	0.363	0.242	1.23	0.821	0.415	0.276	1.39	0.927	0.486	0.323
	42	1.21	0.808	0.373	0.248	1.36	0.906	0.427	0.284	1.54	1.02	0.502	0.334
	44	1.33	0.887	0.383	0.255	1.49	0.994	0.440	0.293	1.69	1.12	0.520	0.346
	46	1.46	0.969	0.394	0.262	1.63	1.09	0.454	0.302	1.84	1.23	0.539	0.358
	48	1.59	1.06	0.405	0.269	1.78	1.18	0.468	0.311	2.01	1.33	0.564	0.375
	50	1.72	1.15	0.417	0.277	1.93	1.28	0.484	0.322	2.18	1.45	0.592	0.394
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		1.28		0.850		1.41		0.941		1.60		1.06	
$t_y \times 10^3$ (kips)$^{-1}$		0.318		0.212		0.348		0.232		0.389		0.259	
$t_r \times 10^3$ (kips)$^{-1}$		0.390		0.260		0.428		0.285		0.479		0.319	
r_x/r_y		3.65				3.67				3.69			

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W30

Shape		W30×											
		261				235				211			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.434	0.289	0.378	0.251	0.483	0.321	0.421	0.280	0.537	0.357	0.474	0.316
	11	0.481	0.320	0.378	0.251	0.535	0.356	0.421	0.280	0.596	0.397	0.474	0.316
	12	0.491	0.326	0.378	0.251	0.546	0.363	0.421	0.280	0.608	0.405	0.474	0.316
	13	0.501	0.333	0.380	0.253	0.558	0.371	0.424	0.282	0.621	0.413	0.479	0.319
	14	0.513	0.341	0.385	0.256	0.571	0.380	0.430	0.286	0.636	0.423	0.486	0.323
	15	0.525	0.350	0.390	0.260	0.585	0.389	0.436	0.290	0.652	0.434	0.493	0.328
	16	0.539	0.359	0.395	0.263	0.601	0.400	0.442	0.294	0.670	0.446	0.501	0.333
	17	0.555	0.369	0.400	0.266	0.618	0.411	0.448	0.298	0.689	0.459	0.509	0.338
	18	0.571	0.380	0.406	0.270	0.637	0.424	0.455	0.303	0.711	0.473	0.517	0.344
	19	0.589	0.392	0.411	0.274	0.657	0.437	0.461	0.307	0.734	0.488	0.525	0.349
	20	0.609	0.405	0.417	0.277	0.680	0.452	0.468	0.312	0.759	0.505	0.533	0.355
	22	0.654	0.435	0.429	0.285	0.730	0.486	0.483	0.321	0.816	0.543	0.551	0.367
	24	0.707	0.470	0.441	0.293	0.790	0.525	0.498	0.331	0.884	0.588	0.571	0.380
	26	0.769	0.512	0.454	0.302	0.860	0.572	0.514	0.342	0.963	0.641	0.591	0.393
	28	0.843	0.561	0.468	0.311	0.943	0.628	0.532	0.354	1.06	0.704	0.613	0.408
	30	0.929	0.618	0.483	0.321	1.04	0.693	0.550	0.366	1.17	0.778	0.637	0.424
	32	1.03	0.687	0.499	0.332	1.16	0.771	0.570	0.379	1.30	0.866	0.663	0.441
	34	1.16	0.769	0.516	0.343	1.30	0.864	0.592	0.394	1.46	0.973	0.690	0.459
	36	1.30	0.862	0.534	0.355	1.46	0.969	0.615	0.409	1.64	1.09	0.721	0.479
	38	1.44	0.961	0.553	0.368	1.62	1.08	0.640	0.426	1.83	1.21	0.754	0.501
	40	1.60	1.06	0.574	0.382	1.80	1.20	0.667	0.444	2.02	1.35	0.803	0.535
	42	1.76	1.17	0.597	0.397	1.98	1.32	0.705	0.469	2.23	1.48	0.860	0.572
	44	1.94	1.29	0.625	0.416	2.18	1.45	0.749	0.498	2.45	1.63	0.916	0.609
	46	2.12	1.41	0.661	0.440	2.38	1.58	0.793	0.528	2.68	1.78	0.972	0.647
	48	2.30	1.53	0.697	0.463	2.59	1.72	0.838	0.557	2.91	1.94	1.03	0.684
	50	2.50	1.66	0.732	0.487	2.81	1.87	0.882	0.587	3.16	2.10	1.08	0.721

Other Constants and Properties

	261 ASD	261 LRFD	235 ASD	235 LRFD	211 ASD	211 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.82	1.21	2.04	1.35	2.30	1.53
$t_y \times 10^3$ (kips)$^{-1}$	0.434	0.289	0.482	0.321	0.536	0.357
$t_r \times 10^3$ (kips)$^{-1}$	0.534	0.356	0.593	0.395	0.660	0.440
r_x/r_y	3.71		3.70		3.70	

W30

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W30×											
	191[c]				173[c]				148[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.601	0.400	0.528	0.351	0.677	0.450	0.587	0.391	0.802	0.534	0.713	0.474
11	0.661	0.439	0.528	0.351	0.743	0.495	0.587	0.391	0.988	0.657	0.765	0.509
12	0.674	0.448	0.528	0.351	0.757	0.504	0.587	0.391	1.03	0.685	0.784	0.522
13	0.689	0.458	0.534	0.355	0.772	0.514	0.596	0.396	1.08	0.719	0.804	0.535
14	0.705	0.469	0.543	0.361	0.789	0.525	0.606	0.403	1.14	0.760	0.826	0.549
15	0.723	0.481	0.551	0.367	0.808	0.537	0.616	0.410	1.21	0.806	0.849	0.565
16	0.743	0.495	0.560	0.373	0.828	0.551	0.626	0.417	1.29	0.858	0.873	0.581
17	0.765	0.509	0.569	0.379	0.851	0.566	0.637	0.424	1.38	0.917	0.898	0.597
18	0.789	0.525	0.579	0.385	0.877	0.583	0.649	0.432	1.48	0.985	0.925	0.615
19	0.815	0.542	0.589	0.392	0.907	0.603	0.660	0.439	1.60	1.06	0.953	0.634
20	0.844	0.561	0.599	0.399	0.939	0.625	0.673	0.448	1.73	1.15	0.984	0.655
22	0.908	0.604	0.621	0.413	1.01	0.674	0.698	0.465	2.05	1.36	1.05	0.699
24	0.985	0.655	0.644	0.428	1.10	0.732	0.726	0.483	2.44	1.62	1.13	0.750
26	1.08	0.716	0.669	0.445	1.20	0.801	0.756	0.503	2.86	1.91	1.24	0.827
28	1.18	0.787	0.696	0.463	1.33	0.883	0.789	0.525	3.32	2.21	1.38	0.921
30	1.31	0.871	0.725	0.482	1.47	0.980	0.825	0.549	3.81	2.54	1.53	1.02
32	1.46	0.972	0.757	0.504	1.65	1.10	0.864	0.575	4.34	2.89	1.67	1.11
34	1.64	1.09	0.792	0.527	1.86	1.24	0.907	0.603	4.90	3.26	1.81	1.21
36	1.84	1.23	0.830	0.552	2.08	1.39	0.964	0.641	5.49	3.65	1.96	1.30
38	2.05	1.37	0.886	0.590	2.32	1.54	1.05	0.696				
40	2.28	1.51	0.955	0.635	2.57	1.71	1.13	0.752				
42	2.51	1.67	1.02	0.681	2.83	1.89	1.21	0.807				
44	2.75	1.83	1.09	0.727	3.11	2.07	1.30	0.864				
46	3.01	2.00	1.16	0.773	3.40	2.26	1.38	0.920				
48	3.28	2.18	1.23	0.819	3.70	2.46	1.47	0.976				
50	3.56	2.37	1.30	0.865	4.02	2.67	1.55	1.03				
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.58		1.72		2.90		1.93		5.24		3.49	
$t_y \times 10^3$ (kips)$^{-1}$	0.593		0.395		0.654		0.436		0.767		0.511	
$t_r \times 10^3$ (kips)$^{-1}$	0.729		0.486		0.804		0.536		0.944		0.629	
r_x/r_y	3.70				3.71				5.44			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W30

Shape		W30×											
		132[c]				124[c]				116[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.916	0.609	0.815	0.542	0.991	0.659	0.873	0.581	1.07	0.713	0.943	0.627
	11	1.13	0.750	0.882	0.587	1.22	0.811	0.949	0.631	1.32	0.880	1.03	0.686
	12	1.17	0.781	0.906	0.603	1.27	0.845	0.976	0.649	1.38	0.918	1.06	0.706
	13	1.23	0.818	0.932	0.620	1.33	0.885	1.00	0.668	1.45	0.962	1.09	0.728
	14	1.29	0.860	0.959	0.638	1.40	0.931	1.03	0.688	1.52	1.01	1.13	0.750
	15	1.37	0.913	0.987	0.657	1.48	0.984	1.07	0.710	1.61	1.07	1.16	0.775
	16	1.46	0.974	1.02	0.677	1.57	1.05	1.10	0.733	1.72	1.14	1.20	0.801
	17	1.57	1.04	1.05	0.699	1.69	1.12	1.14	0.757	1.84	1.23	1.25	0.828
	18	1.69	1.12	1.08	0.722	1.82	1.21	1.18	0.783	1.99	1.32	1.29	0.858
	19	1.82	1.21	1.12	0.746	1.97	1.31	1.22	0.811	2.16	1.44	1.34	0.890
	20	1.97	1.31	1.16	0.773	2.14	1.42	1.26	0.840	2.35	1.56	1.39	0.924
	22	2.36	1.57	1.25	0.831	2.56	1.70	1.36	0.907	2.83	1.88	1.51	1.00
	24	2.80	1.87	1.36	0.905	3.04	2.02	1.51	1.01	3.36	2.24	1.71	1.13
	26	3.29	2.19	1.54	1.03	3.57	2.38	1.72	1.14	3.95	2.63	1.94	1.29
	28	3.82	2.54	1.72	1.15	4.14	2.75	1.92	1.28	4.58	3.05	2.18	1.45
	30	4.38	2.92	1.91	1.27	4.75	3.16	2.14	1.42	5.26	3.50	2.42	1.61
	32	4.99	3.32	2.10	1.39	5.41	3.60	2.35	1.56	5.98	3.98	2.67	1.78
	34	5.63	3.75	2.28	1.52	6.10	4.06	2.56	1.71	6.75	4.49	2.92	1.94
	36	6.31	4.20	2.47	1.64	6.84	4.55	2.78	1.85	7.57	5.04	3.17	2.11

Other Constants and Properties

	132[c]		124[c]		116[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	6.10	4.06	6.60	4.39	7.24	4.82
$t_y \times 10^3$ (kips)$^{-1}$	0.858	0.572	0.914	0.609	0.975	0.650
$t_r \times 10^3$ (kips)$^{-1}$	1.06	0.704	1.13	0.750	1.20	0.800
r_x/r_y	5.42		5.43		5.48	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W30

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

$F_y = 50$ ksi

Shape		W30× 108[c]				W30× 99[c]				W30× 90[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.17	0.781	1.03	0.685	1.31	0.869	1.14	0.760	1.49	0.991	1.26	0.838
	11	1.45	0.967	1.14	0.756	1.62	1.08	1.27	0.846	1.84	1.23	1.41	0.936
	12	1.52	1.01	1.17	0.779	1.70	1.13	1.31	0.874	1.92	1.28	1.45	0.968
	13	1.59	1.06	1.21	0.804	1.78	1.19	1.36	0.903	2.02	1.34	1.50	1.00
	14	1.68	1.12	1.25	0.831	1.88	1.25	1.41	0.935	2.13	1.41	1.56	1.04
	15	1.78	1.18	1.29	0.860	2.00	1.33	1.46	0.969	2.25	1.50	1.62	1.08
	16	1.90	1.26	1.34	0.890	2.14	1.42	1.51	1.01	2.40	1.60	1.68	1.12
	17	2.03	1.35	1.39	0.923	2.30	1.53	1.57	1.04	2.58	1.72	1.75	1.16
	18	2.20	1.47	1.44	0.959	2.49	1.66	1.63	1.09	2.79	1.85	1.82	1.21
	19	2.40	1.59	1.50	0.997	2.72	1.81	1.70	1.13	3.03	2.02	1.90	1.27
	20	2.62	1.74	1.56	1.04	2.99	1.99	1.78	1.18	3.33	2.21	1.99	1.32
	22	3.16	2.10	1.71	1.13	3.61	2.41	2.00	1.33	4.03	2.68	2.27	1.51
	24	3.76	2.50	1.97	1.31	4.30	2.86	2.31	1.54	4.79	3.19	2.64	1.76
	26	4.42	2.94	2.25	1.50	5.05	3.36	2.65	1.76	5.63	3.74	3.03	2.02
	28	5.12	3.41	2.53	1.69	5.86	3.90	2.99	1.99	6.52	4.34	3.43	2.28
	30	5.88	3.91	2.82	1.88	6.72	4.47	3.33	2.22	7.49	4.98	3.84	2.56
	32	6.69	4.45	3.12	2.07	7.65	5.09	3.69	2.46	8.52	5.67	4.26	2.84
	34	7.55	5.03	3.41	2.27	8.63	5.74	4.05	2.70	9.62	6.40	4.69	3.12

Other Constants and Properties

	W30×108		W30×99		W30×90	
$b_y \times 10^3$ (kip-ft)$^{-1}$	8.12	5.40	9.23	6.14	10.3	6.83
$t_y \times 10^3$ (kips)$^{-1}$	1.05	0.701	1.15	0.764	1.26	0.843
$t_r \times 10^3$ (kips)$^{-1}$	1.29	0.862	1.41	0.940	1.56	1.04
r_x/r_y	5.53		5.57		5.60	

[c] Shape is slender for compression with $F_y = 50$ ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W27

Shape		W27×											
		539[h]				368[h]				336[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.210	0.140	0.189	0.125	0.309	0.206	0.287	0.191	0.338	0.225	0.315	0.210
	11	0.231	0.154	0.189	0.125	0.344	0.229	0.287	0.191	0.376	0.250	0.315	0.210
	12	0.235	0.157	0.189	0.125	0.351	0.233	0.287	0.191	0.383	0.255	0.315	0.210
	13	0.240	0.160	0.189	0.125	0.358	0.238	0.289	0.192	0.392	0.261	0.318	0.211
	14	0.245	0.163	0.190	0.126	0.367	0.244	0.291	0.194	0.402	0.267	0.320	0.213
	15	0.251	0.167	0.191	0.127	0.376	0.250	0.294	0.195	0.412	0.274	0.323	0.215
	16	0.257	0.171	0.192	0.128	0.386	0.257	0.296	0.197	0.423	0.282	0.326	0.217
	17	0.264	0.176	0.193	0.128	0.398	0.265	0.299	0.199	0.436	0.290	0.329	0.219
	18	0.271	0.181	0.194	0.129	0.410	0.273	0.301	0.200	0.450	0.299	0.332	0.221
	19	0.279	0.186	0.195	0.130	0.423	0.282	0.304	0.202	0.465	0.309	0.336	0.223
	20	0.288	0.192	0.196	0.131	0.438	0.291	0.306	0.204	0.481	0.320	0.339	0.225
	22	0.308	0.205	0.198	0.132	0.471	0.313	0.312	0.207	0.518	0.345	0.345	0.230
	24	0.331	0.220	0.201	0.134	0.510	0.340	0.317	0.211	0.562	0.374	0.352	0.234
	26	0.358	0.238	0.203	0.135	0.557	0.370	0.323	0.215	0.614	0.408	0.360	0.239
	28	0.390	0.260	0.206	0.137	0.611	0.407	0.329	0.219	0.675	0.449	0.367	0.244
	30	0.428	0.285	0.208	0.139	0.676	0.450	0.335	0.223	0.748	0.498	0.375	0.249
	32	0.472	0.314	0.211	0.140	0.753	0.501	0.342	0.227	0.835	0.556	0.383	0.255
	34	0.524	0.348	0.213	0.142	0.847	0.563	0.349	0.232	0.940	0.626	0.391	0.260
	36	0.586	0.390	0.216	0.144	0.949	0.632	0.356	0.237	1.05	0.702	0.400	0.266
	38	0.653	0.435	0.219	0.146	1.06	0.704	0.363	0.241	1.17	0.782	0.409	0.272
	40	0.724	0.481	0.222	0.148	1.17	0.780	0.371	0.247	1.30	0.866	0.419	0.279
	42	0.798	0.531	0.225	0.149	1.29	0.860	0.378	0.252	1.44	0.955	0.429	0.286
	44	0.876	0.583	0.228	0.151	1.42	0.944	0.387	0.257	1.58	1.05	0.440	0.293
	46	0.957	0.637	0.231	0.154	1.55	1.03	0.395	0.263	1.72	1.15	0.451	0.300
	48	1.04	0.693	0.234	0.156	1.69	1.12	0.404	0.269	1.87	1.25	0.463	0.308
	50	1.13	0.752	0.237	0.158	1.83	1.22	0.414	0.275	2.03	1.35	0.475	0.316

Other Constants and Properties

	539 ASD	539 LRFD	368 ASD	368 LRFD	336 ASD	336 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	0.815	0.542	1.28	0.850	1.41	0.941
$t_y \times 10^3$ (kips)$^{-1}$	0.210	0.140	0.309	0.206	0.338	0.225
$t_r \times 10^3$ (kips)$^{-1}$	0.258	0.172	0.380	0.253	0.414	0.276
r_x/r_y	3.48		3.51		3.51	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W27

F_y = 50 ksi

Shape	W27×											
	307[h]				281				258			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.369	0.246	0.346	0.230	0.403	0.268	0.381	0.253	0.440	0.292	0.418	0.278
11	0.412	0.274	0.346	0.230	0.450	0.300	0.381	0.253	0.492	0.327	0.418	0.278
12	0.421	0.280	0.346	0.230	0.460	0.306	0.381	0.253	0.503	0.335	0.419	0.279
13	0.431	0.286	0.349	0.232	0.470	0.313	0.385	0.256	0.515	0.342	0.424	0.282
14	0.441	0.294	0.353	0.235	0.482	0.321	0.389	0.259	0.528	0.351	0.429	0.285
15	0.453	0.301	0.356	0.237	0.495	0.330	0.393	0.262	0.542	0.361	0.434	0.289
16	0.466	0.310	0.360	0.239	0.510	0.339	0.397	0.264	0.558	0.371	0.439	0.292
17	0.480	0.319	0.364	0.242	0.525	0.349	0.402	0.267	0.576	0.383	0.444	0.295
18	0.495	0.330	0.367	0.244	0.542	0.361	0.406	0.270	0.595	0.396	0.450	0.299
19	0.512	0.341	0.371	0.247	0.561	0.373	0.411	0.273	0.616	0.410	0.455	0.303
20	0.531	0.353	0.375	0.250	0.581	0.387	0.416	0.277	0.638	0.425	0.461	0.307
22	0.573	0.381	0.383	0.255	0.628	0.418	0.425	0.283	0.690	0.459	0.473	0.315
24	0.622	0.414	0.392	0.261	0.683	0.454	0.436	0.290	0.752	0.500	0.485	0.323
26	0.681	0.453	0.401	0.267	0.749	0.498	0.447	0.297	0.826	0.549	0.498	0.332
28	0.751	0.500	0.410	0.273	0.827	0.550	0.458	0.305	0.913	0.608	0.512	0.341
30	0.835	0.555	0.420	0.279	0.919	0.612	0.470	0.312	1.02	0.677	0.527	0.351
32	0.934	0.621	0.430	0.286	1.03	0.685	0.482	0.321	1.14	0.761	0.543	0.361
34	1.05	0.701	0.441	0.293	1.16	0.774	0.495	0.330	1.29	0.859	0.559	0.372
36	1.18	0.786	0.452	0.301	1.30	0.867	0.509	0.339	1.45	0.963	0.577	0.384
38	1.32	0.876	0.464	0.309	1.45	0.966	0.524	0.349	1.61	1.07	0.595	0.396
40	1.46	0.970	0.476	0.317	1.61	1.07	0.540	0.359	1.79	1.19	0.615	0.409
42	1.61	1.07	0.490	0.326	1.77	1.18	0.556	0.370	1.97	1.31	0.637	0.424
44	1.76	1.17	0.504	0.335	1.95	1.30	0.574	0.382	2.16	1.44	0.660	0.439
46	1.93	1.28	0.518	0.345	2.13	1.42	0.593	0.394	2.36	1.57	0.685	0.456
48	2.10	1.40	0.534	0.355	2.32	1.54	0.613	0.408	2.57	1.71	0.720	0.479
50	2.28	1.52	0.551	0.366	2.51	1.67	0.638	0.424	2.79	1.86	0.755	0.502

Other Constants and Properties

	307 ASD	307 LRFD	281 ASD	281 LRFD	258 ASD	258 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.57	1.04	1.73	1.15	1.91	1.27
$t_y \times 10^3$ (kips)$^{-1}$	0.369	0.246	0.402	0.268	0.438	0.292
$t_r \times 10^3$ (kips)$^{-1}$	0.455	0.303	0.495	0.330	0.540	0.360
r_x/r_y	3.52		3.54		3.54	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W27

Shape	W27×											
	235				217				194			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	**0.481**	0.320	**0.461**	0.307	**0.522**	0.347	**0.501**	0.333	**0.584**	0.388	**0.565**	0.376
11	**0.540**	0.359	**0.461**	0.307	**0.586**	0.390	**0.501**	0.333	**0.657**	0.437	**0.565**	0.376
12	**0.552**	0.367	**0.463**	0.308	**0.599**	0.399	**0.503**	0.335	**0.672**	0.447	**0.568**	0.378
13	**0.565**	0.376	**0.469**	0.312	**0.613**	0.408	**0.510**	0.339	**0.688**	0.458	**0.576**	0.383
14	**0.580**	0.386	**0.475**	0.316	**0.629**	0.419	**0.517**	0.344	**0.706**	0.470	**0.584**	0.389
15	**0.596**	0.397	**0.481**	0.320	**0.647**	0.431	**0.524**	0.348	**0.727**	0.483	**0.593**	0.395
16	**0.614**	0.408	**0.487**	0.324	**0.667**	0.444	**0.531**	0.353	**0.749**	0.498	**0.602**	0.401
17	**0.633**	0.421	**0.494**	0.328	**0.688**	0.458	**0.538**	0.358	**0.773**	0.514	**0.612**	0.407
18	**0.655**	0.436	**0.500**	0.333	**0.711**	0.473	**0.546**	0.363	**0.800**	0.532	**0.621**	0.413
19	**0.678**	0.451	**0.507**	0.337	**0.737**	0.490	**0.554**	0.369	**0.829**	0.552	**0.631**	0.420
20	**0.704**	0.468	**0.514**	0.342	**0.765**	0.509	**0.562**	0.374	**0.861**	0.573	**0.641**	0.427
22	**0.762**	0.507	**0.529**	0.352	**0.829**	0.551	**0.579**	0.385	**0.935**	0.622	**0.663**	0.441
24	**0.832**	0.553	**0.544**	0.362	**0.905**	0.602	**0.598**	0.398	**1.02**	0.680	**0.686**	0.456
26	**0.915**	0.609	**0.560**	0.373	**0.996**	0.662	**0.617**	0.410	**1.13**	0.750	**0.711**	0.473
28	**1.01**	0.674	**0.578**	0.384	**1.10**	0.734	**0.637**	0.424	**1.25**	0.833	**0.737**	0.490
30	**1.13**	0.753	**0.596**	0.397	**1.23**	0.821	**0.660**	0.439	**1.40**	0.932	**0.766**	0.509
32	**1.28**	0.848	**0.616**	0.410	**1.39**	0.926	**0.683**	0.455	**1.58**	1.05	**0.797**	0.530
34	**1.44**	0.958	**0.637**	0.424	**1.57**	1.04	**0.709**	0.471	**1.79**	1.19	**0.830**	0.552
36	**1.61**	1.07	**0.660**	0.439	**1.76**	1.17	**0.736**	0.490	**2.00**	1.33	**0.867**	0.577
38	**1.80**	1.20	**0.684**	0.455	**1.96**	1.31	**0.766**	0.509	**2.23**	1.49	**0.906**	0.603
40	**1.99**	1.33	**0.710**	0.472	**2.17**	1.45	**0.798**	0.531	**2.48**	1.65	**0.969**	0.644
42	**2.20**	1.46	**0.738**	0.491	**2.40**	1.59	**0.842**	0.560	**2.73**	1.82	**1.03**	0.687
44	**2.41**	1.60	**0.775**	0.516	**2.63**	1.75	**0.892**	0.594	**2.99**	1.99	**1.10**	0.729
46	**2.64**	1.75	**0.818**	0.544	**2.87**	1.91	**0.942**	0.627	**3.27**	2.18	**1.16**	0.771
48	**2.87**	1.91	**0.861**	0.573	**3.13**	2.08	**0.992**	0.660	**3.56**	2.37	**1.22**	0.813
50	**3.11**	2.07	**0.903**	0.601	**3.40**	2.26	**1.04**	0.693	**3.87**	2.57	**1.29**	0.855

Other Constants and Properties

	235 ASD	235 LRFD	217 ASD	217 LRFD	194 ASD	194 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.12**	1.41	**2.31**	1.54	**2.62**	1.74
$t_y \times 10^3$ (kips)$^{-1}$	**0.480**	0.320	**0.521**	0.347	**0.582**	0.388
$t_r \times 10^3$ (kips)$^{-1}$	**0.591**	0.394	**0.641**	0.427	**0.717**	0.478
r_x/r_y	3.54		3.55		3.56	

W27

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W27× 178				W27× 161[c]				W27× 146[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	**0.636**	0.423	**0.625**	0.416	**0.704**	0.468	**0.692**	0.460	**0.793**	0.528	**0.768**	0.511
11	**0.718**	0.478	**0.625**	0.416	**0.793**	0.528	**0.692**	0.460	**0.884**	0.588	**0.768**	0.511
12	**0.735**	0.489	**0.630**	0.419	**0.811**	0.540	**0.698**	0.465	**0.903**	0.601	**0.777**	0.517
13	**0.753**	0.501	**0.640**	0.426	**0.832**	0.554	**0.710**	0.472	**0.924**	0.615	**0.791**	0.526
14	**0.774**	0.515	**0.650**	0.433	**0.855**	0.569	**0.722**	0.480	**0.947**	0.630	**0.805**	0.535
15	**0.796**	0.530	**0.661**	0.440	**0.881**	0.586	**0.734**	0.489	**0.976**	0.649	**0.819**	0.545
16	**0.821**	0.546	**0.671**	0.447	**0.909**	0.604	**0.747**	0.497	**1.01**	0.670	**0.835**	0.555
17	**0.849**	0.565	**0.683**	0.454	**0.939**	0.625	**0.761**	0.506	**1.04**	0.693	**0.850**	0.566
18	**0.879**	0.585	**0.694**	0.462	**0.973**	0.647	**0.774**	0.515	**1.08**	0.719	**0.867**	0.577
19	**0.912**	0.607	**0.706**	0.470	**1.01**	0.672	**0.789**	0.525	**1.12**	0.746	**0.884**	0.588
20	**0.948**	0.631	**0.719**	0.478	**1.05**	0.699	**0.804**	0.535	**1.17**	0.777	**0.901**	0.600
22	**1.03**	0.686	**0.745**	0.496	**1.14**	0.761	**0.835**	0.556	**1.27**	0.847	**0.939**	0.625
24	**1.13**	0.752	**0.773**	0.514	**1.25**	0.835	**0.869**	0.578	**1.40**	0.931	**0.980**	0.652
26	**1.25**	0.831	**0.803**	0.535	**1.39**	0.924	**0.906**	0.603	**1.55**	1.03	**1.02**	0.681
28	**1.39**	0.925	**0.836**	0.556	**1.55**	1.03	**0.946**	0.629	**1.73**	1.15	**1.07**	0.714
30	**1.56**	1.04	**0.872**	0.580	**1.74**	1.16	**0.990**	0.659	**1.95**	1.30	**1.13**	0.749
32	**1.77**	1.18	**0.911**	0.606	**1.98**	1.31	**1.04**	0.691	**2.22**	1.48	**1.19**	0.789
34	**2.00**	1.33	**0.953**	0.634	**2.23**	1.48	**1.09**	0.726	**2.51**	1.67	**1.27**	0.843
36	**2.24**	1.49	**1.00**	0.665	**2.50**	1.66	**1.17**	0.780	**2.81**	1.87	**1.38**	0.918
38	**2.50**	1.66	**1.07**	0.715	**2.79**	1.85	**1.27**	0.843	**3.13**	2.08	**1.49**	0.994
40	**2.76**	1.84	**1.15**	0.766	**3.09**	2.05	**1.36**	0.906	**3.47**	2.31	**1.61**	1.07
42	**3.05**	2.03	**1.23**	0.818	**3.40**	2.26	**1.46**	0.969	**3.82**	2.54	**1.73**	1.15
44	**3.35**	2.23	**1.31**	0.870	**3.73**	2.49	**1.55**	1.03	**4.20**	2.79	**1.84**	1.22
46	**3.66**	2.43	**1.39**	0.922	**4.08**	2.72	**1.65**	1.10	**4.59**	3.05	**1.96**	1.30
48	**3.98**	2.65	**1.46**	0.974	**4.44**	2.96	**1.74**	1.16	**5.00**	3.32	**2.07**	1.38
50	**4.32**	2.87	**1.54**	1.03	**4.82**	3.21	**1.84**	1.22	**5.42**	3.61	**2.19**	1.46

Other Constants and Properties

	W27×178 ASD	W27×178 LRFD	W27×161 ASD	W27×161 LRFD	W27×146 ASD	W27×146 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.92**	1.94	**3.27**	2.17	**3.65**	2.43
$t_y \times 10^3$ (kips)$^{-1}$	**0.635**	0.423	**0.701**	0.467	**0.773**	0.515
$t_r \times 10^3$ (kips)$^{-1}$	**0.782**	0.521	**0.863**	0.575	**0.951**	0.634
r_x/r_y	3.57		3.56		3.59	

[c] Shape is slender for compression with F_y = 50 ksi.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W27

Shape		W27×											
		129[c]				114[c]				102[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.910	0.605	0.902	0.600	1.05	0.698	1.04	0.691	1.21	0.803	1.17	0.777
	11	1.15	0.762	0.975	0.649	1.31	0.874	1.13	0.754	1.51	1.00	1.28	0.854
	12	1.20	0.801	1.00	0.666	1.38	0.915	1.17	0.776	1.58	1.05	1.32	0.880
	13	1.27	0.845	1.03	0.684	1.45	0.964	1.20	0.798	1.66	1.10	1.36	0.907
	14	1.35	0.896	1.06	0.703	1.54	1.02	1.24	0.822	1.75	1.17	1.41	0.936
	15	1.43	0.954	1.09	0.723	1.64	1.09	1.27	0.848	1.86	1.24	1.45	0.967
	16	1.53	1.02	1.12	0.744	1.76	1.17	1.32	0.875	1.99	1.33	1.50	1.00
	17	1.65	1.09	1.15	0.766	1.89	1.26	1.36	0.904	2.15	1.43	1.56	1.03
	18	1.77	1.18	1.19	0.790	2.04	1.36	1.41	0.935	2.33	1.55	1.61	1.07
	19	1.92	1.28	1.23	0.816	2.22	1.47	1.46	0.969	2.53	1.68	1.67	1.11
	20	2.09	1.39	1.27	0.843	2.42	1.61	1.51	1.00	2.77	1.84	1.74	1.16
	22	2.51	1.67	1.36	0.903	2.91	1.94	1.63	1.08	3.34	2.22	1.89	1.26
	24	2.99	1.99	1.46	0.971	3.46	2.30	1.81	1.20	3.98	2.65	2.16	1.44
	26	3.50	2.33	1.63	1.09	4.06	2.70	2.04	1.36	4.67	3.10	2.45	1.63
	28	4.06	2.70	1.81	1.21	4.71	3.14	2.28	1.52	5.41	3.60	2.74	1.82
	30	4.67	3.10	1.99	1.33	5.41	3.60	2.52	1.68	6.21	4.13	3.04	2.02
	32	5.31	3.53	2.18	1.45	6.16	4.10	2.76	1.84	7.07	4.70	3.34	2.22
	34	5.99	3.99	2.36	1.57	6.95	4.62	3.00	2.00	7.98	5.31	3.64	2.42
	36	6.72	4.47	2.54	1.69	7.79	5.18	3.24	2.16				

Other Constants and Properties

	129[c]		114[c]		102[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	6.19	4.12	7.23	4.81	8.21	5.46
$t_y \times 10^3$ (kips)$^{-1}$	0.881	0.587	0.995	0.663	1.11	0.740
$t_r \times 10^3$ (kips)$^{-1}$	1.08	0.723	1.22	0.816	1.37	0.911
r_x/r_y	5.07		5.05		5.12	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W27–W24

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W27× 94[c]				W27× 84[c]				W24× 370[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.33	0.887	1.28	0.853	1.53	1.02	1.46	0.971	0.306	0.204	0.315	0.210
11	1.67	1.11	1.42	0.944	1.92	1.28	1.63	1.09	0.345	0.230	0.315	0.210
12	1.75	1.16	1.46	0.974	2.01	1.34	1.69	1.12	0.353	0.235	0.316	0.210
13	1.84	1.22	1.51	1.01	2.12	1.41	1.75	1.16	0.362	0.241	0.319	0.212
14	1.94	1.29	1.56	1.04	2.24	1.49	1.81	1.20	0.372	0.247	0.321	0.213
15	2.07	1.37	1.62	1.08	2.39	1.59	1.88	1.25	0.382	0.254	0.323	0.215
16	2.21	1.47	1.67	1.11	2.55	1.70	1.95	1.30	0.394	0.262	0.326	0.217
17	2.38	1.58	1.74	1.16	2.75	1.83	2.03	1.35	0.407	0.271	0.328	0.218
18	2.58	1.72	1.80	1.20	2.99	1.99	2.11	1.41	0.422	0.280	0.330	0.220
19	2.81	1.87	1.88	1.25	3.28	2.18	2.20	1.47	0.437	0.291	0.333	0.221
20	3.08	2.05	1.96	1.30	3.61	2.40	2.30	1.53	0.454	0.302	0.335	0.223
22	3.73	2.48	2.17	1.44	4.37	2.91	2.64	1.76	0.494	0.328	0.340	0.226
24	4.44	2.95	2.50	1.66	5.20	3.46	3.06	2.03	0.540	0.359	0.346	0.230
26	5.21	3.47	2.84	1.89	6.11	4.06	3.49	2.32	0.596	0.397	0.351	0.234
28	6.04	4.02	3.19	2.12	7.08	4.71	3.93	2.61	0.663	0.441	0.357	0.237
30	6.94	4.62	3.55	2.36	8.13	5.41	4.38	2.91	0.743	0.495	0.363	0.241
32	7.89	5.25	3.91	2.60	9.25	6.15	4.84	3.22	0.842	0.560	0.369	0.245
34	8.91	5.93	4.27	2.84	10.4	6.95	5.30	3.53	0.950	0.632	0.375	0.249
36									1.07	0.709	0.381	0.254
38									1.19	0.790	0.388	0.258
40									1.32	0.875	0.395	0.263
42									1.45	0.965	0.402	0.267
44									1.59	1.06	0.409	0.272
46									1.74	1.16	0.417	0.277
48									1.89	1.26	0.425	0.283
50									2.05	1.37	0.433	0.288

Other Constants and Properties

	W27×94 ASD	W27×94 LRFD	W27×84 ASD	W27×84 LRFD	W24×370 ASD	W24×370 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	9.18	6.11	10.7	7.14	1.33	0.888
$t_y \times 10^3$ (kips)$^{-1}$	1.21	0.804	1.35	0.898	0.306	0.204
$t_r \times 10^3$ (kips)$^{-1}$	1.48	0.989	1.66	1.1	0.377	0.251
r_x/r_y	5.14		5.17		3.39	

[c] Shape is slender for compression with F_y = 50 ksi.

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W24

Shape	W24×											
	335[h]				306[h]				279[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.339	0.226	0.349	0.232	0.372	0.248	0.386	0.257	0.407	0.271	0.427	0.284
11	0.383	0.255	0.349	0.232	0.421	0.280	0.386	0.257	0.462	0.308	0.427	0.284
12	0.392	0.261	0.351	0.233	0.431	0.287	0.389	0.259	0.474	0.315	0.430	0.286
13	0.403	0.268	0.354	0.235	0.443	0.294	0.392	0.261	0.486	0.324	0.434	0.289
14	0.414	0.275	0.357	0.237	0.455	0.303	0.396	0.263	0.500	0.333	0.438	0.292
15	0.426	0.283	0.359	0.239	0.469	0.312	0.399	0.266	0.516	0.343	0.443	0.294
16	0.439	0.292	0.362	0.241	0.484	0.322	0.403	0.268	0.533	0.354	0.447	0.297
17	0.454	0.302	0.365	0.243	0.501	0.333	0.406	0.270	0.551	0.367	0.451	0.300
18	0.471	0.313	0.368	0.245	0.519	0.345	0.410	0.273	0.572	0.381	0.456	0.303
19	0.489	0.325	0.372	0.247	0.539	0.359	0.414	0.275	0.595	0.396	0.461	0.306
20	0.508	0.338	0.375	0.249	0.561	0.373	0.418	0.278	0.619	0.412	0.465	0.310
22	0.553	0.368	0.381	0.254	0.612	0.407	0.426	0.283	0.676	0.450	0.475	0.316
24	0.607	0.404	0.388	0.258	0.673	0.448	0.434	0.289	0.745	0.496	0.485	0.323
26	0.671	0.447	0.395	0.263	0.745	0.496	0.443	0.294	0.827	0.550	0.496	0.330
28	0.749	0.498	0.402	0.267	0.833	0.554	0.451	0.300	0.926	0.616	0.507	0.337
30	0.842	0.560	0.409	0.272	0.939	0.624	0.461	0.307	1.05	0.696	0.519	0.345
32	0.956	0.636	0.417	0.277	1.07	0.710	0.470	0.313	1.19	0.792	0.531	0.353
34	1.08	0.718	0.425	0.283	1.20	0.801	0.481	0.320	1.34	0.894	0.544	0.362
36	1.21	0.805	0.433	0.288	1.35	0.899	0.491	0.327	1.51	1.00	0.557	0.371
38	1.35	0.897	0.442	0.294	1.50	1.00	0.502	0.334	1.68	1.12	0.571	0.380
40	1.49	0.993	0.451	0.300	1.67	1.11	0.514	0.342	1.86	1.24	0.586	0.390
42	1.65	1.10	0.460	0.306	1.84	1.22	0.526	0.350	2.05	1.36	0.602	0.400
44	1.81	1.20	0.470	0.313	2.02	1.34	0.538	0.358	2.25	1.50	0.618	0.411
46	1.97	1.31	0.480	0.320	2.21	1.47	0.552	0.367	2.46	1.64	0.635	0.423
48	2.15	1.43	0.491	0.327	2.40	1.60	0.565	0.376	2.68	1.78	0.654	0.435
50	2.33	1.55	0.502	0.334	2.61	1.73	0.580	0.386	2.91	1.93	0.673	0.448

Other Constants and Properties

	335[h] ASD	335[h] LRFD	306[h] ASD	306[h] LRFD	279[h] ASD	279[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.50	0.996	1.66	1.11	1.85	1.23
$t_y \times 10^3$ (kips)$^{-1}$	0.339	0.226	0.372	0.248	0.407	0.271
$t_r \times 10^3$ (kips)$^{-1}$	0.417	0.278	0.458	0.305	0.501	0.334
r_x/r_y	3.41		3.41		3.41	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

W24

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W24×											
	250				229				207			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.454	0.302	0.479	0.319	0.497	0.331	0.528	0.351	0.550	0.366	0.588	0.391
11	0.517	0.344	0.479	0.319	0.567	0.377	0.528	0.351	0.629	0.419	0.589	0.392
12	0.530	0.353	0.483	0.322	0.581	0.387	0.534	0.355	0.646	0.430	0.596	0.397
13	0.544	0.362	0.489	0.325	0.597	0.397	0.540	0.359	0.664	0.442	0.604	0.402
14	0.560	0.373	0.494	0.329	0.615	0.409	0.547	0.364	0.684	0.455	0.612	0.407
15	0.578	0.384	0.499	0.332	0.635	0.422	0.553	0.368	0.706	0.470	0.620	0.412
16	0.597	0.397	0.505	0.336	0.656	0.437	0.560	0.372	0.731	0.486	0.628	0.418
17	0.619	0.412	0.511	0.340	0.680	0.453	0.567	0.377	0.758	0.505	0.637	0.424
18	0.642	0.427	0.516	0.344	0.707	0.470	0.574	0.382	0.788	0.525	0.645	0.429
19	0.668	0.444	0.522	0.347	0.736	0.490	0.581	0.387	0.821	0.547	0.654	0.435
20	0.696	0.463	0.528	0.351	0.768	0.511	0.588	0.391	0.858	0.571	0.664	0.442
22	0.762	0.507	0.541	0.360	0.841	0.560	0.604	0.402	0.942	0.626	0.683	0.454
24	0.840	0.559	0.554	0.369	0.930	0.619	0.620	0.412	1.04	0.694	0.703	0.468
26	0.935	0.622	0.568	0.378	1.04	0.690	0.637	0.424	1.17	0.775	0.725	0.483
28	1.05	0.698	0.582	0.387	1.17	0.776	0.655	0.436	1.31	0.874	0.748	0.498
30	1.19	0.791	0.597	0.397	1.33	0.882	0.674	0.449	1.50	0.996	0.773	0.514
32	1.35	0.900	0.613	0.408	1.51	1.00	0.694	0.462	1.70	1.13	0.799	0.532
34	1.53	1.02	0.630	0.419	1.70	1.13	0.716	0.476	1.92	1.28	0.827	0.551
36	1.71	1.14	0.648	0.431	1.91	1.27	0.739	0.492	2.16	1.43	0.858	0.571
38	1.91	1.27	0.667	0.444	2.13	1.42	0.763	0.508	2.40	1.60	0.890	0.592
40	2.11	1.41	0.687	0.457	2.36	1.57	0.789	0.525	2.66	1.77	0.925	0.616
42	2.33	1.55	0.709	0.472	2.60	1.73	0.817	0.544	2.93	1.95	0.966	0.643
44	2.56	1.70	0.732	0.487	2.85	1.90	0.847	0.564	3.22	2.14	1.02	0.679
46	2.80	1.86	0.756	0.503	3.12	2.07	0.884	0.588	3.52	2.34	1.07	0.715
48	3.05	2.03	0.782	0.520	3.39	2.26	0.928	0.617	3.83	2.55	1.13	0.750
50	3.30	2.20	0.815	0.542	3.68	2.45	0.971	0.646	4.16	2.77	1.18	0.786

Other Constants and Properties

	250 ASD	250 LRFD	229 ASD	229 LRFD	207 ASD	207 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.08	1.39	2.31	1.54	2.60	1.73
$t_y \times 10^3$ (kips)$^{-1}$	0.453	0.302	0.497	0.331	0.549	0.366
$t_r \times 10^3$ (kips)$^{-1}$	0.558	0.372	0.611	0.407	0.677	0.451
r_x/r_y	3.41		3.44		3.44	

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W24

Shape	W24× 192				W24× 176				W24× 162			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	**0.593**	0.395	**0.637**	0.424	**0.646**	0.430	**0.697**	0.464	**0.700**	0.466	**0.761**	0.506
11	**0.679**	0.452	**0.639**	0.425	**0.742**	0.494	**0.700**	0.466	**0.802**	0.534	**0.764**	0.508
12	**0.697**	0.464	**0.647**	0.431	**0.762**	0.507	**0.710**	0.472	**0.824**	0.548	**0.776**	0.516
13	**0.717**	0.477	**0.656**	0.437	**0.784**	0.521	**0.721**	0.479	**0.847**	0.564	**0.788**	0.524
14	**0.739**	0.491	**0.665**	0.443	**0.808**	0.538	**0.732**	0.487	**0.874**	0.581	**0.801**	0.533
15	**0.763**	0.508	**0.675**	0.449	**0.835**	0.556	**0.743**	0.494	**0.903**	0.601	**0.814**	0.541
16	**0.790**	0.525	**0.685**	0.455	**0.865**	0.576	**0.754**	0.502	**0.935**	0.622	**0.827**	0.550
17	**0.819**	0.545	**0.695**	0.462	**0.898**	0.598	**0.766**	0.510	**0.971**	0.646	**0.841**	0.560
18	**0.852**	0.567	**0.705**	0.469	**0.935**	0.622	**0.779**	0.518	**1.01**	0.672	**0.856**	0.569
19	**0.888**	0.591	**0.715**	0.476	**0.975**	0.649	**0.791**	0.526	**1.05**	0.701	**0.871**	0.579
20	**0.928**	0.617	**0.726**	0.483	**1.02**	0.678	**0.804**	0.535	**1.10**	0.732	**0.886**	0.589
22	**1.02**	0.678	**0.749**	0.498	**1.12**	0.746	**0.832**	0.554	**1.21**	0.805	**0.919**	0.611
24	**1.13**	0.751	**0.773**	0.515	**1.25**	0.829	**0.862**	0.573	**1.34**	0.894	**0.954**	0.635
26	**1.26**	0.840	**0.799**	0.532	**1.40**	0.929	**0.893**	0.594	**1.50**	1.00	**0.992**	0.660
28	**1.42**	0.948	**0.827**	0.550	**1.58**	1.05	**0.928**	0.617	**1.70**	1.13	**1.03**	0.687
30	**1.63**	1.08	**0.857**	0.570	**1.81**	1.20	**0.964**	0.642	**1.94**	1.29	**1.08**	0.717
32	**1.85**	1.23	**0.889**	0.591	**2.05**	1.37	**1.00**	0.668	**2.21**	1.47	**1.13**	0.749
34	**2.09**	1.39	**0.923**	0.614	**2.32**	1.54	**1.05**	0.697	**2.49**	1.66	**1.18**	0.784
36	**2.34**	1.56	**0.961**	0.639	**2.60**	1.73	**1.10**	0.729	**2.80**	1.86	**1.24**	0.827
38	**2.61**	1.73	**1.00**	0.666	**2.90**	1.93	**1.15**	0.768	**3.12**	2.07	**1.33**	0.887
40	**2.89**	1.92	**1.05**	0.698	**3.21**	2.14	**1.23**	0.819	**3.45**	2.30	**1.42**	0.948
42	**3.19**	2.12	**1.11**	0.740	**3.54**	2.35	**1.31**	0.870	**3.81**	2.53	**1.51**	1.01
44	**3.50**	2.33	**1.18**	0.783	**3.88**	2.58	**1.38**	0.921	**4.18**	2.78	**1.61**	1.07
46	**3.82**	2.54	**1.24**	0.825	**4.24**	2.82	**1.46**	0.971	**4.57**	3.04	**1.70**	1.13
48	**4.16**	2.77	**1.30**	0.867	**4.62**	3.07	**1.54**	1.02	**4.97**	3.31	**1.79**	1.19
50	**4.51**	3.00	**1.37**	0.909	**5.01**	3.34	**1.61**	1.07	**5.39**	3.59	**1.88**	1.25

Other Constants and Properties

	192 ASD	192 LRFD	176 ASD	176 LRFD	162 ASD	162 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.83**	1.88	**3.10**	2.06	**3.39**	2.26
$t_y \times 10^3$ (kips)$^{-1}$	**0.593**	0.395	**0.645**	0.430	**0.699**	0.466
$t_r \times 10^3$ (kips)$^{-1}$	**0.729**	0.486	**0.794**	0.529	**0.860**	0.573
r_x/r_y	3.42		3.45		3.41	

W24

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W24×											
	146				131				117[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	**0.777**	0.517	**0.852**	0.567	**0.867**	0.577	**0.963**	0.641	**0.994**	0.662	**1.09**	0.725
11	**0.894**	0.595	**0.858**	0.571	**1.00**	0.666	**0.972**	0.646	**1.13**	0.752	**1.10**	0.733
12	**0.918**	0.611	**0.872**	0.580	**1.03**	0.685	**0.989**	0.658	**1.16**	0.772	**1.12**	0.748
13	**0.945**	0.629	**0.887**	0.590	**1.06**	0.705	**1.01**	0.670	**1.19**	0.794	**1.15**	0.762
14	**0.975**	0.649	**0.902**	0.600	**1.09**	0.728	**1.03**	0.683	**1.23**	0.821	**1.17**	0.778
15	**1.01**	0.671	**0.918**	0.611	**1.13**	0.754	**1.05**	0.696	**1.28**	0.850	**1.19**	0.794
16	**1.05**	0.696	**0.935**	0.622	**1.18**	0.783	**1.07**	0.710	**1.33**	0.883	**1.22**	0.811
17	**1.09**	0.723	**0.952**	0.633	**1.22**	0.814	**1.09**	0.724	**1.38**	0.919	**1.24**	0.828
18	**1.13**	0.753	**0.970**	0.645	**1.28**	0.849	**1.11**	0.739	**1.44**	0.959	**1.27**	0.846
19	**1.18**	0.786	**0.988**	0.658	**1.33**	0.887	**1.13**	0.754	**1.51**	1.00	**1.30**	0.865
20	**1.24**	0.823	**1.01**	0.670	**1.40**	0.929	**1.16**	0.770	**1.58**	1.05	**1.33**	0.885
22	**1.36**	0.907	**1.05**	0.697	**1.54**	1.03	**1.21**	0.804	**1.75**	1.17	**1.39**	0.928
24	**1.52**	1.01	**1.09**	0.727	**1.72**	1.15	**1.26**	0.841	**1.96**	1.30	**1.46**	0.974
26	**1.70**	1.13	**1.14**	0.759	**1.94**	1.29	**1.33**	0.882	**2.21**	1.47	**1.54**	1.03
28	**1.93**	1.29	**1.19**	0.794	**2.21**	1.47	**1.39**	0.928	**2.53**	1.68	**1.63**	1.08
30	**2.21**	1.47	**1.25**	0.832	**2.54**	1.69	**1.47**	0.978	**2.90**	1.93	**1.73**	1.15
32	**2.52**	1.68	**1.31**	0.874	**2.89**	1.92	**1.56**	1.04	**3.30**	2.20	**1.89**	1.26
34	**2.84**	1.89	**1.39**	0.926	**3.26**	2.17	**1.70**	1.13	**3.73**	2.48	**2.07**	1.38
36	**3.19**	2.12	**1.51**	1.00	**3.65**	2.43	**1.84**	1.23	**4.18**	2.78	**2.25**	1.50
38	**3.55**	2.36	**1.62**	1.08	**4.07**	2.71	**1.99**	1.32	**4.65**	3.10	**2.43**	1.62
40	**3.93**	2.62	**1.73**	1.15	**4.51**	3.00	**2.13**	1.42	**5.16**	3.43	**2.62**	1.74
42	**4.34**	2.89	**1.85**	1.23	**4.97**	3.31	**2.28**	1.52	**5.69**	3.78	**2.80**	1.86
44	**4.76**	3.17	**1.96**	1.30	**5.46**	3.63	**2.42**	1.61	**6.24**	4.15	**2.99**	1.99
46	**5.20**	3.46	**2.07**	1.38	**5.96**	3.97	**2.57**	1.71	**6.82**	4.54	**3.17**	2.11
48	**5.67**	3.77	**2.19**	1.45	**6.49**	4.32	**2.71**	1.80	**7.43**	4.94	**3.35**	2.23
50	**6.15**	4.09	**2.30**	1.53								
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	**3.82**		2.54		**4.37**		2.91		**4.99**		3.32	
$t_y \times 10^3$ (kips)$^{-1}$	**0.776**		0.517		**0.866**		0.577		**0.969**		0.646	
$t_r \times 10^3$ (kips)$^{-1}$	**0.954**		0.636		**1.07**		0.710		**1.19**		0.795	
r_x/r_y	3.42				3.43				3.44			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W24

Shape		W24×							
		104[c]				103[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.14	0.761	1.23	0.820	1.13	0.754	1.27	0.847
	11	1.30	0.865	1.25	0.832	1.52	1.01	1.42	0.944
	12	1.33	0.886	1.28	0.849	1.62	1.08	1.46	0.973
	13	1.37	0.911	1.30	0.867	1.73	1.15	1.51	1.00
	14	1.41	0.938	1.33	0.885	1.86	1.24	1.56	1.03
	15	1.46	0.969	1.36	0.905	2.01	1.34	1.61	1.07
	16	1.51	1.00	1.39	0.925	2.18	1.45	1.66	1.11
	17	1.57	1.04	1.42	0.946	2.38	1.58	1.72	1.14
	18	1.63	1.09	1.46	0.968	2.61	1.74	1.78	1.19
	19	1.71	1.14	1.49	0.991	2.89	1.92	1.85	1.23
	20	1.79	1.19	1.53	1.02	3.20	2.13	1.92	1.28
	22	1.99	1.32	1.61	1.07	3.87	2.57	2.10	1.39
	24	2.23	1.49	1.69	1.13	4.60	3.06	2.38	1.58
	26	2.53	1.68	1.79	1.19	5.40	3.59	2.66	1.77
	28	2.90	1.93	1.90	1.26	6.27	4.17	2.94	1.96
	30	3.33	2.21	2.06	1.37	7.19	4.79	3.22	2.15
	32	3.78	2.52	2.28	1.52	8.18	5.45	3.51	2.33
	34	4.27	2.84	2.51	1.67				
	36	4.79	3.19	2.73	1.82				
	38	5.34	3.55	2.96	1.97				
	40	5.91	3.93	3.20	2.13				
	42	6.52	4.34	3.43	2.28				
	44	7.15	4.76	3.66	2.44				
	46	7.82	5.20	3.90	2.59				
	48	8.51	5.66	4.13	2.75				

Other Constants and Properties

	104[c] ASD	104[c] LRFD	103[c] ASD	103[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	5.71	3.80	8.58	5.71
$t_y \times 10^3$ (kips)$^{-1}$	1.09	0.726	1.10	0.734
$t_r \times 10^3$ (kips)$^{-1}$	1.34	0.893	1.36	0.904
r_x/r_y	3.47		5.03	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W24

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W24×											
	94[c]				84[c]				76			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	**1.26**	0.840	**1.40**	0.933	**1.45**	0.968	**1.59**	1.06	**1.64**	1.09	**1.78**	1.19
6	**1.37**	0.910	**1.40**	0.933	**1.57**	1.05	**1.59**	1.06	**1.78**	1.18	**1.78**	1.19
7	**1.41**	0.937	**1.40**	0.933	**1.62**	1.08	**1.60**	1.06	**1.83**	1.22	**1.79**	1.19
8	**1.46**	0.970	**1.44**	0.960	**1.68**	1.12	**1.64**	1.09	**1.90**	1.26	**1.85**	1.23
9	**1.52**	1.01	**1.48**	0.987	**1.75**	1.16	**1.69**	1.13	**1.97**	1.31	**1.91**	1.27
10	**1.59**	1.06	**1.53**	1.02	**1.83**	1.22	**1.75**	1.16	**2.06**	1.37	**1.97**	1.31
11	**1.67**	1.11	**1.58**	1.05	**1.92**	1.28	**1.81**	1.20	**2.17**	1.44	**2.04**	1.36
12	**1.78**	1.18	**1.63**	1.08	**2.03**	1.35	**1.87**	1.24	**2.30**	1.53	**2.11**	1.41
13	**1.90**	1.26	**1.68**	1.12	**2.16**	1.44	**1.93**	1.29	**2.45**	1.63	**2.19**	1.46
14	**2.04**	1.36	**1.74**	1.15	**2.33**	1.55	**2.00**	1.33	**2.63**	1.75	**2.27**	1.51
15	**2.21**	1.47	**1.80**	1.19	**2.52**	1.68	**2.08**	1.38	**2.84**	1.89	**2.37**	1.57
16	**2.40**	1.60	**1.86**	1.24	**2.75**	1.83	**2.16**	1.44	**3.10**	2.06	**2.46**	1.64
17	**2.62**	1.74	**1.93**	1.28	**3.01**	2.00	**2.25**	1.50	**3.41**	2.27	**2.57**	1.71
18	**2.88**	1.92	**2.01**	1.34	**3.32**	2.21	**2.34**	1.56	**3.77**	2.51	**2.69**	1.79
19	**3.19**	2.12	**2.09**	1.39	**3.68**	2.45	**2.45**	1.63	**4.19**	2.79	**2.82**	1.87
20	**3.53**	2.35	**2.18**	1.45	**4.08**	2.71	**2.56**	1.70	**4.65**	3.09	**3.01**	2.00
22	**4.27**	2.84	**2.43**	1.62	**4.94**	3.28	**2.96**	1.97	**5.62**	3.74	**3.51**	2.33
24	**5.08**	3.38	**2.77**	1.84	**5.87**	3.91	**3.38**	2.25	**6.69**	4.45	**4.03**	2.68
26	**5.96**	3.97	**3.11**	2.07	**6.89**	4.59	**3.81**	2.53	**7.85**	5.23	**4.56**	3.03
28	**6.92**	4.60	**3.45**	2.29	**7.99**	5.32	**4.24**	2.82	**9.11**	6.06	**5.10**	3.39
30	**7.94**	5.28	**3.79**	2.52	**9.18**	6.11	**4.68**	3.11	**10.5**	6.96	**5.64**	3.75
32	**9.03**	6.01	**4.14**	2.75	**10.4**	6.95	**5.12**	3.41	**11.9**	7.92	**6.19**	4.12

Other Constants and Properties

	94[c]		84[c]		76	
$b_y \times 10^3$ (kip-ft)$^{-1}$	**9.50**	6.32	**10.9**	7.27	**12.5**	8.29
$t_y \times 10^3$ (kips)$^{-1}$	**1.20**	0.802	**1.35**	0.899	**1.49**	0.994
$t_r \times 10^3$ (kips)$^{-1}$	**1.48**	0.987	**1.66**	1.11	**1.83**	1.22
r_x/r_y	4.98		5.02		5.05	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W24

Shape	W24×											
	68[c]				62[c]				55[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	1.87	1.25	2.01	1.34	2.07	1.38	2.33	1.55	2.42	1.61	2.66	1.77
6	2.03	1.35	2.01	1.34	2.40	1.60	2.44	1.63	2.80	1.87	2.82	1.87
7	2.09	1.39	2.04	1.36	2.54	1.69	2.56	1.70	2.97	1.97	2.96	1.97
8	2.17	1.44	2.11	1.40	2.72	1.81	2.68	1.78	3.18	2.11	3.11	2.07
9	2.26	1.50	2.18	1.45	2.94	1.95	2.82	1.87	3.44	2.29	3.28	2.18
10	2.37	1.57	2.26	1.50	3.22	2.14	2.97	1.97	3.79	2.52	3.47	2.31
11	2.49	1.66	2.34	1.56	3.58	2.38	3.14	2.09	4.23	2.81	3.68	2.45
12	2.64	1.76	2.43	1.62	4.06	2.70	3.32	2.21	4.80	3.19	3.92	2.61
13	2.82	1.88	2.53	1.68	4.67	3.10	3.54	2.35	5.57	3.70	4.19	2.79
14	3.04	2.02	2.64	1.75	5.41	3.60	3.78	2.51	6.45	4.29	4.54	3.02
15	3.29	2.19	2.75	1.83	6.21	4.13	4.16	2.77	7.41	4.93	5.12	3.40
16	3.60	2.39	2.88	1.91	7.07	4.70	4.64	3.08	8.43	5.61	5.71	3.80
17	3.97	2.64	3.01	2.00	7.98	5.31	5.12	3.41	9.52	6.33	6.33	4.21
18	4.42	2.94	3.16	2.11	8.94	5.95	5.61	3.73	10.7	7.10	6.96	4.63
19	4.93	3.28	3.36	2.23	10.0	6.63	6.12	4.07	11.9	7.91	7.60	5.05
20	5.46	3.63	3.66	2.44	11.0	7.35	6.62	4.41	13.2	8.76	8.25	5.49
22	6.61	4.40	4.29	2.86	13.4	8.89	7.66	5.10	15.9	10.6	9.58	6.37
24	7.86	5.23	4.95	3.29								
26	9.23	6.14	5.62	3.74								
28	10.7	7.12	6.30	4.19								
30	12.3	8.18	7.00	4.66								

Other Constants and Properties

	68 ASD	68 LRFD	62 ASD	62 LRFD	55 ASD	55 LRFD
$b_y \times 10^3$ (kip-ft)	14.5	9.67	22.7	15.1	26.8	17.8
$t_y \times 10^3$ (kips)$^{-1}$	1.66	1.11	1.83	1.22	2.06	1.37
$t_r \times 10^3$ (kips)$^{-1}$	2.04	1.36	2.25	1.50	2.53	1.69
r_x/r_y	5.11		6.69		6.80	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W21

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W21× 201				W21× 182				W21× 166			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.564	0.375	0.672	0.447	0.623	0.414	0.748	0.498	0.684	0.455	0.825	0.549
	6	0.588	0.391	0.672	0.447	0.650	0.432	0.748	0.498	0.714	0.475	0.825	0.549
	7	0.597	0.397	0.672	0.447	0.660	0.439	0.748	0.498	0.725	0.482	0.825	0.549
	8	0.607	0.404	0.672	0.447	0.671	0.447	0.748	0.498	0.738	0.491	0.825	0.549
	9	0.619	0.412	0.672	0.447	0.685	0.456	0.748	0.498	0.753	0.501	0.825	0.549
	10	0.633	0.421	0.672	0.447	0.700	0.466	0.748	0.498	0.770	0.512	0.825	0.549
	11	0.649	0.432	0.675	0.449	0.718	0.478	0.752	0.500	0.789	0.525	0.829	0.552
	12	0.666	0.443	0.682	0.454	0.737	0.491	0.761	0.507	0.811	0.539	0.841	0.559
	13	0.686	0.456	0.690	0.459	0.759	0.505	0.771	0.513	0.835	0.555	0.852	0.567
	14	0.707	0.471	0.698	0.464	0.783	0.521	0.781	0.519	0.862	0.573	0.864	0.575
	15	0.732	0.487	0.706	0.470	0.811	0.539	0.791	0.526	0.892	0.593	0.876	0.583
	16	0.758	0.504	0.714	0.475	0.840	0.559	0.801	0.533	0.925	0.615	0.888	0.591
	17	0.788	0.524	0.723	0.481	0.874	0.581	0.811	0.540	0.962	0.640	0.901	0.599
	18	0.820	0.546	0.731	0.487	0.910	0.605	0.822	0.547	1.00	0.667	0.914	0.608
	19	0.856	0.569	0.740	0.492	0.950	0.632	0.833	0.554	1.05	0.696	0.927	0.617
	20	0.895	0.596	0.749	0.499	0.995	0.662	0.844	0.562	1.10	0.729	0.941	0.626
	22	0.986	0.656	0.768	0.511	1.10	0.730	0.868	0.578	1.21	0.805	0.970	0.646
	24	1.10	0.730	0.788	0.524	1.22	0.813	0.893	0.594	1.35	0.897	1.00	0.666
	26	1.23	0.819	0.809	0.538	1.37	0.914	0.920	0.612	1.52	1.01	1.03	0.688
	28	1.39	0.928	0.831	0.553	1.56	1.04	0.948	0.631	1.72	1.15	1.07	0.712
	30	1.60	1.06	0.854	0.568	1.79	1.19	0.978	0.650	1.98	1.31	1.11	0.737
	32	1.82	1.21	0.879	0.585	2.03	1.35	1.01	0.672	2.25	1.50	1.15	0.764
	34	2.05	1.36	0.905	0.602	2.30	1.53	1.04	0.694	2.54	1.69	1.19	0.793
	36	2.30	1.53	0.933	0.621	2.57	1.71	1.08	0.718	2.84	1.89	1.24	0.824
	38	2.56	1.70	0.962	0.640	2.87	1.91	1.12	0.744	3.17	2.11	1.29	0.858
	40	2.84	1.89	0.994	0.661	3.18	2.11	1.16	0.772	3.51	2.34	1.35	0.897
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		2.68		1.78		2.99		1.99		3.30		2.19	
$t_y \times 10^3$ (kips)$^{-1}$		0.563		0.375		0.621		0.414		0.683		0.455	
$t_r \times 10^3$ (kips)$^{-1}$		0.693		0.462		0.765		0.510		0.840		0.560	
r_x/r_y		3.14				3.13				3.13			

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W21

Shape	W21×											
	147				132				122			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	**0.773**	0.514	**0.955**	0.635	**0.861**	0.573	**1.07**	0.712	**0.931**	0.620	**1.16**	0.772
6	**0.807**	0.537	**0.955**	0.635	**0.899**	0.598	**1.07**	0.712	**0.974**	0.648	**1.16**	0.772
7	**0.820**	0.546	**0.955**	0.635	**0.914**	0.608	**1.07**	0.712	**0.990**	0.658	**1.16**	0.772
8	**0.835**	0.556	**0.955**	0.635	**0.931**	0.619	**1.07**	0.712	**1.01**	0.671	**1.16**	0.772
9	**0.852**	0.567	**0.955**	0.635	**0.951**	0.632	**1.07**	0.712	**1.03**	0.685	**1.16**	0.772
10	**0.872**	0.580	**0.955**	0.635	**0.973**	0.647	**1.07**	0.712	**1.05**	0.701	**1.16**	0.772
11	**0.895**	0.595	**0.963**	0.641	**0.998**	0.664	**1.08**	0.719	**1.08**	0.720	**1.17**	0.781
12	**0.920**	0.612	**0.978**	0.651	**1.03**	0.683	**1.10**	0.731	**1.11**	0.740	**1.19**	0.795
13	**0.948**	0.631	**0.993**	0.661	**1.06**	0.704	**1.12**	0.743	**1.15**	0.764	**1.22**	0.809
14	**0.980**	0.652	**1.01**	0.671	**1.09**	0.728	**1.14**	0.756	**1.19**	0.789	**1.24**	0.823
15	**1.01**	0.675	**1.02**	0.682	**1.13**	0.755	**1.16**	0.769	**1.23**	0.818	**1.26**	0.838
16	**1.05**	0.701	**1.04**	0.693	**1.18**	0.784	**1.18**	0.783	**1.28**	0.850	**1.28**	0.854
17	**1.10**	0.729	**1.06**	0.704	**1.23**	0.816	**1.20**	0.797	**1.33**	0.885	**1.31**	0.870
18	**1.14**	0.761	**1.08**	0.716	**1.28**	0.852	**1.22**	0.811	**1.39**	0.925	**1.33**	0.887
19	**1.20**	0.796	**1.09**	0.728	**1.34**	0.892	**1.24**	0.826	**1.45**	0.968	**1.36**	0.905
20	**1.25**	0.834	**1.11**	0.740	**1.41**	0.935	**1.27**	0.842	**1.53**	1.02	**1.39**	0.923
22	**1.39**	0.924	**1.15**	0.767	**1.56**	1.04	**1.31**	0.875	**1.69**	1.13	**1.45**	0.962
24	**1.55**	1.03	**1.19**	0.795	**1.74**	1.16	**1.37**	0.911	**1.90**	1.26	**1.51**	1.00
26	**1.75**	1.17	**1.24**	0.826	**1.97**	1.31	**1.43**	0.949	**2.15**	1.43	**1.58**	1.05
28	**2.00**	1.33	**1.29**	0.858	**2.25**	1.50	**1.49**	0.992	**2.46**	1.63	**1.65**	1.10
30	**2.29**	1.53	**1.34**	0.894	**2.59**	1.72	**1.56**	1.04	**2.82**	1.88	**1.74**	1.16
32	**2.61**	1.74	**1.40**	0.933	**2.94**	1.96	**1.64**	1.09	**3.21**	2.13	**1.83**	1.22
34	**2.94**	1.96	**1.47**	0.975	**3.32**	2.21	**1.72**	1.14	**3.62**	2.41	**1.97**	1.31
36	**3.30**	2.20	**1.54**	1.02	**3.73**	2.48	**1.85**	1.23	**4.06**	2.70	**2.13**	1.41
38	**3.68**	2.45	**1.64**	1.09	**4.15**	2.76	**1.99**	1.32	**4.52**	3.01	**2.28**	1.52
40	**4.08**	2.71	**1.75**	1.16	**4.60**	3.06	**2.12**	1.41	**5.01**	3.34	**2.44**	1.62

Other Constants and Properties

	147		132		122	
$b_y \times 10^3$ (kip-ft)$^{-1}$	**3.85**	2.56	**4.33**	2.88	**4.71**	3.14
$t_y \times 10^3$ (kips)$^{-1}$	**0.771**	0.514	**0.860**	0.573	**0.930**	0.620
$t_r \times 10^3$ (kips)$^{-1}$	**0.950**	0.633	**1.06**	0.705	**1.14**	0.763
r_x/r_y	3.11		3.11		3.11	

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W21

F_y = 50 ksi

Shape	W21×											
	111				101[c]				93			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	**1.02**	0.680	**1.28**	0.850	**1.14**	0.755	**1.41**	0.937	**1.22**	0.813	**1.61**	1.07
6	**1.07**	0.711	**1.28**	0.850	**1.18**	0.786	**1.41**	0.937	**1.37**	0.909	**1.61**	1.07
7	**1.09**	0.723	**1.28**	0.850	**1.20**	0.798	**1.41**	0.937	**1.42**	0.947	**1.63**	1.09
8	**1.11**	0.737	**1.28**	0.850	**1.22**	0.811	**1.41**	0.937	**1.49**	0.992	**1.68**	1.12
9	**1.13**	0.753	**1.28**	0.850	**1.24**	0.827	**1.41**	0.937	**1.57**	1.05	**1.73**	1.15
10	**1.16**	0.771	**1.28**	0.850	**1.27**	0.847	**1.41**	0.937	**1.67**	1.11	**1.78**	1.18
11	**1.19**	0.791	**1.29**	0.861	**1.31**	0.870	**1.43**	0.951	**1.78**	1.18	**1.83**	1.22
12	**1.22**	0.814	**1.32**	0.877	**1.35**	0.895	**1.46**	0.969	**1.91**	1.27	**1.89**	1.25
13	**1.26**	0.840	**1.34**	0.894	**1.39**	0.924	**1.49**	0.989	**2.07**	1.37	**1.95**	1.29
14	**1.31**	0.869	**1.37**	0.911	**1.44**	0.956	**1.52**	1.01	**2.25**	1.50	**2.01**	1.34
15	**1.35**	0.901	**1.40**	0.928	**1.49**	0.992	**1.55**	1.03	**2.46**	1.64	**2.08**	1.38
16	**1.41**	0.937	**1.42**	0.947	**1.55**	1.03	**1.58**	1.05	**2.71**	1.80	**2.15**	1.43
17	**1.47**	0.976	**1.45**	0.966	**1.62**	1.07	**1.61**	1.07	**3.00**	2.00	**2.23**	1.48
18	**1.53**	1.02	**1.48**	0.986	**1.69**	1.12	**1.65**	1.10	**3.35**	2.23	**2.32**	1.54
19	**1.61**	1.07	**1.51**	1.01	**1.77**	1.18	**1.69**	1.12	**3.74**	2.49	**2.41**	1.60
20	**1.69**	1.12	**1.55**	1.03	**1.86**	1.24	**1.72**	1.15	**4.14**	2.75	**2.51**	1.67
22	**1.87**	1.25	**1.62**	1.08	**2.07**	1.37	**1.81**	1.20	**5.01**	3.33	**2.77**	1.84
24	**2.10**	1.40	**1.69**	1.13	**2.32**	1.54	**1.90**	1.26	**5.96**	3.97	**3.12**	2.07
26	**2.38**	1.59	**1.78**	1.18	**2.63**	1.75	**2.00**	1.33	**7.00**	4.66	**3.46**	2.30
28	**2.73**	1.82	**1.87**	1.24	**3.02**	2.01	**2.11**	1.40	**8.12**	5.40	**3.81**	2.54
30	**3.14**	2.09	**1.97**	1.31	**3.47**	2.31	**2.24**	1.49	**9.32**	6.20	**4.16**	2.77
32	**3.57**	2.38	**2.12**	1.41	**3.95**	2.63	**2.46**	1.64				
34	**4.03**	2.68	**2.30**	1.53	**4.46**	2.96	**2.68**	1.79				
36	**4.52**	3.01	**2.49**	1.66	**5.00**	3.32	**2.91**	1.94				
38	**5.03**	3.35	**2.68**	1.79	**5.57**	3.70	**3.14**	2.09				
40	**5.58**	3.71	**2.87**	1.91	**6.17**	4.10	**3.37**	2.24				

Other Constants and Properties

	111 ASD	111 LRFD	101[c] ASD	101[c] LRFD	93 ASD	93 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**5.22**	3.48	**5.77**	3.84	**10.3**	6.83
$t_y \times 10^3$ (kips)$^{-1}$	**1.02**	0.680	**1.12**	0.747	**1.22**	0.813
$t_r \times 10^3$ (kips)$^{-1}$	**1.26**	0.837	**1.38**	0.919	**1.50**	1.00
r_x/r_y	3.12		3.12		4.73	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W21

Shape	W21×											
	83[c]				73[c]				68[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	1.38	0.919	1.82	1.21	1.62	1.08	2.07	1.38	1.77	1.17	2.23	1.48
6	1.54	1.02	1.82	1.21	1.78	1.19	2.07	1.38	1.94	1.29	2.23	1.48
7	1.60	1.06	1.85	1.23	1.85	1.23	2.11	1.40	2.01	1.34	2.27	1.51
8	1.68	1.12	1.90	1.26	1.93	1.28	2.18	1.45	2.10	1.40	2.35	1.56
9	1.77	1.18	1.96	1.30	2.02	1.35	2.25	1.50	2.20	1.46	2.43	1.61
10	1.88	1.25	2.02	1.34	2.14	1.43	2.32	1.55	2.32	1.55	2.51	1.67
11	2.01	1.34	2.09	1.39	2.29	1.53	2.40	1.60	2.47	1.64	2.60	1.73
12	2.16	1.44	2.16	1.43	2.47	1.64	2.49	1.66	2.66	1.77	2.70	1.80
13	2.33	1.55	2.23	1.48	2.68	1.78	2.58	1.72	2.89	1.92	2.81	1.87
14	2.54	1.69	2.31	1.54	2.92	1.94	2.68	1.79	3.15	2.10	2.93	1.95
15	2.78	1.85	2.40	1.59	3.20	2.13	2.79	1.86	3.46	2.30	3.05	2.03
16	3.07	2.04	2.49	1.66	3.54	2.36	2.91	1.94	3.83	2.55	3.19	2.12
17	3.40	2.26	2.59	1.72	3.94	2.62	3.04	2.02	4.26	2.84	3.34	2.22
18	3.81	2.53	2.70	1.79	4.41	2.93	3.18	2.11	4.78	3.18	3.50	2.33
19	4.24	2.82	2.82	1.87	4.91	3.27	3.33	2.22	5.33	3.54	3.72	2.47
20	4.70	3.13	2.94	1.96	5.45	3.62	3.58	2.38	5.90	3.93	4.03	2.68
22	5.69	3.78	3.36	2.24	6.59	4.38	4.13	2.75	7.14	4.75	4.66	3.10
24	6.77	4.50	3.80	2.53	7.84	5.22	4.69	3.12	8.50	5.65	5.30	3.53
26	7.94	5.29	4.24	2.82	9.20	6.12	5.25	3.49	10.0	6.64	5.95	3.96
28	9.21	6.13	4.67	3.11	10.7	7.10	5.81	3.87	11.6	7.70	6.60	4.39
30	10.6	7.04	5.11	3.40	12.3	8.15	6.37	4.24	13.3	8.83	7.25	4.83

Other Constants and Properties

	83[c] ASD	83[c] LRFD	73[c] ASD	73[c] LRFD	68[c] ASD	68[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	11.7	7.77	13.4	8.91	14.6	9.71
$t_y \times 10^3$ (kips)$^{-1}$	1.37	0.913	1.55	1.03	1.66	1.11
$t_r \times 10^3$ (kips)$^{-1}$	1.69	1.12	1.91	1.27	2.05	1.37
r_x/r_y	4.74		4.77		4.78	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W21

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W21×											
	62[c]				57[c]				55[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	1.98	1.32	2.47	1.65	2.17	1.44	2.76	1.84	2.29	1.52	2.83	1.88
6	2.18	1.45	2.47	1.65	2.56	1.70	2.91	1.94	2.52	1.68	2.83	1.88
7	2.26	1.50	2.54	1.69	2.72	1.81	3.04	2.03	2.61	1.74	2.92	1.94
8	2.36	1.57	2.62	1.74	2.93	1.95	3.19	2.12	2.73	1.81	3.02	2.01
9	2.47	1.65	2.71	1.81	3.20	2.13	3.35	2.23	2.86	1.91	3.14	2.09
10	2.61	1.74	2.81	1.87	3.56	2.37	3.53	2.35	3.03	2.01	3.26	2.17
11	2.78	1.85	2.92	1.94	4.01	2.67	3.73	2.48	3.23	2.15	3.40	2.26
12	2.98	1.99	3.04	2.02	4.58	3.05	3.95	2.63	3.47	2.31	3.55	2.36
13	3.23	2.15	3.16	2.10	5.31	3.53	4.20	2.80	3.76	2.50	3.71	2.47
14	3.54	2.35	3.30	2.19	6.16	4.10	4.49	2.98	4.11	2.73	3.88	2.58
15	3.90	2.59	3.44	2.29	7.07	4.70	4.94	3.29	4.55	3.03	4.07	2.71
16	4.33	2.88	3.61	2.40	8.04	5.35	5.47	3.64	5.07	3.37	4.29	2.85
17	4.84	3.22	3.78	2.52	9.08	6.04	6.01	4.00	5.71	3.80	4.52	3.01
18	5.43	3.61	3.98	2.65	10.2	6.77	6.55	4.36	6.40	4.26	4.90	3.26
19	6.05	4.02	4.33	2.88	11.3	7.54	7.10	4.72	7.13	4.74	5.37	3.57
20	6.70	4.46	4.70	3.13	12.6	8.36	7.65	5.09	7.90	5.26	5.85	3.89
21	7.39	4.92	5.08	3.38	13.8	9.21	8.20	5.46	8.71	5.80	6.33	4.21
22	8.11	5.39	5.46	3.63	15.2	10.1	8.76	5.83	9.56	6.36	6.82	4.54
23	8.86	5.90	5.85	3.89					10.4	6.95	7.32	4.87
24	9.65	6.42	6.24	4.15					11.4	7.57	7.82	5.20
25	10.5	6.97	6.63	4.41					12.3	8.21	8.33	5.54
26	11.3	7.53	7.02	4.67					13.4	8.88	8.84	5.88
27	12.2	8.13	7.42	4.93					14.4	9.58	9.36	6.23
28	13.1	8.74	7.81	5.20					15.5	10.3	9.88	6.57
29	14.1	9.37	8.21	5.46								
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	16.4		10.9		24.1		16.0		19.4		12.9	
$t_y \times 10^3$ (kips)$^{-1}$	1.83		1.22		1.99		1.33		2.06		1.37	
$t_r \times 10^3$ (kips)$^{-1}$	2.25		1.50		2.45		1.63		2.53		1.69	
r_x/r_y	4.82				6.18				4.86			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W21

Shape	W21× 50[c]				48[c,f]				44[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	2.54	1.69	3.24	2.15	2.70	1.80	3.36	2.23	2.98	1.98	3.73	2.48
6	3.01	2.00	3.46	2.30	2.99	1.99	3.36	2.23	3.54	2.36	4.03	2.68
7	3.21	2.14	3.63	2.41	3.10	2.06	3.47	2.31	3.79	2.52	4.24	2.82
8	3.47	2.31	3.82	2.54	3.24	2.16	3.61	2.40	4.10	2.73	4.48	2.98
9	3.81	2.53	4.03	2.68	3.42	2.27	3.76	2.50	4.51	3.00	4.75	3.16
10	4.24	2.82	4.26	2.84	3.62	2.41	3.92	2.61	5.04	3.35	5.05	3.36
11	4.83	3.21	4.53	3.01	3.88	2.58	4.10	2.73	5.74	3.82	5.39	3.59
12	5.57	3.70	4.83	3.21	4.18	2.78	4.30	2.86	6.69	4.45	5.78	3.85
13	6.51	4.33	5.17	3.44	4.55	3.03	4.51	3.00	7.86	5.23	6.24	4.15
14	7.55	5.03	5.69	3.79	5.01	3.34	4.74	3.16	9.11	6.06	7.10	4.72
15	8.67	5.77	6.38	4.24	5.58	3.72	5.00	3.33	10.5	6.96	7.98	5.31
16	9.87	6.56	7.08	4.71	6.30	4.19	5.30	3.52	11.9	7.92	8.89	5.92
17	11.1	7.41	7.80	5.19	7.11	4.73	5.74	3.82	13.4	8.94	9.82	6.53
18	12.5	8.31	8.54	5.68	7.97	5.30	6.34	4.22	15.1	10.0	10.8	7.17
19	13.9	9.26	9.28	6.17	8.88	5.91	6.96	4.63	16.8	11.2	11.7	7.81
20	15.4	10.3	10.0	6.67	9.84	6.55	7.59	5.05	18.6	12.4	12.7	8.46
21	17.0	11.3	10.8	7.17	10.9	7.22	8.24	5.48	20.5	13.6	13.7	9.12
22					11.9	7.92	8.90	5.92				
23					13.0	8.66	9.57	6.37				
24					14.2	9.43	10.3	6.82				
26					15.4	10.2	10.9	7.28				
27					16.6	11.1	11.6	7.74				
28					17.9	11.9	12.3	8.21				
29												

Other Constants and Properties

	50[c] ASD	50[c] LRFD	48[c,f] ASD	48[c,f] LRFD	44[c] ASD	44[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	29.2	19.4	24.2	16.1	35.0	23.3
$t_y \times 10^3$ (kips)$^{-1}$	2.27	1.51	2.36	1.57	2.57	1.71
$t_r \times 10^3$ (kips)$^{-1}$	2.79	1.86	2.90	1.94	3.16	2.11
r_x/r_y	6.29		4.96		6.40	

[c] Shape is slender for compression with F_y = 50 ksi.

[f] Shape does not meet compact limit for flexure with F_y = 50 ksi.

Note: Heavy line indicates *Kl*/*r* equal to or greater than 200.

W18

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W18×											
	311[h]				283[h]				258[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.365	0.243	0.473	0.314	0.401	0.267	0.527	0.351	0.440	0.293	0.583	0.388
6	0.381	0.253	0.473	0.314	0.420	0.279	0.527	0.351	0.461	0.307	0.583	0.388
7	0.387	0.257	0.473	0.314	0.426	0.284	0.527	0.351	0.469	0.312	0.583	0.388
8	0.394	0.262	0.473	0.314	0.434	0.289	0.527	0.351	0.478	0.318	0.583	0.388
9	0.402	0.268	0.473	0.314	0.444	0.295	0.527	0.351	0.488	0.325	0.583	0.388
10	0.412	0.274	0.473	0.314	0.454	0.302	0.527	0.351	0.500	0.333	0.583	0.388
11	0.422	0.281	0.474	0.315	0.466	0.310	0.530	0.352	0.513	0.342	0.587	0.390
12	0.434	0.289	0.477	0.317	0.480	0.319	0.533	0.355	0.529	0.352	0.591	0.393
13	0.447	0.298	0.480	0.319	0.495	0.329	0.537	0.357	0.546	0.363	0.595	0.396
14	0.462	0.308	0.483	0.321	0.512	0.341	0.540	0.359	0.565	0.376	0.600	0.399
15	0.479	0.319	0.486	0.323	0.531	0.353	0.544	0.362	0.586	0.390	0.604	0.402
16	0.497	0.331	0.489	0.325	0.552	0.367	0.547	0.364	0.609	0.405	0.609	0.405
17	0.517	0.344	0.492	0.327	0.575	0.382	0.551	0.367	0.635	0.423	0.613	0.408
18	0.540	0.359	0.495	0.329	0.600	0.399	0.555	0.369	0.664	0.442	0.618	0.411
19	0.564	0.375	0.498	0.331	0.628	0.418	0.559	0.372	0.696	0.463	0.623	0.414
20	0.592	0.394	0.501	0.333	0.660	0.439	0.563	0.374	0.732	0.487	0.627	0.417
22	0.655	0.436	0.507	0.338	0.732	0.487	0.571	0.380	0.814	0.541	0.637	0.424
24	0.732	0.487	0.514	0.342	0.821	0.546	0.579	0.385	0.915	0.609	0.647	0.431
26	0.826	0.550	0.521	0.346	0.930	0.619	0.587	0.391	1.04	0.691	0.658	0.438
28	0.942	0.627	0.528	0.351	1.07	0.709	0.596	0.397	1.19	0.794	0.669	0.445
30	1.08	0.720	0.535	0.356	1.22	0.814	0.605	0.402	1.37	0.912	0.680	0.452
32	1.23	0.819	0.542	0.361	1.39	0.926	0.614	0.409	1.56	1.04	0.692	0.460
34	1.39	0.924	0.550	0.366	1.57	1.05	0.624	0.415	1.76	1.17	0.704	0.468
36	1.56	1.04	0.557	0.371	1.76	1.17	0.633	0.421	1.97	1.31	0.716	0.476
38	1.74	1.15	0.565	0.376	1.96	1.31	0.644	0.428	2.20	1.46	0.729	0.485
40	1.92	1.28	0.573	0.381	2.17	1.45	0.654	0.435	2.44	1.62	0.742	0.494
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.72		1.15		1.93		1.28		2.15		1.43	
$t_y \times 10^3$ (kips)$^{-1}$	0.365		0.243		0.401		0.267		0.440		0.293	
$t_r \times 10^3$ (kips)$^{-1}$	0.449		0.299		0.494		0.329		0.542		0.361	
r_x/r_y	2.96				2.96				2.96			

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W18

Shape	W18×											
	234[h]				211				192			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.485	0.323	0.649	0.432	0.537	0.358	0.727	0.484	0.592	0.394	0.806	0.536
6	0.508	0.338	0.649	0.432	0.564	0.375	0.727	0.484	0.622	0.414	0.806	0.536
7	0.517	0.344	0.649	0.432	0.574	0.382	0.727	0.484	0.633	0.421	0.806	0.536
8	0.527	0.351	0.649	0.432	0.585	0.389	0.727	0.484	0.646	0.430	0.806	0.536
9	0.539	0.359	0.649	0.432	0.598	0.398	0.727	0.484	0.661	0.440	0.806	0.536
10	0.552	0.368	0.649	0.432	0.614	0.408	0.727	0.484	0.678	0.451	0.807	0.537
11	0.568	0.378	0.654	0.435	0.631	0.420	0.734	0.488	0.697	0.464	0.815	0.542
12	0.585	0.389	0.659	0.438	0.650	0.433	0.740	0.493	0.719	0.479	0.823	0.548
13	0.604	0.402	0.664	0.442	0.672	0.447	0.747	0.497	0.744	0.495	0.831	0.553
14	0.626	0.416	0.670	0.446	0.697	0.464	0.754	0.502	0.772	0.514	0.840	0.559
15	0.650	0.432	0.675	0.449	0.724	0.482	0.761	0.506	0.803	0.534	0.848	0.564
16	0.676	0.450	0.681	0.453	0.754	0.502	0.768	0.511	0.837	0.557	0.857	0.570
17	0.706	0.470	0.686	0.457	0.788	0.524	0.775	0.516	0.875	0.582	0.866	0.576
18	0.738	0.491	0.692	0.461	0.825	0.549	0.782	0.520	0.918	0.611	0.875	0.582
19	0.775	0.515	0.698	0.465	0.867	0.577	0.790	0.525	0.965	0.642	0.884	0.588
20	0.815	0.542	0.704	0.468	0.913	0.607	0.797	0.530	1.02	0.677	0.894	0.595
22	0.909	0.605	0.716	0.477	1.02	0.679	0.813	0.541	1.14	0.758	0.913	0.608
24	1.02	0.681	0.729	0.485	1.15	0.767	0.829	0.552	1.29	0.859	0.934	0.621
26	1.17	0.775	0.742	0.494	1.32	0.875	0.846	0.563	1.48	0.983	0.955	0.635
28	1.34	0.894	0.756	0.503	1.52	1.01	0.864	0.575	1.71	1.14	0.977	0.650
30	1.54	1.03	0.770	0.512	1.74	1.16	0.882	0.587	1.96	1.31	1.00	0.666
32	1.75	1.17	0.785	0.522	1.99	1.32	0.901	0.600	2.23	1.49	1.03	0.682
34	1.98	1.32	0.800	0.532	2.24	1.49	0.921	0.613	2.52	1.68	1.05	0.699
36	2.22	1.48	0.816	0.543	2.51	1.67	0.942	0.627	2.83	1.88	1.08	0.718
38	2.47	1.65	0.832	0.554	2.80	1.86	0.964	0.641	3.15	2.10	1.11	0.737
40	2.74	1.82	0.850	0.565	3.10	2.06	0.987	0.657	3.49	2.32	1.14	0.757

Other Constants and Properties

	234[h] ASD	234[h] LRFD	211 ASD	211 LRFD	192 ASD	192 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.39	1.59	2.70	1.80	2.99	1.99
$t_y \times 10^3$ (kips)$^{-1}$	0.485	0.323	0.537	0.358	0.591	0.394
$t_r \times 10^3$ (kips)$^{-1}$	0.596	0.397	0.660	0.440	0.728	0.485
r_x/r_y	2.96		2.96		2.97	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W18

F_y = 50 ksi

Shape	W18×											
	175				158				143			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.651	0.433	0.895	0.596	0.721	0.480	1.00	0.666	0.794	0.528	1.11	0.736
6	0.684	0.455	0.895	0.596	0.758	0.505	1.00	0.666	0.836	0.556	1.11	0.736
7	0.696	0.463	0.895	0.596	0.772	0.514	1.00	0.666	0.851	0.567	1.11	0.736
8	0.711	0.473	0.895	0.596	0.789	0.525	1.00	0.666	0.870	0.579	1.11	0.736
9	0.728	0.484	0.895	0.596	0.808	0.537	1.00	0.666	0.891	0.593	1.11	0.736
10	0.747	0.497	0.898	0.597	0.830	0.552	1.00	0.668	0.916	0.609	1.11	0.740
11	0.769	0.512	0.907	0.604	0.854	0.568	1.02	0.676	0.943	0.628	1.13	0.750
12	0.794	0.528	0.917	0.610	0.882	0.587	1.03	0.685	0.975	0.649	1.14	0.760
13	0.822	0.547	0.927	0.617	0.914	0.608	1.04	0.693	1.01	0.672	1.16	0.770
14	0.853	0.568	0.938	0.624	0.949	0.631	1.05	0.702	1.05	0.698	1.17	0.780
15	0.888	0.591	0.948	0.631	0.989	0.658	1.07	0.710	1.09	0.728	1.19	0.791
16	0.927	0.617	0.959	0.638	1.03	0.687	1.08	0.719	1.14	0.761	1.21	0.802
17	0.970	0.646	0.970	0.646	1.08	0.719	1.10	0.729	1.20	0.797	1.22	0.814
18	1.02	0.678	0.982	0.653	1.14	0.756	1.11	0.738	1.26	0.838	1.24	0.825
19	1.07	0.713	0.993	0.661	1.20	0.796	1.12	0.748	1.33	0.883	1.26	0.838
20	1.13	0.753	1.01	0.669	1.26	0.841	1.14	0.758	1.40	0.934	1.28	0.850
22	1.27	0.845	1.03	0.685	1.42	0.946	1.17	0.779	1.58	1.05	1.32	0.876
24	1.44	0.960	1.06	0.702	1.62	1.08	1.20	0.801	1.80	1.20	1.36	0.904
26	1.66	1.10	1.08	0.721	1.86	1.24	1.24	0.824	2.08	1.38	1.40	0.933
28	1.92	1.28	1.11	0.740	2.16	1.44	1.28	0.849	2.41	1.61	1.45	0.965
30	2.21	1.47	1.14	0.760	2.48	1.65	1.32	0.875	2.77	1.84	1.50	0.999
32	2.51	1.67	1.17	0.781	2.82	1.88	1.36	0.903	3.15	2.10	1.56	1.04
34	2.83	1.88	1.21	0.804	3.18	2.12	1.40	0.933	3.56	2.37	1.61	1.07
36	3.18	2.11	1.24	0.827	3.57	2.38	1.45	0.965	3.99	2.65	1.68	1.12
38	3.54	2.35	1.28	0.853	3.98	2.65	1.50	0.999	4.45	2.96	1.75	1.16
40	3.92	2.61	1.32	0.880	4.41	2.93	1.56	1.04	4.93	3.28	1.83	1.21

Row labels: Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending

Other Constants and Properties

	175 ASD	175 LRFD	158 ASD	158 LRFD	143 ASD	143 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	3.36	2.24	3.76	2.50	4.17	2.78
$t_y \times 10^3$ (kips)$^{-1}$	0.650	0.433	0.720	0.480	0.792	0.528
$t_r \times 10^3$ (kips)$^{-1}$	0.800	0.533	0.885	0.590	0.975	0.650
r_x/r_y	2.97		2.96		2.97	

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W18

Shape	W18× 130				W18× 119				W18× 106			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.874	0.582	1.23	0.817	0.953	0.634	1.36	0.905	1.07	0.714	1.55	1.03
6	0.921	0.613	1.23	0.817	1.00	0.668	1.36	0.905	1.13	0.753	1.55	1.03
7	0.938	0.624	1.23	0.817	1.02	0.681	1.36	0.905	1.15	0.768	1.55	1.03
8	0.959	0.638	1.23	0.817	1.05	0.696	1.36	0.905	1.18	0.785	1.55	1.03
9	0.983	0.654	1.23	0.817	1.07	0.713	1.36	0.905	1.21	0.805	1.55	1.03
10	1.01	0.672	1.24	0.823	1.10	0.733	1.37	0.912	1.24	0.828	1.56	1.04
11	1.04	0.693	1.25	0.835	1.14	0.756	1.39	0.926	1.28	0.855	1.59	1.06
12	1.08	0.716	1.27	0.847	1.17	0.782	1.41	0.941	1.33	0.884	1.62	1.08
13	1.12	0.742	1.29	0.859	1.22	0.811	1.44	0.956	1.38	0.918	1.65	1.10
14	1.16	0.772	1.31	0.872	1.27	0.843	1.46	0.972	1.44	0.955	1.68	1.12
15	1.21	0.805	1.33	0.885	1.32	0.879	1.49	0.989	1.50	0.998	1.71	1.14
16	1.27	0.842	1.35	0.899	1.38	0.920	1.51	1.01	1.57	1.04	1.74	1.16
17	1.33	0.883	1.37	0.913	1.45	0.965	1.54	1.02	1.65	1.10	1.78	1.18
18	1.40	0.929	1.39	0.928	1.53	1.02	1.57	1.04	1.74	1.16	1.81	1.21
19	1.47	0.980	1.42	0.943	1.61	1.07	1.59	1.06	1.84	1.22	1.85	1.23
20	1.56	1.04	1.44	0.958	1.71	1.13	1.62	1.08	1.95	1.29	1.89	1.26
22	1.76	1.17	1.49	0.991	1.93	1.28	1.68	1.12	2.20	1.47	1.97	1.31
24	2.01	1.34	1.54	1.03	2.20	1.47	1.75	1.17	2.53	1.68	2.06	1.37
26	2.32	1.55	1.60	1.06	2.55	1.70	1.82	1.21	2.94	1.96	2.15	1.43
28	2.70	1.79	1.66	1.10	2.96	1.97	1.90	1.27	3.41	2.27	2.26	1.50
30	3.10	2.06	1.72	1.15	3.40	2.26	1.99	1.32	3.91	2.60	2.38	1.58
32	3.52	2.34	1.79	1.19	3.87	2.57	2.08	1.39	4.45	2.96	2.52	1.67
34	3.98	2.65	1.87	1.25	4.37	2.90	2.19	1.45	5.03	3.34	2.72	1.81
36	4.46	2.97	1.96	1.30	4.89	3.26	2.34	1.56	5.64	3.75	2.92	1.94
38	4.97	3.30	2.07	1.38	5.45	3.63	2.49	1.66	6.28	4.18	3.12	2.08
40	5.50	3.66	2.20	1.46	6.04	4.02	2.65	1.76	6.96	4.63	3.32	2.21

Other Constants and Properties

	130 ASD	130 LRFD	119 ASD	119 LRFD	106 ASD	106 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	4.64	3.09	5.16	3.43	5.89	3.92
$t_y \times 10^3$ (kips)$^{-1}$	0.873	0.582	0.951	0.634	1.07	0.714
$t_r \times 10^3$ (kips)$^{-1}$	1.07	0.716	1.17	0.780	1.32	0.878
r_x/r_y	2.97		2.94		2.95	

W18

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W18× 97				W18× 86				W18× 76[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.17	0.778	1.69	1.12	1.32	0.878	1.92	1.27	1.52	1.01	2.19	1.45
6	1.23	0.822	1.69	1.12	1.39	0.928	1.92	1.27	1.59	1.06	2.19	1.45
7	1.26	0.838	1.69	1.12	1.42	0.946	1.92	1.27	1.62	1.08	2.19	1.45
8	1.29	0.857	1.69	1.12	1.45	0.968	1.92	1.27	1.66	1.10	2.19	1.45
9	1.32	0.879	1.69	1.12	1.49	0.993	1.92	1.27	1.70	1.13	2.19	1.45
10	1.36	0.904	1.71	1.14	1.54	1.02	1.94	1.29	1.75	1.16	2.22	1.48
11	1.40	0.933	1.74	1.16	1.59	1.06	1.98	1.32	1.81	1.20	2.27	1.51
12	1.45	0.966	1.77	1.18	1.64	1.09	2.02	1.35	1.87	1.24	2.32	1.54
13	1.51	1.00	1.81	1.20	1.71	1.14	2.06	1.37	1.94	1.29	2.37	1.58
14	1.57	1.04	1.84	1.23	1.78	1.18	2.11	1.40	2.03	1.35	2.43	1.62
15	1.64	1.09	1.88	1.25	1.86	1.24	2.16	1.43	2.12	1.41	2.49	1.65
16	1.72	1.14	1.92	1.28	1.95	1.30	2.20	1.47	2.22	1.48	2.55	1.69
17	1.80	1.20	1.96	1.30	2.05	1.36	2.25	1.50	2.34	1.56	2.61	1.74
18	1.90	1.27	2.00	1.33	2.16	1.44	2.31	1.53	2.47	1.64	2.68	1.78
19	2.01	1.34	2.04	1.36	2.29	1.52	2.36	1.57	2.62	1.74	2.75	1.83
20	2.13	1.42	2.09	1.39	2.43	1.61	2.42	1.61	2.78	1.85	2.82	1.88
22	2.42	1.61	2.18	1.45	2.76	1.83	2.55	1.69	3.16	2.10	2.98	1.98
24	2.77	1.85	2.29	1.52	3.17	2.11	2.68	1.79	3.65	2.43	3.16	2.10
26	3.23	2.15	2.41	1.60	3.70	2.46	2.84	1.89	4.26	2.84	3.36	2.24
28	3.75	2.49	2.54	1.69	4.29	2.86	3.01	2.01	4.94	3.29	3.67	2.44
30	4.30	2.86	2.68	1.78	4.93	3.28	3.29	2.19	5.67	3.78	4.06	2.70
32	4.89	3.26	2.91	1.94	5.60	3.73	3.60	2.39	6.46	4.30	4.45	2.96
34	5.52	3.68	3.15	2.10	6.33	4.21	3.90	2.60	7.29	4.85	4.85	3.22
36	6.19	4.12	3.39	2.25	7.09	4.72	4.21	2.80	8.17	5.44	5.24	3.49
38	6.90	4.59	3.63	2.41	7.90	5.26	4.52	3.01	9.10	6.06	5.64	3.75
40	7.65	5.09	3.87	2.57	8.76	5.83	4.83	3.21	10.1	6.71	6.04	4.02

Other Constants and Properties

	W18×97 ASD	W18×97 LRFD	W18×86 ASD	W18×86 LRFD	W18×76[c] ASD	W18×76[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	6.44	4.29	7.36	4.90	8.44	5.62
$t_y \times 10^3$ (kips)$^{-1}$	1.17	0.778	1.32	0.878	1.50	1.00
$t_r \times 10^3$ (kips)$^{-1}$	1.44	0.958	1.62	1.08	1.84	1.23
r_x/r_y	2.95		2.95		2.96	

[c] Shape is slender for compression with F_y = 50 ksi.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W18

Shape		W18×											
		71				65				60[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.60	1.07	2.44	1.62	1.75	1.16	2.68	1.78	1.94	1.29	2.90	1.93
	6	1.83	1.22	2.44	1.62	2.00	1.33	2.68	1.78	2.17	1.45	2.90	1.93
	7	1.92	1.27	2.51	1.67	2.09	1.39	2.76	1.84	2.27	1.51	3.00	1.99
	8	2.02	1.35	2.59	1.72	2.21	1.47	2.85	1.90	2.40	1.60	3.10	2.06
	9	2.15	1.43	2.67	1.78	2.36	1.57	2.95	1.96	2.56	1.70	3.21	2.13
	10	2.31	1.53	2.76	1.83	2.53	1.68	3.05	2.03	2.75	1.83	3.32	2.21
	11	2.49	1.66	2.85	1.90	2.73	1.82	3.15	2.10	2.97	1.98	3.44	2.29
	12	2.71	1.80	2.95	1.96	2.97	1.98	3.27	2.17	3.24	2.16	3.58	2.38
	13	2.97	1.97	3.05	2.03	3.26	2.17	3.39	2.26	3.56	2.37	3.72	2.48
	14	3.27	2.18	3.17	2.11	3.60	2.40	3.52	2.35	3.94	2.62	3.88	2.58
	15	3.64	2.42	3.29	2.19	4.01	2.67	3.67	2.44	4.38	2.92	4.05	2.69
	16	4.07	2.71	3.42	2.28	4.49	2.99	3.83	2.55	4.93	3.28	4.24	2.82
	17	4.60	3.06	3.57	2.37	5.07	3.38	4.00	2.66	5.56	3.70	4.44	2.95
	18	5.15	3.43	3.72	2.48	5.69	3.78	4.18	2.78	6.24	4.15	4.67	3.10
	19	5.74	3.82	3.90	2.59	6.34	4.22	4.41	2.94	6.95	4.62	5.03	3.35
	20	6.36	4.23	4.12	2.74	7.02	4.67	4.75	3.16	7.70	5.12	5.42	3.60
	22	7.70	5.12	4.69	3.12	8.50	5.65	5.42	3.60	9.32	6.20	6.20	4.13
	24	9.16	6.09	5.26	3.50	10.1	6.73	6.09	4.05	11.1	7.38	6.99	4.65
	26	10.7	7.15	5.82	3.87	11.9	7.90	6.76	4.50	13.0	8.66	7.78	5.18
	28	12.5	8.29	6.39	4.25	13.8	9.16	7.43	4.95	15.1	10.0	8.57	5.70

Other Constants and Properties

	71		65		60[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	14.4	9.60	15.8	10.5	17.3	11.5
$t_y \times 10^3$ (kips)$^{-1}$	1.60	1.07	1.75	1.16	1.89	1.26
$t_r \times 10^3$ (kips)$^{-1}$	1.97	1.31	2.15	1.43	2.33	1.55
r_x/r_y	4.41		4.43		4.45	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates *Kl/r* equal to or greater than 200.

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

W18

F_y = 50 ksi

Shape		W18×											
		55[c]				50[c]				46[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	2.14	1.43	3.18	2.12	2.43	1.62	3.53	2.35	2.64	1.76	3.93	2.61
	6	2.41	1.60	3.19	2.12	2.72	1.81	3.55	2.36	3.18	2.12	4.19	2.79
	7	2.51	1.67	3.30	2.20	2.84	1.89	3.68	2.45	3.41	2.27	4.39	2.92
	8	2.64	1.76	3.42	2.27	2.99	1.99	3.81	2.54	3.71	2.47	4.61	3.07
	9	2.80	1.86	3.55	2.36	3.16	2.11	3.96	2.64	4.12	2.74	4.85	3.23
	10	3.01	2.00	3.68	2.45	3.38	2.25	4.12	2.74	4.65	3.09	5.12	3.41
	11	3.26	2.17	3.83	2.55	3.64	2.42	4.29	2.86	5.31	3.53	5.43	3.61
	12	3.55	2.36	3.99	2.65	3.97	2.64	4.48	2.98	6.14	4.08	5.77	3.84
	13	3.90	2.60	4.16	2.77	4.38	2.91	4.69	3.12	7.19	4.78	6.16	4.10
	14	4.32	2.88	4.35	2.89	4.86	3.23	4.91	3.27	8.34	5.55	6.70	4.46
	15	4.82	3.21	4.55	3.03	5.44	3.62	5.16	3.43	9.57	6.37	7.45	4.96
	16	5.43	3.61	4.78	3.18	6.14	4.09	5.43	3.62	10.9	7.24	8.21	5.46
	17	6.13	4.08	5.03	3.35	6.93	4.61	5.76	3.83	12.3	8.18	8.98	5.98
	18	6.87	4.57	5.39	3.59	7.77	5.17	6.30	4.19	13.8	9.17	9.76	6.49
	19	7.66	5.09	5.86	3.90	8.66	5.76	6.86	4.56	15.4	10.2	10.5	7.01
	20	8.48	5.64	6.32	4.21	9.60	6.39	7.42	4.94	17.0	11.3	11.3	7.53
	21	9.35	6.22	6.79	4.52	10.6	7.04	7.99	5.31	18.8	12.5	12.1	8.05
	22	10.3	6.83	7.26	4.83	11.6	7.73	8.56	5.69				
	23	11.2	7.46	7.73	5.15	12.7	8.45	9.13	6.08				
	24	12.2	8.13	8.21	5.46	13.8	9.20	9.71	6.46				
	25	13.3	8.82	8.69	5.78	15.0	10.0	10.3	6.85				
	26	14.3	9.54	9.16	6.10	16.2	10.8	10.9	7.23				
	27	15.5	10.3	9.64	6.41	17.5	11.6	11.5	7.62				

Other Constants and Properties

	55 ASD	55 LRFD	50 ASD	50 LRFD	46 ASD	46 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	19.3	12.8	21.5	14.3	30.5	20.3
$t_y \times 10^3$ (kips)$^{-1}$	2.06	1.37	2.27	1.52	2.46	1.64
$t_r \times 10^3$ (kips)$^{-1}$	2.53	1.69	2.80	1.87	3.03	2.02
r_x/r_y	4.44		4.47		5.62	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W18

Shape		W18×							
		40[c]				35[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	3.16	2.10	4.54	3.02	3.71	2.47	5.36	3.56
	6	3.80	2.53	4.88	3.25	4.49	2.99	5.84	3.88
	7	4.08	2.71	5.13	3.41	4.83	3.21	6.16	4.10
	8	4.43	2.95	5.40	3.60	5.28	3.51	6.53	4.34
	9	4.88	3.25	5.71	3.80	5.86	3.90	6.94	4.62
	10	5.47	3.64	6.06	4.03	6.62	4.40	7.41	4.93
	11	6.26	4.16	6.45	4.29	7.64	5.08	7.94	5.28
	12	7.27	4.84	6.89	4.58	9.00	5.99	8.56	5.69
	13	8.53	5.68	7.39	4.92	10.6	7.03	9.59	6.38
	14	9.90	6.59	8.32	5.54	12.3	8.15	10.9	7.23
	15	11.4	7.56	9.29	6.18	14.1	9.36	12.2	8.11
	16	12.9	8.60	10.3	6.84	16.0	10.7	13.5	9.01
	17	14.6	9.71	11.3	7.51	18.1	12.0	14.9	9.92
	18	16.4	10.9	12.3	8.19	20.3	13.5	16.3	10.9
	19	18.2	12.1	13.3	8.87	22.6	15.0	17.7	11.8
	20	20.2	13.4	14.4	9.56	25.0	16.6	19.2	12.7
	21	22.3	14.8	15.4	10.2				

Other Constants and Properties

	40[c] ASD	40[c] LRFD	35[c] ASD	35[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	35.6	23.7	44.2	29.4
$t_y \times 10^3$ (kips)$^{-1}$	2.83	1.89	3.24	2.16
$t_r \times 10^3$ (kips)$^{-1}$	3.49	2.33	3.99	2.66
r_x/r_y	5.68		5.77	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W16

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W16×											
	100				89				77			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	1.13	0.755	1.80	1.20	1.28	0.850	2.04	1.35	1.48	0.983	2.38	1.58
6	1.20	0.801	1.80	1.20	1.36	0.903	2.04	1.35	1.57	1.05	2.38	1.58
7	1.23	0.819	1.80	1.20	1.39	0.923	2.04	1.35	1.61	1.07	2.38	1.58
8	1.26	0.840	1.80	1.20	1.42	0.947	2.04	1.35	1.65	1.10	2.38	1.58
9	1.30	0.864	1.80	1.20	1.47	0.975	2.04	1.36	1.70	1.13	2.39	1.59
10	1.34	0.892	1.83	1.22	1.51	1.01	2.08	1.38	1.76	1.17	2.44	1.62
11	1.39	0.924	1.86	1.24	1.57	1.04	2.12	1.41	1.82	1.21	2.49	1.65
12	1.44	0.960	1.89	1.26	1.63	1.09	2.16	1.44	1.89	1.26	2.54	1.69
13	1.50	1.00	1.93	1.28	1.70	1.13	2.20	1.46	1.98	1.32	2.59	1.72
14	1.57	1.05	1.96	1.30	1.78	1.19	2.24	1.49	2.07	1.38	2.65	1.76
15	1.65	1.10	1.99	1.33	1.87	1.25	2.29	1.52	2.18	1.45	2.71	1.80
16	1.74	1.16	2.03	1.35	1.97	1.31	2.33	1.55	2.30	1.53	2.77	1.84
17	1.84	1.22	2.07	1.38	2.09	1.39	2.38	1.59	2.43	1.62	2.84	1.89
18	1.95	1.30	2.11	1.40	2.21	1.47	2.43	1.62	2.58	1.72	2.90	1.93
19	2.07	1.38	2.15	1.43	2.36	1.57	2.49	1.65	2.75	1.83	2.97	1.98
20	2.21	1.47	2.19	1.46	2.52	1.68	2.54	1.69	2.95	1.96	3.05	2.03
22	2.55	1.69	2.28	1.52	2.91	1.93	2.66	1.77	3.41	2.27	3.21	2.14
24	2.97	1.98	2.37	1.58	3.40	2.26	2.79	1.85	4.00	2.66	3.39	2.26
26	3.49	2.32	2.48	1.65	3.99	2.66	2.93	1.95	4.69	3.12	3.59	2.39
28	4.05	2.69	2.59	1.72	4.63	3.08	3.09	2.05	5.44	3.62	3.83	2.55
30	4.65	3.09	2.72	1.81	5.32	3.54	3.26	2.17	6.25	4.16	4.20	2.80
32	5.29	3.52	2.86	1.90	6.05	4.03	3.53	2.35	7.11	4.73	4.58	3.04
34	5.97	3.97	3.05	2.03	6.83	4.54	3.81	2.53	8.03	5.34	4.95	3.29
36	6.69	4.45	3.26	2.17	7.66	5.09	4.08	2.71	9.00	5.99	5.31	3.54
38	7.46	4.96	3.47	2.31	8.53	5.68	4.35	2.90	10.0	6.67	5.68	3.78
40	8.26	5.50	3.68	2.45	9.45	6.29	4.62	3.08	11.1	7.39	6.05	4.02

Other Constants and Properties

	100 ASD	100 LRFD	89 ASD	89 LRFD	77 ASD	77 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	6.49	4.32	7.41	4.93	8.67	5.77
$t_y \times 10^3$ (kips)$^{-1}$	1.13	0.755	1.28	0.850	1.47	0.983
$t_r \times 10^3$ (kips)$^{-1}$	1.39	0.929	1.57	1.05	1.82	1.21
r_x/r_y	2.83		2.83		2.83	

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W16

Shape	W16×											
	67[c]				57				50[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	1.70	1.13	2.74	1.82	1.99	1.33	3.39	2.26	2.29	1.53	3.87	2.58
6	1.81	1.20	2.74	1.82	2.31	1.54	3.43	2.28	2.63	1.75	3.92	2.61
7	1.85	1.23	2.74	1.82	2.44	1.62	3.54	2.35	2.78	1.85	4.06	2.70
8	1.90	1.26	2.74	1.82	2.59	1.72	3.65	2.43	2.96	1.97	4.20	2.80
9	1.95	1.30	2.76	1.84	2.78	1.85	3.78	2.51	3.17	2.11	4.36	2.90
10	2.02	1.34	2.82	1.88	3.00	2.00	3.91	2.60	3.43	2.29	4.53	3.01
11	2.10	1.39	2.88	1.92	3.28	2.18	4.05	2.70	3.75	2.49	4.71	3.13
12	2.18	1.45	2.95	1.96	3.60	2.40	4.21	2.80	4.13	2.75	4.91	3.27
13	2.28	1.52	3.02	2.01	3.99	2.66	4.37	2.91	4.58	3.05	5.12	3.41
14	2.39	1.59	3.09	2.06	4.46	2.97	4.55	3.03	5.12	3.41	5.36	3.56
15	2.51	1.67	3.17	2.11	5.02	3.34	4.75	3.16	5.78	3.85	5.61	3.74
16	2.65	1.76	3.25	2.16	5.71	3.80	4.96	3.30	6.58	4.38	5.90	3.92
17	2.81	1.87	3.33	2.22	6.45	4.29	5.19	3.45	7.43	4.94	6.21	4.13
18	2.98	1.98	3.42	2.27	7.23	4.81	5.44	3.62	8.33	5.54	6.71	4.47
19	3.18	2.12	3.51	2.34	8.06	5.36	5.82	3.87	9.28	6.17	7.25	4.83
20	3.40	2.27	3.61	2.40	8.93	5.94	6.24	4.15	10.3	6.84	7.80	5.19
22	3.94	2.62	3.82	2.54	10.8	7.19	7.08	4.71	12.4	8.28	8.89	5.92
24	4.63	3.08	4.07	2.71	12.9	8.55	7.92	5.27	14.8	9.85	9.99	6.65
26	5.44	3.62	4.34	2.89	15.1	10.0	8.76	5.83	17.4	11.6	11.1	7.37
28	6.31	4.20	4.82	3.21								
30	7.24	4.82	5.31	3.53								
32	8.24	5.48	5.80	3.86								
34	9.30	6.19	6.29	4.18								
36	10.4	6.94	6.77	4.51								
38	11.6	7.73	7.26	4.83								
40	12.9	8.57	7.75	5.15								
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	10.0		6.68		18.9		12.5		21.9		14.5	
$t_y \times 10^3$ (kips)$^{-1}$	1.69		1.13		1.99		1.33		2.26		1.51	
$t_r \times 10^3$ (kips)$^{-1}$	2.09		1.39		2.45		1.63		2.78		1.86	
r_x/r_y	2.83				4.20				4.20			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W16

F_y = 50 ksi

Shape	W16×											
	45[c]				40[c]				36[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	2.61	1.74	4.33	2.88	3.04	2.02	4.88	3.25	3.44	2.29	5.57	3.70
6	2.98	1.98	4.40	2.93	3.45	2.29	4.96	3.30	3.92	2.61	5.71	3.80
7	3.13	2.08	4.56	3.03	3.62	2.41	5.16	3.43	4.12	2.74	5.94	3.95
8	3.31	2.21	4.73	3.15	3.82	2.54	5.36	3.57	4.36	2.90	6.20	4.12
9	3.56	2.37	4.92	3.27	4.07	2.71	5.59	3.72	4.67	3.10	6.48	4.31
10	3.86	2.57	5.12	3.41	4.38	2.92	5.83	3.88	5.04	3.35	6.79	4.51
11	4.22	2.81	5.35	3.56	4.76	3.17	6.10	4.06	5.50	3.66	7.12	4.74
12	4.66	3.10	5.59	3.72	5.25	3.49	6.40	4.26	6.09	4.05	7.49	4.99
13	5.18	3.45	5.85	3.89	5.84	3.88	6.72	4.47	6.83	4.54	7.91	5.26
14	5.82	3.87	6.14	4.08	6.55	4.36	7.08	4.71	7.72	5.14	8.37	5.57
15	6.59	4.39	6.46	4.30	7.42	4.94	7.48	4.97	8.83	5.87	8.89	5.91
16	7.50	4.99	6.81	4.53	8.45	5.62	7.97	5.30	10.0	6.68	9.80	6.52
17	8.47	5.63	7.34	4.88	9.54	6.34	8.77	5.84	11.3	7.54	10.8	7.20
18	9.49	6.32	8.00	5.32	10.7	7.11	9.59	6.38	12.7	8.46	11.9	7.90
19	10.6	7.04	8.67	5.77	11.9	7.93	10.4	6.93	14.2	9.42	12.9	8.60
20	11.7	7.80	9.34	6.22	13.2	8.78	11.3	7.49	15.7	10.4	14.0	9.32
21	12.9	8.60	10.0	6.67	14.6	9.68	12.1	8.05	17.3	11.5	15.1	10.0
22	14.2	9.44	10.7	7.12	16.0	10.6	12.9	8.62	19.0	12.6	16.2	10.8
23	15.5	10.3	11.4	7.57	17.5	11.6	13.8	9.18	20.8	13.8	17.3	11.5
24	16.9	11.2	12.1	8.02	19.0	12.6	14.7	9.75	22.6	15.0	18.4	12.2
25	18.3	12.2	12.7	8.48	20.6	13.7	15.5	10.3	24.5	16.3	19.5	13.0
26	19.8	13.2	13.4	8.93	22.3	14.8	16.4	10.9				
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	24.6		16.3		28.1		18.7		33.0		21.9	
$t_y \times 10^3$ (kips)$^{-1}$	2.51		1.68		2.83		1.89		3.15		2.10	
$t_r \times 10^3$ (kips)$^{-1}$	3.09		2.06		3.48		2.32		3.88		2.59	
r_x/r_y	4.24				4.22				4.28			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued) Combined Axial and Bending

W Shapes

W16

Shape		W16×							
		31[c]				26[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	4.09	2.72	6.60	4.39	5.05	3.36	8.06	5.36
	6	5.08	3.38	7.28	4.84	6.33	4.21	9.06	6.03
	7	5.53	3.68	7.71	5.13	6.91	4.59	9.65	6.42
	8	6.11	4.06	8.18	5.45	7.67	5.11	10.3	6.86
	9	6.87	4.57	8.73	5.81	8.70	5.79	11.1	7.37
	10	7.90	5.25	9.35	6.22	10.1	6.71	12.0	7.97
	11	9.28	6.18	10.1	6.70	12.0	8.00	13.0	8.66
	12	11.0	7.35	11.0	7.31	14.3	9.52	15.0	10.0
	13	13.0	8.62	12.5	8.34	16.8	11.2	17.2	11.4
	14	15.0	10.0	14.1	9.40	19.5	13.0	19.4	12.9
	15	17.3	11.5	15.8	10.5	22.4	14.9	21.8	14.5
	16	19.6	13.1	17.4	11.6	25.4	16.9	24.2	16.1
	17	22.2	14.7	19.1	12.7	28.7	19.1	26.6	17.7
	18	24.8	16.5	20.8	13.8	32.2	21.4	29.1	19.3
	19	27.7	18.4	22.5	14.9				

Other Constants and Properties				
$b_y \times 10^3$ (kip-ft)$^{-1}$	50.7	33.7	65.0	43.3
$t_y \times 10^3$ (kips)$^{-1}$	3.65	2.44	4.34	2.89
$t_r \times 10^3$ (kips)$^{-1}$	4.50	3.00	5.34	3.56
r_x/r_y	5.48		5.59	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

$F_y = 50$ ksi

Shape	W14×											
	730[h]				665[h]				605[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending: 0	0.155	0.103	0.215	0.143	0.170	0.113	0.241	0.160	0.188	0.125	0.270	0.180
11	0.165	0.110	0.215	0.143	0.181	0.120	0.241	0.160	0.200	0.133	0.270	0.180
12	0.166	0.111	0.215	0.143	0.183	0.122	0.241	0.160	0.202	0.134	0.270	0.180
13	0.168	0.112	0.215	0.143	0.185	0.123	0.241	0.160	0.204	0.136	0.270	0.180
14	0.171	0.114	0.215	0.143	0.188	0.125	0.241	0.160	0.207	0.138	0.270	0.180
15	0.173	0.115	0.215	0.143	0.190	0.127	0.241	0.160	0.210	0.140	0.270	0.180
16	0.176	0.117	0.215	0.143	0.193	0.129	0.241	0.160	0.214	0.142	0.270	0.180
17	0.178	0.119	0.215	0.143	0.197	0.131	0.241	0.160	0.217	0.145	0.270	0.180
18	0.181	0.121	0.215	0.143	0.200	0.133	0.242	0.161	0.221	0.147	0.271	0.180
19	0.185	0.123	0.216	0.143	0.204	0.135	0.242	0.161	0.225	0.150	0.272	0.181
20	0.188	0.125	0.216	0.144	0.208	0.138	0.242	0.161	0.230	0.153	0.272	0.181
22	0.196	0.130	0.217	0.144	0.216	0.144	0.243	0.162	0.240	0.160	0.273	0.182
24	0.205	0.136	0.217	0.145	0.226	0.151	0.244	0.163	0.252	0.167	0.274	0.183
26	0.215	0.143	0.218	0.145	0.238	0.158	0.245	0.163	0.265	0.176	0.276	0.183
28	0.226	0.150	0.219	0.146	0.251	0.167	0.246	0.164	0.280	0.186	0.277	0.184
30	0.239	0.159	0.220	0.146	0.266	0.177	0.247	0.164	0.297	0.197	0.278	0.185
32	0.254	0.169	0.221	0.147	0.282	0.188	0.248	0.165	0.316	0.210	0.279	0.186
34	0.270	0.180	0.221	0.147	0.301	0.201	0.249	0.166	0.338	0.225	0.280	0.187
36	0.289	0.192	0.222	0.148	0.323	0.215	0.250	0.166	0.363	0.241	0.282	0.187
38	0.310	0.206	0.223	0.148	0.347	0.231	0.251	0.167	0.391	0.260	0.283	0.188
40	0.334	0.222	0.224	0.149	0.375	0.250	0.252	0.168	0.423	0.282	0.284	0.189
42	0.361	0.240	0.225	0.150	0.407	0.271	0.253	0.168	0.460	0.306	0.285	0.190
44	0.392	0.261	0.226	0.150	0.443	0.295	0.254	0.169	0.503	0.335	0.287	0.191
46	0.429	0.285	0.226	0.151	0.485	0.322	0.255	0.170	0.550	0.366	0.288	0.191
48	0.467	0.311	0.227	0.151	0.528	0.351	0.256	0.171	0.599	0.399	0.289	0.192
50	0.506	0.337	0.228	0.152	0.573	0.381	0.257	0.171	0.650	0.432	0.290	0.193

Other Constants and Properties

	730[h] ASD	730[h] LRFD	665[h] ASD	665[h] LRFD	605[h] ASD	605[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	0.437	0.290	0.488	0.325	0.546	0.364
$t_y \times 10^3$ (kips)$^{-1}$	0.155	0.103	0.170	0.113	0.188	0.125
$t_r \times 10^3$ (kips)$^{-1}$	0.191	0.127	0.210	0.140	0.231	0.154
r_x/r_y	1.74		1.73		1.71	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W14

Shape	W14× 550[h]				500[h]				455[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.206	0.137	0.302	0.201	0.227	0.151	0.339	0.226	0.249	0.166	0.381	0.253
11	0.220	0.146	0.302	0.201	0.242	0.161	0.339	0.226	0.266	0.177	0.381	0.253
12	0.222	0.148	0.302	0.201	0.245	0.163	0.339	0.226	0.270	0.179	0.381	0.253
13	0.225	0.150	0.302	0.201	0.249	0.166	0.339	0.226	0.273	0.182	0.381	0.253
14	0.228	0.152	0.302	0.201	0.252	0.168	0.339	0.226	0.278	0.185	0.381	0.253
15	0.232	0.154	0.302	0.201	0.256	0.171	0.339	0.226	0.282	0.188	0.381	0.253
16	0.236	0.157	0.302	0.201	0.261	0.173	0.340	0.226	0.287	0.191	0.381	0.254
17	0.240	0.160	0.303	0.201	0.265	0.177	0.340	0.227	0.292	0.194	0.382	0.254
18	0.244	0.162	0.303	0.202	0.270	0.180	0.341	0.227	0.298	0.198	0.383	0.255
19	0.249	0.166	0.304	0.202	0.276	0.183	0.342	0.228	0.304	0.202	0.384	0.256
20	0.254	0.169	0.305	0.203	0.282	0.187	0.343	0.228	0.310	0.207	0.385	0.256
22	0.265	0.177	0.306	0.204	0.295	0.196	0.345	0.229	0.325	0.216	0.387	0.258
24	0.279	0.185	0.308	0.205	0.309	0.206	0.346	0.230	0.342	0.227	0.389	0.259
26	0.293	0.195	0.309	0.206	0.327	0.217	0.348	0.232	0.361	0.240	0.392	0.261
28	0.310	0.207	0.310	0.207	0.346	0.230	0.350	0.233	0.383	0.255	0.394	0.262
30	0.330	0.219	0.312	0.208	0.368	0.245	0.352	0.234	0.408	0.272	0.396	0.263
32	0.352	0.234	0.313	0.209	0.394	0.262	0.353	0.235	0.437	0.291	0.398	0.265
34	0.377	0.251	0.315	0.209	0.422	0.281	0.355	0.236	0.470	0.313	0.400	0.266
36	0.406	0.270	0.316	0.210	0.455	0.303	0.357	0.238	0.508	0.338	0.403	0.268
38	0.438	0.292	0.318	0.211	0.493	0.328	0.359	0.239	0.551	0.366	0.405	0.269
40	0.475	0.316	0.319	0.213	0.536	0.357	0.361	0.240	0.600	0.399	0.407	0.271
42	0.518	0.345	0.321	0.214	0.586	0.390	0.363	0.241	0.657	0.437	0.409	0.272
44	0.568	0.378	0.322	0.215	0.643	0.428	0.365	0.243	0.721	0.480	0.412	0.274
46	0.621	0.413	0.324	0.216	0.703	0.468	0.367	0.244	0.789	0.525	0.414	0.276
48	0.676	0.450	0.326	0.217	0.765	0.509	0.369	0.245	0.859	0.571	0.417	0.277
50	0.733	0.488	0.327	0.218	0.830	0.552	0.370	0.247	0.932	0.620	0.419	0.279

Other Constants and Properties

	550[h] ASD	550[h] LRFD	500[h] ASD	500[h] LRFD	455[h] ASD	455[h] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	0.611	0.407	0.683	0.454	0.761	0.506
$t_y \times 10^3$ (kips)$^{-1}$	0.206	0.137	0.227	0.151	0.249	0.166
$t_r \times 10^3$ (kips)$^{-1}$	0.254	0.169	0.279	0.186	0.306	0.204
r_x/r_y	1.70		1.69		1.67	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W14×											
	426[h]				398[h]				370[h]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.267	0.178	0.410	0.273	0.285	0.190	0.445	0.296	0.306	0.204	0.484	0.322
11	0.286	0.190	0.410	0.273	0.306	0.203	0.445	0.296	0.329	0.219	0.484	0.322
12	0.290	0.193	0.410	0.273	0.310	0.206	0.445	0.296	0.333	0.222	0.484	0.322
13	0.294	0.195	0.410	0.273	0.314	0.209	0.445	0.296	0.338	0.225	0.484	0.322
14	0.298	0.198	0.410	0.273	0.319	0.212	0.445	0.296	0.343	0.228	0.484	0.322
15	0.303	0.202	0.410	0.273	0.324	0.216	0.445	0.296	0.349	0.232	0.484	0.322
16	0.308	0.205	0.411	0.273	0.330	0.220	0.446	0.297	0.355	0.236	0.485	0.323
17	0.314	0.209	0.412	0.274	0.336	0.224	0.447	0.298	0.362	0.241	0.487	0.324
18	0.320	0.213	0.413	0.275	0.343	0.228	0.448	0.298	0.369	0.246	0.489	0.325
19	0.327	0.218	0.414	0.276	0.350	0.233	0.450	0.299	0.377	0.251	0.490	0.326
20	0.334	0.222	0.415	0.276	0.358	0.238	0.451	0.300	0.386	0.257	0.492	0.327
22	0.350	0.233	0.418	0.278	0.376	0.250	0.454	0.302	0.405	0.270	0.495	0.329
24	0.369	0.245	0.420	0.280	0.396	0.263	0.457	0.304	0.427	0.284	0.498	0.331
26	0.390	0.259	0.423	0.281	0.419	0.279	0.460	0.306	0.453	0.301	0.502	0.334
28	0.414	0.276	0.425	0.283	0.445	0.296	0.462	0.308	0.482	0.321	0.505	0.336
30	0.442	0.294	0.428	0.285	0.475	0.316	0.465	0.310	0.515	0.343	0.508	0.338
32	0.474	0.315	0.430	0.286	0.510	0.339	0.468	0.312	0.554	0.368	0.512	0.340
34	0.510	0.339	0.433	0.288	0.550	0.366	0.471	0.313	0.597	0.397	0.515	0.343
36	0.551	0.367	0.435	0.290	0.595	0.396	0.474	0.315	0.648	0.431	0.519	0.345
38	0.599	0.399	0.438	0.291	0.647	0.431	0.477	0.317	0.705	0.469	0.522	0.347
40	0.654	0.435	0.441	0.293	0.707	0.470	0.480	0.320	0.772	0.514	0.526	0.350
42	0.718	0.478	0.443	0.295	0.778	0.517	0.483	0.322	0.850	0.566	0.530	0.352
44	0.788	0.524	0.446	0.297	0.853	0.568	0.487	0.324	0.933	0.621	0.533	0.355
46	0.861	0.573	0.449	0.299	0.933	0.621	0.490	0.326	1.02	0.679	0.537	0.357
48	0.938	0.624	0.451	0.300	1.02	0.676	0.493	0.328	1.11	0.739	0.541	0.360
50	1.02	0.677	0.454	0.302	1.10	0.733	0.496	0.330	1.21	0.802	0.545	0.362
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	0.821		0.546		0.886		0.590		0.963		0.641	
$t_y \times 10^3$ (kips)$^{-1}$	0.267		0.178		0.285		0.190		0.306		0.204	
$t_r \times 10^3$ (kips)$^{-1}$	0.329		0.219		0.351		0.234		0.377		0.251	
r_x/r_y	1.67				1.66				1.66			

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Table 6–1 (continued) Combined Axial and Bending W Shapes

F_y = 50 ksi

W14

Shape		W14× 342h				W14× 311h				W14× 283h			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.331	0.220	0.530	0.353	0.365	0.243	0.591	0.393	0.401	0.267	0.657	0.437
	11	0.355	0.236	0.530	0.353	0.393	0.261	0.591	0.393	0.432	0.287	0.657	0.437
	12	0.360	0.239	0.530	0.353	0.398	0.265	0.591	0.393	0.438	0.291	0.657	0.437
	13	0.365	0.243	0.530	0.353	0.404	0.269	0.591	0.393	0.444	0.296	0.657	0.437
	14	0.371	0.247	0.530	0.353	0.411	0.273	0.591	0.393	0.452	0.301	0.657	0.437
	15	0.377	0.251	0.530	0.353	0.418	0.278	0.591	0.393	0.460	0.306	0.658	0.438
	16	0.384	0.256	0.532	0.354	0.426	0.283	0.593	0.395	0.468	0.312	0.661	0.440
	17	0.392	0.261	0.534	0.355	0.434	0.289	0.596	0.396	0.478	0.318	0.663	0.441
	18	0.400	0.266	0.536	0.356	0.443	0.295	0.598	0.398	0.488	0.325	0.666	0.443
	19	0.409	0.272	0.538	0.358	0.453	0.301	0.600	0.399	0.499	0.332	0.669	0.445
	20	0.418	0.278	0.539	0.359	0.464	0.309	0.602	0.401	0.511	0.340	0.672	0.447
	22	0.439	0.292	0.543	0.361	0.488	0.324	0.607	0.404	0.538	0.358	0.677	0.451
	24	0.463	0.308	0.547	0.364	0.515	0.343	0.612	0.407	0.569	0.378	0.683	0.455
	26	0.491	0.327	0.551	0.367	0.547	0.364	0.617	0.410	0.604	0.402	0.689	0.458
	28	0.523	0.348	0.555	0.369	0.583	0.388	0.621	0.413	0.645	0.429	0.695	0.462
	30	0.560	0.373	0.559	0.372	0.625	0.416	0.626	0.417	0.692	0.460	0.701	0.466
	32	0.602	0.401	0.563	0.375	0.673	0.448	0.631	0.420	0.746	0.496	0.707	0.471
	34	0.651	0.433	0.567	0.377	0.728	0.485	0.636	0.423	0.808	0.537	0.714	0.475
	36	0.706	0.470	0.571	0.380	0.792	0.527	0.642	0.427	0.879	0.585	0.720	0.479
	38	0.770	0.513	0.576	0.383	0.865	0.575	0.647	0.430	0.962	0.640	0.726	0.483
	40	0.844	0.562	0.580	0.386	0.950	0.632	0.652	0.434	1.06	0.704	0.733	0.488
	42	0.931	0.619	0.584	0.389	1.05	0.697	0.658	0.438	1.17	0.777	0.740	0.492
	44	1.02	0.680	0.589	0.392	1.15	0.765	0.663	0.441	1.28	0.852	0.747	0.497
	46	1.12	0.743	0.593	0.395	1.26	0.836	0.669	0.445	1.40	0.932	0.754	0.501
	48	1.22	0.809	0.598	0.398	1.37	0.911	0.674	0.449	1.52	1.01	0.761	0.506
	50	1.32	0.878	0.602	0.401	1.48	0.988	0.680	0.453	1.65	1.10	0.768	0.511

Other Constants and Properties

	342h ASD	342h LRFD	311h ASD	311h LRFD	283h ASD	283h LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.05	0.701	1.17	0.780	1.30	0.865
$t_y \times 10^3$ (kips)$^{-1}$	0.330	0.220	0.365	0.243	0.401	0.267
$t_r \times 10^3$ (kips)$^{-1}$	0.407	0.271	0.449	0.299	0.494	0.329
r_x/r_y	1.65		1.64		1.63	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W14×											
	257				233				211			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.442	0.294	0.732	0.487	0.488	0.325	0.817	0.544	0.539	0.359	0.914	0.608
11	0.476	0.317	0.732	0.487	0.526	0.350	0.817	0.544	0.582	0.387	0.914	0.608
12	0.483	0.321	0.732	0.487	0.534	0.355	0.817	0.544	0.591	0.393	0.914	0.608
13	0.491	0.326	0.732	0.487	0.542	0.361	0.817	0.544	0.600	0.399	0.914	0.608
14	0.499	0.332	0.732	0.487	0.552	0.367	0.817	0.544	0.611	0.406	0.914	0.608
15	0.508	0.338	0.733	0.488	0.562	0.374	0.819	0.545	0.622	0.414	0.917	0.610
16	0.518	0.344	0.736	0.490	0.573	0.381	0.823	0.548	0.634	0.422	0.922	0.613
17	0.528	0.351	0.740	0.492	0.585	0.389	0.827	0.551	0.648	0.431	0.927	0.617
18	0.540	0.359	0.743	0.494	0.598	0.398	0.832	0.553	0.662	0.441	0.932	0.620
19	0.552	0.367	0.746	0.497	0.612	0.407	0.836	0.556	0.678	0.451	0.937	0.624
20	0.566	0.376	0.750	0.499	0.627	0.417	0.840	0.559	0.695	0.463	0.942	0.627
22	0.596	0.396	0.757	0.503	0.661	0.440	0.849	0.565	0.733	0.488	0.953	0.634
24	0.631	0.420	0.764	0.508	0.700	0.466	0.857	0.571	0.777	0.517	0.964	0.641
26	0.671	0.446	0.771	0.513	0.745	0.496	0.866	0.577	0.829	0.551	0.975	0.649
28	0.717	0.477	0.778	0.518	0.797	0.530	0.876	0.583	0.887	0.590	0.987	0.657
30	0.770	0.512	0.786	0.523	0.857	0.570	0.885	0.589	0.955	0.636	0.999	0.664
32	0.832	0.553	0.794	0.528	0.927	0.617	0.895	0.595	1.03	0.688	1.01	0.672
34	0.902	0.600	0.801	0.533	1.01	0.670	0.904	0.602	1.12	0.748	1.02	0.681
36	0.984	0.654	0.809	0.539	1.10	0.731	0.914	0.608	1.23	0.818	1.04	0.689
38	1.08	0.717	0.818	0.544	1.21	0.802	0.925	0.615	1.35	0.898	1.05	0.698
40	1.19	0.791	0.826	0.549	1.33	0.886	0.935	0.622	1.49	0.994	1.06	0.707
42	1.31	0.872	0.834	0.555	1.47	0.977	0.946	0.629	1.65	1.10	1.08	0.716
44	1.44	0.957	0.843	0.561	1.61	1.07	0.957	0.637	1.81	1.20	1.09	0.725
46	1.57	1.05	0.852	0.567	1.76	1.17	0.968	0.644	1.98	1.31	1.10	0.735
48	1.71	1.14	0.861	0.573	1.92	1.28	0.980	0.652	2.15	1.43	1.12	0.744
50	1.86	1.24	0.870	0.579	2.08	1.38	0.991	0.660	2.33	1.55	1.13	0.755

Other Constants and Properties

	257 ASD	257 LRFD	233 ASD	233 LRFD	211 ASD	211 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.45	0.964	1.61	1.07	1.80	1.20
$t_y \times 10^3$ (kips)$^{-1}$	0.441	0.294	0.488	0.325	0.539	0.359
$t_r \times 10^3$ (kips)$^{-1}$	0.543	0.362	0.600	0.400	0.662	0.441
r_x/r_y	1.62		1.62		1.61	

Table 6–1 (continued) Combined Axial and Bending W Shapes

F_y = 50 ksi

W14

Shape		W14× 193				W14× 176				W14× 159			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	**0.588**	0.391	**1.00**	0.668	**0.645**	0.429	**1.11**	0.741	**0.715**	0.475	**1.24**	0.826
	11	**0.636**	0.423	**1.00**	0.668	**0.698**	0.464	**1.11**	0.741	**0.774**	0.515	**1.24**	0.826
	12	**0.645**	0.429	**1.00**	0.668	**0.709**	0.471	**1.11**	0.741	**0.786**	0.523	**1.24**	0.826
	13	**0.656**	0.436	**1.00**	0.668	**0.720**	0.479	**1.11**	0.741	**0.799**	0.531	**1.24**	0.826
	14	**0.667**	0.444	**1.00**	0.668	**0.733**	0.488	**1.11**	0.741	**0.813**	0.541	**1.24**	0.826
	15	**0.680**	0.452	**1.01**	0.670	**0.747**	0.497	**1.12**	0.745	**0.829**	0.551	**1.25**	0.831
	16	**0.693**	0.461	**1.01**	0.675	**0.762**	0.507	**1.13**	0.750	**0.846**	0.563	**1.26**	0.837
	17	**0.708**	0.471	**1.02**	0.679	**0.779**	0.518	**1.13**	0.755	**0.864**	0.575	**1.27**	0.843
	18	**0.724**	0.482	**1.03**	0.683	**0.797**	0.530	**1.14**	0.760	**0.884**	0.588	**1.28**	0.850
	19	**0.742**	0.494	**1.03**	0.687	**0.816**	0.543	**1.15**	0.765	**0.906**	0.603	**1.29**	0.856
	20	**0.761**	0.506	**1.04**	0.691	**0.837**	0.557	**1.16**	0.770	**0.930**	0.619	**1.30**	0.863
	22	**0.803**	0.534	**1.05**	0.700	**0.884**	0.588	**1.17**	0.781	**0.983**	0.654	**1.32**	0.876
	24	**0.852**	0.567	**1.06**	0.709	**0.939**	0.625	**1.19**	0.791	**1.04**	0.695	**1.34**	0.889
	26	**0.908**	0.604	**1.08**	0.718	**1.00**	0.667	**1.21**	0.803	**1.11**	0.742	**1.36**	0.904
	28	**0.973**	0.648	**1.09**	0.727	**1.08**	0.715	**1.22**	0.814	**1.20**	0.796	**1.38**	0.918
	30	**1.05**	0.698	**1.11**	0.736	**1.16**	0.772	**1.24**	0.826	**1.29**	0.860	**1.40**	0.933
	32	**1.14**	0.755	**1.12**	0.746	**1.26**	0.837	**1.26**	0.838	**1.40**	0.933	**1.43**	0.949
	34	**1.24**	0.822	**1.14**	0.756	**1.37**	0.912	**1.28**	0.851	**1.53**	1.02	**1.45**	0.965
	36	**1.35**	0.899	**1.15**	0.767	**1.50**	0.999	**1.30**	0.864	**1.68**	1.12	**1.47**	0.981
	38	**1.49**	0.989	**1.17**	0.777	**1.65**	1.10	**1.32**	0.877	**1.85**	1.23	**1.50**	0.998
	40	**1.65**	1.10	**1.18**	0.788	**1.83**	1.22	**1.34**	0.891	**2.05**	1.36	**1.53**	1.02
	42	**1.82**	1.21	**1.20**	0.799	**2.02**	1.34	**1.36**	0.905	**2.26**	1.50	**1.56**	1.03
	44	**1.99**	1.33	**1.22**	0.811	**2.22**	1.48	**1.38**	0.920	**2.48**	1.65	**1.58**	1.05
	46	**2.18**	1.45	**1.24**	0.823	**2.42**	1.61	**1.41**	0.935	**2.71**	1.80	**1.61**	1.07
	48	**2.37**	1.58	**1.26**	0.835	**2.64**	1.76	**1.43**	0.951	**2.95**	1.96	**1.64**	1.09
	50	**2.57**	1.71	**1.27**	0.848	**2.86**	1.90	**1.45**	0.967	**3.20**	2.13	**1.68**	1.12

Other Constants and Properties

	193 ASD	193 LRFD	176 ASD	176 LRFD	159 ASD	159 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**1.98**	1.32	**2.19**	1.45	**2.44**	1.62
$t_y \times 10^3$ (kips)$^{-1}$	**0.587**	0.391	**0.644**	0.429	**0.713**	0.475
$t_r \times 10^3$ (kips)$^{-1}$	**0.723**	0.482	**0.792**	0.528	**0.878**	0.585
r_x/r_y	1.60		1.60		1.60	

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W14×											
	145				132				120			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	**0.783**	0.521	**1.37**	0.912	**0.862**	0.573	**1.52**	1.01	**0.946**	0.629	**1.68**	1.12
11	**0.848**	0.564	**1.37**	0.912	**0.943**	0.627	**1.52**	1.01	**1.04**	0.689	**1.68**	1.12
12	**0.861**	0.573	**1.37**	0.912	**0.959**	0.638	**1.52**	1.01	**1.05**	0.701	**1.68**	1.12
13	**0.876**	0.583	**1.37**	0.912	**0.977**	0.650	**1.52**	1.01	**1.07**	0.715	**1.68**	1.12
14	**0.892**	0.593	**1.37**	0.912	**0.997**	0.663	**1.53**	1.02	**1.10**	0.729	**1.69**	1.13
15	**0.909**	0.605	**1.38**	0.918	**1.02**	0.678	**1.55**	1.03	**1.12**	0.745	**1.71**	1.14
16	**0.928**	0.617	**1.39**	0.926	**1.04**	0.694	**1.56**	1.04	**1.15**	0.763	**1.73**	1.15
17	**0.949**	0.631	**1.40**	0.933	**1.07**	0.711	**1.57**	1.05	**1.18**	0.782	**1.74**	1.16
18	**0.971**	0.646	**1.41**	0.941	**1.10**	0.730	**1.59**	1.06	**1.21**	0.803	**1.76**	1.17
19	**0.995**	0.662	**1.43**	0.949	**1.13**	0.750	**1.60**	1.07	**1.24**	0.826	**1.78**	1.18
20	**1.02**	0.679	**1.44**	0.956	**1.16**	0.772	**1.62**	1.08	**1.28**	0.850	**1.80**	1.20
22	**1.08**	0.719	**1.46**	0.972	**1.24**	0.822	**1.65**	1.10	**1.36**	0.906	**1.84**	1.22
24	**1.15**	0.764	**1.49**	0.989	**1.32**	0.880	**1.68**	1.12	**1.46**	0.971	**1.88**	1.25
26	**1.23**	0.816	**1.51**	1.01	**1.43**	0.948	**1.71**	1.14	**1.57**	1.05	**1.92**	1.27
28	**1.32**	0.877	**1.54**	1.02	**1.54**	1.03	**1.75**	1.16	**1.71**	1.14	**1.96**	1.30
30	**1.42**	0.947	**1.57**	1.04	**1.68**	1.12	**1.78**	1.19	**1.86**	1.24	**2.00**	1.33
32	**1.55**	1.03	**1.60**	1.06	**1.85**	1.23	**1.82**	1.21	**2.04**	1.36	**2.05**	1.36
34	**1.69**	1.12	**1.63**	1.08	**2.04**	1.36	**1.86**	1.24	**2.26**	1.50	**2.10**	1.40
36	**1.85**	1.23	**1.66**	1.10	**2.27**	1.51	**1.90**	1.27	**2.51**	1.67	**2.15**	1.43
38	**2.05**	1.36	**1.69**	1.12	**2.52**	1.68	**1.94**	1.29	**2.80**	1.86	**2.21**	1.47
40	**2.27**	1.51	**1.72**	1.15	**2.80**	1.86	**1.99**	1.32	**3.10**	2.06	**2.26**	1.51
42	**2.50**	1.66	**1.76**	1.17	**3.08**	2.05	**2.04**	1.35	**3.42**	2.28	**2.32**	1.55
44	**2.74**	1.83	**1.79**	1.19	**3.38**	2.25	**2.08**	1.39	**3.75**	2.50	**2.39**	1.59
46	**3.00**	2.00	**1.83**	1.22	**3.70**	2.46	**2.14**	1.42	**4.10**	2.73	**2.45**	1.63
48	**3.27**	2.17	**1.87**	1.24	**4.03**	2.68	**2.19**	1.46	**4.47**	2.97	**2.53**	1.68
50	**3.54**	2.36	**1.91**	1.27	**4.37**	2.91	**2.25**	1.49	**4.85**	3.23	**2.60**	1.73
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	**2.68**		1.78		**3.15**		2.10		**3.49**		2.32	
$t_y \times 10^3$ (kips)$^{-1}$	**0.782**		0.521		**0.860**		0.573		**0.944**		0.629	
$t_r \times 10^3$ (kips)$^{-1}$	**0.962**		0.641		**1.06**		0.705		**1.16**		0.774	
r_x/r_y	1.59				1.67				1.67			

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W14

Shape		W14×							
		109				99[f]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.04	0.694	1.86	1.23	1.15	0.763	2.07	1.38
	11	1.14	0.760	1.86	1.23	1.26	0.837	2.07	1.38
	12	1.16	0.773	1.86	1.23	1.28	0.851	2.07	1.38
	13	1.18	0.788	1.86	1.23	1.30	0.868	2.07	1.38
	14	1.21	0.804	1.87	1.25	1.33	0.886	2.08	1.38
	15	1.24	0.822	1.89	1.26	1.36	0.906	2.10	1.40
	16	1.27	0.842	1.91	1.27	1.39	0.928	2.13	1.42
	17	1.30	0.863	1.93	1.29	1.43	0.951	2.15	1.43
	18	1.33	0.886	1.95	1.30	1.47	0.977	2.18	1.45
	19	1.37	0.911	1.98	1.31	1.51	1.01	2.21	1.47
	20	1.41	0.939	2.00	1.33	1.56	1.04	2.23	1.49
	22	1.50	1.00	2.04	1.36	1.66	1.10	2.29	1.52
	24	1.61	1.07	2.09	1.39	1.78	1.18	2.35	1.56
	26	1.74	1.16	2.14	1.43	1.92	1.28	2.41	1.60
	28	1.89	1.26	2.20	1.46	2.09	1.39	2.48	1.65
	30	2.06	1.37	2.25	1.50	2.28	1.52	2.55	1.69
	32	2.26	1.51	2.31	1.54	2.51	1.67	2.62	1.74
	34	2.50	1.66	2.37	1.58	2.78	1.85	2.70	1.80
	36	2.79	1.85	2.44	1.62	3.10	2.06	2.78	1.85
	38	3.10	2.06	2.51	1.67	3.45	2.29	2.87	1.91
	40	3.44	2.29	2.58	1.72	3.82	2.54	2.96	1.97
	42	3.79	2.52	2.66	1.77	4.21	2.80	3.06	2.04
	44	4.16	2.77	2.74	1.82	4.62	3.08	3.17	2.11
	46	4.55	3.03	2.83	1.88	5.05	3.36	3.31	2.20
	48	4.95	3.29	2.92	1.94	5.50	3.66	3.48	2.32
	50	5.37	3.57	3.06	2.03	5.97	3.97	3.66	2.43

Other Constants and Properties

	109 ASD	109 LRFD	99[f] ASD	99[f] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	3.84	2.56	4.29	2.85
$t_y \times 10^3$ (kips)$^{-1}$	1.04	0.694	1.14	0.763
$t_r \times 10^3$ (kips)$^{-1}$	1.28	0.854	1.41	0.939
r_x/r_y	1.67		1.66	

[f] Shape does not meet compact limit for flexure with F_y = 50 ksi.

W14

Table 6–1 (continued) Combined Axial and Bending W Shapes

F_y = 50 ksi

Shape	W14× 90[f]				W14× 82				W14× 74			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.26	0.840	2.33	1.55	1.39	0.924	2.56	1.71	1.53	1.02	2.83	1.88
6	1.30	0.863	2.33	1.55	1.48	0.983	2.56	1.71	1.63	1.09	2.83	1.88
7	1.31	0.872	2.33	1.55	1.51	1.00	2.56	1.71	1.67	1.11	2.83	1.88
8	1.33	0.882	2.33	1.55	1.55	1.03	2.56	1.71	1.71	1.14	2.83	1.88
9	1.34	0.894	2.33	1.55	1.60	1.06	2.57	1.71	1.76	1.17	2.84	1.89
10	1.36	0.907	2.33	1.55	1.65	1.10	2.61	1.74	1.82	1.21	2.89	1.92
11	1.38	0.921	2.33	1.55	1.71	1.14	2.66	1.77	1.89	1.26	2.94	1.96
12	1.41	0.938	2.33	1.55	1.78	1.18	2.70	1.80	1.96	1.31	2.99	1.99
13	1.44	0.956	2.33	1.55	1.85	1.23	2.75	1.83	2.05	1.36	3.05	2.03
14	1.47	0.976	2.33	1.55	1.94	1.29	2.79	1.86	2.14	1.43	3.10	2.07
15	1.50	0.998	2.33	1.55	2.04	1.36	2.84	1.89	2.25	1.50	3.16	2.10
16	1.54	1.02	2.35	1.57	2.15	1.43	2.89	1.92	2.38	1.58	3.22	2.15
17	1.58	1.05	2.38	1.59	2.28	1.52	2.94	1.96	2.52	1.67	3.29	2.19
18	1.62	1.08	2.42	1.61	2.42	1.61	3.00	1.99	2.67	1.78	3.35	2.23
19	1.67	1.11	2.45	1.63	2.58	1.71	3.05	2.03	2.85	1.89	3.42	2.28
20	1.72	1.14	2.48	1.65	2.75	1.83	3.11	2.07	3.04	2.02	3.50	2.33
22	1.83	1.22	2.55	1.70	3.18	2.12	3.23	2.15	3.51	2.34	3.65	2.43
24	1.97	1.31	2.62	1.74	3.73	2.48	3.37	2.24	4.12	2.74	3.82	2.54
26	2.12	1.41	2.70	1.79	4.38	2.91	3.51	2.34	4.83	3.22	4.00	2.66
28	2.31	1.53	2.78	1.85	5.08	3.38	3.67	2.44	5.61	3.73	4.20	2.80
30	2.52	1.68	2.86	1.91	5.83	3.88	3.84	2.55	6.44	4.28	4.42	2.94
32	2.77	1.85	2.95	1.97	6.63	4.41	4.03	2.68	7.32	4.87	4.73	3.15
34	3.07	2.04	3.05	2.03	7.49	4.98	4.28	2.85	8.27	5.50	5.09	3.38
36	3.43	2.28	3.16	2.10	8.39	5.59	4.57	3.04	9.27	6.17	5.44	3.62
38	3.82	2.54	3.27	2.17	9.35	6.22	4.86	3.24	10.3	6.87	5.80	3.86
40	4.23	2.81	3.39	2.25	10.4	6.90	5.15	3.43	11.4	7.61	6.15	4.09

Other Constants and Properties

	90 ASD	90 LRFD	82 ASD	82 LRFD	74 ASD	74 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	4.90	3.26	7.95	5.29	8.80	5.85
$t_y \times 10^3$ (kips)$^{-1}$	1.26	0.840	1.39	0.924	1.53	1.02
$t_r \times 10^3$ (kips)$^{-1}$	1.55	1.03	1.71	1.14	1.88	1.26
r_x/r_y	1.66		2.44		2.44	

[f] Shape does not meet compact limit for flexure with F_y = 50 ksi.

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W14

Shape	W14×											
	68				61				53			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	1.67	1.11	3.10	2.06	1.86	1.24	3.49	2.32	2.14	1.42	4.09	2.72
6	1.78	1.18	3.10	2.06	1.99	1.32	3.49	2.32	2.37	1.58	4.09	2.72
7	1.82	1.21	3.10	2.06	2.03	1.35	3.49	2.32	2.46	1.64	4.11	2.74
8	1.87	1.24	3.10	2.06	2.09	1.39	3.49	2.32	2.57	1.71	4.21	2.80
9	1.92	1.28	3.12	2.07	2.15	1.43	3.52	2.34	2.70	1.80	4.32	2.88
10	1.99	1.32	3.17	2.11	2.22	1.48	3.59	2.39	2.85	1.90	4.44	2.95
11	2.06	1.37	3.23	2.15	2.30	1.53	3.66	2.44	3.02	2.01	4.56	3.03
12	2.15	1.43	3.30	2.19	2.40	1.60	3.74	2.49	3.23	2.15	4.68	3.12
13	2.24	1.49	3.36	2.24	2.51	1.67	3.82	2.54	3.47	2.31	4.82	3.21
14	2.35	1.56	3.43	2.28	2.63	1.75	3.90	2.59	3.75	2.49	4.96	3.30
15	2.47	1.65	3.50	2.33	2.77	1.84	3.99	2.65	4.07	2.71	5.11	3.40
16	2.61	1.74	3.57	2.38	2.92	1.94	4.08	2.71	4.45	2.96	5.27	3.51
17	2.76	1.84	3.65	2.43	3.09	2.06	4.17	2.78	4.89	3.25	5.44	3.62
18	2.94	1.95	3.73	2.48	3.29	2.19	4.27	2.84	5.40	3.59	5.62	3.74
19	3.13	2.08	3.81	2.53	3.51	2.34	4.38	2.91	6.01	4.00	5.81	3.87
20	3.35	2.23	3.90	2.59	3.76	2.50	4.49	2.98	6.66	4.43	6.02	4.01
22	3.88	2.58	4.08	2.72	4.36	2.90	4.72	3.14	8.06	5.36	6.49	4.31
24	4.56	3.04	4.29	2.85	5.13	3.41	4.98	3.32	9.60	6.38	7.24	4.82
26	5.36	3.56	4.51	3.00	6.02	4.01	5.28	3.51	11.3	7.49	8.01	5.33
28	6.21	4.13	4.76	3.17	6.98	4.65	5.66	3.77	13.1	8.69	8.79	5.85
30	7.13	4.74	5.10	3.39	8.02	5.33	6.20	4.12	15.0	9.97	9.56	6.36
32	8.11	5.40	5.53	3.68	9.12	6.07	6.73	4.48	17.1	11.3	10.3	6.87
34	9.16	6.09	5.95	3.96	10.3	6.85	7.27	4.83				
36	10.3	6.83	6.38	4.24	11.5	7.68	7.80	5.19				
38	11.4	7.61	6.80	4.52	12.9	8.56	8.33	5.54				
40	12.7	8.44	7.22	4.81	14.3	9.48	8.86	5.90				
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	9.65		6.42		10.9		7.23		16.2		10.8	
$t_y \times 10^3$ (kips)$^{-1}$	1.67		1.11		1.86		1.240		2.14		1.42	
$t_r \times 10^3$ (kips)$^{-1}$	2.05		1.37		2.29		1.53		2.63		1.75	
r_x/r_y	2.44				2.44				3.07			

Note: Heavy line indicates Kl/r equal to or greater than 200.

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W14×											
	48				43[c]				38[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**
0	**2.36**	1.57	**4.54**	3.02	**2.67**	1.78	**5.12**	3.41	**3.07**	2.04	**5.79**	3.85
6	**2.62**	1.74	**4.54**	3.02	**2.94**	1.96	**5.12**	3.41	**3.52**	2.34	**5.90**	3.93
7	**2.72**	1.81	**4.57**	3.04	**3.06**	2.03	**5.17**	3.44	**3.71**	2.47	**6.12**	4.07
8	**2.84**	1.89	**4.70**	3.13	**3.20**	2.13	**5.31**	3.54	**3.96**	2.64	**6.36**	4.23
9	**2.98**	1.99	**4.83**	3.21	**3.36**	2.24	**5.47**	3.64	**4.27**	2.84	**6.61**	4.40
10	**3.15**	2.10	**4.97**	3.30	**3.55**	2.36	**5.64**	3.75	**4.64**	3.09	**6.89**	4.58
11	**3.35**	2.23	**5.11**	3.40	**3.78**	2.52	**5.82**	3.87	**5.09**	3.38	**7.19**	4.78
12	**3.58**	2.38	**5.26**	3.50	**4.05**	2.69	**6.01**	4.00	**5.62**	3.74	**7.52**	5.00
13	**3.85**	2.56	**5.43**	3.61	**4.36**	2.90	**6.21**	4.13	**6.28**	4.18	**7.87**	5.24
14	**4.16**	2.77	**5.60**	3.73	**4.72**	3.14	**6.43**	4.27	**7.06**	4.70	**8.27**	5.50
15	**4.52**	3.01	**5.79**	3.85	**5.14**	3.42	**6.66**	4.43	**8.04**	5.35	**8.71**	5.79
16	**4.95**	3.29	**5.99**	3.98	**5.63**	3.75	**6.91**	4.60	**9.15**	6.08	**9.19**	6.12
17	**5.44**	3.62	**6.20**	4.13	**6.20**	4.13	**7.18**	4.77	**10.3**	6.87	**10.0**	6.64
18	**6.02**	4.00	**6.43**	4.28	**6.89**	4.58	**7.47**	4.97	**11.6**	7.70	**10.9**	7.23
19	**6.70**	4.46	**6.67**	4.44	**7.67**	5.11	**7.78**	5.18	**12.9**	8.58	**11.7**	7.81
20	**7.43**	4.94	**6.94**	4.62	**8.50**	5.66	**8.12**	5.40	**14.3**	9.51	**12.6**	8.40
21	**8.19**	5.45	**7.23**	4.81	**9.37**	6.24	**8.72**	5.80	**15.8**	10.5	**13.5**	9.00
22	**8.99**	5.98	**7.70**	5.12	**10.3**	6.84	**9.31**	6.20	**17.3**	11.5	**14.4**	9.59
23	**9.83**	6.54	**8.17**	5.44	**11.2**	7.48	**9.91**	6.59	**18.9**	12.6	**15.3**	10.2
24	**10.7**	7.12	**8.65**	5.76	**12.2**	8.15	**10.5**	6.99	**20.6**	13.7	**16.2**	10.8
25	**11.6**	7.72	**9.13**	6.07	**13.3**	8.84	**11.1**	7.39	**22.3**	14.9	**17.1**	11.4
26	**12.6**	8.35	**9.61**	6.39	**14.4**	9.56	**11.7**	7.78				
27	**13.5**	9.01	**10.1**	6.71	**15.5**	10.3	**12.3**	8.18				
28	**14.6**	9.69	**10.6**	7.02	**16.7**	11.1	**12.9**	8.58				
29	**15.6**	10.4	**11.0**	7.34	**17.9**	11.9	**13.5**	8.98				
30	**16.7**	11.1	**11.5**	7.65	**19.1**	12.7	**14.1**	9.37				

Other Constants and Properties

	48 ASD	48 LRFD	43[c] ASD	43[c] LRFD	38[c] ASD	38[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	**18.2**	12.1	**20.6**	13.7	**29.4**	19.6
$t_y \times 10^3$ (kips)$^{-1}$	**2.36**	1.57	**2.64**	1.76	**2.99**	1.99
$t_r \times 10^3$ (kips)$^{-1}$	**2.90**	1.93	**3.25**	2.17	**3.68**	2.45
r_x/r_y	3.06		3.08		3.79	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W14

Shape		W14× 34[c]				W14× 30[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	3.50	2.33	6.53	4.34	4.02	2.68	7.53	5.01
	6	4.02	2.67	6.67	4.44	4.64	3.08	7.76	5.16
	7	4.23	2.81	6.94	4.61	4.89	3.25	8.09	5.38
	8	4.49	2.99	7.22	4.80	5.20	3.46	8.44	5.62
	9	4.81	3.20	7.53	5.01	5.59	3.72	8.83	5.88
	10	5.24	3.48	7.87	5.23	6.07	4.04	9.26	6.16
	11	5.76	3.83	8.23	5.48	6.70	4.46	9.73	6.48
	12	6.38	4.25	8.64	5.75	7.47	4.97	10.3	6.82
	13	7.14	4.75	9.08	6.04	8.41	5.60	10.8	7.21
	14	8.07	5.37	9.58	6.37	9.56	6.36	11.5	7.64
	15	9.21	6.13	10.1	6.74	11.0	7.30	12.3	8.20
	16	10.5	6.97	10.9	7.28	12.5	8.31	13.7	9.11
	17	11.8	7.87	12.0	8.00	14.1	9.38	15.1	10.0
	18	13.3	8.82	13.1	8.73	15.8	10.5	16.5	11.0
	19	14.8	9.83	14.2	9.46	17.6	11.7	18.0	11.9
	20	16.4	10.9	15.3	10.2	19.5	13.0	19.4	12.9
	21	18.0	12.0	16.5	10.9	21.5	14.3	20.9	13.9
	22	19.8	13.2	17.6	11.7	23.6	15.7	22.4	14.9
	23	21.6	14.4	18.7	12.4	25.8	17.2	23.9	15.9
	24	23.6	15.7	19.8	13.2	28.1	18.7	25.4	16.9
	25	25.6	17.0	21.0	13.9				

Other Constants and Properties

	W14×34 ASD	W14×34 LRFD	W14×30 ASD	W14×30 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	33.6	22.4	39.6	26.4
$t_y \times 10^3$ (kips)$^{-1}$	3.33	2.22	3.77	2.51
$t_r \times 10^3$ (kips)$^{-1}$	4.10	2.74	4.64	3.09
r_x/r_y	3.81		3.85	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W14

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W14×							
	26[c]				22[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending								
0	4.73	3.15	8.86	5.90	5.82	3.87	10.7	7.14
6	6.18	4.11	10.0	6.67	7.65	5.09	12.4	8.24
7	6.85	4.55	10.7	7.09	8.52	5.67	13.3	8.82
8	7.75	5.16	11.4	7.58	9.70	6.45	14.3	9.50
9	9.02	6.00	12.2	8.13	11.3	7.53	15.5	10.3
10	10.7	7.13	13.2	8.77	13.6	9.08	16.8	11.2
11	12.9	8.60	14.3	9.52	16.5	11.0	19.2	12.8
12	15.4	10.2	16.4	10.9	19.6	13.1	22.2	14.8
13	18.0	12.0	18.6	12.4	23.1	15.3	25.3	16.8
14	20.9	13.9	20.8	13.8	26.7	17.8	28.5	18.9
15	24.0	16.0	23.1	15.3	30.7	20.4	31.7	21.1
16	27.3	18.2	25.3	16.9	34.9	23.2	35.0	23.3
17	30.9	20.5	27.6	18.4	39.4	26.2	38.3	25.5
18	34.6	23.0	29.9	19.9				

Other Constants and Properties

	26[c]		22[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	64.3	42.8	81.2	54.0
$t_y \times 10^3$ (kips)$^{-1}$	4.33	2.89	5.13	3.42
$t_r \times 10^3$ (kips)$^{-1}$	5.33	3.56	6.32	4.21
r_x/r_y	5.23		5.33	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued) Combined Axial and Bending W Shapes

F_y = 50 ksi

W12

Shape		W12×											
		336[h]				305[h]				279[h]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.338	0.225	0.591	0.393	0.373	0.248	0.663	0.441	0.408	0.271	0.741	0.493
	6	0.349	0.232	0.591	0.393	0.385	0.256	0.663	0.441	0.422	0.280	0.741	0.493
	7	0.353	0.235	0.591	0.393	0.389	0.259	0.663	0.441	0.427	0.284	0.741	0.493
	8	0.358	0.238	0.591	0.393	0.395	0.263	0.663	0.441	0.433	0.288	0.741	0.493
	9	0.363	0.241	0.591	0.393	0.401	0.267	0.663	0.441	0.439	0.292	0.741	0.493
	10	0.369	0.246	0.591	0.393	0.408	0.271	0.663	0.441	0.447	0.297	0.741	0.493
	11	0.376	0.250	0.591	0.393	0.415	0.276	0.663	0.441	0.456	0.303	0.741	0.493
	12	0.384	0.255	0.591	0.393	0.424	0.282	0.663	0.441	0.466	0.310	0.741	0.493
	13	0.392	0.261	0.592	0.394	0.434	0.289	0.666	0.443	0.476	0.317	0.744	0.495
	14	0.401	0.267	0.594	0.395	0.445	0.296	0.668	0.444	0.488	0.325	0.746	0.497
	15	0.412	0.274	0.596	0.397	0.456	0.304	0.670	0.446	0.502	0.334	0.749	0.499
	16	0.423	0.281	0.598	0.398	0.469	0.312	0.673	0.448	0.516	0.343	0.752	0.500
	17	0.435	0.290	0.600	0.399	0.483	0.322	0.675	0.449	0.532	0.354	0.755	0.502
	18	0.449	0.299	0.602	0.400	0.499	0.332	0.677	0.451	0.550	0.366	0.758	0.504
	19	0.464	0.308	0.604	0.402	0.516	0.343	0.680	0.452	0.569	0.378	0.761	0.506
	20	0.480	0.319	0.606	0.403	0.534	0.355	0.682	0.454	0.590	0.392	0.764	0.508
	22	0.516	0.344	0.610	0.406	0.576	0.383	0.687	0.457	0.637	0.424	0.770	0.512
	24	0.560	0.372	0.614	0.408	0.626	0.416	0.692	0.460	0.693	0.461	0.776	0.516
	26	0.611	0.406	0.618	0.411	0.685	0.456	0.697	0.464	0.760	0.506	0.782	0.520
	28	0.671	0.447	0.622	0.414	0.755	0.502	0.702	0.467	0.840	0.559	0.788	0.525
	30	0.743	0.494	0.626	0.417	0.838	0.557	0.708	0.471	0.935	0.622	0.795	0.529
	32	0.828	0.551	0.631	0.420	0.937	0.623	0.713	0.474	1.05	0.698	0.801	0.533
	34	0.931	0.620	0.635	0.422	1.06	0.703	0.718	0.478	1.18	0.787	0.808	0.537
	36	1.04	0.695	0.639	0.425	1.18	0.788	0.724	0.481	1.33	0.883	0.814	0.542
	38	1.16	0.774	0.644	0.428	1.32	0.878	0.729	0.485	1.48	0.984	0.821	0.546
	40	1.29	0.857	0.648	0.431	1.46	0.973	0.735	0.489	1.64	1.09	0.828	0.551

Other Constants and Properties

	336 ASD	336 LRFD	305 ASD	305 LRFD	279 ASD	279 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.30	0.865	1.46	0.971	1.62	1.08
$t_y \times 10^3$ (kips)$^{-1}$	0.338	0.225	0.372	0.248	0.407	0.271
$t_r \times 10^3$ (kips)$^{-1}$	0.416	0.277	0.458	0.305	0.501	0.334
r_x/r_y	1.85		1.84		1.82	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

W12

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W12×											
	252[h]				230[h]				210			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	0.451	0.300	0.832	0.554	0.493	0.328	0.923	0.614	0.541	0.360	1.02	0.681
6	0.467	0.310	0.832	0.554	0.511	0.340	0.923	0.614	0.560	0.373	1.02	0.681
7	0.472	0.314	0.832	0.554	0.517	0.344	0.923	0.614	0.567	0.377	1.02	0.681
8	0.479	0.319	0.832	0.554	0.525	0.349	0.923	0.614	0.576	0.383	1.02	0.681
9	0.487	0.324	0.832	0.554	0.533	0.355	0.923	0.614	0.585	0.389	1.02	0.681
10	0.496	0.330	0.832	0.554	0.543	0.361	0.923	0.614	0.596	0.397	1.02	0.681
11	0.506	0.336	0.832	0.554	0.554	0.369	0.923	0.614	0.609	0.405	1.02	0.681
12	0.517	0.344	0.833	0.554	0.566	0.377	0.924	0.615	0.622	0.414	1.03	0.683
13	0.529	0.352	0.837	0.557	0.580	0.386	0.928	0.618	0.638	0.424	1.03	0.686
14	0.543	0.361	0.840	0.559	0.596	0.396	0.933	0.621	0.655	0.436	1.04	0.689
15	0.558	0.371	0.844	0.561	0.612	0.407	0.937	0.623	0.674	0.448	1.04	0.693
16	0.574	0.382	0.847	0.564	0.631	0.420	0.941	0.626	0.695	0.462	1.05	0.696
17	0.592	0.394	0.851	0.566	0.651	0.433	0.945	0.629	0.717	0.477	1.05	0.700
18	0.612	0.407	0.854	0.568	0.673	0.448	0.950	0.632	0.742	0.494	1.06	0.703
19	0.634	0.422	0.858	0.571	0.698	0.464	0.954	0.635	0.770	0.512	1.06	0.707
20	0.658	0.438	0.862	0.573	0.724	0.482	0.959	0.638	0.800	0.532	1.07	0.710
22	0.712	0.474	0.869	0.578	0.785	0.523	0.968	0.644	0.868	0.578	1.08	0.718
24	0.777	0.517	0.876	0.583	0.858	0.571	0.977	0.650	0.950	0.632	1.09	0.725
26	0.854	0.568	0.884	0.588	0.945	0.628	0.986	0.656	1.05	0.697	1.10	0.733
28	0.945	0.629	0.892	0.593	1.05	0.697	0.996	0.663	1.16	0.775	1.11	0.741
30	1.05	0.702	0.900	0.599	1.17	0.779	1.01	0.669	1.30	0.868	1.12	0.748
32	1.19	0.790	0.908	0.604	1.32	0.880	1.02	0.676	1.48	0.982	1.14	0.757
34	1.34	0.892	0.916	0.610	1.49	0.993	1.03	0.682	1.67	1.11	1.15	0.765
36	1.50	1.00	0.925	0.615	1.67	1.11	1.04	0.689	1.87	1.24	1.16	0.773
38	1.67	1.11	0.933	0.621	1.86	1.24	1.05	0.696	2.08	1.38	1.18	0.782
40	1.86	1.23	0.942	0.627	2.07	1.37	1.06	0.703	2.31	1.53	1.19	0.791

Other Constants and Properties

	252[h] ASD	252[h] LRFD	230[h] ASD	230[h] LRFD	210 ASD	210 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	1.82	1.21	2.01	1.34	2.24	1.49
$t_y \times 10^3$ (kips)$^{-1}$	0.450	0.300	0.492	0.328	0.540	0.360
$t_r \times 10^3$ (kips)$^{-1}$	0.554	0.369	0.606	0.404	0.665	0.443
r_x/r_y	1.81		1.80		1.80	

[h] Flange thickness greater than 2 in. Special requirements may apply per AISC Specification Section A3.1c.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W12

Shape	W12×											
	190				170				152			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	0.598	0.398	1.15	0.762	0.668	0.444	1.30	0.862	0.746	0.497	1.47	0.975
6	0.620	0.413	1.15	0.762	0.693	0.461	1.30	0.862	0.775	0.516	1.47	0.975
7	0.628	0.418	1.15	0.762	0.702	0.467	1.30	0.862	0.785	0.522	1.47	0.975
8	0.638	0.424	1.15	0.762	0.713	0.474	1.30	0.862	0.798	0.531	1.47	0.975
9	0.648	0.431	1.15	0.762	0.725	0.483	1.30	0.862	0.812	0.540	1.47	0.975
10	0.661	0.440	1.15	0.762	0.739	0.492	1.30	0.862	0.828	0.551	1.47	0.975
11	0.675	0.449	1.15	0.762	0.755	0.503	1.30	0.862	0.846	0.563	1.47	0.975
12	0.691	0.459	1.15	0.764	0.773	0.514	1.30	0.865	0.866	0.576	1.47	0.980
13	0.708	0.471	1.16	0.768	0.793	0.528	1.31	0.870	0.889	0.592	1.48	0.987
14	0.727	0.484	1.16	0.773	0.815	0.542	1.32	0.876	0.914	0.608	1.49	0.994
15	0.749	0.498	1.17	0.777	0.839	0.559	1.32	0.881	0.942	0.627	1.50	1.00
16	0.772	0.514	1.17	0.781	0.866	0.576	1.33	0.887	0.973	0.647	1.51	1.01
17	0.798	0.531	1.18	0.786	0.896	0.596	1.34	0.892	1.01	0.670	1.52	1.01
18	0.826	0.550	1.19	0.790	0.928	0.618	1.35	0.898	1.04	0.694	1.54	1.02
19	0.857	0.570	1.19	0.794	0.964	0.641	1.36	0.903	1.08	0.722	1.55	1.03
20	0.891	0.593	1.20	0.799	1.00	0.667	1.37	0.909	1.13	0.751	1.56	1.04
22	0.969	0.645	1.21	0.808	1.09	0.727	1.38	0.921	1.23	0.820	1.58	1.05
24	1.06	0.707	1.23	0.817	1.20	0.798	1.40	0.932	1.35	0.901	1.60	1.07
26	1.17	0.781	1.24	0.827	1.33	0.883	1.42	0.945	1.50	1.00	1.63	1.08
28	1.31	0.870	1.26	0.837	1.48	0.985	1.44	0.957	1.68	1.12	1.65	1.10
30	1.47	0.976	1.27	0.847	1.67	1.11	1.46	0.970	1.89	1.26	1.68	1.12
32	1.66	1.11	1.29	0.857	1.89	1.26	1.48	0.983	2.15	1.43	1.70	1.13
34	1.88	1.25	1.30	0.867	2.14	1.42	1.50	0.997	2.43	1.62	1.73	1.15
36	2.11	1.40	1.32	0.878	2.40	1.59	1.52	1.01	2.73	1.81	1.76	1.17
38	2.35	1.56	1.34	0.889	2.67	1.78	1.54	1.03	3.04	2.02	1.79	1.19
40	2.60	1.73	1.35	0.900	2.96	1.97	1.56	1.04	3.37	2.24	1.82	1.21

Other Constants and Properties

	190 ASD	190 LRFD	170 ASD	170 LRFD	152 ASD	152 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	2.49	1.66	2.83	1.88	3.21	2.14
$t_y \times 10^3$ (kips)$^{-1}$	0.597	0.398	0.666	0.444	0.746	0.497
$t_r \times 10^3$ (kips)$^{-1}$	0.735	0.490	0.821	0.547	0.917	0.611
r_x/r_y	1.79		1.78		1.77	

W12

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W12×											
		136				120				106			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	0.837	0.557	1.66	1.11	0.947	0.630	1.92	1.27	1.07	0.713	2.17	1.45
	6	0.869	0.578	1.66	1.11	0.984	0.655	1.92	1.27	1.11	0.742	2.17	1.45
	7	0.881	0.586	1.66	1.11	0.998	0.664	1.92	1.27	1.13	0.752	2.17	1.45
	8	0.895	0.595	1.66	1.11	1.01	0.675	1.92	1.27	1.15	0.765	2.17	1.45
	9	0.911	0.606	1.66	1.11	1.03	0.687	1.92	1.27	1.17	0.779	2.17	1.45
	10	0.930	0.618	1.66	1.11	1.05	0.701	1.92	1.27	1.20	0.795	2.17	1.45
	11	0.950	0.632	1.66	1.11	1.08	0.717	1.92	1.27	1.22	0.814	2.17	1.45
	12	0.974	0.648	1.68	1.11	1.11	0.735	1.93	1.28	1.25	0.834	2.19	1.46
	13	1.00	0.665	1.69	1.12	1.14	0.755	1.95	1.30	1.29	0.857	2.22	1.47
	14	1.03	0.684	1.70	1.13	1.17	0.778	1.96	1.31	1.33	0.883	2.24	1.49
	15	1.06	0.706	1.71	1.14	1.21	0.802	1.98	1.32	1.37	0.911	2.26	1.50
	16	1.10	0.729	1.73	1.15	1.25	0.829	2.00	1.33	1.42	0.942	2.28	1.52
	17	1.13	0.755	1.74	1.16	1.29	0.859	2.02	1.34	1.47	0.977	2.31	1.53
	18	1.18	0.783	1.75	1.17	1.34	0.892	2.04	1.35	1.53	1.01	2.33	1.55
	19	1.22	0.814	1.77	1.18	1.40	0.928	2.05	1.37	1.59	1.06	2.35	1.57
	20	1.28	0.849	1.78	1.19	1.46	0.968	2.07	1.38	1.66	1.10	2.38	1.58
	22	1.39	0.927	1.81	1.21	1.59	1.06	2.11	1.41	1.82	1.21	2.43	1.62
	24	1.54	1.02	1.84	1.23	1.76	1.17	2.15	1.43	2.01	1.34	2.48	1.65
	26	1.71	1.14	1.87	1.25	1.96	1.30	2.19	1.46	2.24	1.49	2.54	1.69
	28	1.91	1.27	1.91	1.27	2.20	1.46	2.24	1.49	2.52	1.67	2.60	1.73
	30	2.16	1.44	1.94	1.29	2.49	1.66	2.28	1.52	2.86	1.90	2.66	1.77
	32	2.46	1.64	1.97	1.31	2.84	1.89	2.33	1.55	3.26	2.17	2.72	1.81
	34	2.78	1.85	2.01	1.34	3.20	2.13	2.38	1.58	3.67	2.45	2.79	1.86
	36	3.11	2.07	2.05	1.36	3.59	2.39	2.43	1.62	4.12	2.74	2.86	1.90
	38	3.47	2.31	2.09	1.39	4.00	2.66	2.48	1.65	4.59	3.05	2.93	1.95
	40	3.84	2.56	2.13	1.41	4.43	2.95	2.54	1.69	5.09	3.38	3.01	2.00

Other Constants and Properties

	136		120		106	
$b_y \times 10^3$ (kip-ft)$^{-1}$	3.64	2.42	4.17	2.78	4.74	3.16
$t_y \times 10^3$ (kips)$^{-1}$	0.836	0.557	0.945	0.630	1.07	0.713
$t_r \times 10^3$ (kips)$^{-1}$	1.03	0.685	1.16	0.775	1.32	0.878
r_x/r_y	1.77		1.76		1.76	

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W12

Shape	W12× 96				W12× 87				W12× 79			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.18	0.788	2.42	1.61	1.31	0.869	2.70	1.80	1.44	0.958	2.99	1.99
6	1.23	0.820	2.42	1.61	1.36	0.905	2.70	1.80	1.50	0.998	2.99	1.99
7	1.25	0.832	2.42	1.61	1.38	0.918	2.70	1.80	1.52	1.01	2.99	1.99
8	1.27	0.846	2.42	1.61	1.40	0.934	2.70	1.80	1.55	1.03	2.99	1.99
9	1.30	0.862	2.42	1.61	1.43	0.951	2.70	1.80	1.58	1.05	2.99	1.99
10	1.32	0.880	2.42	1.61	1.46	0.972	2.70	1.80	1.61	1.07	2.99	1.99
11	1.35	0.901	2.43	1.61	1.50	0.995	2.70	1.80	1.65	1.10	3.00	2.00
12	1.39	0.924	2.45	1.63	1.53	1.02	2.74	1.82	1.70	1.13	3.04	2.02
13	1.43	0.950	2.48	1.65	1.58	1.05	2.77	1.84	1.74	1.16	3.08	2.05
14	1.47	0.978	2.51	1.67	1.63	1.08	2.80	1.86	1.80	1.20	3.12	2.08
15	1.52	1.01	2.53	1.69	1.68	1.12	2.84	1.89	1.86	1.24	3.16	2.10
16	1.57	1.05	2.56	1.70	1.74	1.16	2.87	1.91	1.92	1.28	3.21	2.13
17	1.63	1.08	2.59	1.72	1.80	1.20	2.91	1.93	2.00	1.33	3.25	2.16
18	1.69	1.13	2.62	1.74	1.88	1.25	2.94	1.96	2.08	1.38	3.30	2.19
19	1.76	1.17	2.65	1.76	1.96	1.30	2.98	1.98	2.17	1.44	3.34	2.22
20	1.84	1.23	2.68	1.78	2.04	1.36	3.02	2.01	2.26	1.51	3.39	2.26
22	2.02	1.34	2.74	1.83	2.24	1.49	3.10	2.06	2.49	1.66	3.49	2.32
24	2.24	1.49	2.81	1.87	2.49	1.65	3.19	2.12	2.76	1.84	3.60	2.39
26	2.50	1.66	2.88	1.92	2.78	1.85	3.28	2.18	3.10	2.06	3.71	2.47
28	2.81	1.87	2.96	1.97	3.14	2.09	3.37	2.24	3.50	2.33	3.83	2.55
30	3.20	2.13	3.03	2.02	3.58	2.38	3.47	2.31	4.00	2.66	3.96	2.64
32	3.64	2.42	3.12	2.07	4.07	2.71	3.58	2.38	4.55	3.03	4.10	2.73
34	4.11	2.74	3.20	2.13	4.60	3.06	3.70	2.46	5.13	3.42	4.25	2.83
36	4.61	3.07	3.29	2.19	5.15	3.43	3.82	2.54	5.75	3.83	4.41	2.93
38	5.14	3.42	3.39	2.26	5.74	3.82	3.95	2.63	6.41	4.27	4.58	3.05
40	5.69	3.79	3.49	2.33	6.36	4.23	4.09	2.72	7.10	4.73	4.77	3.17

Other Constants and Properties

	W12×96 ASD	W12×96 LRFD	W12×87 ASD	W12×87 LRFD	W12×79 ASD	W12×79 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	5.28	3.51	5.90	3.92	6.56	4.37
$t_y \times 10^3$ (kips)$^{-1}$	1.18	0.788	1.30	0.869	1.44	0.958
$t_r \times 10^3$ (kips)$^{-1}$	1.46	0.970	1.61	1.07	1.77	1.18
r_x/r_y	1.76		1.75		1.75	

Table 6-1 (continued) Combined Axial and Bending W Shapes

W12

F_y = 50 ksi

Shape		W12×											
		72				65[f]				58			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.58	1.05	3.30	2.19	1.75	1.16	3.75	2.50	1.96	1.30	4.12	2.74
	6	1.65	1.10	3.30	2.19	1.82	1.21	3.75	2.50	2.08	1.38	4.12	2.74
	7	1.67	1.11	3.30	2.19	1.85	1.23	3.75	2.50	2.13	1.41	4.12	2.74
	8	1.70	1.13	3.30	2.19	1.88	1.25	3.75	2.50	2.18	1.45	4.12	2.74
	9	1.73	1.15	3.30	2.19	1.92	1.28	3.75	2.50	2.24	1.49	4.13	2.75
	10	1.77	1.18	3.30	2.19	1.96	1.31	3.75	2.50	2.32	1.54	4.21	2.80
	11	1.81	1.21	3.31	2.20	2.01	1.34	3.75	2.50	2.40	1.60	4.28	2.85
	12	1.86	1.24	3.36	2.23	2.07	1.38	3.75	2.50	2.49	1.66	4.36	2.90
	13	1.92	1.27	3.41	2.27	2.13	1.42	3.81	2.54	2.60	1.73	4.44	2.96
	14	1.98	1.31	3.45	2.30	2.19	1.46	3.87	2.58	2.72	1.81	4.53	3.01
	15	2.04	1.36	3.51	2.33	2.27	1.51	3.93	2.62	2.85	1.90	4.62	3.07
	16	2.12	1.41	3.56	2.37	2.35	1.57	4.00	2.66	3.00	2.00	4.71	3.13
	17	2.20	1.46	3.61	2.40	2.44	1.63	4.06	2.70	3.18	2.11	4.81	3.20
	18	2.29	1.52	3.67	2.44	2.54	1.69	4.13	2.75	3.37	2.24	4.91	3.26
	19	2.38	1.59	3.72	2.48	2.66	1.77	4.20	2.80	3.58	2.38	5.01	3.33
	20	2.49	1.66	3.78	2.52	2.78	1.85	4.27	2.84	3.82	2.54	5.12	3.41
	22	2.74	1.83	3.91	2.60	3.06	2.04	4.43	2.95	4.40	2.93	5.35	3.56
	24	3.05	2.03	4.04	2.69	3.40	2.26	4.59	3.06	5.14	3.42	5.60	3.73
	26	3.41	2.27	4.18	2.78	3.82	2.54	4.77	3.17	6.03	4.01	5.88	3.91
	28	3.86	2.57	4.33	2.88	4.33	2.88	4.96	3.30	6.99	4.65	6.19	4.12
	30	4.42	2.94	4.49	2.99	4.95	3.30	5.17	3.44	8.03	5.34	6.55	4.36
	32	5.02	3.34	4.67	3.11	5.64	3.75	5.40	3.59	9.13	6.08	7.09	4.72
	34	5.67	3.77	4.86	3.23	6.36	4.23	5.64	3.75	10.3	6.86	7.63	5.08
	36	6.36	4.23	5.07	3.37	7.13	4.75	5.98	3.98	11.6	7.69	8.18	5.44
	38	7.08	4.71	5.32	3.54	7.95	5.29	6.40	4.26	12.9	8.57	8.71	5.80
	40	7.85	5.22	5.66	3.77	8.81	5.86	6.82	4.54	14.3	9.49	9.25	6.16

Other Constants and Properties

	72 ASD	72 LRFD	65 ASD	65 LRFD	58 ASD	58 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	7.24	4.82	8.31	5.53	11.0	7.29
$t_y \times 10^3$ (kips)$^{-1}$	1.58	1.05	1.75	1.17	1.95	1.30
$t_r \times 10^3$ (kips)$^{-1}$	1.94	1.29	2.15	1.43	2.41	1.60
r_x/r_y	1.75		1.75		2.10	

[f] Shape does not meet compact limit for flexure with F_y = 50 ksi.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W12

Shape	W12×											
	53				50				45			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending												
0	**2.15**	1.43	**4.57**	3.04	**2.29**	1.52	**4.96**	3.30	**2.55**	1.69	**5.55**	3.69
6	**2.28**	1.52	**4.57**	3.04	**2.53**	1.68	**4.96**	3.30	**2.81**	1.87	**5.55**	3.69
7	**2.33**	1.55	**4.57**	3.04	**2.62**	1.74	**4.96**	3.30	**2.92**	1.94	**5.56**	3.70
8	**2.39**	1.59	**4.57**	3.04	**2.73**	1.81	**5.08**	3.38	**3.04**	2.02	**5.70**	3.79
9	**2.46**	1.64	**4.59**	3.06	**2.86**	1.90	**5.19**	3.46	**3.19**	2.12	**5.84**	3.89
10	**2.55**	1.69	**4.68**	3.12	**3.01**	2.00	**5.32**	3.54	**3.36**	2.23	**6.00**	3.99
11	**2.64**	1.76	**4.77**	3.18	**3.19**	2.12	**5.45**	3.62	**3.56**	2.37	**6.15**	4.09
12	**2.75**	1.83	**4.87**	3.24	**3.40**	2.26	**5.58**	3.71	**3.79**	2.52	**6.32**	4.21
13	**2.87**	1.91	**4.97**	3.31	**3.64**	2.42	**5.73**	3.81	**4.06**	2.70	**6.50**	4.32
14	**3.00**	2.00	**5.07**	3.37	**3.92**	2.61	**5.88**	3.91	**4.38**	2.91	**6.69**	4.45
15	**3.15**	2.10	**5.18**	3.45	**4.24**	2.82	**6.03**	4.01	**4.75**	3.16	**6.88**	4.58
16	**3.33**	2.21	**5.29**	3.52	**4.62**	3.07	**6.20**	4.13	**5.17**	3.44	**7.09**	4.72
17	**3.52**	2.34	**5.41**	3.60	**5.05**	3.36	**6.38**	4.24	**5.67**	3.77	**7.32**	4.87
18	**3.74**	2.49	**5.53**	3.68	**5.56**	3.70	**6.56**	4.37	**6.24**	4.15	**7.55**	5.03
19	**3.98**	2.65	**5.66**	3.77	**6.17**	4.10	**6.76**	4.50	**6.93**	4.61	**7.81**	5.20
20	**4.26**	2.83	**5.80**	3.86	**6.84**	4.55	**6.97**	4.64	**7.68**	5.11	**8.08**	5.38
22	**4.91**	3.27	**6.09**	4.05	**8.27**	5.50	**7.44**	4.95	**9.29**	6.18	**8.68**	5.78
24	**5.76**	3.83	**6.41**	4.26	**9.84**	6.55	**7.99**	5.32	**11.1**	7.36	**9.65**	6.42
26	**6.76**	4.50	**6.76**	4.50	**11.6**	7.69	**8.82**	5.87	**13.0**	8.64	**10.7**	7.11
28	**7.84**	5.22	**7.16**	4.76	**13.4**	8.91	**9.65**	6.42	**15.1**	10.0	**11.7**	7.80
30	**9.01**	5.99	**7.80**	5.19	**15.4**	10.2	**10.5**	6.97	**17.3**	11.5	**12.7**	8.48
32	**10.2**	6.82	**8.47**	5.64	**17.5**	11.6	**11.3**	7.52	**19.7**	13.1	**13.8**	9.16
34	**11.6**	7.70	**9.14**	6.08								
36	**13.0**	8.63	**9.80**	6.52								
38	**14.4**	9.61	**10.5**	6.96								
40	**16.0**	10.7	**11.1**	7.40								
Other Constants and Properties												
$b_y \times 10^3$ (kip-ft)$^{-1}$	**12.2**		8.15		**16.7**		11.1		**18.8**		12.5	
$t_y \times 10^3$ (kips)$^{-1}$	**2.14**		1.43		**2.28**		1.52		**2.54**		1.69	
$t_r \times 10^3$ (kips)$^{-1}$	**2.64**		1.76		**2.81**		1.87		**3.13**		2.08	
r_x/r_y	2.11				2.64				2.64			

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W12

F_y = 50 ksi

Shape	W12×											
	40				35[c]				30[c]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	2.86	1.90	6.25	4.16	3.24	2.16	6.96	4.63	3.94	2.62	8.27	5.50
6	3.16	2.10	6.25	4.16	3.79	2.52	7.09	4.72	4.54	3.02	8.46	5.63
7	3.28	2.18	6.27	4.17	4.02	2.67	7.34	4.88	4.79	3.19	8.79	5.85
8	3.42	2.28	6.44	4.29	4.29	2.86	7.61	5.06	5.10	3.39	9.14	6.08
9	3.59	2.39	6.62	4.40	4.63	3.08	7.90	5.26	5.49	3.66	9.53	6.34
10	3.78	2.52	6.80	4.53	5.04	3.35	8.21	5.46	5.99	3.99	9.94	6.62
11	4.01	2.67	7.00	4.66	5.53	3.68	8.55	5.69	6.59	4.39	10.4	6.92
12	4.28	2.85	7.21	4.79	6.12	4.07	8.92	5.93	7.32	4.87	10.9	7.25
13	4.59	3.05	7.43	4.94	6.84	4.55	9.32	6.20	8.20	5.46	11.5	7.62
14	4.95	3.29	7.66	5.10	7.71	5.13	9.75	6.49	9.28	6.17	12.1	8.02
15	5.37	3.57	7.91	5.26	8.79	5.85	10.2	6.81	10.6	7.06	12.7	8.47
16	5.85	3.89	8.18	5.44	10.0	6.66	10.8	7.16	12.1	8.03	13.7	9.12
17	6.42	4.27	8.46	5.63	11.3	7.51	11.5	7.63	13.6	9.07	15.0	10.0
18	7.08	4.71	8.77	5.83	12.7	8.42	12.4	8.27	15.3	10.2	16.3	10.9
19	7.87	5.24	9.09	6.05	14.1	9.39	13.4	8.91	17.0	11.3	17.7	11.8
20	8.72	5.80	9.45	6.29	15.6	10.4	14.4	9.56	18.9	12.5	19.0	12.7
22	10.5	7.02	10.5	6.96	18.9	12.6	16.3	10.8	22.8	15.2	21.7	14.4
24	12.6	8.35	11.8	7.82	22.5	15.0	18.2	12.1	27.2	18.1	24.4	16.2
26	14.7	9.80	13.1	8.69								
28	17.1	11.4	14.4	9.56								
30	19.6	13.1	15.7	10.4								
32	22.3	14.9	16.9	11.3								

Other Constants and Properties

	40		35[c]		30[c]	
$b_y \times 10^3$ (kip-ft)$^{-1}$	21.2	14.1	31.0	20.6	37.3	24.8
$t_y \times 10^3$ (kips)$^{-1}$	2.85	1.90	3.23	2.15	3.79	2.53
$t_r \times 10^3$ (kips)$^{-1}$	3.51	2.34	3.97	2.65	4.67	3.11
r_x/r_y	2.64		3.41		3.43	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

W12

Shape	W12×											
	26^c				22^c				19^c			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	4.66	3.10	9.58	6.37	5.41	3.60	12.2	8.09	6.52	4.34	14.4	9.60
1	4.68	3.11	9.58	6.37	5.48	3.64	12.2	8.09	6.60	4.39	14.4	9.60
2	4.73	3.15	9.58	6.37	5.67	3.77	12.2	8.09	6.84	4.55	14.4	9.60
3	4.82	3.21	9.58	6.37	6.03	4.01	12.2	8.09	7.27	4.84	14.5	9.66
4	4.95	3.30	9.58	6.37	6.58	4.38	13.0	8.64	7.95	5.29	15.6	10.4
5	5.13	3.41	9.58	6.37	7.43	4.94	13.9	9.27	8.96	5.96	16.9	11.2
6	5.36	3.57	9.83	6.54	8.73	5.81	15.0	10.0	10.5	6.99	18.4	12.2
7	5.65	3.76	10.2	6.81	10.6	7.02	16.3	10.9	12.9	8.56	20.1	13.4
8	6.00	3.99	10.7	7.11	13.2	8.75	17.8	11.9	16.3	10.8	22.3	14.8
9	6.44	4.28	11.2	7.43	16.6	11.1	19.7	13.1	20.6	13.7	25.7	17.1
10	6.98	4.64	11.7	7.78	20.6	13.7	22.9	15.2	25.4	16.9	30.4	20.2
11	7.64	5.08	12.3	8.17	24.9	16.5	26.3	17.5	30.8	20.5	35.2	23.4
12	8.49	5.65	12.9	8.60	29.6	19.7	29.8	19.8	36.6	24.4	40.0	26.6
13	9.53	6.34	13.6	9.08	34.7	23.1	33.3	22.2	43.0	28.6	45.0	29.9
14	10.8	7.19	14.4	9.61	40.3	26.8	36.9	24.5				
15	12.4	8.23	15.4	10.3								
16	14.1	9.36	17.1	11.4								
17	15.9	10.6	18.8	12.5								
18	17.8	11.8	20.6	13.7								
19	19.8	13.2	22.3	14.8								
20	22.0	14.6	24.1	16.0								
21	24.2	16.1	25.9	17.2								
22	26.6	17.7	27.6	18.4								
23	29.1	19.3	29.4	19.6								
24	31.7	21.1	31.2	20.8								
25	34.3	22.9	33.0	22.0								

Other Constants and Properties

	26^c ASD	26^c LRFD	22^c ASD	22^c LRFD	19^c ASD	19^c LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	43.6	29.0	97.3	64.8	120	79.5
$t_y \times 10^3$ (kips)$^{-1}$	4.36	2.91	5.14	3.43	5.98	3.99
$t_r \times 10^3$ (kips)$^{-1}$	5.37	3.58	6.33	4.22	7.36	4.91
r_x/r_y	3.42		5.79		5.86	

^c Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

W12

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W12×							
		16[c]				14[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length *KL* (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	7.97	5.30	17.7	11.8	9.40	6.25	20.5	13.6
	1	8.07	5.37	17.7	11.8	9.52	6.33	20.5	13.6
	2	8.39	5.58	17.7	11.8	9.89	6.58	20.5	13.6
	3	8.96	5.96	18.1	12.0	10.6	7.03	21.0	14.0
	4	9.86	6.56	19.6	13.1	11.6	7.74	22.9	15.2
	5	11.3	7.49	21.4	14.3	13.3	8.84	25.1	16.7
	6	13.4	8.90	23.6	15.7	15.9	10.6	27.8	18.5
	7	16.8	11.2	26.3	17.5	20.0	13.3	31.1	20.7
	8	21.8	14.5	29.6	19.7	26.0	17.3	36.3	24.1
	9	27.6	18.3	36.1	24.0	32.9	21.9	44.5	29.6
	10	34.0	22.6	43.0	28.6	40.7	27.1	53.2	35.4
	11	41.2	27.4	50.1	33.3	49.2	32.7	62.3	41.4
	12	49.0	32.6	57.4	38.2	58.5	39.0	71.6	47.6

Other Constants and Properties

	16[c] ASD	16[c] LRFD	14[c] ASD	14[c] LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	158	105	188	125
$t_y \times 10^3$ (kips)$^{-1}$	7.07	4.72	8.02	5.35
$t_r \times 10^3$ (kips)$^{-1}$	8.70	5.80	9.87	6.58
r_x/r_y	6.04		6.14	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates *Kl/r* equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W10

Shape	W10× 112				W10× 100				W10× 88			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.01	0.675	2.42	1.61	1.14	0.756	2.74	1.82	1.29	0.858	3.15	2.10
6	1.07	0.711	2.42	1.61	1.20	0.798	2.74	1.82	1.36	0.906	3.15	2.10
7	1.09	0.725	2.42	1.61	1.22	0.813	2.74	1.82	1.39	0.924	3.15	2.10
8	1.11	0.741	2.42	1.61	1.25	0.832	2.74	1.82	1.42	0.946	3.15	2.10
9	1.14	0.760	2.42	1.61	1.28	0.853	2.74	1.82	1.46	0.971	3.15	2.10
10	1.17	0.781	2.43	1.62	1.32	0.878	2.75	1.83	1.50	0.999	3.17	2.11
11	1.21	0.806	2.45	1.63	1.36	0.906	2.78	1.85	1.55	1.03	3.20	2.13
12	1.25	0.833	2.47	1.64	1.41	0.938	2.80	1.86	1.61	1.07	3.23	2.15
13	1.30	0.864	2.49	1.66	1.46	0.974	2.82	1.88	1.67	1.11	3.27	2.17
14	1.35	0.899	2.51	1.67	1.52	1.01	2.85	1.90	1.74	1.16	3.30	2.19
15	1.41	0.938	2.53	1.68	1.59	1.06	2.87	1.91	1.82	1.21	3.33	2.22
16	1.48	0.982	2.54	1.69	1.67	1.11	2.90	1.93	1.90	1.27	3.36	2.24
17	1.55	1.03	2.56	1.71	1.75	1.17	2.92	1.95	2.00	1.33	3.40	2.26
18	1.63	1.08	2.58	1.72	1.85	1.23	2.95	1.96	2.11	1.41	3.43	2.28
19	1.72	1.15	2.60	1.73	1.95	1.30	2.98	1.98	2.23	1.49	3.47	2.31
20	1.82	1.21	2.63	1.75	2.07	1.38	3.00	2.00	2.37	1.58	3.50	2.33
22	2.06	1.37	2.67	1.77	2.35	1.56	3.06	2.03	2.69	1.79	3.58	2.38
24	2.36	1.57	2.71	1.80	2.69	1.79	3.12	2.07	3.10	2.06	3.65	2.43
26	2.74	1.82	2.76	1.83	3.14	2.09	3.17	2.11	3.62	2.41	3.73	2.48
28	3.17	2.11	2.80	1.86	3.64	2.42	3.24	2.15	4.19	2.79	3.82	2.54
30	3.64	2.42	2.85	1.90	4.18	2.78	3.30	2.20	4.81	3.20	3.91	2.60
32	4.15	2.76	2.90	1.93	4.75	3.16	3.37	2.24	5.48	3.64	4.00	2.66
34	4.68	3.11	2.95	1.96	5.36	3.57	3.44	2.29	6.18	4.11	4.10	2.73
36	5.25	3.49	3.01	2.00	6.01	4.00	3.51	2.33	6.93	4.61	4.20	2.79
38	5.85	3.89	3.06	2.04	6.70	4.46	3.58	2.38	7.72	5.14	4.30	2.86
40	6.48	4.31	3.12	2.07	7.42	4.94	3.66	2.44	8.56	5.69	4.42	2.94

Other Constants and Properties

	W10×112 ASD	W10×112 LRFD	W10×100 ASD	W10×100 LRFD	W10×88 ASD	W10×88 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	5.15	3.43	5.84	3.89	6.71	4.46
$t_y \times 10^3$ (kips)$^{-1}$	1.01	0.675	1.13	0.756	1.29	0.858
$t_r \times 10^3$ (kips)$^{-1}$	1.25	0.830	1.40	0.930	1.58	1.06
r_x/r_y	1.74		1.74		1.73	

W10

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W10× 77				W10× 68				W10× 60			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	1.48	0.982	3.65	2.43	1.67	1.11	4.18	2.78	1.89	1.26	4.78	3.18
6	1.56	1.04	3.65	2.43	1.77	1.18	4.18	2.78	2.00	1.33	4.78	3.18
7	1.59	1.06	3.65	2.43	1.81	1.20	4.18	2.78	2.05	1.36	4.78	3.18
8	1.63	1.08	3.65	2.43	1.85	1.23	4.18	2.78	2.10	1.39	4.78	3.18
9	1.67	1.11	3.65	2.43	1.90	1.26	4.18	2.78	2.15	1.43	4.78	3.18
10	1.72	1.15	3.68	2.45	1.96	1.30	4.22	2.81	2.22	1.48	4.84	3.22
11	1.78	1.19	3.72	2.48	2.02	1.34	4.27	2.84	2.30	1.53	4.90	3.26
12	1.85	1.23	3.76	2.50	2.10	1.39	4.33	2.88	2.38	1.58	4.97	3.31
13	1.92	1.28	3.80	2.53	2.18	1.45	4.38	2.91	2.48	1.65	5.04	3.36
14	2.00	1.33	3.85	2.56	2.27	1.51	4.44	2.95	2.59	1.72	5.12	3.41
15	2.09	1.39	3.89	2.59	2.38	1.58	4.49	2.99	2.71	1.80	5.19	3.46
16	2.20	1.46	3.94	2.62	2.50	1.66	4.55	3.03	2.85	1.89	5.27	3.51
17	2.31	1.54	3.98	2.65	2.63	1.75	4.61	3.07	3.00	2.00	5.35	3.56
18	2.44	1.63	4.03	2.68	2.78	1.85	4.68	3.11	3.17	2.11	5.43	3.62
19	2.59	1.72	4.08	2.71	2.95	1.96	4.74	3.15	3.37	2.24	5.52	3.67
20	2.75	1.83	4.13	2.74	3.13	2.08	4.81	3.20	3.58	2.38	5.61	3.73
22	3.14	2.09	4.23	2.81	3.57	2.38	4.94	3.29	4.09	2.72	5.79	3.85
24	3.62	2.41	4.33	2.88	4.13	2.75	5.09	3.39	4.74	3.15	5.99	3.99
26	4.23	2.82	4.45	2.96	4.83	3.22	5.24	3.49	5.56	3.70	6.20	4.13
28	4.91	3.27	4.56	3.04	5.60	3.73	5.41	3.60	6.44	4.29	6.43	4.28
30	5.63	3.75	4.69	3.12	6.43	4.28	5.58	3.71	7.40	4.92	6.67	4.44
32	6.41	4.26	4.82	3.21	7.32	4.87	5.77	3.84	8.42	5.60	6.94	4.61
34	7.24	4.81	4.96	3.30	8.26	5.50	5.96	3.97	9.50	6.32	7.22	4.80
36	8.11	5.40	5.11	3.40	9.26	6.16	6.18	4.11	10.7	7.09	7.53	5.01
38	9.04	6.01	5.27	3.50	10.3	6.87	6.40	4.26	11.9	7.90	7.96	5.30
40	10.0	6.66	5.43	3.61	11.4	7.61	6.65	4.43	13.2	8.75	8.43	5.61

Other Constants and Properties

	77		68		60	
$b_y \times 10^3$ (kip-ft)$^{-1}$	7.76	5.16	8.88	5.91	10.2	6.77
$t_y \times 10^3$ (kips)$^{-1}$	1.47	0.982	1.67	1.11	1.89	1.26
$t_r \times 10^3$ (kips)$^{-1}$	1.81	1.21	2.05	1.37	2.33	1.55
r_x/r_y	1.73		1.71		1.71	

Table 6-1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

W10

Shape		W10× 54				W10× 49				W10× 45			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	2.11	1.40	5.35	3.56	2.32	1.54	5.90	3.92	2.52	1.68	6.49	4.32
	6	2.24	1.49	5.35	3.56	2.46	1.63	5.90	3.92	2.77	1.84	6.49	4.32
	7	2.28	1.52	5.35	3.56	2.51	1.67	5.90	3.92	2.86	1.90	6.49	4.32
	8	2.34	1.56	5.35	3.56	2.57	1.71	5.90	3.92	2.98	1.98	6.60	4.39
	9	2.40	1.60	5.35	3.56	2.64	1.76	5.90	3.93	3.11	2.07	6.73	4.48
	10	2.48	1.65	5.43	3.61	2.73	1.81	6.00	3.99	3.27	2.17	6.87	4.57
	11	2.56	1.71	5.51	3.67	2.82	1.88	6.10	4.06	3.45	2.30	7.01	4.66
	12	2.66	1.77	5.60	3.72	2.93	1.95	6.20	4.13	3.67	2.44	7.15	4.76
	13	2.77	1.84	5.69	3.78	3.05	2.03	6.31	4.20	3.91	2.60	7.30	4.86
	14	2.89	1.92	5.78	3.84	3.19	2.12	6.42	4.27	4.20	2.79	7.46	4.96
	15	3.03	2.02	5.87	3.91	3.34	2.22	6.54	4.35	4.53	3.01	7.63	5.07
	16	3.18	2.12	5.97	3.97	3.52	2.34	6.66	4.43	4.91	3.27	7.80	5.19
	17	3.36	2.23	6.07	4.04	3.71	2.47	6.78	4.51	5.35	3.56	7.98	5.31
	18	3.55	2.36	6.18	4.11	3.93	2.61	6.91	4.60	5.86	3.90	8.17	5.44
	19	3.77	2.51	6.29	4.18	4.17	2.78	7.04	4.69	6.46	4.30	8.37	5.57
	20	4.01	2.67	6.40	4.26	4.45	2.96	7.18	4.78	7.15	4.76	8.58	5.71
	22	4.59	3.06	6.64	4.41	5.10	3.39	7.48	4.98	8.66	5.76	9.03	6.01
	24	5.32	3.54	6.89	4.58	5.93	3.94	7.80	5.19	10.3	6.85	9.53	6.34
	26	6.24	4.15	7.17	4.77	6.96	4.63	8.15	5.42	12.1	8.04	10.1	6.71
	28	7.24	4.82	7.47	4.97	8.07	5.37	8.53	5.68	14.0	9.33	10.9	7.23
	30	8.31	5.53	7.79	5.18	9.26	6.16	8.95	5.96	16.1	10.7	11.8	7.82
	32	9.46	6.29	8.15	5.42	10.5	7.01	9.47	6.30	18.3	12.2	12.6	8.41
	34	10.7	7.10	8.57	5.70	11.9	7.92	10.2	6.77				
	36	12.0	7.96	9.15	6.09	13.3	8.88	10.9	7.24				
	38	13.3	8.87	9.73	6.48	14.9	9.89	11.6	7.71				
	40	14.8	9.83	10.3	6.86	16.5	11.0	12.3	8.18				
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		11.4		7.57		12.6		8.38		17.6		11.7	
$t_y \times 10^3$ (kips)$^{-1}$		2.11		1.40		2.31		1.54		2.51		1.68	
$t_r \times 10^3$ (kips)$^{-1}$		2.59		1.73		2.84		1.90		3.09		2.06	
r_x/r_y		1.71				1.71				2.15			

Note: Heavy line indicates Kl/r equal to or greater than 200.

W10

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W10×39				W10×33				W10×30			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	2.91	1.94	7.61	5.06	3.44	2.29	9.18	6.11	3.78	2.51	9.73	6.48
6	3.21	2.13	7.61	5.06	3.80	2.53	9.18	6.11	4.62	3.08	10.1	6.74
7	3.32	2.21	7.61	5.07	3.95	2.63	9.22	6.13	4.97	3.31	10.5	6.99
8	3.46	2.30	7.78	5.18	4.11	2.74	9.45	6.29	5.41	3.60	10.9	7.25
9	3.62	2.41	7.96	5.29	4.31	2.87	9.70	6.45	5.95	3.96	11.3	7.53
10	3.81	2.53	8.14	5.41	4.55	3.03	10.0	6.62	6.62	4.41	11.8	7.84
11	4.03	2.68	8.33	5.54	4.83	3.21	10.2	6.80	7.45	4.96	12.3	8.17
12	4.29	2.85	8.53	5.68	5.15	3.42	10.5	7.00	8.48	5.64	12.8	8.54
13	4.58	3.05	8.74	5.81	5.52	3.67	10.8	7.20	9.76	6.49	13.4	8.93
14	4.93	3.28	8.96	5.96	5.95	3.96	11.1	7.42	11.3	7.53	14.1	9.37
15	5.33	3.55	9.19	6.12	6.46	4.30	11.5	7.64	13.0	8.65	14.8	9.85
16	5.79	3.85	9.44	6.28	7.04	4.68	11.9	7.89	14.8	9.84	15.6	10.4
17	6.33	4.21	9.70	6.45	7.72	5.14	12.2	8.15	16.7	11.1	16.8	11.2
18	6.95	4.63	10.0	6.63	8.52	5.67	12.7	8.42	18.7	12.4	18.1	12.1
19	7.69	5.12	10.3	6.82	9.46	6.30	13.1	8.72	20.8	13.9	19.4	12.9
20	8.52	5.67	10.6	7.03	10.5	6.98	13.6	9.04	23.1	15.4	20.7	13.7
22	10.3	6.86	11.2	7.47	12.7	8.44	14.7	9.80	28.0	18.6	23.2	15.4
24	12.3	8.17	12.0	7.98	15.1	10.0	16.5	11.0				
26	14.4	9.58	13.2	8.77	17.7	11.8	18.3	12.2				
28	16.7	11.1	14.4	9.59	20.6	13.7	20.1	13.3				
30	19.2	12.8	15.6	10.4	23.6	15.7	21.8	14.5				
32	21.8	14.5	16.8	11.2	26.8	17.9	23.6	15.7				

Other Constants and Properties

	W10×39		W10×33		W10×30	
$b_y \times 10^3$ (kip-ft)$^{-1}$	20.7	13.8	25.4	16.9	40.3	26.8
$t_y \times 10^3$ (kips)$^{-1}$	2.91	1.94	3.43	2.29	3.77	2.51
$t_r \times 10^3$ (kips)$^{-1}$	3.58	2.39	4.23	2.82	4.64	3.09
r_x/r_y	2.16		2.16		3.20	

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W10

Shape		W10×											
		26				22^c				19			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	4.39	2.92	11.4	7.57	5.19	3.45	13.7	9.12	5.95	3.96	16.5	11.0
	1	4.41	2.94	11.4	7.57	5.22	3.47	13.7	9.12	6.03	4.01	16.5	11.0
	2	4.49	2.99	11.4	7.57	5.30	3.53	13.7	9.12	6.28	4.18	16.5	11.0
	3	4.62	3.07	11.4	7.57	5.44	3.62	13.7	9.12	6.73	4.48	16.5	11.0
	4	4.81	3.20	11.4	7.57	5.66	3.77	13.7	9.12	7.42	4.93	17.4	11.6
	5	5.06	3.37	11.5	7.63	5.98	3.98	13.9	9.23	8.39	5.59	18.6	12.4
	6	5.39	3.58	11.9	7.93	6.38	4.25	14.5	9.63	9.77	6.50	19.9	13.2
	7	5.80	3.86	12.4	8.25	6.89	4.59	15.1	10.1	11.7	7.78	21.4	14.3
	8	6.32	4.20	12.9	8.59	7.54	5.02	15.9	10.6	14.4	9.56	23.2	15.4
	9	6.96	4.63	13.5	8.97	8.34	5.55	16.7	11.1	18.1	12.0	25.3	16.8
	10	7.75	5.16	14.1	9.39	9.34	6.21	17.5	11.7	22.3	14.9	28.2	18.8
	11	8.74	5.81	14.8	9.84	10.6	7.04	18.5	12.3	27.0	18.0	32.3	21.5
	12	10.0	6.63	15.5	10.3	12.1	8.07	19.6	13.0	32.2	21.4	36.4	24.2
	13	11.5	7.65	16.4	10.9	14.1	9.39	20.8	13.9	37.7	25.1	40.5	27.0
	14	13.3	8.87	17.3	11.5	16.4	10.9	22.4	14.9	43.8	29.1	44.7	29.7
	15	15.3	10.2	18.4	12.2	18.8	12.5	24.9	16.6				
	16	17.4	11.6	20.1	13.4	21.4	14.2	27.3	18.2				
	17	19.7	13.1	21.8	14.5	24.1	16.1	29.8	19.8				
	18	22.0	14.7	23.6	15.7	27.1	18.0	32.3	21.5				
	19	24.6	16.3	25.3	16.8	30.1	20.1	34.8	23.1				
	20	27.2	18.1	27.0	18.0	33.4	22.2	37.3	24.8				
	21	30.0	20.0	28.8	19.1	36.8	24.5	39.8	26.5				
	22	32.9	21.9	30.5	20.3	40.4	26.9	42.3	28.1				
Other Constants and Properties													
$b_y \times 10^3$ (kip-ft)$^{-1}$		47.5		31.6		58.4		38.9		106		70.8	
$t_y \times 10^3$ (kips)$^{-1}$		4.38		2.92		5.14		3.43		5.94		3.96	
$t_r \times 10^3$ (kips)$^{-1}$		5.39		3.59		6.33		4.22		7.31		4.87	
r_x/r_y		3.20				3.21				4.74			

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W10

F_y = 50 ksi

Shape		W10×											
		17[c]				15[c]				12[c]			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	6.76	4.50	19.1	12.7	7.77	5.17	22.3	14.8	10.3	6.88	28.5	19.0
	1	6.85	4.55	19.1	12.7	7.87	5.23	22.3	14.8	10.5	6.97	28.5	19.0
	2	7.11	4.73	19.1	12.7	8.19	5.45	22.3	14.8	10.9	7.24	28.5	19.0
	3	7.64	5.08	19.1	12.7	8.76	5.83	22.5	15.0	11.6	7.74	28.8	19.1
	4	8.47	5.64	20.4	13.6	9.79	6.51	24.2	16.1	12.8	8.53	31.1	20.7
	5	9.67	6.44	21.9	14.6	11.3	7.53	26.1	17.4	14.6	9.74	33.9	22.6
	6	11.4	7.57	23.6	15.7	13.5	8.98	28.4	18.9	17.5	11.6	37.3	24.8
	7	13.8	9.17	25.7	17.1	16.6	11.1	31.2	20.7	21.8	14.5	41.3	27.5
	8	17.2	11.4	28.1	18.7	21.2	14.1	34.5	22.9	28.1	18.7	46.4	30.9
	9	21.8	14.5	31.0	20.6	26.8	17.8	39.7	26.4	35.6	23.7	56.5	37.6
	10	26.9	17.9	36.1	24.0	33.1	22.0	46.8	31.1	44.0	29.3	67.2	44.7
	11	32.5	21.6	41.6	27.7	40.1	26.7	54.1	36.0	53.2	35.4	78.3	52.1
	12	38.7	25.8	47.0	31.3	47.7	31.7	61.4	40.9	63.3	42.1	89.7	59.7
	13	45.4	30.2	52.6	35.0	55.9	37.2	68.9	45.8	74.3	49.4	101	67.3
	14	52.7	35.1	58.1	38.6								

Other Constants and Properties

	W10×17		W10×15		W10×12	
$b_y \times 10^3$ (kip-ft)$^{-1}$	127	84.7	155	103	207	138
$t_y \times 10^3$ (kips)$^{-1}$	6.68	4.45	7.56	5.04	9.43	6.29
$t_r \times 10^3$ (kips)$^{-1}$	8.22	5.48	9.30	6.20	11.6	7.74
r_x/r_y	4.79		4.88		4.97	

[c] Shape is slender for compression with F_y = 50 ksi.

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W8

Shape		W8×											
		67				58				48			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	1.70	1.13	5.08	3.38	1.95	1.30	5.96	3.96	2.37	1.58	7.27	4.84
	6	1.85	1.23	5.08	3.38	2.13	1.42	5.96	3.96	2.59	1.72	7.27	4.84
	7	1.90	1.27	5.08	3.38	2.20	1.46	5.96	3.96	2.67	1.78	7.27	4.84
	8	1.97	1.31	5.11	3.40	2.28	1.52	6.00	3.99	2.77	1.84	7.34	4.88
	9	2.05	1.37	5.16	3.43	2.37	1.58	6.07	4.04	2.89	1.92	7.44	4.95
	10	2.15	1.43	5.21	3.47	2.48	1.65	6.14	4.08	3.02	2.01	7.55	5.02
	11	2.25	1.50	5.26	3.50	2.61	1.74	6.21	4.13	3.18	2.12	7.66	5.09
	12	2.38	1.58	5.32	3.54	2.76	1.83	6.29	4.18	3.36	2.24	7.77	5.17
	13	2.52	1.68	5.37	3.58	2.93	1.95	6.36	4.23	3.57	2.38	7.88	5.25
	14	2.69	1.79	5.43	3.61	3.12	2.08	6.44	4.29	3.82	2.54	8.00	5.32
	15	2.87	1.91	5.49	3.65	3.35	2.23	6.52	4.34	4.10	2.73	8.13	5.41
	16	3.09	2.06	5.55	3.69	3.60	2.40	6.61	4.39	4.42	2.94	8.25	5.49
	17	3.34	2.22	5.61	3.73	3.90	2.59	6.69	4.45	4.79	3.19	8.38	5.58
	18	3.63	2.41	5.67	3.77	4.24	2.82	6.78	4.51	5.21	3.47	8.52	5.67
	19	3.95	2.63	5.73	3.82	4.63	3.08	6.87	4.57	5.70	3.80	8.66	5.76
	20	4.33	2.88	5.80	3.86	5.09	3.38	6.96	4.63	6.28	4.18	8.80	5.86
	22	5.24	3.49	5.93	3.95	6.15	4.09	7.15	4.76	7.60	5.06	9.11	6.06
	24	6.24	4.15	6.07	4.04	7.32	4.87	7.35	4.89	9.05	6.02	9.43	6.27
	26	7.32	4.87	6.22	4.14	8.60	5.72	7.56	5.03	10.6	7.07	9.78	6.51
	28	8.49	5.65	6.37	4.24	9.97	6.63	7.79	5.18	12.3	8.19	10.2	6.76
	30	9.75	6.49	6.53	4.35	11.4	7.61	8.03	5.34	14.1	9.41	10.6	7.03
	32	11.1	7.38	6.71	4.46	13.0	8.66	8.28	5.51	16.1	10.7	11.0	7.32
	34	12.5	8.33	6.88	4.58	14.7	9.78	8.56	5.69	18.2	12.1	11.5	7.64

Other Constants and Properties

	67 ASD	67 LRFD	58 ASD	58 LRFD	48 ASD	48 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	10.9	7.25	12.8	8.50	15.6	10.4
$t_y \times 10^3$ (kips)$^{-1}$	1.69	1.13	1.95	1.30	2.36	1.58
$t_r \times 10^3$ (kips)$^{-1}$	2.09	1.39	2.40	1.60	2.91	1.94
r_x/r_y	1.75		1.74		1.74	

Note: Heavy line indicates Kl/r equal to or greater than 200.

W8

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape		W8×							
		40				35			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	2.85	1.89	8.95	5.96	3.25	2.16	10.3	6.83
	6	3.12	2.07	8.95	5.96	3.56	2.37	10.3	6.83
	7	3.22	2.14	8.95	5.96	3.68	2.45	10.3	6.83
	8	3.35	2.23	9.07	6.04	3.82	2.54	10.4	6.94
	9	3.49	2.32	9.23	6.14	3.99	2.66	10.6	7.07
	10	3.66	2.44	9.39	6.24	4.19	2.79	10.8	7.21
	11	3.86	2.57	9.55	6.35	4.42	2.94	11.1	7.36
	12	4.10	2.73	9.72	6.47	4.69	3.12	11.3	7.51
	13	4.36	2.90	9.90	6.59	5.00	3.33	11.5	7.66
	14	4.67	3.11	10.1	6.71	5.36	3.57	11.8	7.83
	15	5.03	3.35	10.3	6.84	5.77	3.84	12.0	8.00
	16	5.44	3.62	10.5	6.97	6.25	4.16	12.3	8.18
	17	5.91	3.93	10.7	7.11	6.80	4.52	12.6	8.37
	18	6.46	4.30	10.9	7.25	7.43	4.95	12.9	8.56
	19	7.09	4.72	11.1	7.40	8.17	5.44	13.2	8.77
	20	7.84	5.22	11.4	7.56	9.04	6.02	13.5	8.98
	22	9.49	6.32	11.9	7.89	10.9	7.28	14.2	9.44
	24	11.3	7.52	12.4	8.25	13.0	8.66	15.0	9.96
	26	13.3	8.82	13.0	8.65	15.3	10.2	15.8	10.5
	28	15.4	10.2	13.6	9.08	17.7	11.8	17.0	11.3
	30	17.7	11.7	14.4	9.58	20.3	13.5	18.4	12.2
	32	20.1	13.4	15.5	10.3	23.2	15.4	19.8	13.2
	34	22.7	15.1	16.5	11.0				
Other Constants and Properties									
$b_y \times 10^3$ (kip-ft)$^{-1}$		19.3		12.8		22.1		14.7	
$t_y \times 10^3$ (kips)$^{-1}$		2.84		1.89		3.24		2.16	
$t_r \times 10^3$ (kips)$^{-1}$		3.50		2.33		3.99		2.66	
r_x/r_y		1.73				1.73			

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W8

Shape		W8×							
		31				28			
Design		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	0	3.66	2.44	11.7	7.80	4.05	2.70	13.1	8.71
	6	4.02	2.67	11.7	7.80	4.68	3.11	13.2	8.77
	7	4.16	2.76	11.7	7.80	4.93	3.28	13.5	9.00
	8	4.32	2.87	11.9	7.94	5.24	3.49	13.9	9.23
	9	4.51	3.00	12.2	8.11	5.61	3.73	14.2	9.48
	10	4.74	3.15	12.5	8.29	6.05	4.03	14.6	9.74
	11	5.00	3.33	12.7	8.48	6.58	4.38	15.0	10.00
	12	5.31	3.53	13.0	8.67	7.22	4.80	15.5	10.3
	13	5.66	3.77	13.3	8.88	7.98	5.31	15.9	10.6
	14	6.07	4.04	13.7	9.09	8.90	5.92	16.4	10.9
	15	6.54	4.35	14.0	9.32	9.99	6.65	17.0	11.3
	16	7.09	4.72	14.4	9.56	11.3	7.54	17.5	11.7
	17	7.72	5.14	14.7	9.81	12.8	8.52	18.1	12.0
	18	8.45	5.62	15.1	10.1	14.3	9.55	18.7	12.5
	19	9.30	6.18	15.6	10.3	16.0	10.6	19.4	12.9
	20	10.3	6.85	16.0	10.6	17.7	11.8	20.2	13.4
	22	12.5	8.29	17.0	11.3	21.4	14.3	22.2	14.7
	24	14.8	9.87	18.0	12.0	25.5	17.0	24.5	16.3
	26	17.4	11.6	19.6	13.1	29.9	19.9	26.9	17.9
	28	20.2	13.4	21.4	14.3				
	30	23.2	15.4	23.3	15.5				
	32	26.4	17.5	25.1	16.7				

Other Constants and Properties

	31		28	
$b_y \times 10^3$ (kip-ft)$^{-1}$	25.3	16.8	35.3	23.5
$t_y \times 10^3$ (kips)$^{-1}$	3.65	2.44	4.04	2.70
$t_r \times 10^3$ (kips)$^{-1}$	4.50	3.00	4.98	3.32
r_x/r_y	1.72		2.13	

Note: Heavy line indicates Kl/r equal to or greater than 200.

W8

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

F_y = 50 ksi

Shape	W8× 24				W8× 21				W8× 18			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	4.72	3.14	15.4	10.3	5.42	3.61	17.5	11.6	6.35	4.22	21.0	13.9
1	4.74	3.15	15.4	10.3	5.46	3.63	17.5	11.6	6.39	4.25	21.0	13.9
2	4.80	3.19	15.4	10.3	5.56	3.70	17.5	11.6	6.53	4.34	21.0	13.9
3	4.90	3.26	15.4	10.3	5.75	3.83	17.5	11.6	6.76	4.50	21.0	13.9
4	5.04	3.35	15.4	10.3	6.03	4.01	17.5	11.6	7.09	4.72	21.0	13.9
5	5.22	3.48	15.4	10.3	6.40	4.26	17.8	11.9	7.55	5.03	21.5	14.3
6	5.46	3.63	15.6	10.4	6.88	4.58	18.5	12.3	8.15	5.42	22.5	15.0
7	5.76	3.83	16.0	10.6	7.50	4.99	19.3	12.8	8.93	5.94	23.5	15.6
8	6.12	4.07	16.5	11.0	8.28	5.51	20.1	13.3	9.91	6.59	24.6	16.4
9	6.56	4.36	17.0	11.3	9.27	6.17	20.9	13.9	11.2	7.42	25.9	17.2
10	7.09	4.71	17.5	11.6	10.5	7.00	21.9	14.6	12.7	8.47	27.3	18.1
11	7.72	5.13	18.1	12.0	12.1	8.04	22.9	15.3	14.7	9.80	28.8	19.2
12	8.47	5.64	18.7	12.4	14.1	9.38	24.1	16.0	17.3	11.5	30.5	20.3
13	9.38	6.24	19.3	12.9	16.5	11.0	25.4	16.9	20.3	13.5	32.5	21.6
14	10.5	6.96	20.0	13.3	19.2	12.8	26.8	17.8	23.6	15.7	35.3	23.5
15	11.8	7.83	20.7	13.8	22.0	14.7	28.6	19.0	27.1	18.0	38.8	25.8
16	13.4	8.90	21.5	14.3	25.1	16.7	31.1	20.7	30.8	20.5	42.4	28.2
17	15.1	10.0	22.4	14.9	28.3	18.8	33.5	22.3	34.8	23.1	45.9	30.5
18	16.9	11.3	23.3	15.5	31.7	21.1	36.0	24.0	39.0	25.9	49.4	32.9
19	18.9	12.5	24.4	16.2	35.3	23.5	38.5	25.6	43.4	28.9	52.9	35.2
20	20.9	13.9	26.0	17.3	39.2	26.1	40.9	27.2	48.1	32.0	56.4	37.5
21	23.0	15.3	27.6	18.4	43.2	28.7	43.3	28.8				
22	25.3	16.8	29.3	19.5								
23	27.6	18.4	30.9	20.5								
24	30.1	20.0	32.5	21.6								
25	32.6	21.7	34.1	22.7								

Other Constants and Properties

	W8×24 ASD	W8×24 LRFD	W8×21 ASD	W8×21 LRFD	W8×18 ASD	W8×18 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	41.6	27.7	62.6	41.7	76.5	50.9
$t_y \times 10^3$ (kips)$^{-1}$	4.71	3.14	5.41	3.61	6.33	4.22
$t_r \times 10^3$ (kips)$^{-1}$	5.80	3.87	6.66	4.44	7.80	5.20
r_x/r_y	2.12		2.77		2.79	

Note: Heavy line indicates Kl/r equal to or greater than 200.

F_y = 50 ksi

Table 6–1 (continued)
Combined Axial and Bending
W Shapes

W8

Shape	W8× 15				W8× 13				W8× 10[c,f]			
Design	$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$		$p \times 10^3$ (kips)$^{-1}$		$b_x \times 10^3$ (kip-ft)$^{-1}$	
Effective length KL (ft) with respect to least radius of gyration r_y or Unbraced Length L_b (ft) for X-X axis bending	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	7.52	5.01	26.2	17.4	8.70	5.79	31.3	20.8	11.7	7.77	40.6	27.0
1	7.63	5.07	26.2	17.4	8.83	5.88	31.3	20.8	11.8	7.86	40.6	27.0
2	7.95	5.29	26.2	17.4	9.23	6.14	31.3	20.8	12.3	8.16	40.6	27.0
3	8.51	5.66	26.2	17.4	9.94	6.62	31.3	20.8	13.1	8.70	40.6	27.0
4	9.37	6.23	27.6	18.4	11.0	7.34	33.4	22.2	14.3	9.53	43.2	28.8
5	10.6	7.05	29.4	19.5	12.6	8.39	35.7	23.8	16.3	10.9	46.7	31.0
6	12.3	8.20	31.3	20.9	14.8	9.87	38.5	25.6	19.3	12.8	50.7	33.7
7	14.7	9.81	33.6	22.4	18.0	12.0	41.6	27.7	23.4	15.5	55.5	36.9
8	18.1	12.0	36.2	24.1	22.5	15.0	45.4	30.2	29.2	19.5	61.3	40.8
9	22.8	15.2	39.3	26.1	28.5	18.9	49.9	33.2	37.0	24.6	70.7	47.1
10	28.1	18.7	42.9	28.6	35.1	23.4	57.2	38.1	45.7	30.4	83.6	55.7
11	34.0	22.6	48.9	32.5	42.5	28.3	65.6	43.7	55.3	36.8	96.9	64.4
12	40.5	26.9	54.9	36.6	50.6	33.7	74.0	49.3	65.8	43.8	110	73.4
13	47.5	31.6	61.0	40.6	59.4	39.5	82.5	54.9	77.2	51.4	124	82.5
14	55.1	36.7	67.0	44.6	68.9	45.8	90.9	60.5	89.6	59.6	138	91.6

Other Constants and Properties

	W8×15 ASD	W8×15 LRFD	W8×13 ASD	W8×13 LRFD	W8×10 ASD	W8×10 LRFD
$b_y \times 10^3$ (kip-ft)$^{-1}$	133	88.8	166	110	218	145
$t_y \times 10^3$ (kips)$^{-1}$	7.51	5.01	8.69	5.79	11.2	7.50
$t_r \times 10^3$ (kips)$^{-1}$	9.24	6.16	10.7	7.13	13.8	9.23
r_x/r_y	3.76		3.81		3.83	

[c] Shape is slender for compression with F_y = 50 ksi.
[f] Shape does not meet compact limit for flexure with F_y = 50 ksi.
Note: Heavy line indicates Kl/r equal to or greater than 200.

PART 7

DESIGN CONSIDERATIONS FOR BOLTS

SCOPE

The specification requirements and other design considerations summarized in this Part apply to the design of bolts in steel-to-steel structural connections. Additional guidance on bolt design is available in AISC Design Guide 17, *High Strength Bolts – A Primer for Structural Engineers*, (Kulak, 2002). For the design of steel-to-concrete anchorage, see Part 14. For the design of connection elements, see Part 9. For the design of simple shear, moment, bracing, and other connections, see Parts 10 through 15. For bolted joints that are part of a seismic force resisting system in which the seismic response modification factor, R, is taken greater than 3, the requirements in the AISC *Seismic Provisions for Structural Steel Buildings* also apply. The AISC *Seismic Provisions for Structural Steel Buildings* is available in Part 6 of the AISC *Seismic Design Manual* from the American Institute of Steel Construction, Inc. at www.aisc.org.

GENERAL REQUIREMENTS FOR BOLTED JOINTS

Fastener Components

The applicable material specifications for fastener components are as given in Part 2. Material and storage requirements fastener components are as given in AISC Specification Section A3.3 and RCSC Specification Section 2. The compatibility of ASTM A563 nuts and F436 washers with ASTM A325, F1852, and A490 bolts is as given in RCSC Specification Table 2.1. These products are given identifying marks, as illustrated in RCSC Specification Figure C-2.1. Alternative-design fasteners, including twist-off-type tension-control bolt assemblies with a strength level matching that of ASTM A490 bolts, and alternative washer-type indicating devices are permitted, subject to the requirements in RCSC Specification Sections 2.8 and 2.6.2, respectively.

Mixing grades of fasteners raises inventory and quality control issues associated with the use of multiple fastener grades. When both ASTM A325 and A490 bolts are used on a project, different diameters can be specified for each to help ensure that the ASTM A490 bolts are installed in the proper location.

Regardless of the bolt type selected, the typical sizes of $^3/_4$-in., $^7/_8$-in., 1-in. and $1^1/_8$-in. diameter are usually preferred. Diameters above 1 in. require special consideration for availability as well as installation, when pretensioned installation is required. Special equipment may be required to pretension large-diameter ASTM A490 bolts.

Proper Selection of Bolt Length

Per RCSC Specification Section 2.3.2, adequate thread engagement is developed when the end of the bolt is at least flush with or projects beyond the face of the nut. To provide for this, the ordered length of ASTM A325, F1852, and A490 bolts should be calculated as the grip (see Figure 7-1) plus the nominal thickness of washers and/or direct-tension indicators, if used, plus the allowance from Table 7-15, with the total rounded to the next higher increment of $^1/_4$ in. up to a 5 in. length and the next higher $^1/_2$ in. over a 5 in. length. Note that bolts longer than five inches are generally available only in $^1/_2$-in. increments, except by special arrangement with the manufacturer or vendor. While longer lengths may be ordered, an 8-in. length is generally the maximum stock length available. Requirements for a minimum stick-through greater than zero are discouraged because of the risk of jamming the nut on the thread runout, particularly in the bolt length range available only in $^1/_2$-in. increments. See Carter (1996) for further information.

Washer Requirements

Requirements for the use of ASTM F436 washers and/or plate washers are given in RCSC Specification Section 6.

Nut Requirements

The compatibility of ASTM A563 nuts with ASTM A325, F1852, and A490 bolts is as given in RCSC Specification Table 2.1.

Bolted Parts

The requirements for connected plies, faying surfaces, bolt holes, and burrs are given in AISC Specification Sections J3.2 and M2.5, and RCSC Specification Section 3. Spacing and edge distance requirements are given in AISC Specification Sections J3.3, J3.4, and J3.5.

PROPER SPECIFICATION OF JOINT TYPE

When ASTM A325, F1852, or A490 high-strength bolts are to be used, the joint type must be specified as snug-tightened, pretensioned, or slip-critical, per RCSC Specification Section 4.

Snug-Tightened Joints

Snug-tightened joints simplify design, installation, and inspection and should be specified whenever pretensioned joints and slip-critical joints are not required. The applicability is summarized and design requirements, installation requirements, and inspection requirements are stipulated for snug-tightened joints per RCSC Specification Section 4.1. Faying surfaces in snug-tightened joints must meet the requirements in RCSC Specification Sections 3.2 and 3.2.1, but not those for slip-critical joints in RCSC Specification Section 3.2.2. Note that there is generally no need to limit the actual level of pretension provided in snug-tightened joints, per RCSC Specification Section 9.1.

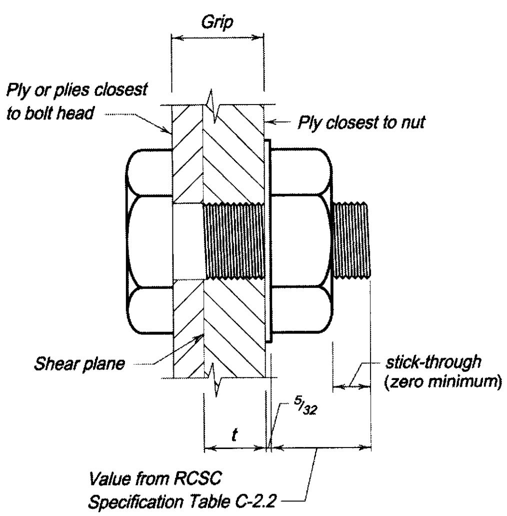


Figure 7–1. Grip and other parameters for bolt length selection.

Pretensioned Joints

When pretension is required but slip-resistance is not of concern, a pretensioned joint should be specified. The applicability is summarized and design requirements, installation requirements, and inspection requirements are stipulated for pretensioned joints per RCSC Specification Section 4.2. Additionally, pretensioned joints are required by default in some cases per AISC Specification Section J1.10. Faying surfaces in pretensioned joints must meet the requirements in RCSC Specification Sections 3.2 and 3.2.1, but not those for slip-critical joints in RCSC Specification Section 3.2.2.

Slip-Critical Joints

The applicability of slip-critical joints is summarized and design requirements, installation requirements, and inspection requirements are stipulated in RCSC Specification Section 4.3. Faying surfaces in slip-critical joints must meet the requirements in RCSC Specification Sections 3.2 and 3.2.2. RCSC defines a faying surface as "the plane of contact between two plies of a joint." Note that the surfaces under the bolt head, washer, and/or nut are not faying surfaces.

Subject to the requirements in RCSC Specification Section 4.3, slip-critical joints are rarely required in building design. Slip-critical joints are appreciably more expensive because of the associated costs of faying-surface preparation. When slip resistance is required and the steel is to be painted, the fabricator should be consulted to determine the most economical approach to providing the necessary slip resistance. Special paint systems that are rated for slip resistance can be specified. Alternatively, a normal paint system can be used with the faying surfaces masked.

DESIGN REQUIREMENTS

Design requirements are found in the AISC Specification as follows. In each case, the available strength determined in accordance with these provisions must equal or exceed the required strength. These requirements are derived from those in the RCSC Specification.

Shear

Available shear strength is determined as given in RCSC Specification Section 5.1 and AISC Specification Section J3.6, with consideration of the presence of fillers and/or shims, per RCSC Specification Section 5.1 and AISC Specification Section J5. When the length of a bolted joint measured parallel to the line of force exceeds 50 in., a 20-percent strength reduction may be applicable, per AISC Specification Table J3.2 footnote f.

Tension

Available tensile strength is determined as given in RCSC Specification Section 5.1 and AISC Specification Section J3.6, with consideration of the effects of prying action, if any. Prying action is a phenomenon (in bolted construction only) whereby the deformation of a fitting under a tensile force increases the tensile force in the bolt. While the effect of prying action is relevant to the design of the bolts, it is primarily a function of the strength and stiffness of the connection elements. Prying action is addressed in Part 9.

Combined Shear and Tension

Available strength for combined shear and tension is determined as given in RCSC Specification Section 5.2 and AISC Specification Section J3.7.

Bearing Strength at Bolt Holes

Available bearing strength at bolt holes is determined as given in RCSC Specification Section 5.3 and AISC Specification Section J3.10.

Slip Resistance

The available strength of slip-critical connections is determined in accordance with AISC Specification Section J3.8. The available strength, ϕR_n or R_n/Ω, is determined by applying the resistance factor or safety factor appropriate for the prevention of slip as a strength or serviceability limit state. In both cases, the required strength is determined using the LRFD load combination for LRFD design and the ASD load combination for ASD design. Slip resistance as a serviceability limit-state is appropriate for most applications.

ECCENTRICALLY LOADED BOLT GROUPS

Eccentricity in the Plane of the Faying Surface

When eccentricity occurs in the plane of the faying surface, the bolts must be designed to resist the combined effect of the direct shear, P_u or P_a, and the additional shear from the induced moment, P_ue or P_ae. Two analysis methods for this type of eccentricity are the instantaneous center of rotation method and the elastic method.

The instantaneous center of rotation method is more accurate, but generally requires the use of tabulated values or an iterative solution. The elastic method is simplified, but may be excessively conservative because it neglects the ductility of the bolt group and the potential for load redistribution.

Instantaneous Center of Rotation Method

Eccentricity produces both a rotation and a translation of one connection element with respect to the other. The combined effect of this rotation and translation is equivalent to a rotation about a point defined as the instantaneous center of rotation (IC), as illustrated in Figure 7-2a. The location of the IC depends upon the geometry of the bolt group as well as the direction and point of application of the load.

The load-deformation relationship for one bolt is illustrated in Figure 7-3, where

$$R = R_{ult}(1 - e^{-10\Delta})^{0.55}$$

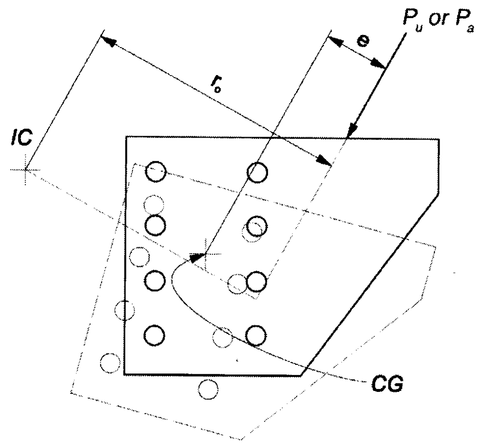
where

R = nominal shear strength of one bolt at a deformation Δ, kips.

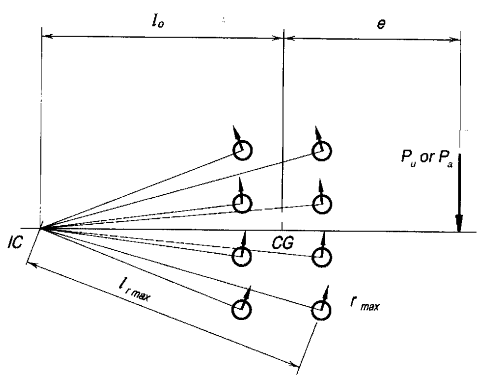
R_{ult} = ultimate shear strength of one bolt, kips.

Δ = total deformation, including shear, bearing and bending deformation in the bolt and bearing deformation of the connection elements, in.

e = 2.718…, base of the natural logarithm.



(a) Instantaneous center of rotation (IC)



(b) Forces on bolts in group for case of θ = 0° for simplicity

Figure 7–2. Illustration for instantaneous center of rotation method.

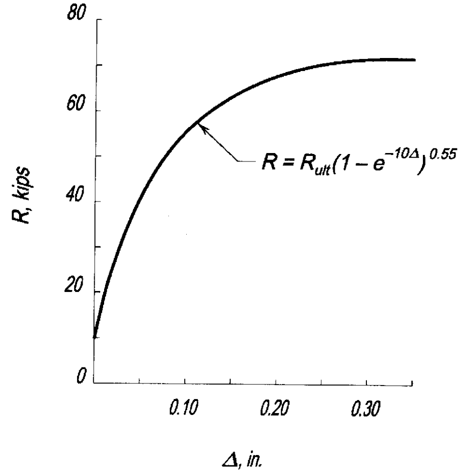


Figure 7–3. Load-definition relationship for one ¾-in. diameter ASTM A325 bolt.

The nominal shear strength of the bolt most remote from the IC can be determined by applying a maximum deformation Δ_{max} to that bolt. The load-deformation relationship is based upon data obtained experimentally for ¾-in. diameter ASTM A325 bolts, where R_{ult} = 74 kips, and Δ_{max} = 0.34 in.

The nominal shear strengths of the other bolts in the joint can be determined by applying a deformation Δ that varies linearly with distance from the IC. The nominal shear strength of the bolt group is, then, the sum of the individual strengths of all bolts.

The individual resistance of each bolt is assumed to act on a line perpendicular to a ray passing through the IC and the centroid of that bolt, as illustrated in Figure 7–2b. If the correct location of the IC has been selected, the three equations of in-plane static equilibrium ($\Sigma F_x = 0$, $\Sigma F_y = 0$, and $\Sigma M = 0$) will be satisfied.

For further information, see Crawford and Kulak (1968).

Elastic Method

For a force applied as illustrated in Figure 7–4, the eccentric force, P_u or P_a, is resolved into a direct shear, P_u or P_a, acting through the center of gravity (CG) of the bolt group and a moment, $P_u e$ or $P_a e$, where e is the eccentricity. Each bolt is then assumed to resist an equal share of the direct shear and a share of the eccentric moment proportional to its distance from the CG. The resultant vectorial sum of these forces is the required strength for the bolt, r_u or r_a.

The shear per bolt due to the concentric force, P_u *or* P_a, is r_p, where

LRFD	ASD
$r_p = \dfrac{P_u}{n}$	$r_p = \dfrac{P_a}{n}$

and n is the number of bolts. To determine the resultant forces on each bolt when P_u or P_a is applied at an angle θ with respect to vertical, r_p must be resolved into horizontal component, r_{px}, and vertical component, r_{py}, where

$$r_{px} = r_p \sin\theta \text{ and } r_{py} = r_p \cos\theta$$

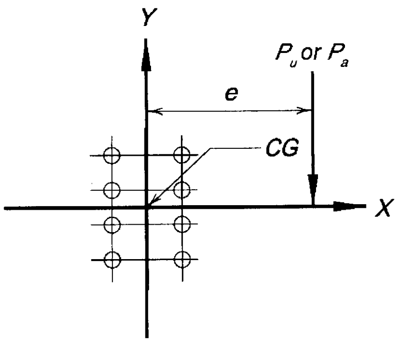


Figure 7–4. Illustration for elastic method.

The shear on the bolt most remote from the CG due to the moment, $P_u e$ or $P_a e$, is r_m, determined as

LRFD	ASD
$r_m = \dfrac{P_u e c}{I_p}$	$r_m = \dfrac{P_a e c}{I_p}$

where

c = radial distance from CG to center of bolt most remote from CG, in.
$I_p = I_x + I_y$ = polar moment of inertia of the bolt group, in.[4] per in.[2]

To determine the resultant force on the most highly stressed bolt, r_m must be resolved into horizontal component, r_{mx}, and vertical component, r_{my}, where

LRFD	ASD
$r_{mx} = \dfrac{P_u e c_y}{I_p}$ and $r_{my} = \dfrac{P_u e c_x}{I_p}$	$r_{mx} = \dfrac{P_a e c_y}{I_p}$ and $r_{my} = \dfrac{P_a e c_x}{I_p}$

In the above equation, c_x and c_y are the horizontal and vertical components of the diagonal distance c. Thus, the required strength per bolt is r_u, where

LRFD	ASD
$r_u = \sqrt{\left(r_{px} + r_{mx}\right)^2 + \left(r_{py} + r_{my}\right)^2}$	$r_a = \sqrt{\left(r_{px} + r_{mx}\right)^2 + \left(r_{py} + r_{my}\right)^2}$

For further information, see Higgins (1971).

Eccentricity Normal to the Plane of the Faying Surface

Eccentricity normal to the plane of the faying surface produces tension above and compression below the neutral axis for a bracket connection as shown in Figure 7–5. The eccentric force, P_u *or* P_a, is resolved into a direct shear, P_u *or* P_a, acting at the faying surface of the joint and a moment normal to the plane of the faying surface, $P_u e$ or $P_a e$, where e is the eccentricity. Each bolt is then assumed to resist an equal share of the concentric force, P_u *or* P_a, and the moment is resisted by tension in the bolts above the neutral axis and compression below the neutral axis.

Two design approaches for this type of eccentricity are available: Case I, in which the neutral axis is not taken at the center of gravity (CG), and Case II, in which the neutral axis is taken at the CG.

Case I—Neutral Axis Not at Center of Gravity

The shear per bolt due to the concentric force, r_{uv} or r_{av}, is determined as

LRFD	ASD
$r_{uv} = \dfrac{P_u}{n}$	$r_{av} = \dfrac{P_a}{n}$

where n is the number of bolts in the connection.

A trial position for the neutral axis can be selected at one-sixth of the total bracket depth, measured upward from the bottom (line X-X in Figure 7–6a). To provide for reasonable proportions and to account for the bending stiffness of the connection elements, the effective width of the compression block b_{eff} should be taken as

$$b_{eff} = 8t_f \leq b_f$$

where

t_f = lesser connection element thickness, in.
b_f = connection element width, in.

This effective width is valid for bracket flanges made from W-shapes, S-shapes, welded plates, and angles. Where the bracket flange thickness is not constant, the average flange thickness should be used.

The assumed location of the neutral axis can be evaluated by checking static equilibrium assuming an elastic stress distribution. Equating the moment of the bolt area above the neutral axis with the moment of the compression block area below the neutral axis,

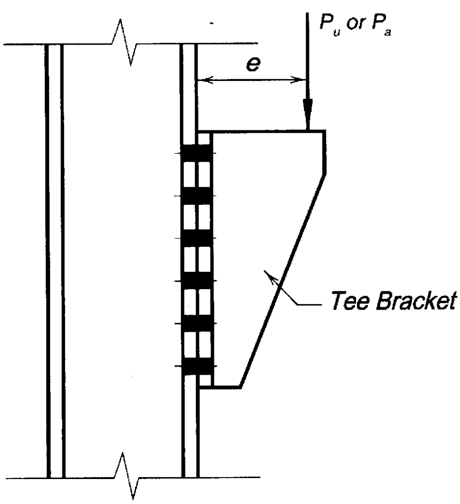


Figure 7–5. Tee bracket subject to eccentric loading normal to the plane of the faying surface.

$$\Sigma A_b \times y = b_{eff} \times d \times d/2$$

In the above equation,

ΣA_b = sum of the areas of all bolts above the neutral axis, in.^{2}
y = distance from line X-X to CG of the bolt group above neutral axis, in.
d = depth of compression block, in.

The value of d may then be adjusted until a reasonable equality exists.

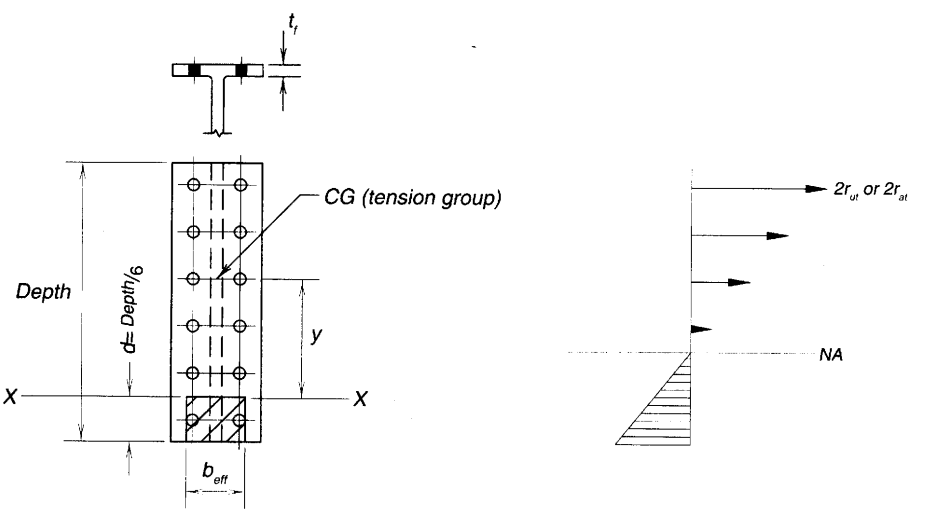
Once the neutral axis has been located, the tensile force per bolt, r_{ut} or r_{at}, as illustrated in Figure 7–6b, may be determined as

LRFD	ASD
$r_{ut} = \dfrac{P_u ec}{I_x} \times A_b$	$r_{at} = \dfrac{P_a ec}{I_x} \times A_b$

where

c = distance from neutral axis to most remote bolt in group, in.
I_x = combined moment of inertia of bolt group and compression block about neutral axis, in.^{4}

Bolts above the neutral axis are subjected to the shear force, the tensile force, and the effect of prying action (see Part 9); bolts below the neutral axis are subjected to the shear force only.



(a) Initial approximation of location of NA
(b) Force diagram with final location of NA

Figure 7–6. Location of neutral axis (NA) for out-of-plane eccentric loading using Case I.

Case II—Neutral Axis at Center of Gravity

This method provides a more direct, but also a more conservative result. As for Case I, the shear force per bolt, r_{uv} or r_{av}, due to the concentric force, P_u *or* P_a, is determined as

LRFD	ASD
$r_{uv} = \dfrac{P_u}{n}$	$r_{av} = \dfrac{P_a}{n}$

where n is the number of bolts in the connection.

The neutral axis is assumed to be located at the CG of the bolt group as illustrated in Figure 7–7. The bolts above the neutral axis are in tension and the bolts below the neutral axis are said to be in "compression." To obtain a more accurate result, a plastic stress distribution is assumed; this assumption is justified because this method is still more conservative than Case I. Accordingly, the tensile force in each bolt above the neutral axis, r_{ut} or r_{at}, due to the moment, $P_u e$ or $P_a e$, is determined as

LRFD	ASD
$r_{ut} = \dfrac{P_u e}{n' d_m}$	$r_{at} = \dfrac{P_a e}{n' d_m}$

where

n' = number of bolts above the neutral axis
d_m = moment arm between resultant tensile force and resultant compressive force, in.

Bolts above the neutral axis are subjected to the shear force, the tensile force, and the effect of prying action (see Part 9); bolts below the neutral axis are subjected to the shear force, r_{uv} or r_{av}, only.

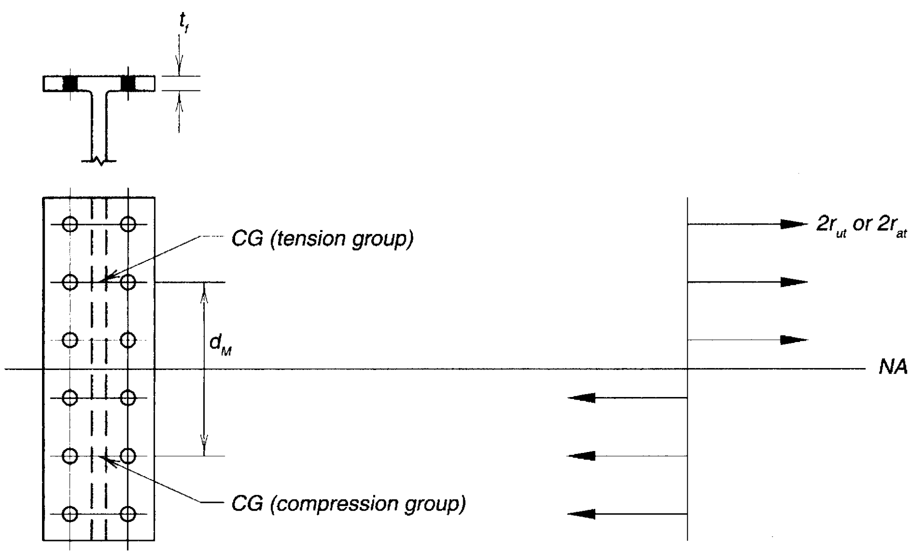


Figure 7–7. Location of neutral axis (NA) for out-of-plane eccentric loading using Case II.

SPECIAL CONSIDERATIONS FOR HOLLOW STRUCTURAL SECTIONS

Through-Bolting to HSS

Long bolts that extend through the entire HSS are satisfactory for shear connections that do not require a fully tensioned installation. The flexibility of the walls of the HSS precludes installation of fully tensioned bolts. Standard structural bolts may be used, although ASTM A449 Bolts may be required for longer lengths. The bolts are designed for static shear and the only limit-state involving the HSS is bolt bearing. The available strength due to shear is determined as ϕR_n or R_n/Ω, with

$$R_n = 1.8nF_y dt$$
$$\phi = 0.75 \qquad \Omega = 2.00$$

where

n = number of fasteners
d = fastener diameter, in.
F_y = yield strength of HSS, ksi
t = thickness of HSS, in.

The available strength due to pull-out from tension in one fastener, is determined as ϕR_n or R_n/Ω, with

$$R_n = 0.85 d_w t F_u$$
$$\phi = 0.50 \qquad \Omega = 3.00$$

where

d_w = diameter of part in contact with the inner surface of the HSS, in.
F_u = ultimate strength of the HSS, ksi.

Blind Bolts

Special fasteners are available that eliminate the need for access to install a nut (Korol et al, 1993; Henderson, 1996). The shank of the fastener is inserted through holes in the parts to be connected until the head bears on the outer ply (see Figure 7–8). In some cases, a special wrench is used on the open side to keep the outer part of the shank from rotating and simultaneously turn the threaded part of the shank. A wedge or other mechanism on the blind side causes the fixed part of the shank to expand and form a contact with the inside of the HSS. Some fasteners contain a break-off mechanism when the fastener is pretensioned. Recent versions of these fasteners meet the requirements for a pretensioned A325 bolt (Henderson, 1996) and could be used in slip-critical or tension conditions. HSS limit-states are bolt bearing in shear tear-out of the bolt in tension and wall distortion. Manufacturers' literature must be consulted to determine the available strength of blind bolts.

Flow-Drilling

Flow-drilling is a process that can be used to produce a threaded hole in an HSS to permit blind bolting when the inside of the HSS is inaccessible (Sherman, 1995; Henderson, 1996). The process is to force a hole through the HSS with a carbide conical tool rotating at sufficient speed to produce high rapid heating, which softens the material in a local area. The material that is displaced as the tool is forced through the plate forms a truncated hollow cone (bushing) on the inner surface and a small upset on the outer surface. Tools can be obtained with a milling collar so that the material on the outer surface is removed, producing a flat surface allowing parts to be brought in close contact. A cold-formed tap is then used to roll a thread into the hole without any chips or removal of material. The resulting threaded hole has the approximate dimensions and hardness of a heavy hex nut. Shear and tension strengths of A325 bolts can be developed for certain combinations of bolt size and HSS thickness (see Figure 7–9).

Drilling equipment with suitable rotational speed, torque, and thrust is required, but with small sizes and thicknesses, field installation with conventional tools is possible. The bolts are designed with the normal criteria and the HSS limit-states are bolt bearing in shear and distortion of the HSS wall in tension. HSS strength is not affected by the process except for the reduction in area due to the holes.

Threaded Studs to HSS

Threaded studs are available in $^3/_8$-in. to $^7/_8$-in. diameters and can be shop- or field-welded to an HSS with a stud-welding gun. The connection is similar to a bolted connection with an external nut. The strength of the stud in tension or shear is based on manufacturer's recommendations and tests. The HSS limit state is distortion of the wall. When using threaded studs, countersunk holes must be used in the attached element to clear the weld fillet at the base of the stud.

Nailing to HSS

Power-driven nails that are installed with a powder-actuated gun are satisfactory for pure shear connections where the combined thickness of the attachment and the HSS does not exceed $^1/_2$ in. This system was tested as splices between telescoping round HSS loaded with an axial force (Packer, 1996). The shear resistance of the fasteners is taken as the number of nails times the shear strength of a single nail and ignores any secondary contribution from a dimpling effect between the materials. The limit-state for the HSS is shear-bearing. See Packer (1996).

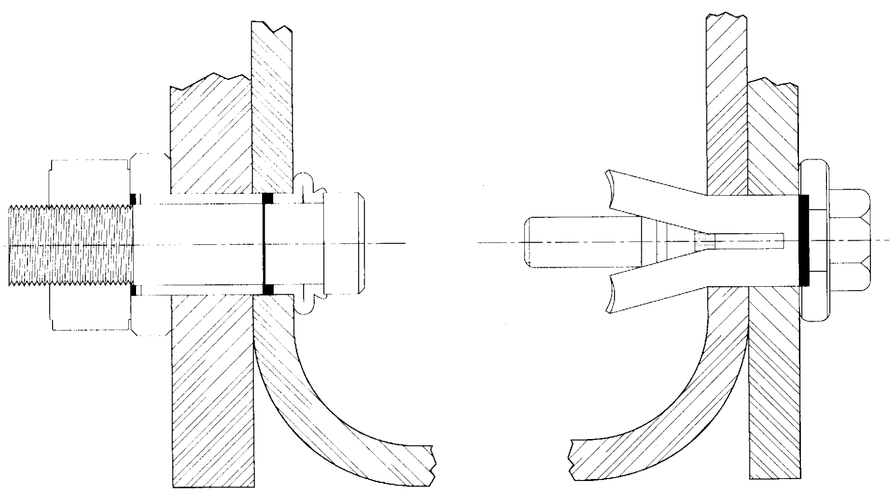


Figure 7–8. Two types of blind bolts.

Screwing To HSS

Self-tapping screws with or without self-drilling points are available for connecting materials with combined thicknesses up to 1/2 in. The screws have diameters from 0.08 in. to 0.25 in. The limit-states for connections in the AISI *North American Specification for the Design of Cold-Formed Steel Members* (AISI, 2001) are associated with bearing failure of the material or pull-out of the screw either in direct tension or after tilting occurs in a shear load. Failure of the screws themselves is prevented by requiring that the product be 25 percent stronger than the available shear or tension strength of the material. Edge distances and spacing of screws should not exceed 3 times the screw diameter, d. For attaching material with thickness t_1 and ultimate strength F_{u1} to an HSS with thickness t and strength F_u, the available strength, ϕP_n or P_n/Ω, is determined as follows, with $\phi = 0.5$ and $\Omega = 3.0$.

Connection shear per screw

For $t/t_1 \leq 1$, P_n is the smallest of

$$\begin{Bmatrix} 4.2\left(t^3 d\right)^{1/2} F_u \\ 2.7 t_1 d F_{u1} \\ 2.7 t d F_u \end{Bmatrix}$$

For $t/t_1 \geq 2.5$, P_n is the smaller of

$$\begin{Bmatrix} 2.7 t_1 d F_{u1} \\ 2.7 t d F_u \end{Bmatrix}$$

For $1 < t/t_1 < 2.5$, P_n is determined by linear interpolation between the above two cases.

Connection tension per screw, P_n, is the smaller of

$$\begin{Bmatrix} 0.85 t_c d F_u \\ 1.5 t_1 d_w F_{u1} \end{Bmatrix}$$

where

t_c = lesser of the depth of penetration and the HSS thickness
d_w = larger of the screw head or washer diameter, and shall not be taken larger than 1/2 in.

HSS Thickness (in.)	BOLT DIAMETER (in.)				
	1/2	5/8	3/4	7/8	1
3/16	X	X			
1/4	X	X	X		
5/16		X	X	X	
3/8			X	X	X
1/2					X

Figure 7–9. HSS thickness and bolt diameter combinations.

OTHER SPECIFICATION REQUIREMENTS AND DESIGN CONSIDERATIONS

The following other specification requirements and design considerations apply to the design of bolts:

Placement of Bolt Groups

For the required placement of bolt groups at the ends of axially loaded members, see AISC Specification Section J1.7.

Bolts in Combination with Welds or Rivets

For bolts used in combination with welds or rivets, see AISC Specification Section J1.8 or J1.9, respectively.

Galvanizing High-Strength Bolts and Nuts

Galvanizing of high-strength bolts is permitted as follows:

1. By the hot-dip or mechanical process for ASTM A325 Type 1 high-strength bolts, per ASTM A325 Section 4.3.
2. By the mechanical process only for ASTM F1852 twist-off-type tension-control bolt assemblies, per ASTM F1852 Section 6.3.
3. By the hot-dip or mechanical process for ASTM A449 bolts, per ASTM A449 Section 5.1.

Nuts for ASTM A325 and F1852 bolts must be galvanized by the same process as the bolt with which they are used. See RCSC Specification Table 2.1 for compatible nut grade and finish requirements for ASTM A325 and F1852 bolts, and ASTM A563 for compatible nut grade and finish requirements for ASTM A449 bolts.

ASTM A490 bolts are not permitted to be galvanized, per ASTM A490 Section 5.4. See also RCSC Specification Commentary Section 2.3.

Reuse of Bolts

The reuse of high-strength bolts is limited, per RCSC Specification Section 2.3.3. See also Bowman and Betancourt (1991).

Fatigue Applications

For applications involving fatigue, see RCSC Specification Sections 4.2, 4.3, and 5.5 and AISC Specification Appendix 3.

Entering and Tightening Clearances

Clearances must be provided for the entering and tightening of the bolts with an impact wrench. The clearance requirements for conventional high-strength bolts are as given in Table 7–16. When high-strength tension-control bolts are specified, the clearance requirements are as given in Table 7–17.

Fully Threaded ASTM A325 Bolts

ASTM A325 bolts with length equal to or less than four times the nominal bolt diameter may be ordered as fully threaded with the designation ASTM A325T. Fully threaded ASTM A325T bolts are not for use in bearing-type X connections since it would be impossible to exclude the threads from the shear plane. While this supplementary provision exists for ASTM A325 bolts, there is no similar supplementary provision made in ASTM A490 for full-length threading.

ASTM A307 Bolts

Limitations are provided on the use of ASTM A307 bolts, per AISC Specification Sections A3.3, J1.8, and J1.10. ASTM A307 bolts are available with both hex and square heads in diameters from 1/4 in. to 4 in. in grade A for general applications and grade B for cast-iron-flanged piping joints. ASTM A563 Grade A nuts are recommended for use with ASTM A307 bolts. Other suitable grades are listed in ASTM A563 Table X1.1.

ASTM A449 Bolts

Limitations are provided on the use of ASTM A449 bolts, per AISC Specification Sections A3.3 and J3.1.

DESIGN TABLES

Tables 7–1. Available Shear Strength of Bolts

The available bolt shear strengths of various grades and sizes of bolts are summarized in Table 7–1.

Table 7–2. Available Tensile Strength of Bolts

The available bolt tensile strengths of various grades and sizes of bolts are summarized in Table 7–2.

Tables 7–3 and 7–4. Available Resistance to Slip

The available slip resistances of various grades and sizes of bolts are summarized in Tables 7–3 and 7–4. In Table 7–3, the available resistance to slip is tabulated for slip to occur at service-level forces. In Table 7–4, the available resistance to slip is tabulated for slip to occur at strength-level forces.

Tables 7–5 and 7–6. Available Bearing Strength at Bolt Holes

The available bearing strength at bolt holes is tabulated for various spacings and edge distances in Tables 7–5 and 7–6, respectively. Note that these tables may be applied to bolts with countersunk heads, by subtracting one-half the depth of the countersink from the material thickness, t. As illustrated in Figure 7–10, this is equivalent to subtracting $d_b/4$ from the material thickness, t.

Tables 7–7 through 7–14. Coefficients *C* for Eccentrically Loaded Bolt Groups

Tables 7–7 through 7–14 employ the instantaneous center of rotation method for the bolt patterns and eccentric conditions indicated, and inclined loads at 0°, 15°, 30°, 45°, 60°, and 75°. The tabulated non-dimensional coefficient, *C*, represents the number of bolts that are effective in resisting the eccentric shear force.

When Analyzing a Known Bolt Group Geometry

For any of the bolt group geometries shown, the available strength of the eccentrically loaded bolt group, ϕR_n or R_n/Ω, is determined as

$$R_n = C \times r_n$$

$$\phi = 0.75 \qquad \Omega = 2.00$$

In the above equation, r_n is the least nominal strength of one bolt determined from the limit-states of bolt shear strength, bearing strength at bolt holes, and slip resistance (if the connection is to be slip-critical).

When Selecting a Bolt Group

The available strength must be greater than or equal to the required strength, P_u or P_a. Thus, by dividing the required strength, P_u *or* P_a, by the available strength of a single bolt, ϕr_n or r_n/Ω, the minimum coefficient, *C*, is obtained. The bolt group can then be selected from the table corresponding to the appropriate load angle, at the appropriate eccentricity, e_x, for which the coefficient is of that magnitude or greater.

These tables may be used with any bolt diameter and are conservative when used with ASTM A490 bolts (see Kulak, 1975). Linear interpolation within a given table between adjacent values of e_x is permitted. Available strengths determined with these tables provide a reliability equivalent to that for bolts in joints less than 50 in. long subject to shear produced by a concentric load in either bearing-type or slip-critical connections. Although this

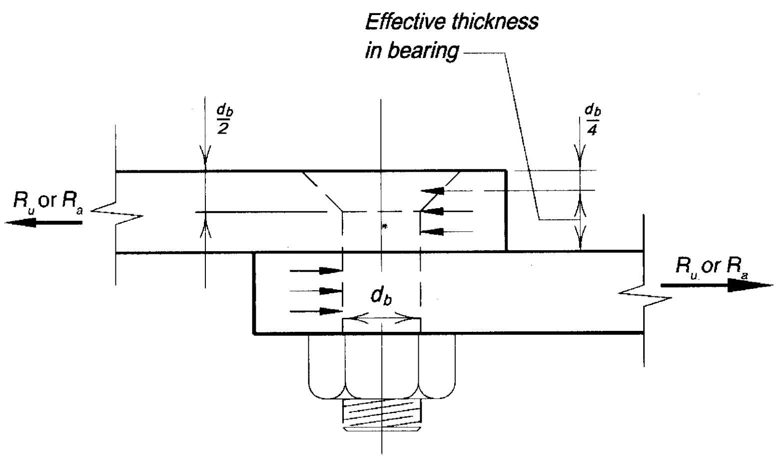


Figure 7–10. Effective bearing-thickness for bolts with countersunk heads.

procedure is based on connections which may experience slip under load, both load tests and analytical studies indicate that it may be conservatively extended to slip-critical connections (Kulak, 1975).

A convergence criterion of one percent was employed for the tabulated iterative solutions. Straight-line interpolation between values for loads at different angles may be significantly unconservative. Either a direct analysis should be performed or the values for the next lower angle increment in the tables should be used for design. For bolt group patterns not treated in these tables, a direct analysis is required if the instantaneous center of rotation method is to be used.

In some cases, it is necessary to calculate the pure moment strength of a bolt group for purposes of linear interpolation. For these cases, the value of C' has been provided for a load angle of 0°. This moment strength of the bolt group is based on the instantaneous center of rotation method and, since a moment-only condition is assumed, the instantaneous center of rotation coincides with the center of gravity of the bolt group. In this case, the strength can be calculated as:

$$M_{max} = 1.25 F_{nv} A_b C'$$

where

$$C' = \sum \left[l_i \left(1 - e^{-\left(\frac{10 l_i \Delta_{max}}{l_{max}}\right)} \right)^{0.55} \right]$$

F_{nv} = the shear strength of an individual bolt from AISC Specification Table J3.2

l_i = the distance of the i^{th} bolt from the center of gravity of the bolt group

Δ_{max} = the maximum deformation on the bolt furthest from the center of gravity, 0.34 in.

l_{max} = the distance of the bolt farthest from the center of gravity of the bolt group to the center

Table 7–15. Dimensions of High-Strength Fasteners

Dimensions of ASTM A325 and A490 bolts, A563 nuts, and F436 washers are given and illustrated in Table 7–15.

Table 7–16 and 17. Entering and Tightening Clearances

Clearance is required for entering and tightening bolts with an impact wrench. The required clearances are given for conventional high-strength bolts and twist-off-type tension-control bolt assemblies in Tables 7–16 and 7–17, respectively.

Table 7–18. Threading Dimensions for High-Strength and Non-High-Strength Bolts

Data regarding the characteristics of the threading dimensions of high-strength and non-high-strength bolts is provided in Table 7–18.

Table 7–19. Weights of High-Strength Fasteners

Weights of conventional ASTM A325 and A490 bolts, A563 nuts, and F436 washers are given in Table 7–19. For dimensions and weights of tension-control ASTM A325 and A490 bolts, refer to manufacturers' literature or the Industrial Fasteners Institute (IFI). For dimensions and weights of ASTM A449 bolts, refer to Table 7–20.

Table 7–20. Dimensions of Non-High-Strength Fasteners

Typical non-high-strength bolt head and nut dimensions are given in Table 7–21. Thread lengths listed in this table may be calculated for non-high-strength bolts as $2d_b + \frac{1}{4}$ in. for bolts up to 6 in. long and $2d_b + \frac{1}{2}$ in. for bolts over 6 in. long, where d_b is the bolt diameter. Note that these thread lengths are longer than those given previously for high-strength bolts in Table 7–15. Threading dimensions are given in Table 7–18.

Tables 7–21, 7–22, and 7–23. Weights of Non-High-Strength Fasteners

Weights of non-high-strength bolts are given in Tables 7–21, 7–22, and 7–23.

PART 7 REFERENCES

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Table 7–1
Available Shear Strength of Bolts, kips

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

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

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

Table 7–2
Available Tensile Strength of Bolts, kips

Nominal Bolt Diameter d_b, in.			**5/8**		**3/4**		**7/8**		**1**	
Nominal Bolt Area, in.^{2}			**0.307**		**0.442**		**0.601**		**0.785**	
ASTM Desig.	F_{nt}/Ω (ksi)	ϕF_{nt} (ksi)	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n
	ASD	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**
A325 & F1852	45.0	67.5	13.8	20.7	19.9	29.8	27.1	40.6	35.3	53.0
A490	56.5	84.8	17.3	26.0	25.0	37.4	34.0	51.0	44.4	66.6
A307	22.5	33.8	6.90	10.4	9.94	14.9	13.5	20.3	17.7	26.5
Nominal Bolt Diameter d_b, in.			**1 1/8**		**1 1/4**		**1 3/8**		**1 1/2**	
Nominal Bolt Area, in.^{2}			**0.994**		**1.23**		**1.48**		**1.77**	
ASTM Desig.	F_{nt}/Ω (ksi)	ϕF_{nt} (ksi)	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n
	ASD	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**	**ASD**	**LRFD**
A325 & F1852	45.0	67.5	44.7	67.1	55.2	82.8	66.8	100	79.5	119
A490	56.5	84.8	56.2	84.2	69.3	104	83.9	126	99.8	150
A307	22.5	33.8	22.4	33.5	27.6	41.4	33.4	50.1	39.8	59.6

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

A325 Table 7–3
Slip-Critical Connections
Available Shear Strength, kips, when
Slip is a Serviceability Limit-State
(Class A Faying Surface, μ = 0.35)

ASTM A325 / F1852 Bolts

Hole Type	Loading	Nominal Bolt Diameter *d*, in.							
		$^5/_8$		$^3/_4$		$^7/_8$		1	
		Minimum ASTM A325/F1852 Bolt Pretension, kips							
		19		28		39		51	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	5.01	7.51	7.38	11.1	10.3	15.4	13.4	20.2
	D	10.0	15.0	14.8	22.1	20.6	30.8	26.9	40.3
OVS/SSL	S	4.26	6.39	6.28	9.41	8.74	13.1	11.4	17.1
	D	8.52	12.8	12.6	18.8	17.5	26.2	22.9	34.3
LSL	S	3.51	5.26	5.17	7.75	7.20	10.8	9.41	14.1
	D	7.01	10.5	10.3	15.5	14.4	21.6	18.8	28.2

Hole Type	Loading	Nominal Bolt Diameter *d*, in.							
		$1^1/_8$		$1^1/_4$		$1^3/_8$		$1^1/_2$	
		Minimum ASTM A325/F1852 Bolt Pretension, kips							
		56		71		85		103	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	14.8	22.1	18.7	28.1	22.4	33.6	27.2	40.7
	D	29.5	44.3	37.4	56.2	44.8	67.2	54.3	81.5
OVS/SSL	S	12.6	18.8	15.9	23.9	19.0	28.6	23.1	34.6
	D	25.1	37.7	31.8	47.7	38.1	57.1	46.2	69.3
LSL	S	10.3	15.5	13.1	19.7	15.7	23.5	19.0	28.5
	D	20.7	31.0	26.2	39.3	31.4	47.1	38.0	57.0

STD = Standard Hole
SSL = Short-Slotted Hole
LSL = Long-Slotted Hole
OVS = Oversized Hole

S = Single Shear
D = Double Shear

ASD	LRFD	
$\Omega_v = 1.50$	$\phi_v = 1.00$	Note: For available slip resistance when slip is a strength limit state, see Table 7-4. For Class B faying surfaces (μ = 0.50), multiply the tabulated available strength by 1.43. The required strength is determined using LRFD load combinations for LRFD design and ASD load combinations for ASD design.

Table 7-3 (continued)
Slip-Critical Connections
Available Shear Strength, kips, when
Slip is a Serviceability Limit-State
(Class A Faying Surface, μ = 0.35)

A490

ASTM A490 Bolts

Hole Type	Loading	Nominal Bolt Diameter *d*, in.							
		5/8		3/4		7/8		1	
		Minimum ASTM A490 Bolt Pretension, kips							
		24		35		49		64	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	6.33	9.49	9.23	13.8	12.9	19.4	16.9	25.3
	D	12.7	19.0	18.5	27.7	25.8	38.8	33.7	50.6
OVS/SSL	S	5.38	8.07	7.84	11.8	11.0	16.5	14.3	21.5
	D	10.8	16.1	15.7	23.5	22.0	32.9	28.7	43.0
LSL	S	4.43	6.64	6.46	9.69	9.04	13.6	11.8	17.7
	D	8.86	13.3	12.9	19.4	18.1	27.1	23.6	35.4

Hole Type	Loading	Nominal Bolt Diameter *d*, in.							
		1 1/8		1 1/4		1 3/8		1 1/2	
		Minimum ASTM A490 Bolt Pretension, kips							
		80		102		121		148	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	21.1	31.6	26.9	40.3	31.9	47.9	39.0	58.5
	D	42.2	63.3	53.8	80.7	63.8	95.7	78.0	117
OVS/SSL	S	17.9	26.9	22.9	34.3	27.1	40.7	33.2	49.8
	D	35.9	53.8	45.7	68.6	54.2	81.4	66.3	99.5
LSL	S	14.8	22.1	18.8	28.2	22.3	33.5	27.3	41.0
	D	29.5	44.3	37.7	56.5	44.7	67.0	54.6	81.9

STD = Standard Hole
SSL = Short-Slotted Hole
LSL = Long-Slotted Hole
OVS = Oversized Hole

S = Single Shear
D = Double Shear

ASD	LRFD	
$\Omega_v = 1.50$	$\phi_v = 1.00$	Note: For available slip resistance when slip is a strength limit state, see Table 7-4. For Class B faying surfaces (μ = 0.50), multiply the tabulated available strength by 1.43. The required strength is determined using LRFD load combinations for LRFD design and ASD load combinations for ASD design.

Table 7–4
Slip-Critical Connections
A325
Available Shear Strength, kips, when
Slip is a Strength Limit-State
(Class A Faying Surface, μ = 0.35)

ASTM A325 / F1852 Bolts

Hole Type	Loading	Nominal Bolt Diameter d, in.							
		$^5/_8$		$^3/_4$		$^7/_8$		1	
		Minimum ASTM A325/F1852 Bolt Pretension, kips							
		19		28		39		51	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	4.29	6.39	6.33	9.41	8.81	13.1	11.5	17.1
	D	8.59	12.8	12.7	18.8	17.6	26.2	23.1	34.3
OVS/SSL	S	3.65	5.43	5.38	8.00	7.49	11.1	9.80	14.6
	D	7.30	10.9	10.8	16.0	15.0	22.3	19.6	29.1
LSL	S	3.01	4.47	4.43	6.59	6.17	9.18	8.07	12.0
	D	6.01	8.94	8.86	13.2	12.3	18.4	16.1	24.0

Hole Type	Loading	Nominal Bolt Diameter d, in.							
		$1^1/_8$		$1^1/_4$		$1^3/_8$		$1^1/_2$	
		Minimum ASTM A325/F1852 Bolt Pretension, kips							
		56		71		85		103	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	12.7	18.8	16.0	23.9	19.2	28.6	23.3	34.6
	D	25.3	37.7	32.1	47.7	38.4	57.1	48.6	69.3
OVS/SSL	S	10.8	16.0	13.6	20.3	16.3	24.3	19.8	29.4
	D	21.5	32.0	27.3	40.6	32.7	48.6	39.6	58.6
LSL	S	8.86	13.2	11.2	16.7	13.4	20.0	16.3	24.2
	D	17.7	26.4	22.5	33.4	26.9	40.0	32.6	48.5

STD = Standard Hole
SSL = Short-Slotted Hole
LSL = Long-Slotted Hole
OVS = Oversized Hole

S = Single Shear
D = Double Shear

ASD	LRFD	
$\Omega_v = 1.76$	$\phi_v = 0.85$	Note: For available slip resistance when slip is a serviceability limit state, see Table 7-3. For Class B faying surfaces (μ = 0.50), multiply the tabulated available strength by 1.43. The required strength is determined using LRFD load combinations for LRFD design and ASD load combinations for ASD design.

Table 7-4 (continued)
Slip-Critical Connections
Available Shear Strength, kips, when
Slip is a Strength Limit-State
(Class A Faying Surface, μ = 0.35)

A490

ASTM A490 Bolts

Hole Type	Loading	Nominal Bolt Diameter d, in.							
		5/8		3/4		7/8		1	
		Minimum ASTM A490 Bolt Pretension, kips							
		24		35		49		64	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	5.42	8.07	7.91	11.8	11.1	16.5	14.5	21.5
	D	10.8	16.1	15.8	23.5	22.1	32.9	28.9	43.0
OVS/SSL	S	4.61	6.86	6.72	10.0	9.41	14.0	12.3	18.3
	D	9.22	13.7	13.4	20.0	18.8	28.0	24.6	36.6
LSL	S	3.80	5.65	5.54	8.24	7.75	11.5	10.0	15.1
	D	7.59	11.3	11.1	16.5	15.5	23.1	20.2	30.1

Hole Type	Loading	Nominal Bolt Diameter d, in.							
		1 1/8		1 1/4		1 3/8		1 1/2	
		Minimum ASTM A490 Bolt Pretension, kips							
		80		102		121		148	
		r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
		ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD	S	18.1	26.9	23.1	34.3	27.3	40.7	33.4	49.8
	D	36.2	53.8	46.1	68.6	54.7	81.4	66.9	99.5
OVS/SSL	S	15.4	22.9	19.6	29.1	23.2	34.6	28.4	42.3
	D	30.7	45.7	39.2	58.3	46.5	69.2	56.9	84.6
LSL	S	12.7	18.8	16.1	24.0	19.1	28.5	23.4	34.8
	D	25.3	37.7	32.3	48.0	38.3	56.9	46.8	69.7

STD = Standard Hole
SSL = Short-Slotted Hole
LSL = Long-Slotted Hole
OVS = Oversized Hole

S = Single Shear
D = Double Shear

ASD	LRFD	
$\Omega_v = 1.76$	$\phi_v = 0.85$	Note: For available slip resistance when slip is a serviceability limit state, see Table 7-3. For Class B faying surfaces (μ = 0.50), multiply the tabulated available strength by 1.43. The required strength is determined using LRFD load combinations for LRFD design and ASD load combinations for ASD design.

Table 7–5
Available Bearing Strength at Bolt Holes Based on Bolt Spacing
kips/in. thickness

Hole Type	Bolt Spacing, s, in.	F_u, ksi	Nominal Bolt Diameter d_b, in.							
			5/8		3/4		7/8		1	
			r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD SSLT	$2^2/_3\, d_b$	58	34.1	51.1	41.3	62.0	48.6	72.9	55.8	83.7
		65	38.2	57.3	46.3	69.5	54.4	81.7	62.6	93.8
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	67.4	101
		65	48.8	73.1	58.5	87.8	68.3	102	75.6	113
SSLP	$2^2/_3\, d_b$	58	27.6	41.3	34.8	52.2	42.1	63.1	47.1	70.7
		65	30.9	46.3	39.0	58.5	47.1	70.7	52.8	79.2
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	58.7	88.1
		65	48.8	73.1	58.5	87.8	68.3	102	65.8	98.7
OVS	$2^2/_3\, d_b$	58	29.7	44.6	37.0	55.5	44.2	66.3	49.3	74.0
		65	33.3	50.0	41.4	62.2	49.6	74.3	55.3	82.9
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	60.9	91.4
		65	48.8	73.1	58.5	87.8	68.3	102	68.3	102
LSLP	$2^2/_3\, d_b$	58	3.62	5.44	4.35	6.53	5.08	7.61	5.80	8.70
		65	4.06	6.09	4.88	7.31	5.69	8.53	6.50	9.75
	3 in.	58	43.5	65.3	39.2	58.7	28.3	42.4	17.4	26.1
		65	48.8	73.1	43.9	65.8	31.7	47.5	19.5	29.3
LSLT	$2^2/_3\, d_b$	58	28.4	42.6	34.4	51.7	40.5	60.7	46.5	69.8
		65	31.8	47.7	38.6	57.9	45.4	68.0	52.1	78.2
	3 in.	58	36.3	54.4	43.5	65.3	50.8	76.1	56.2	84.3
		65	40.6	60.9	48.8	73.1	56.9	85.3	63.0	94.5
STD, SSLT, SSLP, OVS, LSLP	$s \geq s_{full}$	58	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104
		65	48.8	73.1	58.5	87.8	68.3	102	78.0	117
LSLT	$s \geq s_{full}$	58	36.3	54.4	43.5	65.3	50.8	76.1	58.0	87.0
		65	40.6	60.9	48.8	73.1	56.9	85.3	65.0	97.5
Spacing for full bearing strength s_{full}[a], in.		STD, SSLT, LSLT	$1^{15}/_{16}$		$2^5/_{16}$		$2^{11}/_{16}$		$3^1/_{16}$	
		OVS	$2^1/_{16}$		$2^7/_{16}$		$2^{13}/_{16}$		$3^1/_4$	
		SSLP	$2^1/_8$		$2^1/_2$		$2^7/_8$		$3^5/_{16}$	
		LSLP	$2^{13}/_{16}$		$3^3/_8$		$3^{15}/_{16}$		$4^1/_2$	
Minimum Spacing[a] = $2^2/_3\, d_b$, in.			$1^{11}/_{16}$		2		$2^5/_{16}$		$2^{11}/_{16}$	

STD = Standard Hole
SSLT = Short-Slotted Hole oriented transverse to the line of force
SSLP = Short-Slotted Hole oriented parallel to the line of force
OVS = Oversized Hole
LSLP = Long-Slotted Hole oriented parallel to the line of force
LSLT = Long-Slotted Hole oriented transverse to the line of force

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

Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC Specification Section J3.10.

[a] Decimal value has been rounded to the nearest sixteenth of an inch.

Table 7-5 (continued)
Available Bearing Strength at Bolt Holes Based on Bolt Spacing
kips/in. thickness

Hole Type	Bolt Spacing, s, in.	F_u, ksi	Nominal Bolt Diameter d_b, in.							
			$1^1/_8$		$1^1/_4$		$1^3/_8$		$1^1/_2$	
			r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD SSLT	$2^2/_3\ d_b$	58	63.1	94.6	70.3	105	77.6	116	84.8	127
		65	70.7	106	78.8	118	86.9	130	95.1	143
	3 in.	58	63.1	94.6	—	—	—	—	—	—
		65	70.7	106	—	—	—	—	—	—
SSLP	$2^2/_3\ d_b$	58	52.2	78.3	59.5	89.2	66.7	100	74.0	111
		65	58.5	87.8	66.6	99.9	74.8	112	82.9	124
	3 in.	58	52.2	78.3	—	—	—	—	—	—
		65	58.5	87.8	—	—	—	—	—	—
OVS	$2^2/_3\ d_b$	58	54.4	81.6	61.6	92.4	68.9	103	76.1	114
		65	60.9	91.4	69.1	104	77.2	116	85.3	128
	3 in.	58	54.4	81.6	—	—	—	—	—	—
		65	60.9	91.4	—	—	—	—	—	—
LSLP	$2^2/_3\ d_b$	58	6.53	9.79	7.25	10.9	7.98	12.0	8.70	13.1
		65	7.31	11.0	8.13	12.2	8.94	13.4	9.75	14.6
	3 in.	58	6.53	9.79	—	—	—	—	—	—
		65	7.31	11.0	—	—	—	—	—	—
LSLT	$2^2/_3\ d_b$	58	52.6	78.8	58.6	87.9	64.6	97.0	70.7	106
		65	58.9	88.4	65.7	98.5	72.4	109	79.2	119
	3 in.	58	52.6	78.8	—	—	—	—	—	—
		65	58.9	88.4	—	—	—	—	—	—
STD, SSLT, SSLP, OVS, LSLP	$s \geq s_{full}$	58	78.3	117	87.0	131	95.7	144	104	157
		65	87.8	132	97.5	146	107	161	117	176
LSLT	$s \geq s_{full}$	58	65.3	97.9	72.5	109	79.8	120	87.0	131
		65	73.1	110	81.3	122	89.4	134	97.5	146
Spacing for full bearing strength s_{full}[a], in.		STD, SSLT, LSLT	$3^7/_{16}$		$3^{13}/_{16}$		$4^3/_{16}$		$4^9/_{16}$	
		OVS	$3^{11}/_{16}$		$4^1/_{16}$		$4^7/_{16}$		$4^{13}/_{16}$	
		SSLP	$3^3/_4$		$4^1/_8$		$4^1/_2$		$4^7/_8$	
		LSLP	$5^1/_{16}$		$5^5/_8$		$6^3/_{16}$		$6^3/_4$	
Minimum Spacing[a] = $2^2/_3\ d_b$, in.			3		$3^5/_{16}$		$3^{11}/_{16}$		4	

STD = Standard Hole
SSLT = Short-Slotted Hole oriented transverse to the line of force
SSLP = Short-Slotted Hole oriented parallel to the line of force
OVS = Oversized Hole
LSLP = Long-Slotted Hole oriented parallel to the line of force
LSLT = Long-Slotted Hole oriented transverse to the line of force

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

— indicates spacing less than minimum spacing required per AISC Specification Section J3.3.

Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC Specification Section J3.10.

[a] Decimal value has been rounded to the nearest sixteenth of an inch.

Table 7–6
Available Bearing Strength at Bolt Holes Based on Edge Distance
kips/in. thickness

Hole Type	Edge Distance L_e, in.	F_u, ksi	Nominal Bolt Diameter d_b, in. 5/8 r_n/Ω_v ASD	5/8 $\phi_v r_n$ LRFD	3/4 r_n/Ω_v ASD	3/4 $\phi_v r_n$ LRFD	7/8 r_n/Ω_v ASD	7/8 $\phi_v r_n$ LRFD	1 r_n/Ω_v ASD	1 $\phi_v r_n$ LRFD
STD SSLT	1 1/4	58	31.5	47.3	29.4	44.0	27.2	40.8	25.0	37.5
		65	35.3	53.0	32.9	49.4	30.5	45.7	28.0	42.0
	2	58	43.5	65.3	52.2	78.3	53.3	79.9	51.1	76.7
		65	48.8	73.1	58.5	87.8	59.7	89.6	57.3	85.9
SSLP	1 1/4	58	28.3	42.4	26.1	39.2	23.9	35.9	20.7	31.0
		65	31.7	47.5	29.3	43.9	26.8	40.2	23.2	34.7
	2	58	43.5	65.3	52.2	78.3	50.0	75.0	46.8	70.1
		65	48.8	73.1	58.5	87.8	56.1	84.1	52.4	78.6
OVS	1 1/4	58	29.4	44.0	27.2	40.8	25.0	37.5	21.8	32.6
		65	32.9	49.4	30.5	45.7	28.0	42.0	24.4	36.6
	2	58	43.5	65.3	52.2	78.3	51.1	76.7	47.9	71.8
		65	48.8	73.1	58.5	87.8	57.3	85.9	53.6	80.4
LSLP	1 1/4	58	16.3	24.5	10.9	16.3	5.44	8.16	—	—
		65	18.3	27.4	12.2	18.3	6.09	9.14	—	—
	2	58	42.4	63.6	37.0	55.5	31.5	47.3	26.1	39.2
		65	47.5	71.3	41.4	62.2	35.3	53.0	29.3	43.9
LSLT	1 1/4	58	26.3	39.4	24.5	36.7	22.7	34.0	20.8	31.3
		65	29.5	44.2	27.4	41.1	25.4	38.1	23.4	35.0
	2	58	36.3	54.4	43.5	65.3	44.4	66.6	42.6	63.9
		65	40.6	60.9	48.8	73.1	49.8	74.6	47.7	71.6
STD, SSLT, SSLP, OVS, LSLP	$L_e \geq L_{e\ full}$	58	43.5	65.3	52.2	78.3	60.9	91.4	69.6	104
		65	48.8	73.1	58.5	87.8	68.3	102	78.0	117
LSLT	$L_e \geq L_{e\ full}$	58	36.3	54.4	43.5	65.3	50.8	76.1	58.0	87.0
		65	40.6	60.9	48.8	73.1	56.9	85.3	65.0	97.5

Edge distance for full bearing strength $L_e \geq L_{e\ full}$[a], in.	Hole Type	5/8	3/4	7/8	1
	STD, SSLT, LSLT	1 5/8	1 15/16	2 1/4	2 9/16
	OVS	1 11/16	2	2 5/16	2 5/8
	SSLP	1 11/16	2	2 5/16	2 11/16
	LSLP	2 1/16	2 7/16	2 7/8	3 1/4

STD = Standard Hole
SSLT = Short-Slotted Hole oriented transverse to the line of force
SSLP = Short-Slotted Hole oriented parallel to the line of force
OVS = Oversized Hole
LSLP = Long-Slotted Hole oriented parallel to the line of force
LSLT = Long-Slotted Hole oriented transverse to the line of force

ASD	LRFD	
$\Omega_v = 2.00$	$\phi_v = 0.75$	— indicates spacing less than minimum spacing required per AISC Specification Section J3.3. Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC Specification Section J3.10. [a] Decimal value has been rounded to the nearest sixteenth of an inch.

Table 7-6 (continued)
Available Bearing Strength at Bolt Holes Based on Edge Distance
kips/in. thickness

Hole Type	Edge Distance L_e, in.	F_u, ksi	Nominal Bolt Diameter d_b, in.							
			$1^1/_8$		$1^1/_4$		$1^3/_8$		$1^1/_2$	
			r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$	r_n/Ω_v	$\phi_v r_n$
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD SSLT	$1^1/_4$	58	22.8	34.3	20.7	31.0	18.5	27.7	16.3	24.5
		65	25.6	38.4	23.2	34.7	20.7	31.1	18.3	27.4
	2	58	48.9	73.4	46.8	70.1	44.6	66.9	42.4	63.6
		65	54.8	82.3	52.4	78.6	50.0	75.0	47.5	71.3
SSLP	$1^1/_4$	58	17.4	26.1	15.2	22.8	13.1	19.6	10.9	16.3
		65	19.5	29.3	17.1	25.6	14.6	21.9	12.2	18.3
	2	58	43.5	65.3	41.3	62.0	39.2	58.7	37.0	55.5
		65	48.8	73.1	46.3	69.5	43.9	65.8	41.4	62.2
OVS	$1^1/_4$	58	18.5	27.7	16.3	24.5	14.1	21.2	12.0	17.9
		65	20.7	31.1	18.3	27.4	15.8	23.8	13.4	20.1
	2	58	44.6	66.9	42.4	63.6	40.2	60.4	38.1	57.1
		65	50.0	75.0	47.5	71.3	45.1	67.6	42.7	64.0
LSLP	$1^1/_4$	58	—	—	—	—	—	—	—	—
		65	—	—	—	—	—	—	—	—
	2	58	20.7	31.0	15.2	22.8	9.79	14.7	4.35	6.53
		65	23.2	34.7	17.1	25.6	11.0	16.5	4.88	7.31
LSLT	$1^1/_4$	58	19.0	28.5	17.2	25.8	15.4	23.1	13.6	20.4
		65	21.3	32.0	19.3	28.9	17.3	25.9	15.2	22.9
	2	58	40.8	61.2	39.0	58.5	37.2	55.7	35.3	53.0
		65	45.7	68.6	43.7	65.5	41.6	62.5	39.6	59.4
STD, SSLT, SSLP, OVS, LSLP	$L_e \geq L_{e\,full}$	58	78.3	117	87.0	131	95.7	144	104	157
		65	87.8	132	97.5	146	107	161	117	176
LSLT	$L_e \geq L_{e\,full}$	58	65.3	97.9	72.5	109	79.8	120	87.0	131
		65	73.1	110	81.3	122	89.4	134	97.5	146
Edge distance for full bearing strength $L_e \geq L_{e\,full}$[a], in.		STD, SSLT, LSLT	$2^7/_8$		$3^3/_{16}$		$3^1/_2$		$3^{13}/_{16}$	
		OVS	3		$3^5/_{16}$		$3^5/_8$		$3^{15}/_{16}$	
		SSLP	3		$3^5/_{16}$		$3^5/_8$		$3^{15}/_{16}$	
		LSLP	$3^{11}/_{16}$		$4^1/_{16}$		$4^1/_2$		$4^7/_8$	

STD = Standard Hole
SSLT = Short-Slotted Hole oriented transverse to the line of force
SSLP = Short-Slotted Hole oriented parallel to the line of force
OVS = Oversized Hole
LSLP = Long-Slotted Hole oriented parallel to the line of force
LSLT = Long-Slotted Hole oriented transverse to the line of force

ASD	LRFD	
$\Omega_v = 2.00$	$\phi_v = 0.75$	— indicates spacing less than minimum spacing required per AISC Specification Section J3.3. Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC Specification Section J3.10. [a] Decimal value has been rounded to the nearest sixteenth of an inch.

Table 7-7
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

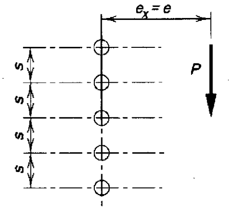
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*										
		2	3	4	5	6	7	8	9	10	11	12
3	2	1.18	2.23	3.32	4.39	5.45	6.48	7.51	8.52	9.53	10.5	11.5
	3	0.88	1.75	2.81	3.90	4.98	6.06	7.12	8.17	9.21	10.2	11.3
	4	0.69	1.40	2.36	3.40	4.47	5.56	6.64	7.72	8.78	9.84	10.9
	5	0.56	1.15	2.01	2.96	3.98	5.05	6.13	7.22	8.30	9.38	10.4
	6	0.48	0.97	1.73	2.59	3.55	4.57	5.63	6.70	7.79	8.87	9.96
	7	0.41	0.83	1.51	2.28	3.17	4.13	5.15	6.20	7.28	8.36	9.44
	8	0.36	0.73	1.34	2.04	2.85	3.75	4.72	5.73	6.78	7.85	8.93
	9	0.32	0.65	1.21	1.83	2.59	3.42	4.34	5.31	6.32	7.36	8.42
	10	0.29	0.59	1.09	1.66	2.36	3.14	4.00	4.92	5.89	6.90	7.94
	12	0.24	0.49	0.92	1.40	2.00	2.68	3.44	4.27	5.15	6.09	7.06
	14	0.21	0.42	0.79	1.21	1.74	2.33	3.01	3.75	4.55	5.41	6.31
	16	0.18	0.37	0.70	1.06	1.53	2.06	2.67	3.33	4.06	4.85	5.68
	18	0.16	0.33	0.62	0.95	1.37	1.84	2.39	3.00	3.66	4.38	5.15
	20	0.15	0.29	0.56	0.85	1.24	1.67	2.16	2.72	3.33	3.99	4.70
	24	0.12	0.25	0.47	0.71	1.03	1.40	1.82	2.29	2.81	3.37	3.99
	28	0.11	0.21	0.40	0.61	0.89	1.20	1.57	1.97	2.42	2.92	3.45
	32	0.09	0.18	0.35	0.54	0.78	1.05	1.37	1.73	2.13	2.57	3.04
	36	0.08	0.16	0.31	0.48	0.69	0.94	1.22	1.54	1.90	2.29	2.72
	C′	2.94	5.89	11.3	17.1	25.1	33.8	44.4	55.9	69.2	83.5	100
6	2	1.63	2.71	3.75	4.77	5.77	6.77	7.76	8.75	9.74	10.7	11.7
	3	1.39	2.48	3.56	4.60	5.63	6.65	7.65	8.66	9.66	10.7	11.6
	4	1.18	2.23	3.32	4.39	5.45	6.48	7.51	8.52	9.53	10.5	11.5
	5	1.01	1.98	3.07	4.15	5.23	6.28	7.33	8.36	9.38	10.4	11.4
	6	0.88	1.75	2.81	3.90	4.98	6.06	7.12	8.17	9.21	10.2	11.3
	7	0.77	1.56	2.58	3.64	4.73	5.81	6.89	7.95	9.00	10.1	11.1
	8	0.69	1.40	2.36	3.40	4.47	5.56	6.64	7.72	8.78	9.84	10.9
	9	0.62	1.26	2.17	3.17	4.22	5.30	6.39	7.47	8.55	9.61	10.7
	10	0.56	1.15	2.01	2.96	3.98	5.05	6.13	7.22	8.30	9.38	10.4
	12	0.48	0.97	1.73	2.59	3.55	4.57	5.63	6.70	7.79	8.87	9.96
	14	0.41	0.83	1.51	2.28	3.17	4.13	5.15	6.20	7.28	8.36	9.44
	16	0.36	0.73	1.34	2.04	2.85	3.75	4.72	5.73	6.78	7.85	8.93
	18	0.32	0.65	1.21	1.83	2.59	3.42	4.34	5.31	6.32	7.36	8.42
	20	0.29	0.59	1.09	1.66	2.36	3.14	4.00	4.92	5.89	6.90	7.94
	24	0.24	0.49	0.92	1.40	2.00	2.68	3.44	4.27	5.15	6.09	7.06
	28	0.21	0.42	0.79	1.21	1.74	2.33	3.01	3.75	4.55	5.41	6.31
	32	0.18	0.37	0.70	1.06	1.53	2.06	2.67	3.33	4.06	4.85	5.68
	36	0.16	0.33	0.62	0.95	1.37	1.84	2.39	3.00	3.66	4.38	5.15
	C′	5.89	11.8	22.5	34.3	50.2	67.6	88.8	112	138	167	199

Table 7–7 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

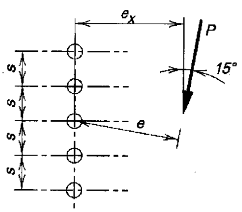
$\phi = 0.75$ $\quad\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*										
		2	3	4	5	6	7	8	9	10	11	12
3	2	1.15	2.20	3.28	4.34	5.39	6.42	7.45	8.46	9.47	10.5	11.5
	3	0.86	1.76	2.78	3.85	4.92	5.98	7.03	8.08	9.11	10.1	11.2
	4	0.67	1.42	2.35	3.36	4.41	5.48	6.55	7.61	8.67	9.72	10.8
	5	0.55	1.17	2.00	2.94	3.94	4.98	6.04	7.11	8.18	9.24	10.3
	6	0.47	0.99	1.73	2.58	3.52	4.52	5.55	6.61	7.67	8.74	9.81
	7	0.41	0.86	1.52	2.30	3.16	4.11	5.10	6.13	7.18	8.24	9.30
	8	0.36	0.75	1.35	2.06	2.86	3.74	4.69	5.68	6.70	7.74	8.80
	9	0.32	0.67	1.22	1.86	2.60	3.43	4.32	5.27	6.26	7.28	8.31
	10	0.29	0.61	1.10	1.69	2.38	3.16	4.00	4.90	5.85	6.84	7.85
	12	0.24	0.51	0.93	1.43	2.03	2.71	3.46	4.28	5.15	6.06	7.01
	14	0.21	0.43	0.81	1.24	1.76	2.37	3.04	3.78	4.57	5.41	6.30
	16	0.19	0.38	0.71	1.09	1.56	2.10	2.70	3.37	4.09	4.87	5.69
	18	0.17	0.34	0.63	0.97	1.39	1.88	2.43	3.04	3.70	4.42	5.18
	20	0.15	0.3	0.57	0.88	1.26	1.70	2.20	2.76	3.37	4.03	4.74
	24	0.12	0.25	0.48	0.73	1.06	1.43	1.86	2.33	2.86	3.43	4.04
	28	0.11	0.22	0.41	0.63	0.91	1.23	1.60	2.02	2.47	2.97	3.51
	32	0.09	0.19	0.36	0.55	0.80	1.08	1.41	1.77	2.18	2.62	3.10
	36	0.08	0.17	0.32	0.49	0.71	0.96	1.26	1.58	1.95	2.34	2.78
6	2	1.61	2.69	3.72	4.74	5.74	6.74	7.73	8.73	9.71	10.7	11.7
	3	1.36	2.45	3.52	4.56	5.59	6.60	7.61	8.61	9.61	10.6	11.6
	4	1.15	2.20	3.28	4.34	5.39	6.42	7.45	8.46	9.47	10.5	11.5
	5	0.98	1.96	3.03	4.10	5.16	6.21	7.25	8.28	9.30	10.3	11.3
	6	0.86	1.76	2.78	3.85	4.92	5.98	7.03	8.08	9.11	10.1	11.2
	7	0.75	1.57	2.55	3.60	4.66	5.73	6.80	7.85	8.90	9.94	11.0
	8	0.67	1.42	2.35	3.36	4.41	5.48	6.55	7.61	8.67	9.72	10.8
	9	0.61	1.29	2.16	3.14	4.17	5.23	6.30	7.36	8.43	9.49	10.5
	10	0.55	1.17	2.00	2.94	3.94	4.98	6.04	7.11	8.18	9.24	10.3
	12	0.47	0.99	1.73	2.58	3.52	4.52	5.55	6.61	7.67	8.74	9.81
	14	0.41	0.86	1.52	2.3	3.16	4.11	5.10	6.13	7.18	8.24	9.30
	16	0.36	0.75	1.35	2.06	2.86	3.74	4.69	5.68	6.70	7.74	8.80
	18	0.32	0.67	1.22	1.86	2.60	3.43	4.32	5.27	6.26	7.28	8.31
	20	0.29	0.61	1.10	1.69	2.38	3.16	4.00	4.90	5.85	6.84	7.85
	24	0.24	0.51	0.93	1.43	2.03	2.71	3.46	4.28	5.15	6.06	7.01
	28	0.21	0.43	0.81	1.24	1.76	2.37	3.04	3.78	4.57	5.41	6.30
	32	0.19	0.38	0.71	1.09	1.56	2.10	2.70	3.37	4.09	4.87	5.69
	36	0.17	0.34	0.63	0.97	1.39	1.88	2.43	3.04	3.70	4.42	5.18

Table 7-7 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

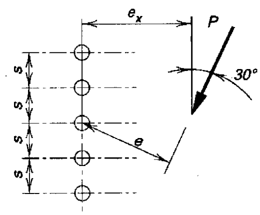
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*										
		2	3	4	5	6	7	8	9	10	11	12
3	2	1.14	2.20	3.25	4.30	5.33	6.36	7.38	8.39	9.40	10.4	11.4
	3	0.86	1.80	2.79	3.83	4.87	5.92	6.96	7.99	9.02	10.0	11.1
	4	0.69	1.50	2.40	3.39	4.41	5.45	6.49	7.53	8.57	9.61	10.6
	5	0.57	1.27	2.08	3.00	3.98	4.99	6.02	7.06	8.11	9.15	10.2
	6	0.49	1.09	1.82	2.68	3.60	4.57	5.58	6.60	7.64	8.68	9.72
	7	0.43	0.95	1.61	2.40	3.27	4.20	5.17	6.17	7.18	8.21	9.25
	8	0.38	0.83	1.44	2.17	2.98	3.86	4.79	5.76	6.75	7.77	8.79
	9	0.34	0.75	1.30	1.98	2.74	3.57	4.46	5.39	6.35	7.34	8.35
	10	0.31	0.67	1.19	1.82	2.52	3.31	4.15	5.05	5.98	6.95	7.93
	12	0.26	0.56	1.01	1.55	2.17	2.87	3.64	4.46	5.33	6.24	7.17
	14	0.23	0.48	0.87	1.35	1.90	2.53	3.23	3.98	4.78	5.63	6.51
	16	0.20	0.42	0.77	1.20	1.69	2.26	2.89	3.58	4.33	5.11	5.94
	18	0.18	0.38	0.69	1.07	1.52	2.04	2.62	3.25	3.94	4.67	5.45
	20	0.16	0.34	0.62	0.97	1.37	1.85	2.38	2.97	3.61	4.30	5.02
	24	0.14	0.28	0.52	0.81	1.16	1.57	2.02	2.53	3.09	3.69	4.33
	28	0.12	0.24	0.45	0.70	1.00	1.36	1.75	2.20	2.69	3.22	3.79
	32	0.10	0.21	0.40	0.61	0.88	1.19	1.54	1.94	2.38	2.85	3.37
	36	0.09	0.19	0.35	0.55	0.78	1.07	1.38	1.74	2.13	2.56	3.03
6	2	1.59	2.66	3.69	4.70	5.71	6.70	7.70	8.69	9.68	10.7	11.7
	3	1.34	2.43	3.48	4.52	5.54	6.55	7.55	8.56	9.55	10.6	11.5
	4	1.14	2.20	3.25	4.30	5.33	6.36	7.38	8.39	9.40	10.4	11.4
	5	0.98	1.99	3.02	4.06	5.11	6.14	7.17	8.20	9.22	10.2	11.2
	6	0.86	1.80	2.79	3.83	4.87	5.92	6.96	7.99	9.02	10.0	11.1
	7	0.77	1.64	2.59	3.60	4.64	5.68	6.73	7.77	8.80	9.83	10.9
	8	0.69	1.50	2.40	3.39	4.41	5.45	6.49	7.53	8.57	9.61	10.6
	9	0.63	1.37	2.23	3.19	4.19	5.22	6.26	7.30	8.34	9.38	10.4
	10	0.57	1.27	2.08	3.00	3.98	4.99	6.02	7.06	8.11	9.15	10.2
	12	0.49	1.09	1.82	2.68	3.60	4.57	5.58	6.60	7.64	8.68	9.72
	14	0.43	0.95	1.61	2.40	3.27	4.20	5.17	6.17	7.18	8.21	9.25
	16	0.38	0.83	1.44	2.17	2.98	3.86	4.79	5.76	6.75	7.77	8.79
	18	0.34	0.75	1.30	1.98	2.74	3.57	4.46	5.39	6.35	7.34	8.35
	20	0.31	0.67	1.19	1.82	2.52	3.31	4.15	5.05	5.98	6.95	7.93
	24	0.26	0.56	1.01	1.55	2.17	2.87	3.64	4.46	5.33	6.24	7.17
	28	0.23	0.48	0.87	1.35	1.90	2.53	3.23	3.98	4.78	5.63	6.51
	32	0.20	0.42	0.77	1.20	1.69	2.26	2.89	3.58	4.33	5.11	5.94
	36	0.18	0.38	0.69	1.07	1.52	2.04	2.62	3.25	3.94	4.67	5.45

Table 7-7 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

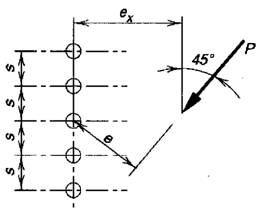
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n										
		2	3	4	5	6	7	8	9	10	11	12
3	2	1.17	2.23	3.26	4.28	5.29	6.30	7.31	8.32	9.32	10.3	11.3
	3	0.92	1.89	2.87	3.87	4.88	5.90	6.91	7.93	8.94	9.95	11.0
	4	0.75	1.63	2.54	3.5	4.49	5.49	6.51	7.52	8.53	9.55	10.6
	5	0.64	1.42	2.25	3.17	4.13	5.11	6.11	7.11	8.12	9.14	10.2
	6	0.55	1.25	2.01	2.88	3.8	4.76	5.73	6.73	7.73	8.73	9.74
	7	0.49	1.11	1.81	2.63	3.51	4.43	5.38	6.36	7.34	8.34	9.34
	8	0.44	0.99	1.64	2.41	3.25	4.14	5.06	6.01	6.98	7.96	8.96
	9	0.40	0.90	1.49	2.22	3.02	3.87	4.77	5.69	6.64	7.61	8.58
	10	0.36	0.81	1.37	2.06	2.82	3.63	4.50	5.39	6.32	7.27	8.23
	12	0.31	0.68	1.17	1.79	2.47	3.22	4.02	4.87	5.74	6.65	7.58
	14	0.27	0.59	1.03	1.58	2.20	2.88	3.62	4.41	5.24	6.11	6.99
	16	0.24	0.52	0.91	1.41	1.97	2.60	3.29	4.03	4.81	5.63	6.48
	18	0.21	0.46	0.82	1.27	1.78	2.36	3.00	3.70	4.43	5.21	6.02
	20	0.19	0.41	0.74	1.16	1.62	2.16	2.76	3.41	4.1	4.84	5.61
	24	0.16	0.35	0.63	0.98	1.38	1.85	2.37	2.94	3.56	4.22	4.92
	28	0.14	0.30	0.54	0.85	1.19	1.61	2.08	2.58	3.14	3.73	4.37
	32	0.12	0.26	0.48	0.75	1.05	1.43	1.84	2.30	2.80	3.34	3.92
	36	0.11	0.23	0.43	0.67	0.94	1.28	1.65	2.07	2.53	3.02	3.55
6	2	1.57	2.64	3.66	4.67	5.67	6.66	7.66	8.65	9.64	10.6	11.6
	3	1.35	2.43	3.46	4.48	5.49	6.49	7.50	8.49	9.49	10.5	11.5
	4	1.17	2.23	3.26	4.28	5.29	6.30	7.31	8.32	9.32	10.3	11.3
	5	1.03	2.05	3.06	4.07	5.09	6.10	7.12	8.13	9.13	10.1	11.1
	6	0.92	1.89	2.87	3.87	4.88	5.90	6.91	7.93	8.94	9.95	11.0
	7	0.83	1.75	2.70	3.68	4.68	5.69	6.71	7.72	8.74	9.75	10.8
	8	0.75	1.63	2.54	3.50	4.49	5.49	6.51	7.52	8.53	9.55	10.6
	9	0.69	1.52	2.39	3.33	4.30	5.30	6.30	7.31	8.33	9.34	10.4
	10	0.64	1.42	2.25	3.17	4.13	5.11	6.11	7.11	8.12	9.14	10.2
	12	0.55	1.25	2.01	2.88	3.80	4.76	5.73	6.73	7.73	8.73	9.74
	14	0.49	1.11	1.81	2.63	3.51	4.43	5.38	6.36	7.34	8.34	9.34
	16	0.44	0.99	1.64	2.41	3.25	4.14	5.06	6.01	6.98	7.96	8.96
	18	0.40	0.9	1.49	2.22	3.02	3.87	4.77	5.69	6.64	7.61	8.58
	20	0.36	0.81	1.37	2.06	2.82	3.63	4.50	5.39	6.32	7.27	8.23
	24	0.31	0.68	1.17	1.79	2.47	3.22	4.02	4.87	5.74	6.65	7.58
	28	0.27	0.59	1.03	1.58	2.20	2.88	3.62	4.41	5.24	6.11	6.99
	32	0.24	0.52	0.91	1.41	1.97	2.60	3.29	4.03	4.81	5.63	6.48
	36	0.21	0.46	0.82	1.27	1.78	2.36	3.00	3.70	4.43	5.21	6.02

Table 7–7 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

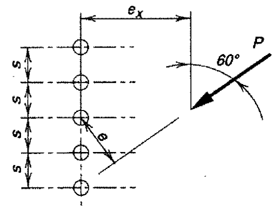
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n* 2	3	4	5	6	7	8	9	10	11	12
3	2	1.27	2.32	3.32	4.31	5.30	6.30	7.29	8.27	9.27	10.3	11.3
	3	1.05	2.05	3.02	4.00	4.98	5.97	6.96	7.94	8.94	9.93	10.9
	4	0.89	1.83	2.77	3.72	4.69	5.66	6.64	7.62	8.61	9.60	10.6
	5	0.77	1.65	2.54	3.47	4.41	5.37	6.34	7.32	8.29	9.28	10.3
	6	0.68	1.49	2.34	3.24	4.16	5.10	6.06	7.02	7.99	8.97	9.95
	7	0.61	1.37	2.17	3.03	3.93	4.85	5.79	6.74	7.71	8.67	9.64
	8	0.56	1.26	2.01	2.83	3.71	4.61	5.54	6.48	7.43	8.39	9.35
	9	0.51	1.16	1.87	2.66	3.51	4.39	5.30	6.23	7.17	8.12	9.07
	10	0.47	1.07	1.74	2.50	3.32	4.19	5.08	5.99	6.92	7.86	8.81
	12	0.40	0.93	1.52	2.22	3.00	3.82	4.67	5.55	6.45	7.37	8.30
	14	0.35	0.81	1.35	2.00	2.73	3.50	4.32	5.16	6.03	6.92	7.83
	16	0.32	0.72	1.21	1.81	2.49	3.23	4.00	4.81	5.65	6.51	7.40
	18	0.29	0.65	1.09	1.66	2.30	2.98	3.72	4.50	5.31	6.14	7.00
	20	0.26	0.58	1.00	1.53	2.12	2.77	3.47	4.21	4.99	5.80	6.63
	24	0.22	0.49	0.85	1.32	1.84	2.41	3.05	3.73	4.45	5.21	5.99
	28	0.19	0.42	0.74	1.15	1.61	2.13	2.71	3.34	4.00	4.70	5.44
	32	0.17	0.37	0.65	1.02	1.43	1.91	2.44	3.02	3.63	4.28	4.97
	36	0.15	0.33	0.59	0.92	1.29	1.72	2.21	2.74	3.31	3.92	4.57
6	2	1.60	2.65	3.65	4.64	5.64	6.63	7.62	8.61	9.60	10.6	11.6
	3	1.42	2.48	3.48	4.48	5.47	6.46	7.45	8.44	9.44	10.4	11.4
	4	1.27	2.32	3.32	4.31	5.30	6.30	7.29	8.27	9.27	10.3	11.3
	5	1.15	2.18	3.17	4.15	5.14	6.13	7.12	8.11	9.10	10.1	11.1
	6	1.05	2.05	3.02	4.00	4.98	5.97	6.96	7.94	8.94	9.93	10.9
	7	0.96	1.93	2.89	3.86	4.83	5.81	6.80	7.78	8.77	9.76	10.8
	8	0.89	1.83	2.77	3.72	4.69	5.66	6.64	7.62	8.61	9.60	10.6
	9	0.83	1.73	2.65	3.59	4.55	5.51	6.49	7.47	8.45	9.43	10.4
	10	0.77	1.65	2.54	3.47	4.41	5.37	6.34	7.32	8.29	9.28	10.3
	12	0.68	1.49	2.34	3.24	4.16	5.10	6.06	7.02	7.99	8.97	9.95
	14	0.61	1.37	2.17	3.03	3.93	4.85	5.79	6.74	7.71	8.67	9.64
	16	0.56	1.26	2.01	2.83	3.71	4.61	5.54	6.48	7.43	8.39	9.35
	18	0.51	1.16	1.87	2.66	3.51	4.39	5.30	6.23	7.17	8.12	9.07
	20	0.47	1.07	1.74	2.50	3.32	4.19	5.08	5.99	6.92	7.86	8.81
	24	0.40	0.93	1.52	2.22	3.00	3.82	4.67	5.55	6.45	7.37	8.30
	28	0.35	0.81	1.35	2.00	2.73	3.50	4.32	5.16	6.03	6.92	7.83
	32	0.32	0.72	1.21	1.81	2.49	3.23	4.00	4.81	5.65	6.51	7.40
	36	0.29	0.65	1.09	1.66	2.30	2.98	3.72	4.50	5.31	6.14	7.00

Table 7–7 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

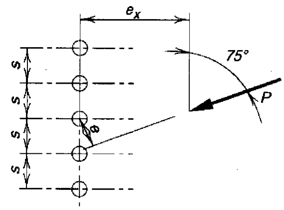
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*										
		2	3	4	5	6	7	8	9	10	11	12
3	2	1.49	2.51	3.49	4.46	5.44	6.42	7.40	8.38	9.36	10.3	11.3
	3	1.32	2.33	3.30	4.27	5.24	6.21	7.18	8.15	9.13	10.1	11.1
	4	1.18	2.18	3.14	4.09	5.05	6.01	6.98	7.95	8.92	9.89	10.9
	5	1.07	2.04	2.99	3.93	4.88	5.84	6.79	7.75	8.72	9.68	10.7
	6	0.98	1.92	2.85	3.79	4.73	5.67	6.62	7.57	8.53	9.49	10.5
	7	0.90	1.82	2.73	3.65	4.58	5.52	6.46	7.40	8.36	9.31	10.3
	8	0.84	1.72	2.62	3.52	4.44	5.37	6.30	7.24	8.19	9.14	10.1
	9	0.78	1.63	2.51	3.40	4.31	5.23	6.16	7.09	8.03	8.97	9.92
	10	0.73	1.55	2.41	3.29	4.19	5.10	6.02	6.94	7.88	8.81	9.76
	12	0.65	1.41	2.23	3.08	3.95	4.84	5.75	6.66	7.59	8.51	9.45
	14	0.58	1.30	2.06	2.88	3.73	4.60	5.50	6.40	7.31	8.23	9.16
	16	0.53	1.20	1.92	2.70	3.52	4.38	5.26	6.15	7.05	7.96	8.88
	18	0.48	1.11	1.78	2.53	3.33	4.17	5.03	5.91	6.80	7.70	8.61
	20	0.44	1.03	1.66	2.38	3.16	3.97	4.82	5.69	6.56	7.45	8.35
	24	0.38	0.89	1.46	2.12	2.85	3.63	4.44	5.27	6.13	6.99	7.87
	28	0.34	0.79	1.29	1.90	2.59	3.33	4.11	4.91	5.73	6.57	7.43
	32	0.30	0.70	1.16	1.73	2.38	3.08	3.81	4.58	5.37	6.19	7.02
	36	0.27	0.62	1.05	1.58	2.19	2.85	3.55	4.28	5.05	5.84	6.65
6	2	1.71	2.72	3.70	4.69	5.67	6.66	7.64	8.79	9.78	10.8	11.7
	3	1.60	2.61	3.59	4.57	5.55	6.53	7.52	8.50	9.48	10.5	11.5
	4	1.49	2.51	3.49	4.46	5.44	6.42	7.40	8.38	9.36	10.3	11.3
	5	1.40	2.42	3.39	4.37	5.34	6.31	7.29	8.26	9.24	10.2	11.2
	6	1.32	2.33	3.30	4.27	5.24	6.21	7.18	8.15	9.13	10.1	11.1
	7	1.25	2.25	3.22	4.18	5.14	6.11	7.07	8.05	9.01	10.0	11.0
	8	1.18	2.18	3.14	4.09	5.05	6.01	6.98	7.95	8.92	9.89	10.9
	9	1.13	2.11	3.06	4.01	4.97	5.92	6.88	7.85	8.81	9.78	10.8
	10	1.07	2.04	2.99	3.93	4.88	5.84	6.79	7.75	8.72	9.68	10.7
	12	0.98	1.92	2.85	3.79	4.73	5.67	6.62	7.57	8.53	9.49	10.5
	14	0.90	1.82	2.73	3.65	4.58	5.52	6.46	7.40	8.36	9.31	10.3
	16	0.84	1.72	2.62	3.52	4.44	5.37	6.30	7.24	8.19	9.14	10.1
	18	0.78	1.63	2.51	3.40	4.31	5.23	6.16	7.09	8.03	8.97	9.92
	20	0.73	1.55	2.41	3.29	4.19	5.10	6.02	6.94	7.88	8.81	9.76
	24	0.65	1.41	2.23	3.08	3.95	4.84	5.75	6.66	7.59	8.51	9.45
	28	0.58	1.30	2.06	2.88	3.73	4.60	5.50	6.40	7.31	8.23	9.16
	32	0.53	1.20	1.92	2.70	3.52	4.38	5.26	6.15	7.05	7.96	8.88
	36	0.48	1.11	1.78	2.53	3.33	4.17	5.03	5.91	6.80	7.70	8.61

Table 7–8
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

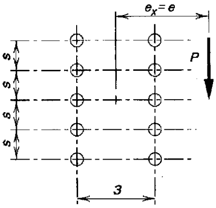
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	0.84	2.54	4.48	6.59	8.72	10.8	12.9	15.0	17.0	19.0	21.0	23.0
	3	0.65	2.03	3.68	5.67	7.77	9.91	12.1	14.2	16.3	18.3	20.4	22.5
	4	0.54	1.67	3.06	4.86	6.84	8.93	11.1	13.2	15.4	17.5	19.6	21.7
	5	0.45	1.42	2.59	4.21	6.01	8.00	10.1	12.2	14.4	16.5	18.7	20.8
	6	0.39	1.22	2.25	3.69	5.32	7.17	9.16	11.2	13.4	15.5	17.7	19.8
	7	0.35	1.08	1.99	3.27	4.74	6.46	8.33	10.3	12.4	14.5	16.7	18.8
	8	0.31	0.96	1.78	2.93	4.27	5.86	7.60	9.50	11.5	13.6	15.7	17.8
	9	0.28	0.86	1.60	2.65	3.87	5.34	6.97	8.75	10.7	12.7	14.7	16.8
	10	0.26	0.78	1.46	2.42	3.53	4.90	6.42	8.10	9.91	11.8	13.8	15.9
	12	0.22	0.66	1.24	2.06	3.01	4.19	5.51	7.01	8.63	10.4	12.2	14.2
	14	0.19	0.57	1.08	1.78	2.62	3.66	4.82	6.15	7.61	9.19	10.9	12.7
	16	0.17	0.51	0.95	1.57	2.32	3.24	4.27	5.47	6.79	8.23	9.78	11.4
	18	0.15	0.45	0.85	1.41	2.07	2.90	3.83	4.92	6.11	7.43	8.85	10.4
	20	0.14	0.41	0.77	1.27	1.88	2.63	3.48	4.47	5.55	6.76	8.07	9.48
	24	0.12	0.34	0.65	1.07	1.58	2.21	2.93	3.77	4.69	5.72	6.85	8.06
	28	0.10	0.29	0.56	0.92	1.36	1.90	2.53	3.25	4.05	4.95	5.93	7.00
	32	0.09	0.26	0.49	0.80	1.19	1.67	2.22	2.86	3.57	4.36	5.23	6.18
	36	0.08	0.23	0.43	0.72	1.06	1.49	1.98	2.55	3.18	3.90	4.67	5.52
	C′	2.94	8.33	15.8	26.0	38.7	54.2	72.2	93.1	117	143	172	204
6	2	0.84	3.24	5.39	7.47	9.51	11.5	13.5	15.5	17.5	19.5	21.5	23.4
	3	0.65	2.79	4.93	7.08	9.17	11.2	13.3	15.3	17.3	19.3	21.3	23.3
	4	0.54	2.41	4.44	6.60	8.75	10.9	12.9	15.0	17.0	19.1	21.1	23.1
	5	0.45	2.10	3.97	6.11	8.27	10.4	12.5	14.6	16.7	18.7	20.8	22.8
	6	0.39	1.85	3.55	5.62	7.77	9.93	12.1	14.2	16.3	18.4	20.4	22.5
	7	0.35	1.64	3.18	5.17	7.27	9.43	11.6	13.7	15.9	18.0	20.1	22.1
	8	0.31	1.47	2.87	4.75	6.79	8.92	11.1	13.3	15.4	17.5	19.6	21.7
	9	0.28	1.34	2.61	4.39	6.34	8.43	10.6	12.7	14.9	17.1	19.2	21.3
	10	0.26	1.22	2.39	4.06	5.92	7.96	10.1	12.2	14.4	16.6	18.7	20.9
	12	0.22	1.04	2.04	3.52	5.20	7.10	9.12	11.2	13.4	15.5	17.7	19.9
	14	0.19	0.90	1.77	3.09	4.61	6.36	8.27	10.3	12.4	14.5	16.7	18.9
	16	0.17	0.80	1.57	2.75	4.12	5.74	7.52	9.44	11.5	13.5	15.7	17.8
	18	0.15	0.71	1.41	2.48	3.72	5.21	6.87	8.68	10.6	12.6	14.7	16.8
	20	0.14	0.64	1.28	2.25	3.38	4.77	6.31	8.02	9.85	11.8	13.8	15.9
	24	0.12	0.54	1.07	1.90	2.86	4.06	5.40	6.91	8.55	10.3	12.2	14.1
	28	0.10	0.46	0.93	1.64	2.47	3.52	4.70	6.05	7.52	9.12	10.8	12.6
	32	0.09	0.41	0.81	1.44	2.18	3.11	4.16	5.37	6.69	8.15	9.71	11.4
	36	0.08	0.36	0.73	1.29	1.94	2.78	3.72	4.81	6.02	7.34	8.78	10.3
	C′	2.94	13.2	26.5	47.0	71.4	103	138	180	226	279	337	400

Table 7-8 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

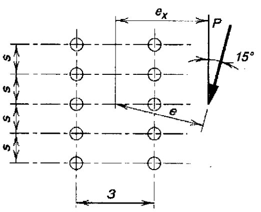
$\phi = 0.75$ $\quad\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	0.87	2.54	4.47	6.54	8.63	10.7	12.8	14.8	16.9	18.9	20.9	22.9
	3	0.68	2.04	3.71	5.63	7.69	9.80	11.9	14.0	16.1	18.2	20.2	22.3
	4	0.55	1.69	3.11	4.85	6.79	8.84	10.9	13.1	15.2	17.3	19.4	21.5
	5	0.47	1.44	2.66	4.21	6.00	7.94	9.98	12.1	14.2	16.3	18.4	20.5
	6	0.41	1.25	2.31	3.70	5.34	7.15	9.09	11.1	13.2	15.3	17.4	19.6
	7	0.36	1.10	2.04	3.29	4.79	6.46	8.30	10.2	12.3	14.3	16.4	18.6
	8	0.32	0.98	1.83	2.96	4.32	5.87	7.60	9.45	11.4	13.4	15.5	17.6
	9	0.29	0.88	1.65	2.68	3.94	5.37	6.99	8.74	10.6	12.6	14.6	16.6
	10	0.27	0.81	1.51	2.45	3.61	4.93	6.45	8.11	9.88	11.8	13.7	15.7
	12	0.23	0.68	1.28	2.09	3.08	4.24	5.58	7.05	8.66	10.4	12.2	14.1
	14	0.20	0.59	1.11	1.82	2.69	3.71	4.90	6.21	7.67	9.23	10.9	12.7
	16	0.17	0.52	0.98	1.61	2.38	3.29	4.36	5.54	6.86	8.29	9.83	11.5
	18	0.16	0.47	0.88	1.44	2.13	2.96	3.92	4.99	6.20	7.51	8.93	10.4
	20	0.14	0.42	0.79	1.31	1.93	2.68	3.56	4.54	5.65	6.85	8.17	9.57
	24	0.12	0.35	0.67	1.10	1.62	2.26	3.00	3.84	4.79	5.82	6.96	8.17
	28	0.10	0.30	0.57	0.94	1.40	1.95	2.60	3.32	4.15	5.05	6.05	7.12
	32	0.09	0.27	0.50	0.83	1.23	1.72	2.28	2.93	3.66	4.46	5.34	6.29
	36	0.08	0.24	0.45	0.74	1.10	1.53	2.04	2.61	3.27	3.98	4.78	5.64
6	2	0.87	3.21	5.35	7.42	9.45	11.5	13.5	15.5	17.4	19.4	21.4	23.4
	3	0.68	2.76	4.88	7.00	9.09	11.1	13.2	15.2	17.2	19.2	21.2	23.2
	4	0.55	2.38	4.40	6.53	8.65	10.7	12.8	14.9	16.9	18.9	20.9	22.9
	5	0.47	2.07	3.96	6.04	8.17	10.3	12.4	14.5	16.5	18.6	20.6	22.6
	6	0.41	1.83	3.56	5.56	7.67	9.80	11.9	14.0	16.1	18.2	20.3	22.3
	7	0.36	1.63	3.22	5.12	7.19	9.30	11.4	13.6	15.7	17.8	19.9	21.9
	8	0.32	1.47	2.92	4.73	6.72	8.81	10.9	13.1	15.2	17.3	19.4	21.5
	9	0.29	1.34	2.66	4.37	6.29	8.33	10.4	12.6	14.7	16.8	18.9	21.0
	10	0.27	1.23	2.45	4.05	5.90	7.88	9.95	12.1	14.2	16.3	18.5	20.6
	12	0.23	1.05	2.09	3.53	5.21	7.06	9.04	11.1	13.2	15.3	17.5	19.6
	14	0.2	0.91	1.83	3.11	4.64	6.35	8.22	10.2	12.2	14.3	16.5	18.6
	16	0.17	0.81	1.62	2.78	4.17	5.75	7.51	9.38	11.4	13.4	15.5	17.6
	18	0.16	0.72	1.45	2.50	3.77	5.24	6.88	8.66	10.5	12.5	14.5	16.6
	20	0.14	0.66	1.32	2.28	3.45	4.80	6.34	8.02	9.82	11.7	13.7	15.7
	24	0.12	0.55	1.11	1.93	2.93	4.10	5.46	6.95	8.57	10.3	12.1	14.0
	28	0.10	0.48	0.96	1.67	2.54	3.57	4.78	6.11	7.58	9.15	10.8	12.6
	32	0.09	0.42	0.84	1.47	2.24	3.16	4.24	5.44	6.77	8.21	9.75	11.4
	36	0.08	0.37	0.75	1.32	2.00	2.83	3.80	4.89	6.10	7.42	8.85	10.4

Table 7–8 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

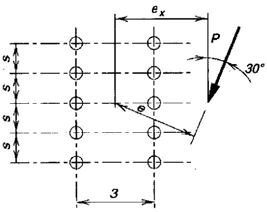
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	0.97	2.60	4.52	6.54	8.59	10.6	12.7	14.7	16.7	18.8	20.8	22.8
	3	0.75	2.12	3.83	5.71	7.71	9.75	11.8	13.9	15.9	18.0	20.0	22.1
	4	0.62	1.78	3.29	4.99	6.88	8.87	10.9	13.0	15.1	17.1	19.2	21.3
	5	0.52	1.53	2.85	4.39	6.16	8.06	10.0	12.1	14.1	16.2	18.3	20.4
	6	0.45	1.34	2.51	3.89	5.54	7.33	9.23	11.2	13.2	15.3	17.3	19.4
	7	0.40	1.19	2.23	3.48	5.01	6.70	8.51	10.4	12.4	14.4	16.4	18.5
	8	0.36	1.07	2.00	3.15	4.57	6.14	7.86	9.68	11.6	13.6	15.6	17.6
	9	0.32	0.97	1.81	2.87	4.19	5.66	7.28	9.02	10.9	12.8	14.7	16.7
	10	0.30	0.88	1.66	2.64	3.87	5.24	6.77	8.43	10.2	12.0	13.9	15.9
	12	0.25	0.75	1.41	2.27	3.34	4.54	5.92	7.43	9.04	10.8	12.5	14.4
	14	0.22	0.65	1.23	1.98	2.93	3.99	5.24	6.61	8.09	9.67	11.4	13.1
	16	0.19	0.58	1.08	1.76	2.60	3.56	4.69	5.94	7.30	8.77	10.3	12.0
	18	0.17	0.52	0.97	1.58	2.34	3.21	4.24	5.38	6.64	8.0	9.45	11.0
	20	0.16	0.47	0.88	1.43	2.12	2.92	3.87	4.92	6.08	7.3	8.70	10.1
	24	0.13	0.39	0.74	1.21	1.79	2.48	3.29	4.18	5.19	6.3	7.48	8.75
	28	0.12	0.34	0.64	1.04	1.55	2.14	2.85	3.63	4.52	5.5	6.54	7.68
	32	0.10	0.30	0.56	0.92	1.36	1.89	2.51	3.21	4.00	4.9	5.81	6.83
	36	0.09	0.26	0.50	0.82	1.21	1.69	2.25	2.87	3.59	4.4	5.22	6.15
6	2	0.97	3.20	5.31	7.37	9.39	11.4	13.4	15.4	17.4	19.4	21.3	23.3
	3	0.75	2.75	4.86	6.95	9.01	11.1	13.1	15.1	17.1	19.1	21.1	23.1
	4	0.62	2.39	4.42	6.49	8.57	10.6	12.7	14.7	16.8	18.8	20.8	22.8
	5	0.52	2.10	4.02	6.04	8.11	10.2	12.3	14.3	16.4	18.4	20.4	22.5
	6	0.45	1.87	3.67	5.61	7.66	9.73	11.8	13.9	16.0	18.0	20.1	22.1
	7	0.40	1.69	3.36	5.21	7.21	9.27	11.4	13.4	15.5	17.6	19.6	21.7
	8	0.36	1.53	3.08	4.84	6.79	8.82	10.9	13.0	15.1	17.1	19.2	21.3
	9	0.32	1.40	2.84	4.51	6.40	8.39	10.4	12.5	14.6	16.7	18.7	20.8
	10	0.30	1.29	2.63	4.21	6.04	7.98	9.99	12.0	14.1	16.2	18.3	20.4
	12	0.25	1.12	2.28	3.70	5.39	7.23	9.16	11.2	13.2	15.3	17.3	19.4
	14	0.22	0.98	2.00	3.29	4.86	6.57	8.41	10.3	12.3	14.4	16.4	18.5
	16	0.19	0.87	1.78	2.95	4.40	6.01	7.75	9.6	11.5	13.5	15.5	17.6
	18	0.17	0.79	1.60	2.68	4.02	5.52	7.17	8.9	10.8	12.7	14.7	16.7
	20	0.16	0.71	1.45	2.45	3.70	5.09	6.65	8.3	10.1	12.0	13.9	15.9
	24	0.13	0.60	1.23	2.08	3.17	4.39	5.79	7.3	8.95	10.7	12.5	14.4
	28	0.12	0.52	1.06	1.82	2.77	3.85	5.11	6.5	7.99	9.59	11.3	13.0
	32	0.10	0.46	0.93	1.61	2.45	3.42	4.56	5.8	7.20	8.68	10.3	11.9
	36	0.09	0.41	0.83	1.44	2.20	3.08	4.12	5.3	6.53	7.91	9.37	10.9

Table 7-8 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

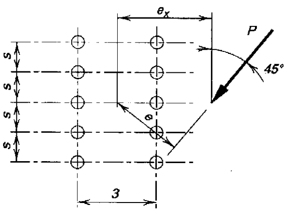
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.17	2.79	4.67	6.62	8.61	10.6	12.6	14.6	16.6	18.6	20.6	22.6
	3	0.92	2.32	4.06	5.92	7.86	9.83	11.8	13.9	15.9	17.9	19.9	21.9
	4	0.75	1.99	3.57	5.31	7.16	9.09	11.1	13.1	15.1	17.1	19.1	21.1
	5	0.64	1.74	3.17	4.78	6.53	8.39	10.3	12.3	14.3	16.3	18.3	20.3
	6	0.55	1.54	2.84	4.33	5.98	7.76	9.63	11.6	13.5	15.5	17.5	19.5
	7	0.49	1.38	2.57	3.93	5.49	7.20	9.00	10.9	12.8	14.8	16.7	18.7
	8	0.44	1.25	2.33	3.60	5.06	6.70	8.43	10.3	12.1	14.0	16.0	18.0
	9	0.40	1.14	2.13	3.31	4.69	6.25	7.91	9.67	11.5	13.4	15.3	17.2
	10	0.36	1.05	1.96	3.06	4.36	5.85	7.44	9.14	10.9	12.7	14.6	16.5
	12	0.31	0.90	1.68	2.65	3.83	5.17	6.63	8.20	9.86	11.6	13.4	15.2
	14	0.27	0.78	1.47	2.33	3.40	4.61	5.95	7.41	8.97	10.6	12.3	14.1
	16	0.24	0.69	1.31	2.08	3.05	4.16	5.38	6.74	8.20	9.75	11.4	13.1
	18	0.21	0.62	1.17	1.88	2.76	3.77	4.91	6.18	7.55	9.00	10.5	12.1
	20	0.19	0.56	1.06	1.71	2.52	3.45	4.51	5.69	6.97	8.34	9.80	11.3
	24	0.16	0.48	0.90	1.45	2.14	2.94	3.87	4.91	6.04	7.26	8.57	9.95
	28	0.14	0.41	0.77	1.26	1.86	2.56	3.38	4.30	5.30	6.41	7.59	8.85
	32	0.12	0.36	0.68	1.11	1.64	2.27	3.00	3.82	4.73	5.73	6.80	7.94
	36	0.11	0.32	0.61	0.99	1.47	2.03	2.70	3.44	4.26	5.17	6.15	7.20
6	2	1.17	3.24	5.30	7.32	9.33	11.3	13.3	15.3	17.3	19.3	21.3	23.2
	3	0.92	2.84	4.90	6.93	8.96	11.0	13.0	15.0	17.0	19.0	21.0	23.0
	4	0.75	2.51	4.52	6.53	8.56	10.6	12.6	14.6	16.6	18.6	20.6	22.6
	5	0.64	2.24	4.17	6.15	8.15	10.2	12.2	14.2	16.2	18.3	20.3	22.3
	6	0.55	2.03	3.86	5.78	7.76	9.77	11.8	13.8	15.8	17.9	19.9	21.9
	7	0.49	1.85	3.59	5.45	7.39	9.38	11.4	13.4	15.4	17.5	19.5	21.5
	8	0.44	1.70	3.35	5.13	7.03	9.00	11.0	13.0	15.0	17.1	19.1	21.1
	9	0.40	1.57	3.13	4.85	6.70	8.63	10.6	12.6	14.6	16.7	18.7	20.7
	10	0.36	1.46	2.94	4.58	6.38	8.28	10.2	12.2	14.2	16.3	18.3	20.3
	12	0.31	1.28	2.60	4.11	5.81	7.64	9.54	11.5	13.5	15.5	17.5	19.5
	14	0.27	1.13	2.32	3.71	5.31	7.06	8.89	10.8	12.7	14.7	16.7	18.7
	16	0.24	1.01	2.09	3.36	4.88	6.55	8.31	10.2	12.0	14.0	15.9	17.9
	18	0.21	0.92	1.90	3.07	4.50	6.09	7.78	9.56	11.4	13.3	15.2	17.2
	20	0.19	0.84	1.73	2.83	4.18	5.69	7.31	9.02	10.8	12.7	14.6	16.5
	24	0.16	0.72	1.47	2.43	3.64	5.00	6.48	8.08	9.76	11.5	13.3	15.2
	28	0.14	0.62	1.28	2.13	3.22	4.45	5.80	7.28	8.86	10.5	12.2	14.0
	32	0.12	0.55	1.13	1.90	2.88	3.99	5.24	6.62	8.09	9.65	11.3	13.0
	36	0.11	0.49	1.01	1.71	2.61	3.62	4.77	6.05	7.43	8.90	10.4	12.1

Table 7–8 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

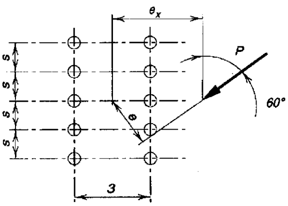
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.51	3.17	4.97	6.85	8.77	10.7	12.7	14.6	16.6	18.6	20.6	22.5
	3	1.24	2.76	4.47	6.30	8.19	10.1	12.0	14.0	16.0	17.9	19.9	21.9
	4	1.04	2.43	4.04	5.81	7.65	9.53	11.5	13.4	15.3	17.3	19.3	21.2
	5	0.89	2.16	3.70	5.39	7.17	9.01	10.9	12.8	14.7	16.7	18.6	20.6
	6	0.77	1.95	3.40	5.01	6.73	8.52	10.4	12.3	14.2	16.1	18.0	20.0
	7	0.68	1.77	3.13	4.67	6.33	8.07	9.88	11.7	13.6	15.5	17.4	19.4
	8	0.61	1.62	2.90	4.37	5.96	7.65	9.42	11.2	13.1	15.0	16.9	18.8
	9	0.56	1.49	2.70	4.09	5.62	7.26	8.98	10.8	12.6	14.5	16.3	18.2
	10	0.51	1.38	2.52	3.84	5.31	6.89	8.58	10.3	12.1	14.0	15.8	17.7
	12	0.43	1.20	2.21	3.40	4.76	6.25	7.85	9.53	11.3	13.0	14.9	16.7
	14	0.38	1.06	1.96	3.05	4.30	5.71	7.23	8.83	10.5	12.2	14.0	15.8
	16	0.34	0.95	1.76	2.75	3.92	5.24	6.68	8.20	9.79	11.5	13.2	14.9
	18	0.30	0.85	1.60	2.51	3.59	4.84	6.19	7.64	9.16	10.8	12.4	14.1
	20	0.27	0.78	1.46	2.30	3.32	4.48	5.76	7.14	8.60	10.1	11.7	13.4
	24	0.23	0.66	1.24	1.97	2.87	3.90	5.04	6.29	7.64	9.06	10.6	12.1
	28	0.20	0.57	1.07	1.72	2.52	3.44	4.47	5.61	6.85	8.17	9.55	11.0
	32	0.18	0.50	0.95	1.52	2.24	3.07	4.01	5.06	6.20	7.41	8.70	10.1
	36	0.16	0.45	0.85	1.37	2.02	2.77	3.63	4.59	5.65	6.77	7.98	9.26
6	2	1.51	3.39	5.36	7.33	9.31	11.3	13.3	15.2	17.2	19.2	21.2	23.2
	3	1.24	3.08	5.04	7.01	8.98	11.0	12.9	14.9	16.9	18.9	20.9	22.8
	4	1.04	2.80	4.73	6.69	8.66	10.6	12.6	14.6	16.6	18.6	20.5	22.5
	5	0.89	2.57	4.45	6.39	8.35	10.3	12.3	14.3	16.2	18.2	20.2	22.2
	6	0.77	2.37	4.20	6.11	8.05	10.0	12.0	13.9	15.9	17.9	19.9	21.8
	7	0.68	2.19	3.98	5.85	7.76	9.70	11.7	13.6	15.6	17.6	19.5	21.5
	8	0.61	2.04	3.77	5.61	7.49	9.41	11.4	13.3	15.3	17.2	19.2	21.2
	9	0.56	1.91	3.59	5.38	7.24	9.13	11.1	13.0	15.0	16.9	18.9	20.9
	10	0.51	1.80	3.42	5.17	7.00	8.87	10.8	12.7	14.7	16.6	18.6	20.5
	12	0.43	1.60	3.11	4.78	6.54	8.37	10.2	12.1	14.1	16.0	18.0	19.9
	14	0.38	1.44	2.85	4.43	6.13	7.91	9.74	11.6	13.5	15.4	17.4	19.3
	16	0.34	1.31	2.63	4.12	5.74	7.48	9.27	11.1	13.0	14.9	16.8	18.7
	18	0.30	1.20	2.43	3.84	5.40	7.08	8.84	10.7	12.5	14.4	16.3	18.2
	20	0.27	1.10	2.26	3.58	5.08	6.71	8.43	10.2	12.0	13.9	15.7	17.6
	24	0.23	0.95	1.97	3.15	4.53	6.06	7.69	9.39	11.2	12.9	14.8	16.6
	28	0.20	0.84	1.73	2.80	4.08	5.52	7.06	8.68	10.4	12.1	13.9	15.7
	32	0.18	0.74	1.54	2.52	3.71	5.05	6.51	8.05	9.66	11.3	13.1	14.8
	36	0.16	0.67	1.39	2.28	3.39	4.65	6.02	7.49	9.03	10.7	12.3	14.0

Table 7-8 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

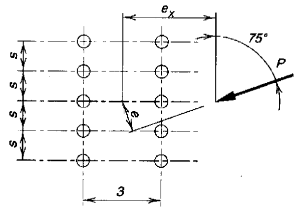
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
	2	1.84	3.63	5.44	7.29	9.17	11.1	13.0	14.9	16.9	18.8	20.8	22.7
	3	1.71	3.41	5.17	6.97	8.82	10.7	12.6	14.5	16.4	18.4	20.3	22.3
	4	1.57	3.19	4.90	6.67	8.50	10.4	12.2	14.1	16.0	18.0	19.9	21.8
	5	1.44	2.98	4.65	6.39	8.19	10.0	11.9	13.8	15.7	17.6	19.5	21.4
	6	1.31	2.79	4.41	6.12	7.90	9.71	11.6	13.4	15.3	17.2	19.1	21.0
	7	1.20	2.61	4.19	5.88	7.62	9.42	11.3	13.1	15.0	16.9	18.8	20.7
	8	1.10	2.45	3.99	5.65	7.37	9.14	11.0	12.8	14.7	16.5	18.4	20.3
	9	1.01	2.31	3.81	5.43	7.14	8.89	10.7	12.5	14.3	16.2	18.1	20.0
3	10	0.93	2.18	3.63	5.23	6.91	8.65	10.4	12.2	14.1	15.9	17.8	19.6
	12	0.81	1.95	3.33	4.86	6.49	8.19	9.94	11.7	13.5	15.3	17.2	19.0
	14	0.71	1.77	3.06	4.53	6.11	7.76	9.47	11.2	13.0	14.8	16.6	18.4
	16	0.63	1.61	2.83	4.23	5.75	7.36	9.03	10.8	12.5	14.3	16.1	17.9
	18	0.57	1.48	2.63	3.96	5.42	6.98	8.61	10.3	12.0	13.8	15.6	17.4
	20	0.52	1.36	2.45	3.72	5.12	6.63	8.23	9.88	11.6	13.3	15.1	16.9
	24	0.44	1.18	2.15	3.30	4.60	6.02	7.53	9.12	10.8	12.4	14.2	15.9
	28	0.38	1.04	1.91	2.95	4.16	5.49	6.93	8.45	10.0	11.7	13.3	15.0
	32	0.34	0.92	1.71	2.67	3.78	5.04	6.41	7.86	9.37	10.9	12.6	14.2
	36	0.30	0.83	1.55	2.43	3.47	4.65	5.94	7.32	8.78	10.3	11.9	13.5
	2	1.84	3.66	5.55	7.48	9.42	11.4	13.3	15.3	17.6	19.6	21.5	23.5
	3	1.71	3.49	5.36	7.27	9.20	11.2	13.1	15.1	17.0	19.0	21.0	22.9
	4	1.57	3.32	5.18	7.08	9.00	10.9	12.9	14.8	16.8	18.7	20.7	22.7
	5	1.44	3.16	5.01	6.89	8.81	10.7	12.7	14.6	16.6	18.5	20.5	22.4
	6	1.31	3.02	4.84	6.72	8.62	10.5	12.5	14.4	16.3	18.3	20.2	22.2
	7	1.20	2.88	4.69	6.55	8.44	10.4	12.3	14.2	16.1	18.1	20.0	22.0
	8	1.10	2.75	4.54	6.39	8.27	10.2	12.1	14.0	15.9	17.9	19.8	21.8
	9	1.01	2.63	4.40	6.24	8.11	10.0	11.9	13.8	15.7	17.7	19.6	21.5
6	10	0.93	2.52	4.27	6.09	7.95	9.83	11.7	13.6	15.6	17.5	19.4	21.3
	12	0.81	2.32	4.03	5.82	7.66	9.52	11.4	13.3	15.2	17.1	19.0	20.9
	14	0.71	2.15	3.82	5.57	7.38	9.22	11.1	13.0	14.9	16.7	18.7	20.6
	16	0.63	2.00	3.62	5.35	7.13	8.95	10.8	12.7	14.5	16.4	18.3	20.2
	18	0.57	1.87	3.44	5.14	6.90	8.69	10.5	12.4	14.2	16.1	18.0	19.9
	20	0.52	1.75	3.28	4.94	6.67	8.45	10.3	12.1	13.9	15.8	17.7	19.5
	24	0.44	1.55	2.98	4.57	6.24	7.98	9.75	11.6	13.4	15.2	17.1	18.9
	28	0.38	1.40	2.74	4.24	5.85	7.54	9.28	11.1	12.9	14.7	16.5	18.3
	32	0.34	1.27	2.52	3.95	5.49	7.13	8.83	10.6	12.4	14.1	16.0	17.8
	36	0.30	1.16	2.33	3.68	5.16	6.75	8.41	10.1	11.9	13.7	15.4	17.3

Table 7–9
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

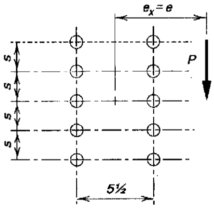
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.14	2.75	4.59	6.61	8.69	10.8	12.9	14.9	17.0	19.0	21.0	23.0
	3	0.94	2.32	3.92	5.80	7.82	9.90	12.0	14.1	16.2	18.3	20.4	22.4
	4	0.80	1.99	3.39	5.10	6.98	9.00	11.1	13.2	15.3	17.4	19.6	21.7
	5	0.70	1.74	2.96	4.51	6.24	8.15	10.2	12.3	14.4	16.5	18.6	20.8
	6	0.62	1.54	2.62	4.03	5.60	7.39	9.30	11.3	13.4	15.5	17.7	19.8
	7	0.55	1.38	2.36	3.63	5.07	6.72	8.53	10.5	12.5	14.6	16.7	18.8
	8	0.50	1.25	2.14	3.30	4.61	6.15	7.84	9.67	11.6	13.6	15.7	17.8
	9	0.46	1.14	1.96	3.01	4.22	5.66	7.23	8.97	10.8	12.8	14.8	16.9
	10	0.42	1.04	1.80	2.78	3.89	5.23	6.70	8.34	10.1	12.0	13.9	15.9
	12	0.37	0.90	1.55	2.39	3.36	4.53	5.82	7.28	8.87	10.6	12.4	14.3
	14	0.32	0.79	1.36	2.10	2.96	3.99	5.13	6.44	7.87	9.42	11.1	12.8
	16	0.29	0.70	1.21	1.87	2.64	3.55	4.58	5.76	7.05	8.47	9.99	11.6
	18	0.26	0.63	1.09	1.68	2.37	3.20	4.14	5.21	6.38	7.68	9.08	10.6
	20	0.24	0.57	0.99	1.53	2.16	2.91	3.77	4.75	5.82	7.02	8.30	9.69
	24	0.20	0.48	0.84	1.29	1.83	2.46	3.19	4.03	4.94	5.97	7.07	8.28
	28	0.18	0.42	0.73	1.11	1.58	2.13	2.77	3.49	4.29	5.19	6.15	7.21
	32	0.16	0.37	0.64	0.98	1.39	1.88	2.44	3.08	3.79	4.58	5.44	6.38
	36	0.14	0.33	0.57	0.88	1.24	1.68	2.18	2.75	3.39	4.10	4.87	5.72
	C′	5.40	12.3	21.2	32.3	45.8	61.8	80.3	102	125	152	181	213
6	2	1.14	3.25	5.37	7.45	9.49	11.5	13.5	15.5	17.5	19.5	21.4	23.4
	3	0.94	2.86	4.93	7.05	9.14	11.2	13.2	15.3	17.3	19.3	21.3	23.3
	4	0.80	2.52	4.47	6.59	8.72	10.8	12.9	15.0	17.0	19.0	21.0	23.1
	5	0.70	2.24	4.04	6.12	8.25	10.4	12.5	14.6	16.7	18.7	20.8	22.8
	6	0.62	2.00	3.65	5.66	7.77	9.91	12.1	14.2	16.3	18.4	20.4	22.5
	7	0.55	1.80	3.31	5.23	7.29	9.42	11.6	13.7	15.8	17.9	20.0	22.1
	8	0.50	1.64	3.02	4.84	6.83	8.93	11.1	13.2	15.4	17.5	19.6	21.7
	9	0.46	1.50	2.77	4.49	6.39	8.45	10.6	12.7	14.9	17.0	19.2	21.3
	10	0.42	1.38	2.56	4.18	5.99	7.99	10.1	12.2	14.4	16.5	18.7	20.8
	12	0.37	1.19	2.21	3.65	5.29	7.16	9.15	11.2	13.4	15.5	17.7	19.8
	14	0.32	1.04	1.95	3.24	4.72	6.44	8.32	10.3	12.4	14.5	16.7	18.8
	16	0.29	0.93	1.74	2.90	4.24	5.83	7.59	9.48	11.5	13.6	15.7	17.8
	18	0.26	0.84	1.57	2.62	3.84	5.31	6.95	8.74	10.7	12.6	14.7	16.8
	20	0.24	0.76	1.43	2.39	3.50	4.87	6.39	8.08	9.89	11.8	13.8	15.9
	24	0.20	0.64	1.21	2.02	2.98	4.16	5.49	6.99	8.61	10.4	12.2	14.1
	28	0.18	0.55	1.05	1.76	2.59	3.63	4.80	6.13	7.59	9.18	10.9	12.7
	32	0.16	0.49	0.93	1.55	2.29	3.21	4.25	5.45	6.77	8.21	9.76	11.4
	36	0.14	0.43	0.83	1.38	2.05	2.88	3.81	4.90	6.09	7.41	8.83	10.4
	C′	5.40	16.0	30.6	51.0	76.2	107	143	185	232	284	342	406

Table 7–9 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

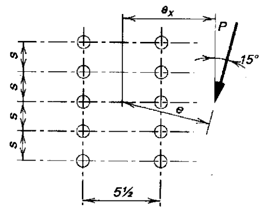
$\phi = 0.75$ $\qquad \Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.18	2.78	4.61	6.59	8.64	10.7	12.8	14.8	16.8	18.9	20.9	22.9
	3	0.97	2.34	3.97	5.80	7.78	9.83	11.9	14.0	16.1	18.1	20.2	22.2
	4	0.83	2.02	3.45	5.11	6.97	8.94	11.0	13.1	15.2	17.3	19.3	21.4
	5	0.72	1.77	3.03	4.54	6.26	8.12	10.1	12.1	14.2	16.3	18.4	20.5
	6	0.64	1.57	2.70	4.06	5.65	7.39	9.27	11.2	13.3	15.4	17.5	19.6
	7	0.57	1.41	2.43	3.66	5.13	6.74	8.52	10.4	12.4	14.4	16.5	18.6
	8	0.52	1.28	2.20	3.34	4.68	6.18	7.86	9.65	11.6	13.5	15.6	17.6
	9	0.48	1.17	2.01	3.06	4.30	5.70	7.27	8.97	10.8	12.7	14.7	16.7
	10	0.44	1.07	1.85	2.82	3.98	5.27	6.76	8.36	10.1	11.9	13.8	15.8
	12	0.38	0.93	1.60	2.44	3.44	4.58	5.90	7.34	8.91	10.6	12.4	14.2
	14	0.33	0.81	1.40	2.15	3.03	4.05	5.22	6.51	7.94	9.47	11.1	12.8
	16	0.30	0.72	1.25	1.91	2.70	3.62	4.68	5.84	7.14	8.54	10.1	11.7
	18	0.27	0.65	1.13	1.72	2.44	3.27	4.23	5.28	6.48	7.77	9.16	10.7
	20	0.25	0.59	1.02	1.57	2.22	2.98	3.86	4.83	5.93	7.11	8.40	9.78
	24	0.21	0.50	0.87	1.33	1.88	2.53	3.27	4.11	5.05	6.07	7.19	8.39
	28	0.18	0.43	0.75	1.15	1.63	2.19	2.84	3.57	4.39	5.29	6.28	7.33
	32	0.16	0.38	0.66	1.01	1.43	1.93	2.50	3.15	3.88	4.68	5.56	6.50
	36	0.14	0.34	0.59	0.90	1.28	1.73	2.24	2.82	3.48	4.19	4.99	5.84
6	2	1.18	3.24	5.34	7.40	9.43	11.5	13.5	15.4	17.4	19.4	21.4	23.4
	3	0.97	2.85	4.90	6.99	9.07	11.1	13.2	15.2	17.2	19.2	21.2	23.2
	4	0.83	2.51	4.45	6.53	8.63	10.7	12.8	14.8	16.9	18.9	20.9	22.9
	5	0.72	2.23	4.05	6.07	8.16	10.3	12.4	14.5	16.5	18.6	20.6	22.6
	6	0.64	2.00	3.68	5.62	7.69	9.80	11.9	14.0	16.1	18.2	20.2	22.3
	7	0.57	1.81	3.36	5.20	7.22	9.31	11.4	13.5	15.7	17.7	19.8	21.9
	8	0.52	1.65	3.08	4.82	6.78	8.83	10.9	13.1	15.2	17.3	19.4	21.5
	9	0.48	1.52	2.83	4.48	6.36	8.37	10.5	12.6	14.7	16.8	18.9	21.0
	10	0.44	1.40	2.62	4.18	5.98	7.93	9.97	12.1	14.2	16.3	18.4	20.6
	12	0.38	1.21	2.27	3.66	5.31	7.13	9.08	11.1	13.2	15.3	17.4	19.6
	14	0.33	1.07	2.00	3.25	4.76	6.44	8.28	10.2	12.3	14.3	16.4	18.6
	16	0.30	0.95	1.79	2.92	4.29	5.85	7.58	9.43	11.4	13.4	15.5	17.6
	18	0.27	0.86	1.62	2.65	3.90	5.34	6.97	8.72	10.6	12.5	14.6	16.6
	20	0.25	0.78	1.47	2.42	3.58	4.91	6.43	8.09	9.87	11.7	13.7	15.7
	24	0.21	0.66	1.25	2.06	3.05	4.21	5.55	7.03	8.64	10.4	12.2	14.1
	28	0.18	0.57	1.08	1.79	2.66	3.68	4.87	6.19	7.65	9.22	10.9	12.6
	32	0.16	0.50	0.95	1.58	2.35	3.26	4.33	5.52	6.84	8.27	9.81	11.4
	36	0.14	0.45	0.85	1.42	2.11	2.93	3.90	4.97	6.18	7.49	8.91	10.4

Table 7–9 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips

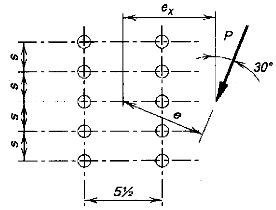
r_n = nominal strength per bolt, kips

e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)

e_x = horizontal component of e, in.

s = bolt spacing, in.

C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.30	2.90	4.72	6.66	8.65	10.7	12.7	14.7	16.7	18.7	20.8	22.8
	3	1.08	2.47	4.13	5.94	7.86	9.85	11.9	13.9	16.0	18.0	20.0	22.1
	4	0.92	2.14	3.64	5.30	7.12	9.04	11.0	13.0	15.1	17.1	19.2	21.2
	5	0.80	1.89	3.24	4.76	6.46	8.29	10.2	12.2	14.2	16.3	18.3	20.4
	6	0.71	1.69	2.91	4.29	5.88	7.61	9.45	11.4	13.4	15.4	17.4	19.5
	7	0.64	1.53	2.63	3.90	5.38	7.01	8.76	10.6	12.5	14.5	16.5	18.6
	8	0.58	1.39	2.40	3.57	4.95	6.49	8.14	9.92	11.8	13.7	15.7	17.7
	9	0.53	1.28	2.20	3.29	4.58	6.02	7.59	9.29	11.1	12.9	14.9	16.8
	10	0.49	1.18	2.03	3.04	4.26	5.61	7.09	8.72	10.4	12.2	14.1	16.0
	12	0.42	1.02	1.76	2.65	3.72	4.92	6.25	7.73	9.31	11.0	12.8	14.6
	14	0.37	0.90	1.55	2.34	3.29	4.37	5.58	6.93	8.38	9.93	11.6	13.3
	16	0.33	0.80	1.38	2.09	2.95	3.92	5.03	6.26	7.59	9.03	10.6	12.2
	18	0.30	0.72	1.25	1.89	2.67	3.55	4.57	5.70	6.93	8.27	9.70	11.2
	20	0.27	0.66	1.13	1.73	2.43	3.25	4.19	5.23	6.36	7.62	8.95	10.4
	24	0.23	0.56	0.96	1.46	2.07	2.77	3.57	4.47	5.47	6.56	7.73	8.99
	28	0.20	0.48	0.83	1.27	1.79	2.41	3.11	3.90	4.78	5.75	6.78	7.91
	32	0.18	0.43	0.73	1.12	1.58	2.13	2.76	3.46	4.25	5.11	6.04	7.06
	36	0.16	0.38	0.66	1.00	1.42	1.91	2.47	3.10	3.81	4.59	5.44	6.36
6	2	1.30	3.27	5.33	7.36	9.38	11.4	13.4	15.4	17.4	19.3	21.3	23.3
	3	1.08	2.89	4.91	6.96	9.01	11.0	13.1	15.1	17.1	19.1	21.1	23.1
	4	0.92	2.56	4.50	6.53	8.58	10.6	12.7	14.7	16.8	18.8	20.8	22.8
	5	0.80	2.29	4.13	6.10	8.14	10.2	12.3	14.3	16.4	18.4	20.4	22.5
	6	0.71	2.08	3.80	5.69	7.70	9.75	11.8	13.9	15.9	18.0	20.0	22.1
	7	0.64	1.89	3.51	5.31	7.27	9.30	11.4	13.4	15.5	17.6	19.6	21.7
	8	0.58	1.74	3.25	4.96	6.86	8.86	10.9	13.0	15.0	17.1	19.2	21.3
	9	0.53	1.61	3.02	4.64	6.49	8.44	10.5	12.5	14.6	16.7	18.7	20.8
	10	0.49	1.49	2.81	4.35	6.13	8.04	10.0	12.1	14.1	16.2	18.3	20.4
	12	0.42	1.30	2.47	3.85	5.51	7.31	9.22	11.2	13.2	15.3	17.3	19.4
	14	0.37	1.15	2.19	3.44	4.98	6.67	8.49	10.4	12.4	14.4	16.4	18.5
	16	0.33	1.03	1.96	3.11	4.54	6.12	7.83	9.66	11.6	13.5	15.6	17.6
	18	0.30	0.93	1.78	2.83	4.16	5.63	7.26	9.00	10.8	12.8	14.7	16.7
	20	0.27	0.85	1.62	2.60	3.83	5.21	6.74	8.41	10.2	12.0	13.9	15.9
	24	0.23	0.72	1.38	2.23	3.30	4.51	5.89	7.40	9.02	10.7	12.5	14.4
	28	0.20	0.63	1.20	1.95	2.89	3.96	5.21	6.59	8.07	9.66	11.3	13.1
	32	0.18	0.55	1.06	1.73	2.57	3.53	4.67	5.92	7.28	8.75	10.3	12.0
	36	0.16	0.50	0.95	1.55	2.31	3.18	4.22	5.36	6.61	7.98	9.43	11.0

Table 7–9 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

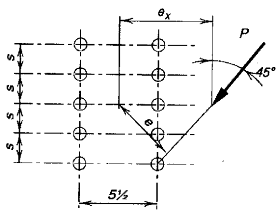
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.53	3.18	4.96	6.84	8.77	10.7	12.7	14.7	16.7	18.7	20.7	22.6
	3	1.30	2.76	4.42	6.22	8.09	10.0	12.0	14.0	15.9	17.9	19.9	21.9
	4	1.11	2.43	3.97	5.67	7.46	9.32	11.2	13.2	15.2	17.2	19.2	21.2
	5	0.98	2.17	3.60	5.19	6.89	8.68	10.6	12.5	14.4	16.4	18.4	20.4
	6	0.87	1.95	3.28	4.77	6.37	8.09	9.90	11.8	13.7	15.6	17.6	19.6
	7	0.78	1.78	3.01	4.40	5.91	7.56	9.31	11.1	13.0	14.9	16.9	18.8
	8	0.71	1.63	2.77	4.07	5.50	7.07	8.76	10.5	12.4	14.2	16.2	18.1
	9	0.65	1.50	2.57	3.78	5.13	6.64	8.26	9.97	11.8	13.6	15.5	17.4
	10	0.60	1.39	2.39	3.52	4.81	6.25	7.81	9.45	11.2	13.0	14.8	16.7
	12	0.52	1.22	2.08	3.09	4.26	5.58	7.01	8.54	10.2	11.9	13.6	15.4
	14	0.45	1.08	1.85	2.75	3.82	5.02	6.34	7.76	9.28	10.9	12.6	14.3
	16	0.41	0.96	1.65	2.48	3.45	4.55	5.77	7.09	8.53	10.1	11.6	13.3
	18	0.37	0.87	1.50	2.25	3.14	4.16	5.29	6.53	7.87	9.30	10.8	12.4
	20	0.33	0.79	1.37	2.06	2.88	3.82	4.87	6.04	7.30	8.65	10.1	11.6
	24	0.28	0.68	1.16	1.76	2.47	3.28	4.21	5.23	6.35	7.55	8.85	10.2
	28	0.25	0.59	1.01	1.53	2.15	2.87	3.69	4.61	5.61	6.69	7.87	9.11
	32	0.22	0.52	0.89	1.35	1.91	2.55	3.29	4.11	5.01	6.00	7.07	8.20
	36	0.20	0.46	0.80	1.21	1.71	2.29	2.96	3.70	4.53	5.43	6.40	7.44
6	2	1.53	3.39	5.36	7.35	9.35	11.3	13.3	15.3	17.3	19.3	21.3	23.2
	3	1.30	3.04	4.99	6.98	8.98	11.0	13.0	15.0	17.0	19.0	21.0	22.9
	4	1.11	2.74	4.64	6.60	8.60	10.6	12.6	14.6	16.6	18.6	20.6	22.6
	5	0.98	2.49	4.31	6.24	8.21	10.2	12.2	14.2	16.3	18.3	20.3	22.3
	6	0.87	2.28	4.02	5.89	7.84	9.82	11.8	13.8	15.9	17.9	19.9	21.9
	7	0.78	2.10	3.76	5.57	7.48	9.44	11.4	13.4	15.5	17.5	19.5	21.5
	8	0.71	1.94	3.53	5.28	7.13	9.07	11.0	13.0	15.1	17.1	19.1	21.1
	9	0.65	1.81	3.32	5.00	6.81	8.71	10.7	12.7	14.7	16.7	18.7	20.7
	10	0.60	1.69	3.13	4.74	6.50	8.37	10.3	12.3	14.3	16.3	18.3	20.3
	12	0.52	1.50	2.80	4.29	5.94	7.74	9.61	11.5	13.5	15.5	17.5	19.5
	14	0.45	1.34	2.52	3.89	5.45	7.17	8.98	10.9	12.8	14.7	16.7	18.7
	16	0.41	1.21	2.29	3.55	5.02	6.67	8.41	10.2	12.1	14.0	16.0	17.9
	18	0.37	1.10	2.09	3.26	4.65	6.22	7.89	9.65	11.5	13.4	15.3	17.2
	20	0.33	1.01	1.92	3.01	4.33	5.82	7.42	9.11	10.9	12.7	14.6	16.5
	24	0.28	0.86	1.64	2.61	3.79	5.13	6.60	8.17	9.84	11.6	13.4	15.2
	28	0.25	0.75	1.44	2.30	3.36	4.58	5.92	7.38	8.95	10.6	12.3	14.1
	32	0.22	0.67	1.27	2.05	3.02	4.12	5.35	6.72	8.18	9.73	11.4	13.0
	36	0.20	0.60	1.14	1.85	2.73	3.74	4.88	6.15	7.52	8.98	10.5	12.1

Table 7-9 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

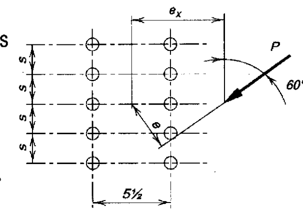
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.78	3.55	5.34	7.17	9.04	10.9	12.9	14.8	16.7	18.7	20.6	22.6
	3	1.62	3.26	4.95	6.71	8.53	10.4	12.3	14.2	16.1	18.1	20.0	22.0
	4	1.45	2.97	4.57	6.27	8.04	9.86	11.7	13.6	15.5	17.5	19.4	21.4
	5	1.31	2.71	4.23	5.86	7.58	9.36	11.2	13.1	15.0	16.9	18.8	20.7
	6	1.18	2.48	3.93	5.50	7.16	8.90	10.7	12.5	14.4	16.3	18.2	20.1
	7	1.07	2.28	3.66	5.18	6.79	8.48	10.2	12.0	13.9	15.7	17.6	19.5
	8	0.98	2.11	3.43	4.88	6.45	8.09	9.80	11.6	13.4	15.2	17.1	19.0
	9	0.90	1.97	3.22	4.61	6.12	7.72	9.39	11.1	12.9	14.7	16.6	18.4
	10	0.83	1.84	3.03	4.37	5.82	7.37	9.00	10.7	12.5	14.2	16.1	17.9
	12	0.72	1.62	2.70	3.93	5.28	6.73	8.28	9.91	11.6	13.4	15.1	16.9
	14	0.64	1.45	2.43	3.56	4.81	6.19	7.66	9.22	10.9	12.5	14.3	16.0
	16	0.57	1.31	2.21	3.24	4.42	5.71	7.11	8.60	10.2	11.8	13.5	15.2
	18	0.52	1.19	2.02	2.98	4.07	5.29	6.63	8.05	9.55	11.1	12.7	14.4
	20	0.47	1.09	1.85	2.75	3.77	4.93	6.19	7.55	8.98	10.5	12.1	13.7
	24	0.40	0.93	1.59	2.37	3.28	4.32	5.46	6.69	8.01	9.41	10.9	12.4
	28	0.35	0.82	1.39	2.08	2.90	3.83	4.86	5.99	7.21	8.51	9.88	11.3
	32	0.31	0.72	1.24	1.86	2.59	3.43	4.37	5.41	6.54	7.75	9.02	10.4
	36	0.28	0.65	1.11	1.67	2.34	3.11	3.97	4.93	5.98	7.10	8.29	9.55
6	2	1.78	3.59	5.48	7.41	9.36	11.3	13.3	15.3	17.2	19.2	21.2	23.2
	3	1.62	3.35	5.20	7.12	9.06	11.0	13.0	15.0	16.9	18.9	20.9	22.9
	4	1.45	3.11	4.93	6.82	8.75	10.7	12.7	14.6	16.6	18.6	20.6	22.5
	5	1.31	2.89	4.66	6.53	8.45	10.4	12.3	14.3	16.3	18.2	20.2	22.2
	6	1.18	2.70	4.42	6.26	8.16	10.1	12.0	14.0	15.9	17.9	19.9	21.9
	7	1.07	2.52	4.19	6.01	7.88	9.79	11.7	13.7	15.6	17.6	19.6	21.5
	8	0.98	2.36	3.99	5.77	7.62	9.51	11.4	13.4	15.3	17.3	19.2	21.2
	9	0.90	2.23	3.81	5.55	7.37	9.24	11.1	13.1	15.0	17.0	18.9	20.9
	10	0.83	2.10	3.64	5.35	7.13	8.98	10.9	12.8	14.7	16.7	18.6	20.6
	12	0.72	1.89	3.34	4.97	6.70	8.49	10.3	12.2	14.1	16.1	18.0	19.9
	14	0.64	1.71	3.08	4.63	6.29	8.04	9.85	11.7	13.6	15.5	17.4	19.3
	16	0.57	1.57	2.85	4.32	5.92	7.62	9.39	11.2	13.1	15.0	16.9	18.8
	18	0.52	1.44	2.65	4.04	5.58	7.22	8.95	10.7	12.6	14.4	16.3	18.2
	20	0.47	1.33	2.47	3.79	5.26	6.86	8.55	10.3	12.1	13.9	15.8	17.7
	24	0.40	1.16	2.17	3.36	4.71	6.21	7.82	9.50	11.2	13.0	14.8	16.7
	28	0.35	1.02	1.92	3.00	4.26	5.67	7.19	8.80	10.5	12.2	14.0	15.8
	32	0.31	0.91	1.72	2.71	3.88	5.20	6.64	8.17	9.77	11.4	13.1	14.9
	36	0.28	0.82	1.56	2.46	3.55	4.80	6.16	7.61	9.14	10.7	12.4	14.1

Table 7-9 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

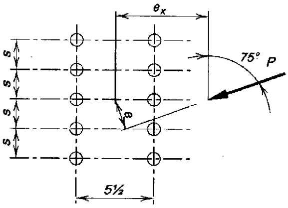
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
	2	1.92	3.82	5.70	7.57	9.45	11.3	13.2	15.2	17.1	19.0	20.9	22.9
	3	1.87	3.72	5.54	7.36	9.19	11.1	12.9	14.8	16.7	18.6	20.5	22.5
	4	1.82	3.60	5.37	7.14	8.94	10.8	12.6	14.5	16.3	18.2	20.1	22.1
	5	1.75	3.47	5.18	6.92	8.68	10.5	12.3	14.1	16.0	17.9	19.8	21.7
	6	1.68	3.33	5.00	6.69	8.42	10.2	12.0	13.8	15.7	17.5	19.4	21.3
	7	1.60	3.19	4.81	6.47	8.17	9.92	11.7	13.5	15.3	17.2	19.1	20.9
	8	1.52	3.06	4.63	6.26	7.93	9.66	11.4	13.2	15.0	16.9	18.7	20.6
	9	1.45	2.93	4.46	6.05	7.70	9.41	11.2	12.9	14.7	16.5	18.4	20.3
3	10	1.38	2.80	4.29	5.85	7.48	9.16	10.9	12.6	14.4	16.2	18.1	19.9
	12	1.25	2.57	3.98	5.48	7.07	8.71	10.4	12.1	13.9	15.7	17.5	19.3
	14	1.13	2.36	3.70	5.15	6.69	8.29	9.96	11.7	13.4	15.2	16.9	18.7
	16	1.03	2.18	3.45	4.85	6.34	7.90	9.53	11.2	12.9	14.7	16.4	18.2
	18	0.95	2.02	3.23	4.57	6.01	7.54	9.13	10.8	12.5	14.2	15.9	17.7
	20	0.87	1.88	3.03	4.32	5.71	7.19	8.75	10.4	12.0	13.7	15.4	17.2
	24	0.75	1.65	2.69	3.87	5.17	6.57	8.05	9.60	11.2	12.9	14.5	16.2
	28	0.66	1.46	2.42	3.50	4.71	6.03	7.44	8.93	10.5	12.1	13.7	15.4
	32	0.59	1.31	2.18	3.19	4.32	5.56	6.90	8.32	9.81	11.4	12.9	14.6
	36	0.53	1.19	1.99	2.92	3.98	5.15	6.42	7.78	9.21	10.7	12.2	13.8
	2	1.92	3.80	5.69	7.59	9.51	11.5	13.4	15.4	17.6	19.6	21.5	23.5
	3	1.87	3.70	5.55	7.42	9.32	11.2	13.2	15.1	17.1	19.0	21.0	23.0
	4	1.82	3.59	5.40	7.25	9.14	11.1	13.0	14.9	16.9	18.8	20.8	22.7
	5	1.75	3.48	5.26	7.09	8.96	10.9	12.8	14.7	16.6	18.6	20.5	22.5
	6	1.68	3.36	5.11	6.93	8.78	10.7	12.6	14.5	16.4	18.4	20.3	22.2
	7	1.60	3.24	4.97	6.77	8.62	10.5	12.4	14.3	16.2	18.1	20.1	22.0
	8	1.52	3.13	4.84	6.62	8.45	10.3	12.2	14.1	16.0	17.9	19.9	21.8
	9	1.45	3.02	4.71	6.47	8.29	10.2	12.0	13.9	15.8	17.7	19.7	21.6
6	10	1.38	2.91	4.58	6.33	8.14	9.98	11.9	13.7	15.6	17.6	19.5	21.4
	12	1.25	2.72	4.34	6.07	7.85	9.67	11.5	13.4	15.3	17.2	19.1	21.0
	14	1.13	2.54	4.13	5.82	7.57	9.38	11.2	13.1	15.0	16.8	18.7	20.6
	16	1.03	2.38	3.92	5.59	7.32	9.10	10.9	12.8	14.6	16.5	18.4	20.3
	18	0.95	2.24	3.74	5.38	7.09	8.85	10.7	12.5	14.3	16.2	18.1	19.9
	20	0.87	2.11	3.57	5.17	6.87	8.61	10.4	12.2	14.0	15.9	17.7	19.6
	24	0.75	1.88	3.27	4.80	6.44	8.15	9.90	11.7	13.5	15.3	17.1	19.0
	28	0.66	1.70	3.00	4.47	6.06	7.72	9.43	11.2	13.0	14.8	16.6	18.4
	32	0.59	1.55	2.77	4.17	5.70	7.31	8.99	10.7	12.5	14.3	16.1	17.9
	36	0.53	1.42	2.57	3.90	5.37	6.93	8.57	10.3	12.0	13.8	15.5	17.3

Table 7–10
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

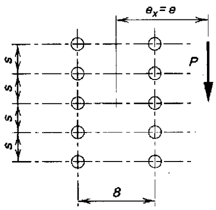
$\phi = 0.75$ $\qquad \Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.31	2.91	4.71	6.66	8.69	10.8	12.8	14.9	16.9	18.9	21.0	23.0
	3	1.12	2.54	4.14	5.95	7.90	9.93	12.0	14.1	16.2	18.2	20.3	22.4
	4	0.98	2.24	3.66	5.33	7.15	9.10	11.1	13.2	15.3	17.4	19.5	21.6
	5	0.87	1.99	3.27	4.80	6.48	8.33	10.3	12.3	14.4	16.5	18.6	20.7
	6	0.79	1.80	2.95	4.35	5.90	7.63	9.49	11.5	13.5	15.6	17.7	19.8
	7	0.71	1.63	2.68	3.97	5.40	7.02	8.77	10.7	12.6	14.6	16.7	18.8
	8	0.65	1.49	2.46	3.65	4.97	6.48	8.13	9.91	11.8	13.8	15.8	17.9
	9	0.60	1.38	2.27	3.37	4.59	6.01	7.55	9.24	11.1	13.0	14.9	17.0
	10	0.56	1.28	2.11	3.13	4.27	5.59	7.04	8.64	10.4	12.2	14.1	16.1
	12	0.49	1.11	1.84	2.73	3.73	4.90	6.19	7.63	9.18	10.9	12.6	14.5
	14	0.44	0.99	1.64	2.42	3.31	4.36	5.50	6.80	8.20	9.73	11.4	13.1
	16	0.39	0.89	1.47	2.17	2.98	3.91	4.95	6.13	7.40	8.80	10.3	11.9
	18	0.36	0.80	1.33	1.97	2.70	3.55	4.50	5.57	6.73	8.02	9.39	10.9
	20	0.33	0.73	1.22	1.80	2.47	3.25	4.12	5.10	6.17	7.35	8.62	9.99
	24	0.28	0.63	1.04	1.53	2.10	2.77	3.51	4.35	5.28	6.30	7.39	8.59
	28	0.25	0.55	0.91	1.33	1.83	2.41	3.06	3.79	4.60	5.50	6.46	7.51
	32	0.22	0.48	0.80	1.18	1.62	2.13	2.71	3.36	4.08	4.87	5.73	6.67
	36	0.20	0.43	0.72	1.06	1.45	1.91	2.43	3.01	3.66	4.37	5.15	5.99
	C′	7.85	16.8	27.3	39.9	54.6	71.5	90.9	113	137	164	194	226
6	2	1.31	3.28	5.35	7.42	9.47	11.5	13.5	15.5	17.5	19.5	21.4	23.4
	3	1.12	2.93	4.94	7.03	9.12	11.2	13.2	15.3	17.3	19.3	21.3	23.3
	4	0.98	2.63	4.52	6.59	8.70	10.8	12.9	14.9	17.0	19.0	21.0	23.0
	5	0.87	2.37	4.13	6.15	8.25	10.4	12.5	14.6	16.6	18.7	20.7	22.8
	6	0.79	2.15	3.78	5.72	7.78	9.90	12.0	14.1	16.2	18.3	20.4	22.4
	7	0.71	1.97	3.47	5.32	7.33	9.43	11.6	13.7	15.8	17.9	20.0	22.1
	8	0.65	1.81	3.19	4.95	6.89	8.95	11.1	13.2	15.4	17.5	19.6	21.7
	9	0.60	1.67	2.95	4.62	6.48	8.49	10.6	12.7	14.9	17.0	19.1	21.3
	10	0.56	1.55	2.75	4.33	6.10	8.05	10.1	12.2	14.4	16.5	18.7	20.8
	12	0.49	1.35	2.40	3.82	5.43	7.25	9.21	11.3	13.4	15.5	17.7	19.8
	14	0.44	1.20	2.14	3.41	4.86	6.56	8.40	10.4	12.4	14.5	16.7	18.8
	16	0.39	1.08	1.92	3.07	4.40	5.96	7.69	9.56	11.5	13.6	15.7	17.8
	18	0.36	0.97	1.75	2.79	4.00	5.46	7.06	8.83	10.7	12.7	14.7	16.8
	20	0.33	0.89	1.60	2.56	3.67	5.02	6.52	8.18	9.97	11.9	13.9	15.9
	24	0.28	0.76	1.37	2.18	3.14	4.32	5.62	7.11	8.71	10.4	12.3	14.2
	28	0.25	0.66	1.19	1.90	2.75	3.78	4.93	6.26	7.70	9.27	11.0	12.7
	32	0.22	0.58	1.05	1.68	2.44	3.35	4.38	5.58	6.88	8.31	9.85	11.5
	36	0.20	0.52	0.95	1.51	2.19	3.01	3.94	5.02	6.21	7.52	8.93	10.4
	C′	7.85	19.6	35.6	56.6	82.5	114	150	192	239	292	350	414

Table 7-10 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

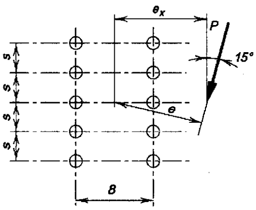
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.35	2.96	4.75	6.67	8.67	10.7	12.7	14.8	16.8	18.8	20.9	22.9
	3	1.16	2.58	4.20	5.98	7.90	9.89	11.9	14.0	16.0	18.1	20.2	22.2
	4	1.02	2.28	3.73	5.37	7.17	9.08	11.1	13.1	15.2	17.3	19.3	21.4
	5	0.90	2.03	3.35	4.85	6.53	8.34	10.3	12.2	14.3	16.3	18.4	20.5
	6	0.81	1.84	3.03	4.40	5.96	7.66	9.48	11.4	13.4	15.4	17.5	19.6
	7	0.74	1.67	2.76	4.02	5.48	7.06	8.79	10.6	12.6	14.5	16.6	18.6
	8	0.68	1.53	2.53	3.70	5.05	6.53	8.17	9.91	11.8	13.7	15.7	17.7
	9	0.63	1.42	2.34	3.43	4.68	6.07	7.61	9.27	11.0	12.9	14.8	16.8
	10	0.58	1.31	2.17	3.19	4.36	5.66	7.12	8.69	10.4	12.2	14.0	16.0
	12	0.51	1.15	1.90	2.79	3.82	4.97	6.28	7.69	9.23	10.9	12.6	14.4
	14	0.45	1.02	1.69	2.48	3.40	4.43	5.61	6.88	8.29	9.79	11.4	13.1
	16	0.41	0.91	1.51	2.23	3.05	3.99	5.05	6.21	7.50	8.88	10.4	11.9
	18	0.37	0.83	1.37	2.02	2.77	3.63	4.60	5.66	6.84	8.11	9.48	11.0
	20	0.34	0.76	1.26	1.85	2.54	3.32	4.21	5.19	6.28	7.45	8.73	10.1
	24	0.29	0.65	1.07	1.58	2.16	2.84	3.60	4.45	5.39	6.40	7.52	8.71
	28	0.25	0.56	0.93	1.37	1.89	2.47	3.14	3.88	4.71	5.61	6.59	7.64
	32	0.23	0.50	0.83	1.22	1.67	2.19	2.78	3.44	4.18	4.98	5.86	6.80
	36	0.20	0.45	0.74	1.09	1.50	1.96	2.49	3.09	3.75	4.47	5.27	6.12
6	2	1.35	3.29	5.33	7.39	9.42	11.4	13.4	15.4	17.4	19.4	21.4	23.4
	3	1.16	2.94	4.93	6.99	9.05	11.1	13.1	15.2	17.2	19.2	21.2	23.2
	4	1.02	2.64	4.52	6.55	8.63	10.7	12.8	14.8	16.9	18.9	20.9	22.9
	5	0.90	2.38	4.15	6.12	8.18	10.3	12.4	14.4	16.5	18.5	20.6	22.6
	6	0.81	2.17	3.82	5.70	7.72	9.80	11.9	14.0	16.1	18.2	20.2	22.3
	7	0.74	1.99	3.52	5.31	7.28	9.33	11.4	13.5	15.6	17.7	19.8	21.9
	8	0.68	1.83	3.25	4.95	6.86	8.87	11.0	13.1	15.2	17.3	19.4	21.5
	9	0.63	1.69	3.02	4.63	6.46	8.43	10.5	12.6	14.7	16.8	18.9	21.0
	10	0.58	1.58	2.81	4.34	6.10	8.00	10.0	12.1	14.2	16.3	18.4	20.5
	12	0.51	1.38	2.47	3.84	5.45	7.23	9.15	11.2	13.2	15.3	17.4	19.6
	14	0.45	1.23	2.20	3.44	4.91	6.56	8.38	10.3	12.3	14.4	16.5	18.6
	16	0.41	1.10	1.98	3.11	4.46	5.99	7.69	9.52	11.5	13.5	15.5	17.6
	18	0.37	1.00	1.80	2.83	4.08	5.49	7.09	8.82	10.7	12.6	14.6	16.6
	20	0.34	0.92	1.65	2.60	3.75	5.06	6.56	8.20	9.96	11.8	13.8	15.7
	24	0.29	0.78	1.41	2.23	3.22	4.36	5.70	7.15	8.74	10.4	12.2	14.1
	28	0.25	0.68	1.23	1.95	2.82	3.83	5.02	6.32	7.76	9.31	11.0	12.7
	32	0.23	0.60	1.09	1.73	2.50	3.41	4.47	5.64	6.96	8.38	9.90	11.5
	36	0.20	0.54	0.97	1.55	2.25	3.07	4.03	5.09	6.30	7.60	9.01	10.5

Table 7–10 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

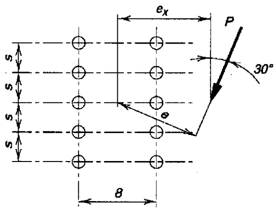
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.49	3.12	4.91	6.80	8.75	10.7	12.7	14.7	16.7	18.7	20.8	22.7
	3	1.29	2.74	4.39	6.16	8.04	9.98	12.0	14.0	16.0	18.0	20.0	22.1
	4	1.13	2.43	3.95	5.60	7.37	9.24	11.2	13.2	15.2	17.2	19.2	21.3
	5	1.00	2.18	3.58	5.10	6.77	8.55	10.4	12.4	14.3	16.3	18.4	20.4
	6	0.90	1.98	3.26	4.67	6.23	7.93	9.72	11.6	13.5	15.5	17.5	19.5
	7	0.82	1.81	2.99	4.30	5.76	7.37	9.08	10.9	12.8	14.7	16.7	18.7
	8	0.75	1.67	2.76	3.97	5.35	6.87	8.49	10.2	12.0	13.9	15.9	17.8
	9	0.70	1.55	2.56	3.69	4.98	6.42	7.96	9.62	11.4	13.2	15.1	17.0
	10	0.65	1.44	2.38	3.44	4.66	6.02	7.49	9.07	10.8	12.5	14.4	16.2
	12	0.57	1.26	2.09	3.03	4.13	5.34	6.66	8.12	9.67	11.3	13.0	14.8
	14	0.50	1.12	1.86	2.71	3.69	4.78	5.99	7.33	8.75	10.3	11.9	13.6
	16	0.45	1.01	1.67	2.44	3.33	4.33	5.44	6.66	7.98	9.39	10.9	12.5
	18	0.41	0.92	1.52	2.22	3.03	3.95	4.97	6.10	7.32	8.64	10.1	11.5
	20	0.38	0.84	1.39	2.03	2.78	3.62	4.57	5.62	6.75	7.98	9.30	10.7
	24	0.32	0.72	1.19	1.74	2.38	3.11	3.93	4.84	5.83	6.92	8.08	9.32
	28	0.28	0.63	1.04	1.52	2.08	2.72	3.44	4.24	5.13	6.09	7.12	8.24
	32	0.25	0.56	0.92	1.35	1.84	2.41	3.06	3.77	4.57	5.43	6.36	7.37
	36	0.23	0.50	0.83	1.21	1.66	2.17	2.75	3.40	4.11	4.89	5.74	6.66
6	2	1.49	3.36	5.36	7.37	9.38	11.4	13.4	15.4	17.4	19.3	21.3	23.3
	3	1.29	3.02	4.97	6.99	9.01	11.0	13.1	15.1	17.1	19.1	21.1	23.1
	4	1.13	2.73	4.60	6.58	8.61	10.7	12.7	14.7	16.7	18.8	20.8	22.8
	5	1.00	2.48	4.26	6.18	8.18	10.2	12.3	14.3	16.4	18.4	20.4	22.4
	6	0.90	2.27	3.96	5.80	7.76	9.79	11.8	13.9	15.9	18.0	20.0	22.1
	7	0.82	2.09	3.68	5.44	7.36	9.35	11.4	13.5	15.5	17.6	19.6	21.7
	8	0.75	1.93	3.43	5.11	6.97	8.93	11.0	13.0	15.1	17.1	19.2	21.2
	9	0.70	1.80	3.21	4.81	6.61	8.53	10.5	12.6	14.6	16.7	18.7	20.8
	10	0.65	1.68	3.01	4.53	6.27	8.14	10.1	12.1	14.2	16.2	18.3	20.4
	12	0.57	1.49	2.67	4.05	5.67	7.43	9.31	11.3	13.3	15.3	17.4	19.4
	14	0.50	1.33	2.39	3.65	5.15	6.81	8.60	10.5	12.4	14.4	16.5	18.5
	16	0.45	1.20	2.16	3.31	4.71	6.27	7.96	9.76	11.7	13.6	15.6	17.6
	18	0.41	1.09	1.97	3.03	4.34	5.79	7.39	9.12	10.9	12.8	14.8	16.8
	20	0.38	1.00	1.81	2.80	4.01	5.37	6.89	8.53	10.3	12.1	14.0	15.9
	24	0.32	0.86	1.55	2.41	3.48	4.68	6.04	7.53	9.14	10.8	12.6	14.5
	28	0.28	0.75	1.35	2.12	3.06	4.13	5.36	6.72	8.19	9.76	11.4	13.2
	32	0.25	0.67	1.20	1.89	2.73	3.69	4.81	6.05	7.40	8.86	10.4	12.0
	36	0.23	0.60	1.08	1.70	2.46	3.34	4.36	5.50	6.74	8.09	9.53	11.1

Table 7–10 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

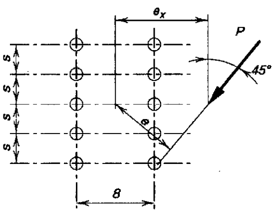
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.70	3.43	5.22	7.06	8.95	10.9	12.8	14.8	16.8	18.7	20.7	22.7
	3	1.51	3.09	4.76	6.52	8.35	10.2	12.2	14.1	16.1	18.0	20.0	22.0
	4	1.35	2.78	4.34	6.01	7.78	9.60	11.5	13.4	15.3	17.3	19.3	21.3
	5	1.21	2.52	3.97	5.57	7.25	9.01	10.8	12.7	14.6	16.6	18.5	20.5
	6	1.10	2.30	3.67	5.17	6.78	8.47	10.2	12.1	13.9	15.9	17.8	19.8
	7	1.00	2.12	3.40	4.82	6.35	7.97	9.67	11.5	13.3	15.2	17.1	19.0
	8	0.92	1.96	3.17	4.51	5.96	7.51	9.15	10.9	12.7	14.5	16.4	18.3
	9	0.85	1.82	2.96	4.23	5.60	7.08	8.68	10.4	12.1	13.9	15.7	17.6
	10	0.79	1.70	2.78	3.97	5.28	6.70	8.24	9.86	11.5	13.3	15.1	17.0
	12	0.69	1.50	2.46	3.54	4.73	6.04	7.46	8.97	10.6	12.2	14.0	15.7
	14	0.61	1.34	2.21	3.18	4.27	5.48	6.80	8.21	9.70	11.3	12.9	14.6
	16	0.55	1.21	2.00	2.88	3.89	5.01	6.23	7.54	8.95	10.4	12.0	13.6
	18	0.50	1.11	1.82	2.64	3.56	4.60	5.74	6.97	8.30	9.71	11.2	12.7
	20	0.46	1.02	1.67	2.42	3.29	4.25	5.31	6.47	7.73	9.06	10.5	11.9
	24	0.40	0.87	1.43	2.09	2.84	3.68	4.62	5.65	6.77	7.96	9.23	10.6
	28	0.35	0.76	1.26	1.83	2.49	3.24	4.07	5.00	6.00	7.08	8.24	9.47
	32	0.31	0.68	1.12	1.63	2.22	2.89	3.64	4.47	5.38	6.37	7.43	8.56
	36	0.28	0.61	1.00	1.46	2.00	2.60	3.29	4.04	4.87	5.78	6.75	7.79
6	2	1.70	3.52	5.44	7.40	9.37	11.4	13.3	15.3	17.3	19.3	21.3	23.2
	3	1.51	3.23	5.11	7.06	9.03	11.0	13.0	15.0	17.0	19.0	21.0	22.9
	4	1.35	2.96	4.79	6.70	8.67	10.7	12.7	14.6	16.6	18.6	20.6	22.6
	5	1.21	2.72	4.48	6.36	8.30	10.3	12.3	14.3	16.3	18.3	20.3	22.3
	6	1.10	2.51	4.20	6.03	7.94	9.90	11.9	13.9	15.9	17.9	19.9	21.9
	7	1.00	2.33	3.96	5.73	7.60	9.53	11.5	13.5	15.5	17.5	19.5	21.5
	8	0.92	2.18	3.73	5.45	7.27	9.17	11.1	13.1	15.1	17.1	19.1	21.1
	9	0.85	2.04	3.53	5.19	6.96	8.83	10.8	12.7	14.7	16.7	18.7	20.7
	10	0.79	1.92	3.35	4.94	6.67	8.50	10.4	12.4	14.3	16.3	18.3	20.3
	12	0.69	1.71	3.02	4.50	6.13	7.88	9.73	11.6	13.6	15.5	17.5	19.5
	14	0.61	1.55	2.75	4.12	5.65	7.33	9.11	11.0	12.9	14.8	16.8	18.8
	16	0.55	1.41	2.51	3.78	5.22	6.83	8.55	10.3	12.2	14.1	16.0	18.0
	18	0.50	1.29	2.31	3.49	4.85	6.39	8.04	9.77	11.6	13.4	15.3	17.3
	20	0.46	1.19	2.13	3.24	4.53	6.00	7.57	9.25	11.0	12.8	14.7	16.6
	24	0.40	1.03	1.84	2.82	3.99	5.32	6.76	8.32	9.97	11.7	13.5	15.3
	28	0.35	0.90	1.62	2.50	3.56	4.76	6.09	7.53	9.08	10.7	12.4	14.2
	32	0.31	0.80	1.44	2.24	3.20	4.30	5.52	6.86	8.32	9.85	11.5	13.1
	36	0.28	0.72	1.30	2.02	2.90	3.92	5.04	6.30	7.66	9.10	10.6	12.2

Table 7–10 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

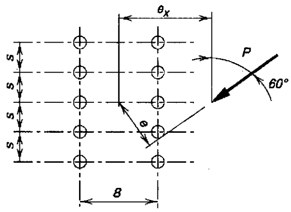
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.86	3.71	5.56	7.41	9.28	11.2	13.1	15.0	16.9	18.8	20.8	22.7
	3	1.77	3.52	5.29	7.07	8.88	10.7	12.6	14.5	16.4	18.3	20.2	22.1
	4	1.66	3.31	4.99	6.70	8.45	10.3	12.1	13.9	15.8	17.7	19.6	21.6
	5	1.54	3.10	4.70	6.34	8.04	9.79	11.6	13.4	15.3	17.1	19.0	21.0
	6	1.43	2.90	4.41	6.00	7.64	9.35	11.1	12.9	14.7	16.6	18.5	20.4
	7	1.33	2.71	4.15	5.68	7.27	8.94	10.7	12.4	14.2	16.1	17.9	19.8
	8	1.24	2.54	3.92	5.39	6.94	8.56	10.3	12.0	13.8	15.6	17.4	19.3
	9	1.16	2.38	3.70	5.12	6.63	8.22	9.86	11.6	13.3	15.1	16.9	18.7
	10	1.08	2.24	3.51	4.88	6.34	7.89	9.49	11.2	12.9	14.6	16.4	18.2
	12	0.96	2.00	3.17	4.44	5.82	7.28	8.81	10.4	12.1	13.8	15.5	17.3
	14	0.86	1.81	2.88	4.07	5.36	6.73	8.19	9.72	11.3	13.0	14.7	16.4
	16	0.77	1.64	2.64	3.74	4.95	6.25	7.64	9.11	10.7	12.2	13.9	15.6
	18	0.70	1.51	2.43	3.46	4.59	5.83	7.15	8.56	10.0	11.6	13.2	14.8
	20	0.65	1.39	2.25	3.21	4.28	5.45	6.71	8.06	9.48	11.0	12.5	14.1
	24	0.56	1.20	1.95	2.80	3.76	4.81	5.96	7.19	8.50	9.88	11.3	12.8
	28	0.49	1.06	1.72	2.48	3.34	4.29	5.34	6.47	7.68	8.97	10.3	11.7
	32	0.43	0.94	1.54	2.22	3.00	3.87	4.83	5.87	6.99	8.19	9.46	10.8
	36	0.39	0.85	1.39	2.01	2.72	3.52	4.40	5.36	6.41	7.53	8.71	9.96
6	2	1.86	3.72	5.59	7.50	9.43	11.4	13.3	15.3	17.3	19.2	21.2	23.2
	3	1.77	3.55	5.37	7.25	9.16	11.1	13.0	15.0	17.0	18.9	20.9	22.9
	4	1.66	3.36	5.14	6.98	8.88	10.8	12.7	14.7	16.7	18.6	20.6	22.6
	5	1.54	3.17	4.90	6.72	8.59	10.5	12.4	14.4	16.3	18.3	20.3	22.2
	6	1.43	2.99	4.67	6.46	8.31	10.2	12.1	14.1	16.0	18.0	19.9	21.9
	7	1.33	2.82	4.46	6.21	8.05	9.92	11.8	13.8	15.7	17.7	19.6	21.6
	8	1.24	2.67	4.26	5.98	7.79	9.65	11.5	13.5	15.4	17.3	19.3	21.3
	9	1.16	2.52	4.08	5.76	7.55	9.39	11.3	13.2	15.1	17.0	19.0	20.9
	10	1.08	2.40	3.91	5.56	7.32	9.14	11.0	12.9	14.8	16.7	18.7	20.6
	12	0.96	2.17	3.61	5.20	6.90	8.66	10.5	12.4	14.2	16.1	18.1	20.0
	14	0.86	1.98	3.35	4.87	6.51	8.23	10.0	11.8	13.7	15.6	17.5	19.4
	16	0.77	1.82	3.11	4.57	6.15	7.81	9.56	11.4	13.2	15.1	16.9	18.9
	18	0.70	1.69	2.91	4.30	5.81	7.43	9.13	10.9	12.7	14.5	16.4	18.3
	20	0.65	1.57	2.72	4.05	5.50	7.07	8.73	10.5	12.2	14.1	15.9	17.8
	24	0.56	1.37	2.41	3.61	4.96	6.43	8.00	9.67	11.4	13.2	15.0	16.8
	28	0.49	1.22	2.15	3.25	4.49	5.88	7.38	8.97	10.6	12.3	14.1	15.9
	32	0.43	1.09	1.94	2.94	4.10	5.41	6.83	8.34	9.92	11.6	13.3	15.0
	36	0.39	0.99	1.76	2.69	3.77	5.00	6.35	7.78	9.30	10.9	12.5	14.2

Table 7–10 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

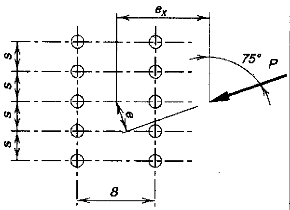
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.94	3.87	5.79	7.70	9.61	11.5	13.4	15.3	17.3	19.2	21.1	23.0
	3	1.92	3.82	5.70	7.58	9.45	11.3	13.2	15.1	17.0	18.9	20.8	22.7
	4	1.89	3.75	5.60	7.43	9.26	11.1	12.9	14.8	16.7	18.5	20.4	22.3
	5	1.85	3.67	5.48	7.28	9.07	10.9	12.7	14.5	16.4	18.2	20.1	22.0
	6	1.81	3.59	5.35	7.11	8.87	10.6	12.4	14.2	16.1	17.9	19.8	21.6
	7	1.76	3.50	5.22	6.94	8.67	10.4	12.2	14.0	15.8	17.6	19.4	21.3
	8	1.71	3.40	5.08	6.76	8.46	10.2	11.9	13.7	15.5	17.3	19.1	21.0
	9	1.66	3.30	4.94	6.59	8.26	9.96	11.7	13.4	15.2	17.0	18.8	20.6
	10	1.61	3.20	4.80	6.42	8.06	9.73	11.4	13.2	14.9	16.7	18.5	20.3
	12	1.51	3.01	4.53	6.08	7.67	9.30	11.0	12.7	14.4	16.2	17.9	19.7
	14	1.41	2.82	4.27	5.76	7.31	8.90	10.5	12.2	13.9	15.6	17.4	19.2
	16	1.31	2.65	4.03	5.47	6.96	8.52	10.1	11.8	13.4	15.2	16.9	18.6
	18	1.23	2.48	3.80	5.19	6.64	8.16	9.73	11.3	13.0	14.7	16.4	18.1
	20	1.15	2.34	3.60	4.93	6.34	7.82	9.36	10.9	12.6	14.2	15.9	17.7
	24	1.01	2.08	3.23	4.48	5.80	7.20	8.67	10.2	11.8	13.4	15.0	16.7
	28	0.90	1.87	2.93	4.08	5.33	6.65	8.06	9.52	11.0	12.6	14.2	15.9
	32	0.81	1.69	2.67	3.75	4.91	6.17	7.51	8.91	10.4	11.9	13.5	15.1
	36	0.73	1.54	2.45	3.45	4.55	5.74	7.01	8.36	9.77	11.2	12.8	14.3
6	2	1.94	3.86	5.77	7.68	9.60	11.5	13.5	15.4	17.6	19.6	21.5	23.5
	3	1.92	3.80	5.68	7.55	9.45	11.4	13.3	15.2	17.2	19.1	21.1	23.0
	4	1.89	3.74	5.57	7.42	9.29	11.2	13.1	15.0	16.9	18.9	20.8	22.8
	5	1.85	3.66	5.46	7.29	9.14	11.0	12.9	14.8	16.7	18.7	20.6	22.6
	6	1.81	3.58	5.35	7.15	8.98	10.8	12.7	14.6	16.5	18.5	20.4	22.3
	7	1.76	3.49	5.23	7.01	8.83	10.7	12.5	14.4	16.3	18.3	20.2	22.1
	8	1.71	3.40	5.12	6.88	8.68	10.5	12.4	14.3	16.2	18.1	20.0	21.9
	9	1.66	3.31	5.00	6.74	8.53	10.4	12.2	14.1	16.0	17.9	19.8	21.7
	10	1.61	3.22	4.89	6.61	8.38	10.2	12.0	13.9	15.8	17.7	19.6	21.5
	12	1.51	3.05	4.67	6.36	8.10	9.89	11.7	13.6	15.4	17.3	19.2	21.1
	14	1.41	2.88	4.46	6.12	7.84	9.61	11.4	13.3	15.1	17.0	18.9	20.8
	16	1.31	2.73	4.26	5.89	7.59	9.33	11.1	12.9	14.8	16.6	18.5	20.4
	18	1.23	2.58	4.08	5.68	7.35	9.08	10.8	12.7	14.5	16.3	18.2	20.1
	20	1.15	2.45	3.90	5.47	7.13	8.84	10.6	12.4	14.2	16.0	17.9	19.7
	24	1.01	2.21	3.59	5.10	6.71	8.38	10.1	11.9	13.6	15.5	17.3	19.1
	28	0.90	2.01	3.32	4.77	6.32	7.96	9.65	11.4	13.1	14.9	16.7	18.5
	32	0.81	1.84	3.08	4.47	5.97	7.56	9.21	10.9	12.7	14.4	16.2	18.0
	36	0.73	1.70	2.87	4.19	5.64	7.19	8.80	10.5	12.2	13.9	15.7	17.5

Table 7-11
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

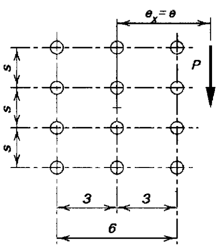
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	1	2	3	4	5	6	7	8	9	10	11	12
		Number of Bolts in One Vertical Row, *n*											
	2	1.71	4.07	6.81	9.86	13.0	16.1	19.3	22.3	25.4	28.5	31.5	34.5
	3	1.42	3.40	5.79	8.61	11.7	14.8	18.0	21.1	24.3	27.4	30.5	33.6
	4	1.21	2.90	4.97	7.53	10.4	13.4	16.6	19.8	23.0	26.1	29.3	32.5
	5	1.05	2.51	4.34	6.64	9.24	12.1	15.2	18.3	21.5	24.7	27.9	31.1
	6	0.92	2.21	3.85	5.91	8.27	11.0	13.9	16.9	20.0	23.2	26.4	29.7
	7	0.81	1.96	3.44	5.31	7.46	9.95	12.7	15.6	18.6	21.8	25.0	28.2
	8	0.72	1.76	3.11	4.80	6.78	9.09	11.6	14.4	17.3	20.4	23.5	26.7
	9	0.64	1.60	2.83	4.38	6.20	8.34	10.7	13.3	16.1	19.1	22.1	25.2
	10	0.58	1.46	2.59	4.02	5.71	7.70	9.91	12.4	15.0	17.9	20.8	23.8
3	12	0.49	1.24	2.21	3.44	4.91	6.65	8.59	10.8	13.2	15.7	18.5	21.3
	14	0.42	1.08	1.92	3.00	4.30	5.83	7.57	9.53	11.7	14.0	16.5	19.2
	16	0.37	0.95	1.70	2.66	3.82	5.19	6.75	8.51	10.5	12.6	14.9	17.3
	18	0.33	0.85	1.52	2.39	3.43	4.67	6.08	7.68	9.45	11.4	13.5	15.8
	20	0.29	0.77	1.37	2.16	3.11	4.24	5.53	6.99	8.61	10.4	12.3	14.4
	24	0.24	0.64	1.15	1.82	2.62	3.57	4.67	5.92	7.30	8.84	10.5	12.3
	28	0.21	0.55	0.99	1.57	2.26	3.08	4.04	5.12	6.33	7.67	9.13	10.7
	32	0.18	0.49	0.87	1.38	1.98	2.71	3.55	4.51	5.58	6.77	8.06	9.47
	36	0.16	0.43	0.77	1.23	1.77	2.42	3.17	4.03	4.99	6.05	7.21	8.48
	C′	5.89	15.8	28.0	44.7	64.3	88.5	116	148	183	223	267	315
	2	1.71	4.85	8.04	11.2	14.2	17.3	20.3	23.2	26.2	29.2	32.2	35.1
	3	1.42	4.24	7.36	10.6	13.7	16.8	19.9	22.9	25.9	28.9	31.9	34.9
	4	1.21	3.72	6.66	9.86	13.1	16.2	19.4	22.4	25.5	28.5	31.6	34.6
	5	1.05	3.29	6.00	9.14	12.4	15.6	18.7	21.9	25.0	28.1	31.1	34.2
	6	0.92	2.93	5.41	8.44	11.6	14.9	18.1	21.2	24.4	27.5	30.6	33.7
	7	0.81	2.63	4.90	7.79	10.9	14.1	17.3	20.6	23.7	26.9	30.0	33.2
	8	0.72	2.38	4.46	7.20	10.2	13.4	16.6	19.8	23.0	26.2	29.4	32.6
	9	0.64	2.17	4.09	6.67	9.54	12.6	15.8	19.1	22.3	25.5	28.7	31.9
	10	0.58	2.00	3.78	6.20	8.94	12.0	15.1	18.3	21.6	24.8	28.0	31.2
6	12	0.49	1.71	3.27	5.41	7.88	10.7	13.7	16.8	20.0	23.3	26.5	29.8
	14	0.42	1.49	2.87	4.78	7.01	9.61	12.4	15.4	18.6	21.8	25.0	28.2
	16	0.37	1.32	2.55	4.28	6.29	8.69	11.3	14.2	17.2	20.3	23.5	26.7
	18	0.33	1.19	2.30	3.86	5.70	7.91	10.4	13.1	15.9	18.9	22.0	25.2
	20	0.29	1.08	2.09	3.51	5.20	7.25	9.54	12.1	14.8	17.7	20.7	23.8
	24	0.24	0.91	1.76	2.97	4.42	6.19	8.19	10.4	12.9	15.5	18.3	21.2
	28	0.21	0.78	1.52	2.57	3.84	5.39	7.14	9.15	11.4	13.7	16.3	19.0
	32	0.18	0.69	1.33	2.27	3.39	4.77	6.33	8.13	10.1	12.3	14.6	17.1
	36	0.16	0.61	1.19	2.03	3.03	4.27	5.67	7.30	9.10	11.1	13.2	15.5
	C′	5.89	22.4	43.3	74.4	112	158	212	275	345	424	510	606

Table 7-11 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

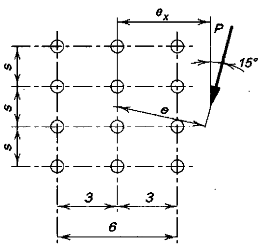
$$R_n = C \times r_n$$

$\phi = 0.75$ or $\Omega = 2.00$

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.77	4.10	6.84	9.82	12.9	16.0	19.1	22.2	25.2	28.3	31.3	34.3
	3	1.47	3.45	5.86	8.61	11.6	14.7	17.8	20.9	24.1	27.2	30.3	33.3
	4	1.25	2.95	5.07	7.55	10.4	13.3	16.4	19.5	22.7	25.8	29.0	32.1
	5	1.08	2.57	4.44	6.67	9.26	12.1	15.1	18.1	21.3	24.4	27.6	30.7
	6	0.94	2.26	3.93	5.96	8.33	11.0	13.8	16.8	19.8	23.0	26.1	29.3
	7	0.83	2.01	3.52	5.37	7.55	9.97	12.7	15.5	18.5	21.5	24.7	27.8
	8	0.74	1.81	3.18	4.87	6.88	9.13	11.7	14.4	17.2	20.2	23.2	26.4
	9	0.66	1.64	2.90	4.45	6.31	8.40	10.8	13.3	16.1	18.9	21.9	25.0
	10	0.60	1.50	2.65	4.10	5.81	7.77	9.99	12.4	15.0	17.8	20.7	23.6
	12	0.50	1.28	2.27	3.52	5.01	6.74	8.71	10.9	13.2	15.8	18.4	21.2
	14	0.43	1.11	1.98	3.08	4.40	5.93	7.69	9.62	11.8	14.1	16.5	19.1
	16	0.38	0.98	1.75	2.73	3.91	5.29	6.87	8.62	10.6	12.7	15.0	17.4
	18	0.34	0.88	1.57	2.45	3.52	4.77	6.20	7.80	9.59	11.5	13.6	15.9
	20	0.30	0.79	1.42	2.22	3.19	4.33	5.65	7.12	8.76	10.5	12.5	14.6
	24	0.25	0.67	1.19	1.87	2.69	3.66	4.78	6.04	7.45	8.99	10.7	12.5
	28	0.22	0.57	1.02	1.61	2.32	3.17	4.14	5.24	6.47	7.82	9.31	10.9
	32	0.19	0.50	0.90	1.42	2.04	2.79	3.65	4.62	5.72	6.92	8.24	9.66
	36	0.17	0.45	0.80	1.26	1.82	2.49	3.26	4.13	5.11	6.20	7.38	8.66
6	2	1.77	4.83	7.98	11.1	14.1	17.2	20.2	23.2	26.1	29.1	32.1	35.0
	3	1.47	4.22	7.31	10.5	13.6	16.7	19.7	22.8	25.8	28.8	31.8	34.8
	4	1.25	3.71	6.64	9.77	12.9	16.1	19.2	22.3	25.3	28.3	31.4	34.4
	5	1.08	3.28	6.01	9.06	12.2	15.4	18.5	21.7	24.8	27.8	30.9	33.9
	6	0.94	2.94	5.45	8.38	11.5	14.7	17.8	21.0	24.1	27.2	30.3	33.4
	7	0.83	2.65	4.97	7.75	10.8	13.9	17.1	20.3	23.5	26.6	29.7	32.8
	8	0.74	2.40	4.55	7.17	10.1	13.2	16.4	19.6	22.7	25.9	29.1	32.2
	9	0.66	2.20	4.18	6.66	9.49	12.5	15.6	18.8	22.0	25.2	28.4	31.5
	10	0.60	2.02	3.86	6.20	8.92	11.9	14.9	18.1	21.3	24.5	27.6	30.8
	12	0.50	1.74	3.34	5.43	7.91	10.6	13.6	16.6	19.8	23.0	26.1	29.3
	14	0.43	1.52	2.94	4.82	7.07	9.60	12.4	15.3	18.4	21.5	24.6	27.8
	16	0.38	1.35	2.62	4.32	6.38	8.71	11.3	14.1	17.0	20.1	23.2	26.3
	18	0.34	1.22	2.36	3.91	5.79	7.95	10.4	13.0	15.8	18.8	21.8	24.9
	20	0.30	1.10	2.14	3.57	5.30	7.31	9.60	12.1	14.8	17.6	20.5	23.5
	24	0.25	0.93	1.81	3.03	4.52	6.26	8.28	10.5	12.9	15.5	18.2	21.1
	28	0.22	0.80	1.56	2.63	3.93	5.47	7.26	9.24	11.4	13.8	16.3	18.9
	32	0.19	0.71	1.37	2.32	3.47	4.85	6.45	8.23	10.2	12.4	14.7	17.1
	36	0.17	0.63	1.23	2.08	3.11	4.35	5.80	7.41	9.23	11.2	13.3	15.6

Table 7–11 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

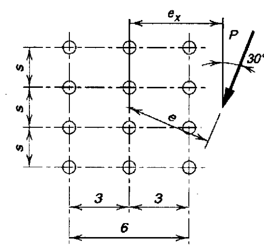
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	1.94	4.26	6.99	9.90	12.9	16.0	19.0	22.0	25.1	28.1	31.1	34.1
	3	1.61	3.63	6.09	8.80	11.7	14.7	17.7	20.8	23.9	27.0	30.0	33.1
	4	1.37	3.15	5.35	7.83	10.6	13.5	16.5	19.5	22.6	25.7	28.7	31.8
	5	1.19	2.77	4.74	7.00	9.54	12.3	15.2	18.2	21.2	24.3	27.4	30.5
	6	1.04	2.45	4.23	6.30	8.67	11.3	14.1	17.0	19.9	23.0	26.0	29.1
	7	0.92	2.19	3.81	5.71	7.92	10.4	13.0	15.8	18.7	21.7	24.7	27.8
	8	0.82	1.98	3.45	5.22	7.27	9.58	12.1	14.8	17.6	20.5	23.4	26.4
	9	0.74	1.80	3.16	4.79	6.71	8.88	11.2	13.8	16.5	19.3	22.2	25.2
	10	0.67	1.65	2.90	4.42	6.22	8.26	10.5	12.9	15.5	18.2	21.1	24.0
	12	0.56	1.41	2.49	3.82	5.41	7.22	9.23	11.5	13.8	16.4	19.0	21.8
	14	0.48	1.23	2.18	3.36	4.78	6.40	8.22	10.3	12.4	14.8	17.2	19.8
	16	0.42	1.08	1.93	2.99	4.26	5.73	7.40	9.25	11.3	13.4	15.7	18.2
	18	0.38	0.97	1.73	2.69	3.85	5.18	6.71	8.41	10.3	12.3	14.4	16.7
	20	0.34	0.88	1.57	2.44	3.50	4.73	6.14	7.70	9.42	11.3	13.3	15.4
	24	0.28	0.74	1.32	2.06	2.96	4.01	5.22	6.58	8.08	9.72	11.5	13.4
	28	0.24	0.64	1.14	1.78	2.56	3.48	4.54	5.73	7.05	8.51	10.1	11.8
	32	0.21	0.56	1.00	1.57	2.26	3.07	4.01	5.07	6.25	7.55	8.96	10.5
	36	0.19	0.50	0.89	1.40	2.02	2.75	3.59	4.54	5.61	6.78	8.06	9.44
6	2	1.94	4.86	7.96	11.0	14.1	17.1	20.1	23.1	26.0	29.0	32.0	35.0
	3	1.61	4.27	7.32	10.4	13.5	16.6	19.6	22.6	25.6	28.6	31.6	34.6
	4	1.37	3.78	6.70	9.75	12.9	15.9	19.0	22.1	25.1	28.1	31.1	34.2
	5	1.19	3.39	6.14	9.10	12.2	15.3	18.4	21.5	24.5	27.6	30.6	33.7
	6	1.04	3.06	5.64	8.48	11.5	14.6	17.7	20.8	23.9	27.0	30.1	33.1
	7	0.92	2.78	5.19	7.91	10.9	13.9	17.0	20.1	23.2	26.3	29.4	32.5
	8	0.82	2.54	4.80	7.38	10.3	13.3	16.3	19.4	22.6	25.7	28.8	31.9
	9	0.74	2.34	4.45	6.90	9.67	12.6	15.7	18.7	21.9	25.0	28.1	31.2
	10	0.67	2.16	4.14	6.46	9.14	12.0	15.0	18.1	21.2	24.3	27.4	30.5
	12	0.56	1.87	3.61	5.71	8.20	10.9	13.8	16.8	19.8	22.9	26.0	29.1
	14	0.48	1.65	3.20	5.10	7.41	9.95	12.7	15.6	18.5	21.5	24.6	27.7
	16	0.42	1.47	2.86	4.60	6.74	9.12	11.7	14.5	17.3	20.3	23.3	26.4
	18	0.38	1.33	2.58	4.19	6.17	8.39	10.8	13.5	16.2	19.1	22.0	25.0
	20	0.34	1.21	2.35	3.84	5.68	7.75	10.1	12.6	15.2	18.0	20.9	23.8
	24	0.28	1.02	2.00	3.29	4.89	6.71	8.78	11.1	13.5	16.1	18.8	21.6
	28	0.24	0.88	1.73	2.86	4.28	5.90	7.77	9.83	12.1	14.5	17.0	19.6
	32	0.21	0.78	1.52	2.54	3.80	5.25	6.95	8.83	10.9	13.1	15.4	17.9
	36	0.19	0.70	1.36	2.27	3.41	4.73	6.28	8.00	9.88	11.9	14.1	16.4

Table 7–11 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

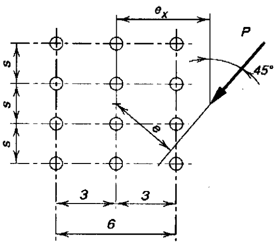
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.23	4.67	7.33	10.2	13.1	16.0	19.0	22.0	25.0	28.0	31.0	33.9
	3	1.89	4.06	6.50	9.19	12.0	14.9	17.9	20.9	23.9	26.9	29.9	32.9
	4	1.63	3.57	5.84	8.36	11.1	13.9	16.8	19.7	22.7	25.7	28.7	31.7
	5	1.42	3.17	5.27	7.63	10.2	12.9	15.7	18.6	21.5	24.5	27.5	30.5
	6	1.25	2.84	4.78	6.99	9.40	12.0	14.7	17.6	20.4	23.4	26.3	29.3
	7	1.11	2.57	4.36	6.42	8.70	11.2	13.8	16.6	19.4	22.3	25.2	28.2
	8	0.99	2.33	3.99	5.92	8.09	10.5	13.0	15.7	18.4	21.2	24.1	27.0
	9	0.90	2.13	3.68	5.49	7.54	9.80	12.2	14.8	17.5	20.3	23.1	26.0
	10	0.81	1.96	3.40	5.10	7.05	9.21	11.6	14.0	16.6	19.3	22.1	24.9
	12	0.68	1.68	2.95	4.46	6.22	8.19	10.4	12.7	15.1	17.7	20.3	23.0
	14	0.59	1.47	2.59	3.95	5.55	7.35	9.34	11.5	13.8	16.2	18.7	21.3
	16	0.52	1.31	2.31	3.54	4.99	6.65	8.49	10.5	12.7	14.9	17.3	19.8
	18	0.46	1.17	2.08	3.20	4.54	6.06	7.77	9.64	11.7	13.8	16.1	18.5
	20	0.41	1.06	1.89	2.92	4.15	5.56	7.15	8.90	10.8	12.8	15.0	17.2
	24	0.35	0.90	1.60	2.48	3.54	4.76	6.15	7.70	9.39	11.2	13.1	15.2
	28	0.30	0.77	1.38	2.15	3.08	4.16	5.39	6.77	8.28	9.91	11.7	13.5
	32	0.26	0.68	1.22	1.90	2.72	3.68	4.79	6.03	7.39	8.87	10.5	12.2
	36	0.23	0.61	1.08	1.69	2.44	3.30	4.30	5.42	6.66	8.02	9.49	11.1
6	2	2.23	5.02	8.01	11.0	14.0	17.0	20.0	23.0	25.9	28.9	31.9	34.8
	3	1.89	4.50	7.44	10.4	13.5	16.5	19.5	22.5	25.5	28.4	31.4	34.4
	4	1.63	4.05	6.89	9.86	12.9	15.9	18.9	21.9	24.9	27.9	30.9	33.9
	5	1.42	3.68	6.40	9.30	12.3	15.3	18.3	21.3	24.4	27.4	30.4	33.4
	6	1.25	3.36	5.96	8.78	11.7	14.7	17.7	20.7	23.8	26.8	29.8	32.8
	7	1.11	3.09	5.57	8.29	11.2	14.1	17.1	20.1	23.2	26.2	29.2	32.3
	8	0.99	2.86	5.22	7.84	10.6	13.6	16.5	19.5	22.6	25.6	28.6	31.7
	9	0.90	2.65	4.90	7.43	10.2	13.0	16.0	19.0	22.0	25.0	28.0	31.1
	10	0.81	2.47	4.61	7.04	9.69	12.5	15.4	18.4	21.4	24.4	27.4	30.4
	12	0.68	2.16	4.11	6.35	8.85	11.6	14.4	17.3	20.2	23.2	26.2	29.2
	14	0.59	1.92	3.69	5.76	8.11	10.7	13.4	16.2	19.1	22.1	25.0	28.0
	16	0.52	1.72	3.34	5.25	7.47	9.94	12.6	15.3	18.1	21.0	23.9	26.9
	18	0.46	1.56	3.04	4.82	6.91	9.26	11.8	14.4	17.2	20.0	22.9	25.8
	20	0.41	1.43	2.79	4.44	6.43	8.66	11.1	13.6	16.3	19.0	21.9	24.7
	24	0.35	1.22	2.38	3.84	5.62	7.64	9.84	12.2	14.7	17.3	20.0	22.8
	28	0.30	1.06	2.08	3.37	4.98	6.81	8.82	11.0	13.4	15.8	18.4	21.1
	32	0.26	0.94	1.84	3.00	4.46	6.12	7.97	10.0	12.2	14.6	17.0	19.5
	36	0.23	0.84	1.65	2.71	4.04	5.56	7.27	9.18	11.2	13.4	15.7	18.1

Table 7–11 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

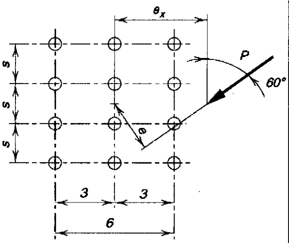
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.59	5.21	7.88	10.6	13.4	16.3	19.2	22.1	25.0	28.0	30.9	33.9
	3	2.32	4.73	7.27	9.91	12.7	15.5	18.3	21.2	24.1	27.0	30.0	32.9
	4	2.07	4.29	6.69	9.23	11.9	14.6	17.5	20.3	23.2	26.1	29.0	32.0
	5	1.84	3.90	6.18	8.63	11.2	13.9	16.6	19.5	22.3	25.2	28.1	31.0
	6	1.65	3.56	5.73	8.08	10.6	13.2	15.9	18.7	21.5	24.3	27.2	30.1
	7	1.49	3.27	5.32	7.59	10.0	12.6	15.2	17.9	20.7	23.5	26.3	29.2
	8	1.35	3.01	4.95	7.13	9.48	12.0	14.5	17.2	19.9	22.7	25.5	28.4
	9	1.23	2.78	4.63	6.71	8.98	11.4	13.9	16.5	19.2	22.0	24.7	27.6
	10	1.12	2.58	4.34	6.33	8.52	10.9	13.3	15.9	18.5	21.2	24.0	26.8
	12	0.95	2.25	3.84	5.67	7.70	9.91	12.3	14.7	17.3	19.9	22.6	25.3
	14	0.83	1.98	3.43	5.11	7.00	9.08	11.3	13.7	16.1	18.7	21.3	23.9
	16	0.73	1.77	3.09	4.64	6.40	8.36	10.5	12.7	15.1	17.5	20.1	22.6
	18	0.65	1.60	2.81	4.24	5.89	7.73	9.74	11.9	14.2	16.5	19.0	21.5
	20	0.59	1.46	2.57	3.9	5.44	7.19	9.09	11.1	13.3	15.6	17.9	20.4
	24	0.49	1.24	2.20	3.35	4.72	6.27	7.99	9.85	11.9	14.0	16.2	18.5
	28	0.42	1.07	1.91	2.93	4.15	5.55	7.10	8.81	10.7	12.6	14.7	16.8
	32	0.37	0.95	1.69	2.60	3.70	4.97	6.38	7.95	9.65	11.5	13.4	15.4
	36	0.33	0.85	1.51	2.34	3.34	4.49	5.79	7.23	8.81	10.5	12.3	14.2
6	2	2.59	5.32	8.17	11.1	14.0	17.0	19.9	22.9	25.8	28.8	31.8	34.7
	3	2.32	4.94	7.73	10.6	13.5	16.5	19.4	22.4	25.4	28.3	31.3	34.3
	4	2.07	4.57	7.31	10.2	13.1	16.0	19.0	21.9	24.9	27.8	30.8	33.8
	5	1.84	4.25	6.91	9.73	12.6	15.5	18.5	21.4	24.4	27.4	30.3	33.3
	6	1.65	3.95	6.55	9.32	12.2	15.1	18.0	20.9	23.9	26.9	29.8	32.8
	7	1.49	3.69	6.22	8.94	11.8	14.6	17.5	20.5	23.4	26.4	29.3	32.3
	8	1.35	3.46	5.92	8.58	11.4	14.2	17.1	20.0	22.9	25.9	28.8	31.8
	9	1.23	3.25	5.64	8.25	11.0	13.8	16.7	19.6	22.5	25.4	28.4	31.3
	10	1.12	3.06	5.39	7.94	10.6	13.4	16.3	19.1	22.0	24.9	27.9	30.8
	12	0.95	2.73	4.92	7.37	9.97	12.7	15.5	18.3	21.2	24.1	27.0	29.9
	14	0.83	2.46	4.52	6.85	9.36	12.0	14.7	17.5	20.3	23.2	26.1	29.0
	16	0.73	2.23	4.18	6.39	8.80	11.4	14.0	16.8	19.6	22.4	25.3	28.1
	18	0.65	2.04	3.87	5.97	8.28	10.8	13.4	16.1	18.8	21.6	24.4	27.3
	20	0.59	1.88	3.60	5.59	7.81	10.2	12.8	15.4	18.1	20.9	23.7	26.5
	24	0.49	1.63	3.15	4.94	6.99	9.25	11.7	14.2	16.8	19.5	22.2	25.0
	28	0.42	1.43	2.79	4.41	6.31	8.44	10.7	13.1	15.7	18.2	20.9	23.6
	32	0.37	1.27	2.49	3.97	5.74	7.74	9.90	12.2	14.6	17.1	19.7	22.3
	36	0.33	1.15	2.25	3.61	5.26	7.13	9.17	11.4	13.7	16.1	18.6	21.1

Table 7–11 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

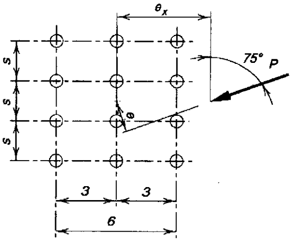
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.86	5.68	8.47	11.3	14.1	16.9	19.8	22.6	25.5	28.4	31.3	34.2
	3	2.77	5.49	8.19	10.9	13.7	16.4	19.2	22.1	24.9	27.8	30.7	33.6
	4	2.66	5.27	7.89	10.5	13.2	16.0	18.8	21.6	24.4	27.2	30.1	33.0
	5	2.53	5.04	7.58	10.2	12.8	15.5	18.3	21.0	23.9	26.7	29.5	32.4
	6	2.40	4.81	7.27	9.81	12.4	15.1	17.8	20.6	23.3	26.2	29.0	31.8
	7	2.26	4.57	6.97	9.47	12.0	14.7	17.4	20.1	22.9	25.6	28.4	31.3
	8	2.13	4.35	6.69	9.13	11.7	14.3	16.9	19.6	22.4	25.1	27.9	30.7
	9	2.00	4.13	6.41	8.82	11.3	13.9	16.5	19.2	21.9	24.7	27.4	30.2
	10	1.89	3.93	6.15	8.51	11.0	13.5	16.1	18.8	21.5	24.2	27.0	29.8
	12	1.67	3.57	5.67	7.95	10.4	12.9	15.4	18.0	20.7	23.4	26.1	28.8
	14	1.49	3.25	5.25	7.44	9.77	12.2	14.7	17.3	19.9	22.6	25.3	28.0
	16	1.34	2.97	4.87	6.98	9.23	11.6	14.1	16.6	19.2	21.8	24.5	27.2
	18	1.21	2.73	4.54	6.56	8.74	11.1	13.5	16.0	18.5	21.1	23.7	26.4
	20	1.10	2.53	4.24	6.18	8.28	10.5	12.9	15.3	17.8	20.4	23.0	25.6
	24	0.93	2.19	3.75	5.52	7.48	9.59	11.8	14.2	16.6	19.1	21.6	24.2
	28	0.80	1.93	3.34	4.97	6.79	8.78	10.9	13.2	15.5	17.9	20.4	22.9
	32	0.71	1.72	3.01	4.51	6.20	8.08	10.1	12.3	14.5	16.8	19.2	21.7
	36	0.63	1.55	2.74	4.12	5.70	7.47	9.40	11.5	13.6	15.9	18.2	20.6
6	2	2.86	5.66	8.48	11.3	14.2	17.1	20.1	23.0	26.4	29.3	32.3	35.2
	3	2.77	5.49	8.25	11.1	13.9	16.8	19.7	22.7	25.6	28.5	31.5	34.4
	4	2.66	5.30	8.02	10.8	13.6	16.5	19.4	22.3	25.2	28.2	31.1	34.0
	5	2.53	5.10	7.79	10.6	13.4	16.2	19.1	22.0	24.9	27.8	30.8	33.7
	6	2.40	4.91	7.56	10.3	13.1	15.9	18.8	21.7	24.6	27.5	30.4	33.3
	7	2.26	4.72	7.34	10.1	12.9	15.7	18.5	21.4	24.3	27.2	30.1	33.0
	8	2.13	4.54	7.14	9.83	12.6	15.4	18.3	21.1	24.0	26.9	29.8	32.7
	9	2.00	4.37	6.94	9.61	12.4	15.2	18.0	20.8	23.7	26.6	29.5	32.4
	10	1.89	4.21	6.75	9.40	12.1	14.9	17.7	20.6	23.4	26.3	29.2	32.1
	12	1.67	3.90	6.39	9.00	11.7	14.4	17.2	20.0	22.9	25.7	28.6	31.5
	14	1.49	3.63	6.06	8.63	11.3	14.0	16.8	19.6	22.4	25.2	28.1	30.9
	16	1.34	3.39	5.75	8.29	10.9	13.6	16.3	19.1	21.9	24.7	27.5	30.4
	18	1.21	3.17	5.47	7.96	10.6	13.2	15.9	18.7	21.4	24.2	27.0	29.9
	20	1.10	2.98	5.22	7.66	10.2	12.9	15.5	18.2	21.0	23.8	26.6	29.4
	24	0.93	2.65	4.76	7.10	9.57	12.2	14.8	17.5	20.2	22.9	25.7	28.5
	28	0.80	2.38	4.37	6.60	8.99	11.5	14.1	16.7	19.4	22.1	24.8	27.6
	32	0.71	2.16	4.03	6.15	8.45	10.9	13.4	16.0	18.7	21.3	24.0	26.8
	36	0.63	1.97	3.73	5.75	7.96	10.3	12.8	15.3	17.9	20.6	23.3	26.0

Table 7–12
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

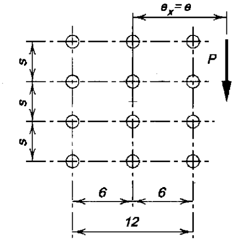
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.15	4.55	7.17	10.0	13.0	16.0	19.1	22.2	25.3	28.3	31.4	34.4
	3	1.91	4.06	6.43	9.06	11.9	14.9	17.9	21.0	24.1	27.2	30.3	33.4
	4	1.71	3.65	5.80	8.23	10.9	13.7	16.7	19.8	22.9	26.0	29.1	32.3
	5	1.55	3.31	5.27	7.51	9.97	12.7	15.5	18.5	21.5	24.7	27.8	31.0
	6	1.42	3.02	4.82	6.88	9.16	11.7	14.4	17.3	20.3	23.3	26.4	29.6
	7	1.31	2.77	4.44	6.34	8.46	10.8	13.4	16.1	19.0	22.0	25.1	28.2
	8	1.21	2.56	4.10	5.87	7.85	10.1	12.5	15.1	17.9	20.7	23.7	26.8
	9	1.12	2.38	3.81	5.46	7.31	9.39	11.7	14.1	16.8	19.6	22.5	25.5
	10	1.05	2.21	3.55	5.09	6.84	8.79	10.9	13.3	15.8	18.5	21.3	24.2
	12	0.92	1.94	3.12	4.48	6.03	7.78	9.70	11.8	14.1	16.6	19.1	21.9
	14	0.81	1.72	2.77	3.99	5.38	6.95	8.69	10.6	12.7	14.9	17.3	19.9
	16	0.72	1.53	2.48	3.58	4.84	6.27	7.85	9.60	11.5	13.6	15.8	18.1
	18	0.64	1.38	2.25	3.25	4.40	5.70	7.15	8.75	10.5	12.4	14.4	16.6
	20	0.58	1.26	2.05	2.96	4.02	5.21	6.55	8.03	9.65	11.4	13.3	15.3
	24	0.49	1.06	1.73	2.52	3.42	4.45	5.60	6.88	8.29	9.82	11.5	13.2
	28	0.42	0.92	1.50	2.19	2.97	3.87	4.88	6.00	7.24	8.59	10.1	11.6
	32	0.37	0.81	1.32	1.93	2.63	3.42	4.32	5.32	6.42	7.62	8.93	10.3
	36	0.33	0.72	1.18	1.72	2.35	3.06	3.87	4.77	5.76	6.84	8.02	9.29
	C'	11.8	26.5	43.3	63.7	86.8	114	144	178	216	257	302	352
6	2	2.15	4.94	7.98	11.1	14.2	17.2	20.2	23.2	26.2	29.2	32.1	35.1
	3	1.91	4.48	7.39	10.5	13.6	16.7	19.8	22.8	25.8	28.9	31.9	34.8
	4	1.71	4.07	6.81	9.86	13.0	16.1	19.3	22.3	25.4	28.5	31.5	34.5
	5	1.55	3.71	6.27	9.22	12.3	15.5	18.6	21.8	24.9	28.0	31.0	34.1
	6	1.42	3.40	5.79	8.61	11.7	14.8	18.0	21.1	24.3	27.4	30.5	33.6
	7	1.31	3.13	5.35	8.05	11.0	14.1	17.3	20.5	23.6	26.8	29.9	33.1
	8	1.21	2.90	4.97	7.53	10.4	13.4	16.6	19.8	23.0	26.1	29.3	32.5
	9	1.12	2.69	4.64	7.07	9.78	12.8	15.9	19.0	22.2	25.4	28.6	31.8
	10	1.05	2.51	4.34	6.64	9.24	12.1	15.2	18.3	21.5	24.7	27.9	31.1
	12	0.92	2.21	3.85	5.91	8.27	11.0	13.9	16.9	20.0	23.2	26.4	29.7
	14	0.81	1.96	3.44	5.31	7.46	9.95	12.7	15.6	18.6	21.8	25.0	28.2
	16	0.72	1.76	3.11	4.80	6.78	9.09	11.6	14.4	17.3	20.4	23.5	26.7
	18	0.64	1.60	2.83	4.38	6.20	8.34	10.7	13.3	16.1	19.1	22.1	25.2
	20	0.58	1.46	2.59	4.02	5.71	7.70	9.91	12.4	15.0	17.9	20.8	23.8
	24	0.49	1.24	2.21	3.44	4.91	6.65	8.59	10.8	13.2	15.7	18.5	21.3
	28	0.42	1.08	1.92	3.00	4.30	5.83	7.57	9.53	11.7	14.0	16.5	19.2
	32	0.37	0.95	1.70	2.66	3.82	5.19	6.75	8.51	10.5	12.6	14.9	17.3
	36	0.33	0.85	1.52	2.39	3.43	4.67	6.08	7.68	9.45	11.4	13.5	15.8
	C'	11.8	31.6	56.1	89.4	129	177	232	296	366	446	533	629

Table 7–12 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

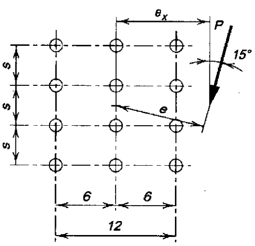
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.22	4.62	7.25	10.1	13.0	16.0	19.0	22.1	25.1	28.2	31.2	34.2
	3	1.97	4.13	6.53	9.13	11.9	14.9	17.9	20.9	24.0	27.1	30.1	33.2
	4	1.77	3.72	5.91	8.31	10.9	13.7	16.7	19.7	22.7	25.8	28.9	32.0
	5	1.61	3.38	5.39	7.60	10.1	12.7	15.5	18.4	21.4	24.5	27.6	30.7
	6	1.47	3.10	4.93	6.98	9.28	11.8	14.4	17.2	20.2	23.2	26.2	29.3
	7	1.35	2.85	4.54	6.45	8.59	10.9	13.5	16.1	19.0	21.9	24.9	27.9
	8	1.25	2.63	4.21	5.98	7.98	10.2	12.6	15.1	17.8	20.7	23.6	26.6
	9	1.16	2.44	3.91	5.57	7.45	9.51	11.8	14.2	16.8	19.5	22.4	25.3
	10	1.08	2.28	3.65	5.21	6.97	8.92	11.1	13.4	15.9	18.5	21.2	24.1
	12	0.94	2.00	3.20	4.59	6.16	7.91	9.84	11.9	14.2	16.6	19.2	21.9
	14	0.83	1.77	2.85	4.09	5.50	7.08	8.84	10.8	12.8	15.0	17.4	19.9
	16	0.74	1.58	2.56	3.68	4.96	6.40	8.00	9.75	11.7	13.7	15.9	18.2
	18	0.66	1.43	2.31	3.34	4.51	5.83	7.30	8.91	10.7	12.6	14.6	16.8
	20	0.60	1.30	2.11	3.05	4.13	5.34	6.70	8.19	9.82	11.6	13.5	15.5
	24	0.50	1.10	1.79	2.59	3.52	4.56	5.74	7.03	8.45	10.0	11.7	13.4
	28	0.43	0.95	1.55	2.25	3.06	3.98	5.01	6.15	7.40	8.77	10.2	11.8
	32	0.38	0.84	1.37	1.99	2.70	3.52	4.43	5.45	6.57	7.79	9.12	10.5
	36	0.34	0.75	1.22	1.78	2.42	3.15	3.98	4.89	5.90	7.01	8.20	9.49
6	2	2.22	4.97	7.97	11.0	14.1	17.1	20.1	23.1	26.1	29.1	32.1	35.0
	3	1.97	4.50	7.40	10.5	13.5	16.6	19.7	22.7	25.7	28.7	31.7	34.7
	4	1.77	4.10	6.84	9.82	12.9	16.0	19.1	22.2	25.2	28.3	31.3	34.3
	5	1.61	3.75	6.32	9.20	12.3	15.4	18.5	21.6	24.7	27.8	30.8	33.9
	6	1.47	3.45	5.86	8.61	11.6	14.7	17.8	20.9	24.1	27.2	30.3	33.3
	7	1.35	3.18	5.44	8.06	11.0	14.0	17.1	20.3	23.4	26.5	29.6	32.7
	8	1.25	2.95	5.07	7.55	10.4	13.3	16.4	19.5	22.7	25.8	29.0	32.1
	9	1.16	2.75	4.73	7.09	9.78	12.7	15.7	18.8	22.0	25.1	28.3	31.4
	10	1.08	2.57	4.44	6.67	9.26	12.1	15.1	18.1	21.3	24.4	27.6	30.7
	12	0.94	2.26	3.93	5.96	8.33	11.0	13.8	16.8	19.8	23.0	26.1	29.3
	14	0.83	2.01	3.52	5.37	7.55	9.97	12.7	15.5	18.5	21.5	24.7	27.8
	16	0.74	1.81	3.18	4.87	6.88	9.13	11.7	14.4	17.2	20.2	23.2	26.4
	18	0.66	1.64	2.90	4.45	6.31	8.40	10.8	13.3	16.1	18.9	21.9	25.0
	20	0.60	1.50	2.65	4.10	5.81	7.77	9.99	12.4	15.0	17.8	20.7	23.6
	24	0.50	1.28	2.27	3.52	5.01	6.74	8.71	10.9	13.2	15.8	18.4	21.2
	28	0.43	1.11	1.98	3.08	4.40	5.93	7.69	9.62	11.8	14.1	16.5	19.1
	32	0.38	0.98	1.75	2.73	3.91	5.29	6.87	8.62	10.6	12.7	15.0	17.4
	36	0.34	0.88	1.57	2.45	3.52	4.77	6.20	7.80	9.59	11.5	13.6	15.9

Table 7–12 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

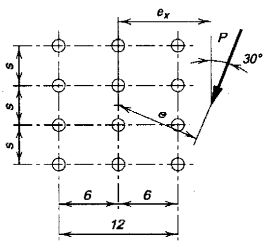
Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

$\phi = 0.75$ $\Omega = 2.00$
or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where
- P = required force, P_u or P_a, kips
- r_n = nominal strength per bolt, kips
- e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
- e_x = horizontal component of e, in.
- s = bolt spacing, in.
- C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.40	4.89	7.53	10.3	13.2	16.1	19.1	22.1	25.1	28.1	31.1	34.1
	3	2.15	4.40	6.84	9.45	12.2	15.1	18.0	21.0	24.0	27.0	30.0	33.0
	4	1.94	3.99	6.24	8.69	11.3	14.0	16.9	19.8	22.8	25.8	28.8	31.9
	5	1.76	3.65	5.74	8.02	10.5	13.1	15.8	18.7	21.6	24.6	27.6	30.6
	6	1.61	3.35	5.29	7.42	9.72	12.2	14.8	17.6	20.4	23.4	26.3	29.3
	7	1.49	3.10	4.90	6.89	9.06	11.4	13.9	16.6	19.3	22.2	25.1	28.1
	8	1.37	2.87	4.55	6.42	8.47	10.7	13.1	15.6	18.3	21.1	23.9	26.9
	9	1.28	2.67	4.24	6.00	7.94	10.1	12.4	14.8	17.4	20.0	22.8	25.7
	10	1.19	2.49	3.97	5.63	7.47	9.49	11.7	14.0	16.5	19.1	21.8	24.6
	12	1.04	2.19	3.50	4.98	6.64	8.48	10.5	12.6	14.9	17.3	19.9	22.5
	14	0.92	1.95	3.12	4.46	5.97	7.64	9.46	11.4	13.6	15.8	18.2	20.7
	16	0.82	1.75	2.81	4.03	5.40	6.93	8.61	10.4	12.4	14.5	16.7	19.1
	18	0.74	1.58	2.55	3.66	4.92	6.33	7.89	9.59	11.4	13.4	15.5	17.7
	20	0.67	1.44	2.33	3.35	4.52	5.82	7.27	8.85	10.6	12.4	14.4	16.4
	24	0.56	1.22	1.98	2.86	3.87	5.00	6.26	7.65	9.16	10.8	12.5	14.4
	28	0.48	1.06	1.72	2.49	3.37	4.37	5.48	6.71	8.06	9.51	11.1	12.8
	32	0.42	0.93	1.52	2.20	2.99	3.88	4.87	5.97	7.18	8.49	9.91	11.4
	36	0.38	0.83	1.36	1.97	2.68	3.48	4.38	5.38	6.47	7.66	8.95	10.3
6	2	2.40	5.11	8.05	11.1	14.1	17.1	20.1	23.0	26.0	29.0	32.0	34.9
	3	2.15	4.66	7.51	10.5	13.5	16.5	19.6	22.6	25.6	28.6	31.6	34.6
	4	1.94	4.26	6.99	9.90	12.9	16.0	19.0	22.0	25.1	28.1	31.1	34.1
	5	1.76	3.92	6.52	9.34	12.3	15.3	18.4	21.5	24.5	27.6	30.6	33.6
	6	1.61	3.63	6.09	8.80	11.7	14.7	17.7	20.8	23.9	27.0	30.0	33.1
	7	1.49	3.38	5.70	8.30	11.1	14.1	17.1	20.2	23.2	26.3	29.4	32.5
	8	1.37	3.15	5.35	7.83	10.6	13.5	16.5	19.5	22.6	25.7	28.7	31.8
	9	1.28	2.95	5.03	7.40	10.0	12.9	15.8	18.8	21.9	25.0	28.1	31.2
	10	1.19	2.77	4.74	7.00	9.54	12.3	15.2	18.2	21.2	24.3	27.4	30.5
	12	1.04	2.45	4.23	6.30	8.67	11.3	14.1	17.0	19.9	23.0	26.0	29.1
	14	0.92	2.19	3.81	5.71	7.92	10.4	13.0	15.8	18.7	21.7	24.7	27.8
	16	0.82	1.98	3.45	5.22	7.27	9.58	12.1	14.8	17.6	20.5	23.4	26.4
	18	0.74	1.80	3.16	4.79	6.71	8.88	11.2	13.8	16.5	19.3	22.2	25.2
	20	0.67	1.65	2.90	4.42	6.22	8.26	10.5	12.9	15.5	18.2	21.1	24.0
	24	0.56	1.41	2.49	3.82	5.41	7.22	9.23	11.5	13.8	16.4	19.0	21.8
	28	0.48	1.23	2.18	3.36	4.78	6.40	8.22	10.3	12.4	14.8	17.2	19.8
	32	0.42	1.08	1.93	2.99	4.26	5.73	7.40	9.25	11.3	13.4	15.7	18.2
	36	0.38	0.97	1.73	2.69	3.85	5.18	6.71	8.41	10.3	12.3	14.4	16.7

Table 7–12 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

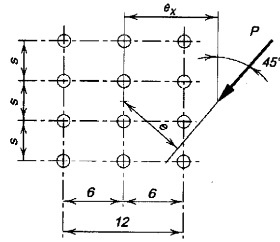
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.64	5.30	8.01	10.8	13.6	16.4	19.3	22.3	25.2	28.1	31.1	34.0
	3	2.43	4.90	7.44	10.1	12.8	15.6	18.4	21.3	24.2	27.1	30.1	33.1
	4	2.23	4.52	6.89	9.38	12.0	14.7	17.5	20.3	23.2	26.1	29.0	32.0
	5	2.05	4.17	6.40	8.75	11.2	13.9	16.6	19.3	22.2	25.0	27.9	30.9
	6	1.89	3.86	5.96	8.20	10.6	13.1	15.7	18.4	21.2	24.0	26.9	29.8
	7	1.75	3.59	5.57	7.70	9.99	12.4	14.9	17.5	20.2	23.0	25.8	28.7
	8	1.63	3.35	5.22	7.25	9.43	11.7	14.2	16.7	19.3	22.1	24.8	27.7
	9	1.52	3.13	4.90	6.83	8.91	11.1	13.5	15.9	18.5	21.2	23.9	26.7
	10	1.42	2.94	4.61	6.45	8.44	10.6	12.8	15.2	17.7	20.3	23.0	25.7
	12	1.25	2.60	4.11	5.78	7.60	9.58	11.7	14.0	16.3	18.8	21.3	23.9
	14	1.11	2.32	3.69	5.21	6.90	8.73	10.7	12.8	15.0	17.4	19.8	22.3
	16	0.99	2.09	3.34	4.74	6.29	8.00	9.85	11.8	13.9	16.1	18.5	20.9
	18	0.90	1.90	3.04	4.33	5.77	7.36	9.10	11.0	12.9	15.0	17.3	19.5
	20	0.81	1.73	2.79	3.98	5.33	6.81	8.44	10.2	12.1	14.1	16.2	18.4
	24	0.68	1.47	2.38	3.42	4.60	5.91	7.35	8.91	10.6	12.4	14.3	16.3
	28	0.59	1.28	2.08	2.99	4.03	5.20	6.49	7.90	9.42	11.1	12.8	14.6
	32	0.52	1.13	1.84	2.65	3.59	4.63	5.80	7.07	8.46	9.95	11.6	13.3
	36	0.46	1.01	1.65	2.38	3.23	4.17	5.23	6.40	7.67	9.04	10.5	12.1
6	2	2.64	5.38	8.22	11.1	14.1	17.0	20.0	23.0	25.9	28.9	31.9	34.8
	3	2.43	5.02	7.78	10.7	13.6	16.6	19.5	22.5	25.5	28.5	31.4	34.4
	4	2.23	4.67	7.33	10.2	13.1	16.0	19.0	22.0	25.0	28.0	31.0	33.9
	5	2.05	4.34	6.90	9.66	12.5	15.5	18.4	21.4	24.4	27.4	30.4	33.4
	6	1.89	4.06	6.50	9.19	12.0	14.9	17.9	20.9	23.9	26.9	29.9	32.9
	7	1.75	3.80	6.16	8.76	11.5	14.4	17.3	20.3	23.3	26.3	29.3	32.3
	8	1.63	3.57	5.84	8.36	11.1	13.9	16.8	19.7	22.7	25.7	28.7	31.7
	9	1.52	3.36	5.54	7.99	10.6	13.4	16.2	19.2	22.1	25.1	28.1	31.1
	10	1.42	3.17	5.27	7.63	10.2	12.9	15.7	18.6	21.5	24.5	27.5	30.5
	12	1.25	2.84	4.78	6.99	9.40	12.0	14.7	17.6	20.4	23.4	26.3	29.3
	14	1.11	2.57	4.36	6.42	8.70	11.2	13.8	16.6	19.4	22.3	25.2	28.2
	16	0.99	2.33	3.99	5.92	8.09	10.5	13.0	15.7	18.4	21.2	24.1	27.0
	18	0.90	2.13	3.68	5.49	7.54	9.80	12.2	14.8	17.5	20.3	23.1	26.0
	20	0.81	1.96	3.40	5.10	7.05	9.21	11.6	14.0	16.6	19.3	22.1	24.9
	24	0.68	1.68	2.95	4.46	6.22	8.19	10.4	12.7	15.1	17.7	20.3	23.0
	28	0.59	1.47	2.59	3.95	5.55	7.35	9.34	11.5	13.8	16.2	18.7	21.3
	32	0.52	1.31	2.31	3.54	4.99	6.65	8.49	10.5	12.7	14.9	17.3	19.8
	36	0.46	1.17	2.08	3.20	4.54	6.06	7.77	9.64	11.7	13.8	16.1	18.5

Table 7–12 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

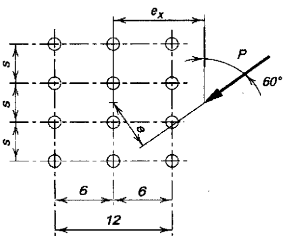
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
	2	2.83	5.64	8.45	11.3	14.1	16.9	19.8	22.6	25.5	28.4	31.3	34.2
	3	2.72	5.43	8.13	10.8	13.6	16.3	19.1	21.9	24.8	27.6	30.5	33.4
	4	2.59	5.18	7.77	10.4	13.0	15.7	18.5	21.2	24.0	26.8	29.7	32.5
	5	2.46	4.92	7.40	9.92	12.5	15.1	17.8	20.5	23.2	26.0	28.9	31.7
	6	2.32	4.66	7.03	9.46	12.0	14.5	17.1	19.8	22.5	25.2	28.0	30.8
	7	2.19	4.41	6.68	9.02	11.4	13.9	16.5	19.1	21.8	24.5	27.2	30.0
	8	2.07	4.17	6.35	8.61	11.0	13.4	15.9	18.4	21.1	23.7	26.5	29.2
	9	1.95	3.95	6.04	8.22	10.5	12.9	15.3	17.8	20.4	23.0	25.7	28.5
3	10	1.84	3.74	5.75	7.86	10.1	12.4	14.8	17.3	19.8	22.4	25.0	27.7
	12	1.65	3.38	5.22	7.19	9.28	11.5	13.8	16.2	18.6	21.1	23.7	26.3
	14	1.49	3.06	4.76	6.61	8.58	10.7	12.9	15.2	17.5	20.0	22.5	25.0
	16	1.35	2.79	4.37	6.09	7.95	9.93	12.0	14.2	16.5	18.9	21.3	23.8
	18	1.23	2.55	4.02	5.64	7.39	9.28	11.3	13.4	15.6	17.9	20.3	22.7
	20	1.12	2.35	3.72	5.24	6.90	8.69	10.6	12.6	14.8	17.0	19.3	21.7
	24	0.95	2.02	3.22	4.57	6.06	7.68	9.43	11.3	13.3	15.4	17.5	19.8
	28	0.83	1.76	2.84	4.04	5.39	6.86	8.47	10.2	12.0	14.0	16.0	18.1
	32	0.73	1.56	2.53	3.61	4.84	6.19	7.66	9.26	11.0	12.8	14.7	16.7
	36	0.65	1.40	2.27	3.26	4.38	5.62	6.98	8.46	10.1	11.7	13.5	15.4
	2	2.83	5.64	8.47	11.3	14.2	17.1	20.0	23.0	25.9	28.9	31.8	34.8
	3	2.72	5.44	8.19	11.0	13.8	16.7	19.6	22.6	25.5	28.4	31.4	34.3
	4	2.59	5.21	7.88	10.6	13.4	16.3	19.2	22.1	25.0	28.0	30.9	33.9
	5	2.46	4.97	7.57	10.3	13.1	15.9	18.8	21.7	24.6	27.5	30.4	33.4
	6	2.32	4.73	7.27	9.91	12.7	15.5	18.3	21.2	24.1	27.0	30.0	32.9
	7	2.19	4.51	6.97	9.56	12.3	15.0	17.9	20.8	23.7	26.6	29.5	32.4
	8	2.07	4.29	6.69	9.23	11.9	14.6	17.5	20.3	23.2	26.1	29.0	32.0
	9	1.95	4.09	6.43	8.92	11.5	14.3	17.0	19.9	22.8	25.6	28.6	31.5
6	10	1.84	3.90	6.18	8.63	11.2	13.9	16.6	19.5	22.3	25.2	28.1	31.0
	12	1.65	3.56	5.73	8.08	10.6	13.2	15.9	18.7	21.5	24.3	27.2	30.1
	14	1.49	3.27	5.32	7.59	10.0	12.6	15.2	17.9	20.7	23.5	26.3	29.2
	16	1.35	3.01	4.95	7.13	9.48	12.0	14.5	17.2	19.9	22.7	25.5	28.4
	18	1.23	2.78	4.63	6.71	8.98	11.4	13.9	16.5	19.2	22.0	24.7	27.6
	20	1.12	2.58	4.34	6.33	8.52	10.9	13.3	15.9	18.5	21.2	24.0	26.8
	24	0.95	2.25	3.84	5.67	7.70	9.91	12.3	14.7	17.3	19.9	22.6	25.3
	28	0.83	1.98	3.43	5.11	7.00	9.08	11.3	13.7	16.1	18.7	21.3	23.9
	32	0.73	1.77	3.09	4.64	6.40	8.36	10.5	12.7	15.1	17.5	20.1	22.6
	36	0.65	1.60	2.81	4.24	5.89	7.73	9.74	11.9	14.2	16.5	19.0	21.5

Table 7–12 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

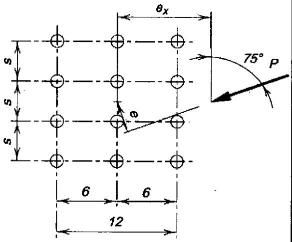
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	1	2	3	4	5	6	7	8	9	10	11	12
		Number of Bolts in One Vertical Row, *n*											
3	2	2.92	5.83	8.73	11.6	14.5	17.4	20.3	23.1	26.0	28.9	31.8	34.7
	3	2.89	5.77	8.63	11.5	14.3	17.2	20.0	22.8	25.7	28.5	31.4	34.2
	4	2.86	5.70	8.51	11.3	14.1	16.9	19.7	22.5	25.3	28.1	30.9	33.7
	5	2.82	5.61	8.38	11.1	13.9	16.6	19.4	22.1	24.9	27.7	30.5	33.3
	6	2.77	5.51	8.23	10.9	13.6	16.3	19.0	21.8	24.5	27.2	30.0	32.8
	7	2.72	5.40	8.06	10.7	13.4	16.0	18.7	21.4	24.1	26.8	29.6	32.3
	8	2.66	5.29	7.89	10.5	13.1	15.7	18.3	21.0	23.7	26.4	29.1	31.9
	9	2.60	5.16	7.71	10.3	12.8	15.4	18.0	20.6	23.3	26.0	28.7	31.4
	10	2.53	5.04	7.53	10.0	12.6	15.1	17.7	20.3	22.9	25.6	28.3	31.0
	12	2.40	4.78	7.16	9.57	12.0	14.5	17.0	19.6	22.1	24.8	27.4	30.1
	14	2.26	4.52	6.80	9.12	11.5	13.9	16.4	18.9	21.4	24.0	26.6	29.3
	16	2.13	4.27	6.45	8.68	11.0	13.3	15.8	18.2	20.7	23.3	25.9	28.5
	18	2.00	4.03	6.12	8.27	10.5	12.8	15.2	17.6	20.1	22.6	25.1	27.7
	20	1.89	3.81	5.80	7.88	10.1	12.3	14.6	17.0	19.4	21.9	24.4	27.0
	24	1.67	3.41	5.24	7.18	9.22	11.4	13.6	15.9	18.2	20.7	23.1	25.6
	28	1.49	3.06	4.75	6.56	8.49	10.5	12.6	14.9	17.1	19.5	21.9	24.3
	32	1.34	2.77	4.33	6.02	7.84	9.77	11.8	13.9	16.1	18.4	20.7	23.1
	36	1.21	2.52	3.97	5.56	7.27	9.10	11.1	13.1	15.2	17.4	19.7	22.0
6	2	2.92	5.82	8.71	11.6	14.5	17.4	20.3	23.5	26.4	29.3	32.3	35.2
	3	2.89	5.76	8.60	11.4	14.3	17.1	20.0	22.9	25.8	28.7	31.7	34.6
	4	2.86	5.68	8.47	11.3	14.1	16.9	19.8	22.6	25.5	28.4	31.3	34.2
	5	2.82	5.59	8.34	11.1	13.9	16.7	19.5	22.4	25.2	28.1	31.0	33.9
	6	2.77	5.49	8.19	10.9	13.7	16.4	19.2	22.1	24.9	27.8	30.7	33.6
	7	2.72	5.39	8.04	10.7	13.4	16.2	19.0	21.8	24.6	27.5	30.4	33.3
	8	2.66	5.27	7.89	10.5	13.2	16.0	18.8	21.6	24.4	27.2	30.1	33.0
	9	2.60	5.16	7.74	10.4	13.0	15.8	18.5	21.3	24.1	27.0	29.8	32.7
	10	2.53	5.04	7.58	10.2	12.8	15.5	18.3	21.0	23.9	26.7	29.5	32.4
	12	2.40	4.81	7.27	9.81	12.4	15.1	17.8	20.6	23.3	26.2	29.0	31.8
	14	2.26	4.57	6.97	9.47	12.0	14.7	17.4	20.1	22.9	25.6	28.4	31.3
	16	2.13	4.35	6.69	9.13	11.7	14.3	16.9	19.6	22.4	25.1	27.9	30.7
	18	2.00	4.13	6.41	8.82	11.3	13.9	16.5	19.2	21.9	24.7	27.4	30.2
	20	1.89	3.93	6.15	8.51	11.0	13.5	16.1	18.8	21.5	24.2	27.0	29.8
	24	1.67	3.57	5.67	7.95	10.4	12.9	15.4	18.0	20.7	23.4	26.1	28.8
	28	1.49	3.25	5.25	7.44	9.77	12.2	14.7	17.3	19.9	22.6	25.3	28.0
	32	1.34	2.97	4.87	6.98	9.23	11.6	14.1	16.6	19.2	21.8	24.5	27.2
	36	1.21	2.73	4.54	6.56	8.74	11.1	13.5	16.0	18.5	21.1	23.7	26.4

Table 7–13
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips

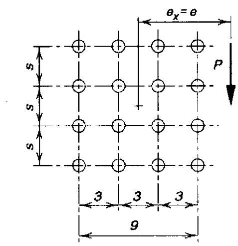
r_n = nominal strength per bolt, kips

e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)

e_x = horizontal component of e, in.

s = bolt spacing, in.

C = coefficient tabulated below



s, in.	e_x, in.	1	2	3	4	5	6	7	8	9	10	11	12
		Number of Bolts in One Vertical Row, *n*											
3	2	2.60	5.70	9.24	13.2	17.3	21.4	25.6	29.7	33.8	37.8	41.9	45.9
	3	2.23	4.92	8.05	11.7	15.6	19.7	23.9	28.1	32.3	36.4	40.6	44.7
	4	1.94	4.30	7.09	10.4	14.0	18.0	22.1	26.3	30.5	34.7	38.9	43.1
	5	1.69	3.79	6.30	9.29	12.6	16.4	20.3	24.4	28.6	32.9	37.1	41.4
	6	1.49	3.37	5.65	8.37	11.5	14.9	18.7	22.6	26.7	30.9	35.2	39.4
	7	1.32	3.03	5.10	7.59	10.4	13.7	17.2	21.0	24.9	29.0	33.2	37.5
	8	1.18	2.74	4.63	6.92	9.56	12.6	15.9	19.5	23.3	27.3	31.4	35.5
	9	1.07	2.50	4.24	6.35	8.81	11.6	14.7	18.1	21.7	25.6	29.6	33.7
	10	0.98	2.29	3.89	5.86	8.15	10.8	13.7	16.9	20.3	24.0	27.9	31.9
	12	0.83	1.96	3.34	5.06	7.06	9.37	12.0	14.8	17.9	21.3	24.9	28.6
	14	0.73	1.72	2.92	4.44	6.21	8.27	10.6	13.2	16.0	19.1	22.3	25.8
	16	0.65	1.52	2.59	3.95	5.54	7.39	9.48	11.8	14.4	17.2	20.2	23.4
	18	0.58	1.37	2.33	3.55	4.99	6.67	8.57	10.7	13.1	15.6	18.4	21.4
	20	0.53	1.24	2.11	3.23	4.53	6.07	7.81	9.77	11.9	14.3	16.9	19.6
	24	0.44	1.04	1.78	2.72	3.83	5.14	6.62	8.30	10.2	12.2	14.4	16.8
	28	0.38	0.90	1.54	2.35	3.31	4.45	5.73	7.20	8.82	10.6	12.6	14.7
	32	0.34	0.79	1.36	2.07	2.91	3.92	5.05	6.35	7.79	9.38	11.1	13.0
	36	0.30	0.71	1.21	1.85	2.60	3.50	4.51	5.68	6.96	8.39	9.95	11.6
	C′	11.3	26.0	44.7	68.1	96.0	129	167	210	258	312	371	435
6	2	2.60	6.48	10.7	14.8	18.9	23.0	27.0	31.0	34.9	38.9	42.9	46.8
	3	2.23	5.75	9.79	14.0	18.2	22.3	26.4	30.5	34.5	38.5	42.5	46.5
	4	1.94	5.12	8.91	13.1	17.4	21.6	25.7	29.9	33.9	38.0	42.0	46.1
	5	1.69	4.58	8.10	12.2	16.4	20.7	24.9	29.1	33.2	37.4	41.4	45.5
	6	1.49	4.13	7.37	11.3	15.5	19.7	24.0	28.3	32.5	36.6	40.8	44.9
	7	1.32	3.74	6.74	10.5	14.5	18.8	23.1	27.3	31.6	35.8	40.0	44.1
	8	1.18	3.41	6.20	9.73	13.6	17.8	22.1	26.4	30.6	34.9	39.1	43.3
	9	1.07	3.13	5.73	9.05	12.8	16.9	21.1	25.4	29.7	34.0	38.2	42.5
	10	0.98	2.89	5.31	8.45	12.0	16.0	20.1	24.4	28.7	33.0	37.3	41.5
	12	0.83	2.50	4.63	7.43	10.7	14.3	18.3	22.4	26.7	31.0	35.3	39.6
	14	0.73	2.19	4.09	6.60	9.53	12.9	16.7	20.6	24.7	29.0	33.3	37.6
	16	0.65	1.95	3.65	5.93	8.59	11.7	15.2	19.0	22.9	27.1	31.3	35.5
	18	0.58	1.76	3.29	5.37	7.81	10.7	14.0	17.5	21.3	25.3	29.4	33.6
	20	0.53	1.60	2.99	4.90	7.15	9.85	12.9	16.2	19.8	23.6	27.6	31.7
	24	0.44	1.35	2.53	4.16	6.10	8.44	11.1	14.0	17.3	20.8	24.4	28.3
	28	0.38	1.17	2.19	3.61	5.31	7.37	9.69	12.3	15.2	18.4	21.8	25.3
	32	0.34	1.03	1.93	3.19	4.69	6.53	8.61	11.0	13.6	16.5	19.6	22.9
	36	0.30	0.92	1.72	2.85	4.20	5.85	7.73	9.89	12.3	14.9	17.7	20.8
	C′	11.3	33.7	63.7	106	156	219	291	375	469	574	690	817

Table 7–13 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

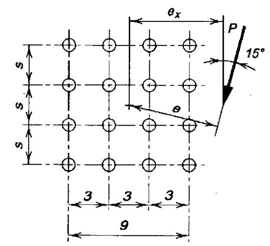
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.68	5.77	9.31	13.2	17.2	21.3	25.4	29.5	33.6	37.6	41.7	45.7
	3	2.30	5.00	8.17	11.7	15.6	19.6	23.7	27.8	32.0	36.1	40.2	44.3
	4	1.99	4.38	7.22	10.4	14.1	17.9	21.9	26.0	30.2	34.4	38.5	42.7
	5	1.74	3.88	6.43	9.37	12.7	16.4	20.2	24.2	28.3	32.5	36.7	40.9
	6	1.53	3.45	5.77	8.47	11.6	15.0	18.6	22.5	26.5	30.6	34.8	39.0
	7	1.36	3.10	5.21	7.71	10.6	13.7	17.2	20.9	24.8	28.8	32.9	37.1
	8	1.22	2.81	4.74	7.05	9.70	12.7	15.9	19.5	23.2	27.1	31.1	35.2
	9	1.11	2.57	4.34	6.48	8.95	11.7	14.8	18.1	21.7	25.5	29.4	33.4
	10	1.01	2.36	4.00	5.98	8.29	10.9	13.8	17.0	20.4	24.0	27.7	31.6
	12	0.86	2.02	3.44	5.18	7.21	9.52	12.1	15.0	18.1	21.4	24.9	28.5
	14	0.75	1.77	3.01	4.55	6.36	8.43	10.8	13.3	16.1	19.2	22.4	25.8
	16	0.67	1.57	2.68	4.05	5.67	7.54	9.66	12.0	14.6	17.3	20.3	23.5
	18	0.60	1.41	2.40	3.65	5.12	6.81	8.74	10.9	13.3	15.8	18.6	21.5
	20	0.54	1.28	2.18	3.32	4.66	6.21	7.98	9.95	12.1	14.5	17.1	19.8
	24	0.46	1.08	1.84	2.80	3.94	5.26	6.78	8.47	10.4	12.4	14.6	17.0
	28	0.40	0.93	1.59	2.43	3.41	4.56	5.89	7.37	9.02	10.8	12.8	14.9
	32	0.35	0.82	1.40	2.14	3.00	4.03	5.19	6.51	7.98	9.59	11.3	13.2
	36	0.31	0.73	1.25	1.91	2.68	3.60	4.65	5.83	7.15	8.59	10.2	11.9
6	2	2.68	6.48	10.6	14.7	18.8	22.9	26.9	30.9	34.8	38.8	42.8	46.7
	3	2.30	5.75	9.75	13.9	18.1	22.2	26.3	30.3	34.3	38.3	42.3	46.3
	4	1.99	5.13	8.91	13.0	17.2	21.4	25.5	29.6	33.7	37.7	41.8	45.8
	5	1.74	4.61	8.14	12.1	16.3	20.5	24.7	28.8	33.0	37.1	41.1	45.2
	6	1.53	4.17	7.45	11.2	15.3	19.5	23.7	27.9	32.1	36.3	40.4	44.5
	7	1.36	3.79	6.84	10.4	14.4	18.6	22.8	27.0	31.2	35.4	39.6	43.7
	8	1.22	3.46	6.30	9.71	13.6	17.6	21.8	26.0	30.3	34.5	38.7	42.9
	9	1.11	3.19	5.83	9.05	12.8	16.7	20.9	25.1	29.3	33.5	37.8	42.0
	10	1.01	2.94	5.42	8.47	12.0	15.9	19.9	24.1	28.3	32.6	36.8	41.0
	12	0.86	2.55	4.73	7.47	10.7	14.3	18.2	22.2	26.4	30.6	34.8	39.1
	14	0.75	2.24	4.18	6.66	9.62	12.9	16.6	20.5	24.5	28.6	32.8	37.1
	16	0.67	2.00	3.74	6.00	8.71	11.8	15.2	18.9	22.8	26.8	30.9	35.1
	18	0.60	1.80	3.38	5.45	7.94	10.8	14.0	17.5	21.2	25.1	29.1	33.2
	20	0.54	1.64	3.08	4.98	7.28	9.92	13.0	16.2	19.8	23.5	27.4	31.4
	24	0.46	1.39	2.60	4.25	6.23	8.54	11.2	14.1	17.3	20.8	24.4	28.1
	28	0.40	1.20	2.26	3.69	5.43	7.48	9.85	12.5	15.4	18.5	21.8	25.3
	32	0.35	1.06	1.99	3.26	4.81	6.65	8.77	11.1	13.8	16.6	19.7	22.9
	36	0.31	0.94	1.78	2.92	4.31	5.97	7.89	10.0	12.5	15.1	17.9	20.9

Table 7–13 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

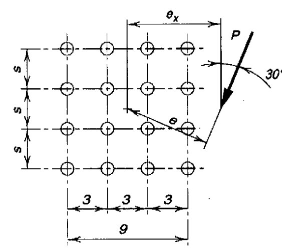
$\phi = 0.75$ $\qquad \Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n: 1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.90	6.06	9.59	13.4	17.3	21.3	25.3	29.4	33.4	37.4	41.4	45.4
	3	2.50	5.31	8.52	12.1	15.8	19.7	23.7	27.8	31.8	35.9	40.0	44.0
	4	2.18	4.70	7.62	10.9	14.4	18.2	22.1	26.1	30.1	34.2	38.3	42.4
	5	1.91	4.18	6.85	9.86	13.2	16.8	20.5	24.4	28.4	32.5	36.6	40.7
	6	1.69	3.75	6.19	8.98	12.1	15.5	19.1	22.9	26.8	30.7	34.8	38.9
	7	1.51	3.38	5.63	8.21	11.1	14.3	17.8	21.4	25.2	29.1	33.1	37.1
	8	1.36	3.07	5.14	7.55	10.3	13.3	16.6	20.0	23.7	27.5	31.4	35.4
	9	1.23	2.81	4.73	6.97	9.54	12.4	15.5	18.8	22.3	26.0	29.8	33.7
	10	1.13	2.59	4.37	6.46	8.88	11.6	14.5	17.7	21.1	24.7	28.3	32.2
	12	0.96	2.23	3.78	5.62	7.78	10.2	12.9	15.8	18.9	22.2	25.7	29.3
	14	0.84	1.95	3.32	4.96	6.90	9.08	11.5	14.2	17.1	20.1	23.4	26.8
	16	0.74	1.73	2.96	4.43	6.19	8.17	10.4	12.9	15.5	18.4	21.4	24.6
	18	0.67	1.56	2.66	4.00	5.60	7.41	9.46	11.7	14.2	16.8	19.7	22.7
	20	0.61	1.42	2.42	3.65	5.11	6.77	8.67	10.8	13.1	15.5	18.2	21.0
	24	0.51	1.20	2.04	3.09	4.34	5.77	7.41	9.22	11.2	13.4	15.7	18.2
	28	0.44	1.03	1.77	2.68	3.77	5.01	6.46	8.05	9.83	11.8	13.9	16.1
	32	0.39	0.91	1.56	2.36	3.32	4.43	5.71	7.14	8.72	10.5	12.3	14.4
	36	0.35	0.81	1.39	2.11	2.97	3.97	5.12	6.40	7.84	9.41	11.1	13.0
6	2	2.90	6.59	10.6	14.7	18.7	22.7	26.7	30.7	34.7	38.7	42.6	46.6
	3	2.50	5.88	9.83	13.9	18.0	22.0	26.1	30.1	34.1	38.1	42.1	46.1
	4	2.18	5.30	9.05	13.0	17.1	21.2	25.3	29.4	33.5	37.5	41.5	45.5
	5	1.91	4.81	8.35	12.2	16.3	20.4	24.5	28.6	32.7	36.8	40.8	44.9
	6	1.69	4.38	7.72	11.4	15.4	19.5	23.6	27.7	31.8	35.9	40.0	44.1
	7	1.51	4.01	7.15	10.7	14.6	18.6	22.7	26.8	31.0	35.1	39.2	43.3
	8	1.36	3.69	6.64	10.0	13.8	17.7	21.8	25.9	30.0	34.2	38.3	42.4
	9	1.23	3.41	6.19	9.41	13.0	16.9	20.9	25.0	29.1	33.3	37.4	41.6
	10	1.13	3.16	5.79	8.85	12.4	16.1	20.1	24.1	28.2	32.4	36.5	40.6
	12	0.96	2.76	5.09	7.88	11.1	14.7	18.5	22.4	26.4	30.5	34.6	38.8
	14	0.84	2.44	4.54	7.08	10.1	13.4	17.0	20.8	24.7	28.8	32.8	36.9
	16	0.74	2.18	4.08	6.41	9.21	12.3	15.7	19.4	23.2	27.1	31.1	35.1
	18	0.67	1.97	3.70	5.85	8.45	11.4	14.6	18.1	21.7	25.5	29.4	33.4
	20	0.61	1.80	3.38	5.37	7.80	10.5	13.6	16.9	20.4	24.1	27.9	31.8
	24	0.51	1.53	2.87	4.61	6.74	9.16	11.9	14.9	18.1	21.5	25.1	28.8
	28	0.44	1.32	2.49	4.02	5.91	8.07	10.5	13.3	16.2	19.4	22.7	26.2
	32	0.39	1.17	2.20	3.57	5.26	7.20	9.45	11.9	14.6	17.6	20.7	23.9
	36	0.35	1.05	1.97	3.21	4.73	6.49	8.55	10.8	13.3	16.0	18.9	22.0

Table 7–13 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

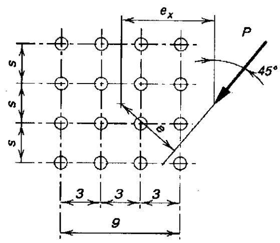
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.26	6.62	10.2	13.9	17.7	21.5	25.5	29.4	33.4	37.3	41.3	45.3
	3	2.87	5.92	9.19	12.7	16.4	20.2	24.0	28.0	31.9	35.9	39.9	43.9
	4	2.54	5.31	8.36	11.7	15.2	18.8	22.6	26.5	30.4	34.4	38.4	42.4
	5	2.25	4.78	7.63	10.8	14.1	17.6	21.3	25.1	29.0	32.9	36.8	40.8
	6	2.01	4.33	6.99	9.94	13.1	16.5	20.1	23.8	27.5	31.4	35.3	39.3
	7	1.81	3.93	6.42	9.20	12.2	15.5	18.9	22.5	26.2	30.0	33.8	37.7
	8	1.64	3.60	5.92	8.55	11.4	14.6	17.9	21.3	24.9	28.6	32.4	36.3
	9	1.49	3.31	5.49	7.96	10.7	13.7	16.9	20.3	23.8	27.4	31.1	34.9
	10	1.37	3.06	5.10	7.44	10.1	12.9	16.0	19.2	22.7	26.2	29.8	33.6
	12	1.17	2.65	4.46	6.55	8.93	11.6	14.4	17.5	20.7	24.0	27.5	31.1
	14	1.03	2.33	3.95	5.83	8.00	10.4	13.1	15.9	18.9	22.1	25.4	28.8
	16	0.91	2.08	3.54	5.24	7.23	9.47	11.9	14.6	17.4	20.4	23.6	26.8
	18	0.82	1.88	3.20	4.75	6.59	8.66	10.9	13.4	16.1	18.9	21.9	25.0
	20	0.74	1.71	2.92	4.35	6.04	7.96	10.1	12.4	15.0	17.6	20.5	23.5
	24	0.63	1.45	2.48	3.71	5.18	6.84	8.71	10.8	13.0	15.4	18.0	20.7
	28	0.54	1.26	2.15	3.23	4.52	5.99	7.65	9.50	11.5	13.7	16.0	18.5
	32	0.48	1.11	1.90	2.86	4.00	5.31	6.81	8.48	10.3	12.3	14.4	16.7
	36	0.43	0.99	1.69	2.56	3.59	4.77	6.13	7.64	9.30	11.1	13.1	15.2
6	2	3.26	6.89	10.8	14.7	18.7	22.7	26.6	30.6	34.6	38.5	42.5	46.5
	3	2.87	6.28	10.1	14.0	18.0	22.0	26.0	30.0	33.9	37.9	41.9	45.9
	4	2.54	5.74	9.38	13.3	17.2	21.2	25.2	29.2	33.2	37.2	41.2	45.2
	5	2.25	5.27	8.75	12.6	16.5	20.4	24.5	28.5	32.5	36.5	40.5	44.5
	6	2.01	4.85	8.20	11.9	15.7	19.7	23.7	27.7	31.7	35.7	39.7	43.8
	7	1.81	4.49	7.70	11.3	15.0	18.9	22.9	26.9	30.9	34.9	39.0	43.0
	8	1.64	4.16	7.25	10.7	14.4	18.2	22.1	26.1	30.1	34.1	38.2	42.2
	9	1.49	3.87	6.83	10.2	13.7	17.5	21.4	25.3	29.3	33.3	37.4	41.4
	10	1.37	3.62	6.45	9.65	13.1	16.8	20.7	24.6	28.5	32.5	36.6	40.6
	12	1.17	3.19	5.78	8.75	12.0	15.6	19.3	23.1	27.0	31.0	35.0	39.0
	14	1.03	2.84	5.21	7.97	11.1	14.5	18.1	21.8	25.6	29.5	33.4	37.4
	16	0.91	2.56	4.74	7.30	10.2	13.5	16.9	20.5	24.3	28.1	32.0	35.9
	18	0.82	2.33	4.33	6.72	9.48	12.6	15.9	19.4	23.0	26.7	30.6	34.4
	20	0.74	2.13	3.98	6.21	8.83	11.8	15.0	18.3	21.8	25.5	29.2	33.1
	24	0.63	1.82	3.42	5.38	7.74	10.4	13.3	16.5	19.8	23.2	26.8	30.5
	28	0.54	1.59	2.99	4.74	6.87	9.30	12.0	14.9	18.0	21.3	24.7	28.2
	32	0.48	1.41	2.65	4.22	6.17	8.38	10.8	13.6	16.5	19.5	22.8	26.1
	36	0.43	1.26	2.38	3.81	5.59	7.62	9.89	12.4	15.2	18.0	21.1	24.3

Table 7–13 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

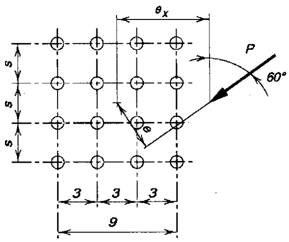
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.63	7.25	10.9	14.6	18.3	22.1	25.9	29.7	33.6	37.5	41.4	45.3
	3	3.38	6.77	10.2	13.8	17.4	21.1	24.8	28.6	32.4	36.3	40.2	44.1
	4	3.10	6.27	9.55	13.0	16.5	20.1	23.7	27.5	31.3	35.1	38.9	42.8
	5	2.84	5.80	8.92	12.2	15.6	19.1	22.7	26.4	30.1	33.9	37.8	41.6
	6	2.60	5.36	8.33	11.5	14.8	18.2	21.7	25.4	29.1	32.8	36.6	40.4
	7	2.38	4.96	7.79	10.8	14.1	17.4	20.9	24.4	28.0	31.7	35.5	39.3
	8	2.19	4.60	7.30	10.2	13.4	16.6	20.0	23.5	27.1	30.7	34.4	38.2
	9	2.02	4.28	6.85	9.68	12.7	15.9	19.2	22.6	26.1	29.7	33.4	37.1
	10	1.87	3.99	6.45	9.17	12.1	15.2	18.4	21.8	25.3	28.8	32.4	36.1
	12	1.62	3.51	5.75	8.27	11.0	13.9	17.0	20.3	23.6	27.0	30.6	34.1
	14	1.43	3.12	5.18	7.50	10.1	12.8	15.8	18.9	22.1	25.4	28.9	32.4
	16	1.27	2.81	4.70	6.85	9.23	11.9	14.7	17.6	20.7	24.0	27.3	30.7
	18	1.15	2.56	4.29	6.28	8.52	11.0	13.7	16.5	19.5	22.6	25.8	29.1
	20	1.04	2.34	3.95	5.80	7.89	10.2	12.8	15.5	18.4	21.4	24.5	27.7
	24	0.88	2.00	3.39	5.01	6.87	8.98	11.3	13.8	16.4	19.2	22.1	25.2
	28	0.76	1.74	2.96	4.39	6.07	7.97	10.1	12.3	14.8	17.4	20.1	23.0
	32	0.67	1.54	2.63	3.91	5.43	7.15	9.06	11.2	13.4	15.8	18.4	21.1
	36	0.60	1.38	2.36	3.52	4.91	6.48	8.22	10.2	12.3	14.5	16.9	19.4
6	2	3.63	7.29	11.1	14.9	18.8	22.7	26.6	30.5	34.5	38.4	42.4	46.3
	3	3.38	6.88	10.6	14.3	18.2	22.1	26.0	29.9	33.9	37.8	41.8	45.7
	4	3.10	6.46	10.0	13.8	17.6	21.5	25.4	29.3	33.2	37.2	41.1	45.1
	5	2.84	6.06	9.55	13.2	17.0	20.9	24.7	28.7	32.6	36.5	40.4	44.4
	6	2.60	5.69	9.09	12.7	16.4	20.3	24.1	28.0	31.9	35.9	39.8	43.8
	7	2.38	5.34	8.66	12.2	15.9	19.7	23.5	27.4	31.3	35.2	39.2	43.1
	8	2.19	5.03	8.27	11.7	15.4	19.1	22.9	26.8	30.7	34.6	38.5	42.4
	9	2.02	4.74	7.90	11.3	14.9	18.6	22.4	26.2	30.1	34.0	37.9	41.8
	10	1.87	4.47	7.55	10.9	14.4	18.1	21.8	25.6	29.5	33.4	37.3	41.2
	12	1.62	4.01	6.93	10.1	13.6	17.1	20.8	24.5	28.3	32.2	36.0	39.9
	14	1.43	3.63	6.38	9.46	12.8	16.2	19.8	23.5	27.3	31.0	34.9	38.7
	16	1.27	3.31	5.91	8.84	12.0	15.4	18.9	22.5	26.2	30.0	33.8	37.6
	18	1.15	3.04	5.49	8.28	11.3	14.6	18.0	21.6	25.2	28.9	32.7	36.5
	20	1.04	2.81	5.12	7.77	10.7	13.9	17.2	20.7	24.3	28.0	31.7	35.4
	24	0.88	2.44	4.49	6.90	9.62	12.6	15.8	19.1	22.6	26.1	29.8	33.4
	28	0.76	2.15	3.99	6.18	8.70	11.5	14.5	17.7	21.1	24.5	28.0	31.6
	32	0.67	1.91	3.58	5.58	7.93	10.6	13.4	16.5	19.7	23.0	26.4	29.9
	36	0.60	1.73	3.24	5.08	7.27	9.76	12.5	15.4	18.4	21.6	24.9	28.3

Table 7–13 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

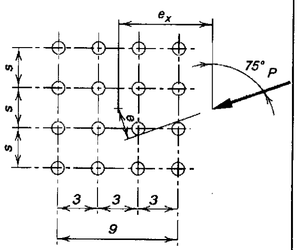
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.86	7.69	11.5	15.3	19.1	22.9	26.7	30.5	34.3	38.2	42.0	45.9
	3	3.79	7.53	11.2	14.9	18.6	22.4	26.1	29.9	33.6	37.4	41.3	45.1
	4	3.70	7.34	11.0	14.6	18.2	21.8	25.5	29.2	33.0	36.7	40.5	44.3
	5	3.59	7.13	10.6	14.2	17.7	21.3	24.9	28.6	32.3	36.1	39.8	43.6
	6	3.47	6.89	10.3	13.8	17.2	20.8	24.4	28.0	31.7	35.4	39.1	42.9
	7	3.34	6.65	9.98	13.4	16.8	20.3	23.8	27.4	31.1	34.7	38.4	42.2
	8	3.20	6.40	9.64	12.9	16.3	19.8	23.3	26.8	30.4	34.1	37.8	41.5
	9	3.07	6.16	9.31	12.6	15.9	19.3	22.8	26.3	29.9	33.5	37.1	40.8
	10	2.94	5.91	8.98	12.2	15.4	18.8	22.2	25.7	29.3	32.9	36.5	40.2
	12	2.68	5.45	8.36	11.4	14.6	17.9	21.3	24.7	28.2	31.8	35.4	39.0
	14	2.45	5.03	7.79	10.7	13.8	17.1	20.4	23.8	27.2	30.7	34.3	37.9
	16	2.24	4.65	7.28	10.1	13.1	16.3	19.5	22.9	26.3	29.7	33.2	36.8
	18	2.06	4.31	6.81	9.55	12.5	15.5	18.7	22.0	25.4	28.8	32.2	35.8
	20	1.90	4.01	6.40	9.03	11.9	14.8	18.0	21.2	24.5	27.9	31.3	34.8
	24	1.63	3.51	5.69	8.13	10.8	13.6	16.6	19.7	22.8	26.1	29.5	32.9
	28	1.43	3.11	5.11	7.36	9.83	12.5	15.3	18.3	21.4	24.6	27.8	31.1
	32	1.27	2.79	4.62	6.71	9.02	11.5	14.2	17.1	20.0	23.1	26.3	29.5
	36	1.14	2.53	4.22	6.15	8.31	10.7	13.3	16.0	18.8	21.8	24.9	28.0
6	2	3.86	7.67	11.5	15.3	19.1	23.0	26.9	30.8	35.2	39.1	43.0	47.0
	3	3.79	7.51	11.2	15.0	18.8	22.6	26.4	30.3	34.2	38.1	42.1	46.0
	4	3.70	7.32	11.0	14.7	18.4	22.2	26.0	29.9	33.8	37.7	41.6	45.5
	5	3.59	7.12	10.7	14.4	18.1	21.8	25.6	29.5	33.3	37.2	41.1	45.0
	6	3.47	6.92	10.4	14.1	17.7	21.5	25.3	29.1	32.9	36.8	40.7	44.6
	7	3.34	6.70	10.2	13.8	17.4	21.1	24.9	28.7	32.5	36.4	40.2	44.1
	8	3.20	6.49	9.92	13.5	17.1	20.8	24.5	28.3	32.1	36.0	39.8	43.7
	9	3.07	6.28	9.66	13.2	16.8	20.5	24.2	28.0	31.8	35.6	39.4	43.3
	10	2.94	6.08	9.42	12.9	16.5	20.2	23.9	27.6	31.4	35.2	39.0	42.9
	12	2.68	5.69	8.95	12.4	15.9	19.5	23.2	26.9	30.7	34.5	38.3	42.1
	14	2.45	5.33	8.51	11.9	15.4	19.0	22.6	26.3	30.0	33.8	37.6	41.4
	16	2.24	4.99	8.10	11.4	14.9	18.4	22.0	25.7	29.4	33.1	36.9	40.7
	18	2.06	4.69	7.72	11.0	14.4	17.9	21.5	25.1	28.8	32.5	36.2	40.0
	20	1.90	4.42	7.36	10.6	13.9	17.4	21.0	24.6	28.2	31.9	35.6	39.3
	24	1.63	3.95	6.74	9.83	13.1	16.5	20.0	23.5	27.1	30.7	34.4	38.1
	28	1.43	3.57	6.21	9.16	12.3	15.6	19.0	22.5	26.1	29.7	33.3	36.9
	32	1.27	3.25	5.74	8.56	11.6	14.8	18.2	21.6	25.1	28.6	32.2	35.9
	36	1.14	2.98	5.33	8.02	11.0	14.1	17.3	20.7	24.1	27.6	31.2	34.8

Table 7–14
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 0°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

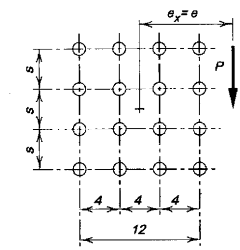
$\phi = 0.75$ $\quad\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.82	5.98	9.46	13.3	17.3	21.3	25.5	29.6	33.7	37.7	41.8	45.8
	3	2.50	5.31	8.43	12.0	15.7	19.7	23.8	28.0	32.2	36.3	40.4	44.6
	4	2.23	4.74	7.58	10.8	14.3	18.2	22.2	26.3	30.4	34.6	38.8	43.0
	5	2.01	4.27	6.86	9.82	13.1	16.7	20.5	24.5	28.6	32.8	37.0	41.3
	6	1.81	3.86	6.24	8.96	12.0	15.4	19.0	22.9	26.9	31.0	35.2	39.4
	7	1.64	3.52	5.70	8.22	11.1	14.2	17.6	21.3	25.2	29.2	33.3	37.5
	8	1.49	3.22	5.24	7.57	10.2	13.2	16.4	19.9	23.6	27.5	31.5	35.6
	9	1.36	2.96	4.83	7.01	9.48	12.3	15.3	18.6	22.1	25.9	29.8	33.8
	10	1.25	2.73	4.47	6.51	8.83	11.4	14.3	17.5	20.8	24.4	28.2	32.1
	12	1.07	2.37	3.89	5.68	7.74	10.1	12.6	15.5	18.5	21.8	25.3	29.0
	14	0.94	2.08	3.42	5.02	6.86	8.95	11.3	13.8	16.6	19.6	22.8	26.2
	16	0.83	1.86	3.05	4.49	6.15	8.04	10.2	12.5	15.0	17.8	20.7	23.9
	18	0.75	1.67	2.75	4.06	5.56	7.29	9.22	11.4	13.7	16.3	19.0	21.9
	20	0.68	1.52	2.50	3.70	5.07	6.65	8.43	10.4	12.6	14.9	17.5	20.2
	24	0.58	1.29	2.12	3.14	4.30	5.66	7.18	8.88	10.8	12.8	15.0	17.4
	28	0.50	1.12	1.84	2.72	3.73	4.92	6.24	7.73	9.37	11.2	13.1	15.2
	32	0.44	0.98	1.62	2.40	3.30	4.34	5.51	6.84	8.29	9.90	11.6	13.5
	36	0.40	0.88	1.45	2.15	2.95	3.89	4.94	6.13	7.43	8.88	10.4	12.1
	C′	15.0	32.8	54.2	79.9	110	145	184	229	279	333	393	458
6	2	2.82	6.54	10.6	14.8	18.9	22.9	26.9	30.9	34.9	38.9	42.8	46.8
	3	2.50	5.90	9.81	14.0	18.1	22.3	26.4	30.4	34.5	38.5	42.5	46.5
	4	2.23	5.33	9.01	13.1	17.3	21.5	25.7	29.8	33.9	37.9	42.0	46.0
	5	2.01	4.84	8.27	12.2	16.4	20.6	24.8	29.0	33.2	37.3	41.4	45.5
	6	1.81	4.42	7.60	11.4	15.5	19.7	24.0	28.2	32.4	36.6	40.7	44.8
	7	1.64	4.05	7.02	10.6	14.6	18.8	23.0	27.3	31.5	35.7	39.9	44.1
	8	1.49	3.73	6.51	9.94	13.7	17.8	22.0	26.3	30.6	34.8	39.1	43.3
	9	1.36	3.45	6.06	9.30	13.0	16.9	21.1	25.3	29.6	33.9	38.2	42.4
	10	1.25	3.20	5.66	8.72	12.2	16.1	20.2	24.4	28.6	32.9	37.2	41.5
	12	1.07	2.80	4.98	7.73	10.9	14.5	18.4	22.5	26.7	30.9	35.2	39.5
	14	0.94	2.47	4.43	6.92	9.81	13.2	16.8	20.7	24.8	29.0	33.2	37.5
	16	0.83	2.21	3.98	6.25	8.90	12.0	15.4	19.1	23.0	27.1	31.3	35.5
	18	0.75	2.00	3.60	5.68	8.13	11.0	14.2	17.7	21.4	25.3	29.4	33.6
	20	0.68	1.82	3.29	5.21	7.47	10.1	13.1	16.4	20.0	23.7	27.7	31.7
	24	0.58	1.55	2.79	4.45	6.40	8.72	11.3	14.3	17.5	20.9	24.5	28.3
	28	0.50	1.34	2.42	3.87	5.59	7.64	9.96	12.6	15.5	18.6	21.9	25.5
	32	0.44	1.18	2.14	3.43	4.95	6.79	8.87	11.2	13.8	16.7	19.7	23.0
	36	0.40	1.06	1.92	3.07	4.44	6.10	7.98	10.1	12.5	15.1	17.9	20.9
	C′	15.0	39.4	71.8	115	167	230	304	388	483	588	705	832

Table 7–14 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 15°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

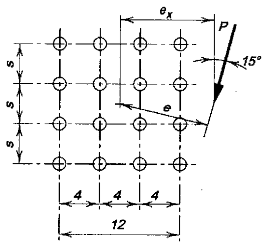
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n: 1	2	3	4	5	6	7	8	9	10	11	12
3	2	2.91	6.06	9.56	13.3	17.2	21.3	25.3	29.4	33.5	37.5	41.6	45.6
	3	2.57	5.40	8.57	12.0	15.8	19.7	23.7	27.8	31.9	36.1	40.2	44.3
	4	2.30	4.84	7.72	10.9	14.4	18.2	22.1	26.1	30.2	34.3	38.5	42.6
	5	2.06	4.37	6.99	9.93	13.2	16.7	20.5	24.4	28.5	32.6	36.7	40.9
	6	1.86	3.96	6.37	9.09	12.1	15.5	19.0	22.8	26.7	30.8	34.9	39.0
	7	1.69	3.61	5.83	8.36	11.2	14.3	17.7	21.3	25.1	29.0	33.1	37.2
	8	1.53	3.31	5.36	7.72	10.4	13.3	16.5	19.9	23.6	27.4	31.3	35.3
	9	1.40	3.04	4.95	7.15	9.64	12.4	15.4	18.7	22.2	25.8	29.7	33.6
	10	1.29	2.81	4.59	6.65	9.0	11.6	14.5	17.6	20.9	24.4	28.1	31.9
	12	1.11	2.44	4.00	5.82	7.9	10.2	12.8	15.6	18.7	21.9	25.3	28.9
	14	0.97	2.15	3.52	5.15	7.0	9.12	11.5	14.0	16.8	19.8	22.9	26.3
	16	0.86	1.92	3.15	4.61	6.3	8.21	10.3	12.7	15.2	18.0	20.9	24.0
	18	0.78	1.73	2.84	4.17	5.7	7.45	9.41	11.6	13.9	16.5	19.2	22.1
	20	0.71	1.57	2.59	3.80	5.2	6.81	8.61	10.6	12.8	15.2	17.7	20.4
	24	0.60	1.33	2.19	3.23	4.4	5.80	7.36	9.07	11.0	13.0	15.3	17.6
	28	0.52	1.15	1.90	2.80	3.9	5.05	6.41	7.91	9.59	11.4	13.4	15.5
	32	0.46	1.02	1.68	2.48	3.4	4.46	5.67	7.01	8.50	10.1	11.9	13.8
	36	0.41	0.91	1.50	2.22	3.0	4.00	5.08	6.29	7.63	9.09	10.7	12.4
6	2	2.91	6.57	10.6	14.7	18.8	22.8	26.8	30.8	34.8	38.8	42.7	46.7
	3	2.57	5.93	9.81	13.9	18.0	22.1	26.2	30.3	34.3	38.3	42.3	46.3
	4	2.30	5.37	9.04	13.0	17.2	21.3	25.5	29.6	33.6	37.7	41.7	45.8
	5	2.06	4.89	8.33	12.2	16.3	20.5	24.6	28.8	32.9	37.0	41.1	45.1
	6	1.86	4.48	7.70	11.4	15.4	19.5	23.7	27.9	32.1	36.2	40.3	44.4
	7	1.69	4.12	7.13	10.6	14.5	18.6	22.8	27.0	31.2	35.4	39.5	43.7
	8	1.53	3.80	6.62	9.95	13.7	17.7	21.8	26.0	30.2	34.4	38.6	42.8
	9	1.40	3.52	6.17	9.32	12.9	16.8	20.9	25.1	29.3	33.5	37.7	41.9
	10	1.29	3.27	5.77	8.76	12.2	16.0	20.0	24.1	28.3	32.5	36.8	41.0
	12	1.11	2.86	5.09	7.80	11.0	14.5	18.3	22.3	26.4	30.6	34.8	39.0
	14	0.97	2.54	4.53	7.00	9.92	13.2	16.8	20.6	24.6	28.7	32.8	37.1
	16	0.86	2.27	4.08	6.34	9.02	12.0	15.4	19.0	22.9	26.9	30.9	35.1
	18	0.78	2.06	3.70	5.78	8.26	11.1	14.2	17.7	21.3	25.2	29.1	33.2
	20	0.71	1.88	3.38	5.30	7.60	10.2	13.2	16.4	19.9	23.6	27.5	31.4
	24	0.60	1.59	2.88	4.54	6.54	8.84	11.5	14.4	17.5	20.9	24.5	28.2
	28	0.52	1.38	2.50	3.96	5.72	7.77	10.1	12.7	15.6	18.7	22.0	25.4
	32	0.46	1.22	2.21	3.51	5.08	6.92	9.03	11.4	14.0	16.8	19.9	23.1
	36	0.41	1.09	1.98	3.15	4.56	6.23	8.15	10.3	12.7	15.3	18.1	21.1

Table 7–14 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 30°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

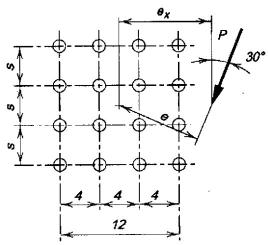
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.14	6.41	9.91	13.6	17.5	21.4	25.4	29.4	33.4	37.4	41.4	45.4
	3	2.79	5.75	8.95	12.4	16.1	20.0	23.9	27.9	31.9	35.9	40.0	44.0
	4	2.50	5.19	8.16	11.4	14.9	18.5	22.4	26.3	30.3	34.3	38.4	42.4
	5	2.25	4.71	7.45	10.5	13.7	17.2	20.9	24.7	28.6	32.6	36.7	40.7
	6	2.04	4.29	6.83	9.65	12.7	16.0	19.6	23.3	27.1	31.0	35.0	39.0
	7	1.85	3.93	6.28	8.92	11.8	15.0	18.3	21.9	25.6	29.4	33.3	37.3
	8	1.69	3.61	5.80	8.27	11.0	14.0	17.2	20.6	24.2	27.9	31.7	35.6
	9	1.55	3.33	5.38	7.70	10.3	13.1	16.2	19.4	22.9	26.5	30.2	34.0
	10	1.43	3.08	5.00	7.19	9.64	12.3	15.3	18.4	21.7	25.2	28.8	32.5
	12	1.23	2.68	4.37	6.32	8.52	11.0	13.6	16.5	19.6	22.8	26.2	29.8
	14	1.08	2.36	3.88	5.62	7.61	9.83	12.3	14.9	17.8	20.8	24.0	27.3
	16	0.96	2.11	3.47	5.05	6.86	8.89	11.1	13.6	16.2	19.0	22.0	25.2
	18	0.87	1.91	3.14	4.57	6.24	8.10	10.2	12.4	14.9	17.5	20.3	23.3
	20	0.79	1.74	2.86	4.18	5.71	7.43	9.35	11.5	13.8	16.2	18.9	21.6
	24	0.67	1.48	2.43	3.56	4.88	6.36	8.03	9.87	11.9	14.1	16.4	18.9
	28	0.58	1.28	2.11	3.10	4.25	5.55	7.02	8.65	10.4	12.4	14.5	16.7
	32	0.51	1.13	1.87	2.74	3.76	4.92	6.23	7.69	9.29	11.0	12.9	14.9
	36	0.46	1.01	1.67	2.45	3.37	4.41	5.60	6.91	8.36	9.95	11.7	13.5
6	2	3.14	6.75	10.7	14.7	18.7	22.7	26.7	30.7	34.7	38.6	42.6	46.6
	3	2.79	6.12	9.94	13.9	18.0	22.0	26.1	30.1	34.1	38.1	42.1	46.1
	4	2.50	5.58	9.23	13.1	17.2	21.2	25.3	29.4	33.4	37.5	41.5	45.5
	5	2.25	5.13	8.58	12.4	16.3	20.4	24.5	28.6	32.7	36.7	40.8	44.8
	6	2.04	4.73	8.00	11.6	15.5	19.5	23.6	27.7	31.8	35.9	40.0	44.1
	7	1.85	4.38	7.47	10.9	14.7	18.7	22.7	26.8	31.0	35.1	39.2	43.3
	8	1.69	4.06	6.98	10.3	14.0	17.9	21.9	25.9	30.1	34.2	38.3	42.4
	9	1.55	3.78	6.55	9.72	13.3	17.1	21.0	25.1	29.2	33.3	37.4	41.5
	10	1.43	3.53	6.15	9.18	12.6	16.3	20.2	24.2	28.3	32.4	36.5	40.6
	12	1.23	3.10	5.47	8.25	11.4	14.9	18.6	22.5	26.5	30.6	34.7	38.8
	14	1.08	2.76	4.90	7.46	10.4	13.7	17.2	21.0	24.9	28.8	32.9	37.0
	16	0.96	2.48	4.43	6.79	9.55	12.6	16.0	19.6	23.3	27.2	31.2	35.2
	18	0.87	2.25	4.04	6.22	8.79	11.7	14.9	18.3	21.9	25.7	29.5	33.5
	20	0.79	2.06	3.70	5.72	8.14	10.9	13.9	17.1	20.6	24.2	28.0	31.9
	24	0.67	1.76	3.17	4.93	7.06	9.48	12.2	15.2	18.3	21.7	25.3	28.9
	28	0.58	1.53	2.76	4.32	6.22	8.38	10.8	13.5	16.5	19.6	22.9	26.3
	32	0.51	1.35	2.45	3.84	5.54	7.50	9.73	12.2	14.9	17.8	20.9	24.1
	36	0.46	1.21	2.19	3.46	5.00	6.77	8.82	11.1	13.6	16.3	19.1	22.2

Table 7–14 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 45°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

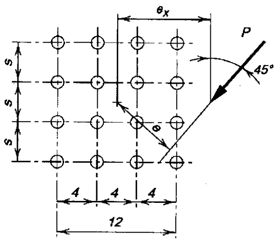
$\phi = 0.75$ $\quad$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.46	6.96	10.5	14.2	18.0	21.8	25.7	29.6	33.5	37.4	41.4	45.3
	3	3.15	6.38	9.73	13.2	16.8	20.6	24.4	28.2	32.1	36.1	40.0	44.0
	4	2.87	5.84	8.97	12.3	15.7	19.3	23.1	26.9	30.7	34.6	38.6	42.5
	5	2.61	5.36	8.30	11.4	14.7	18.2	21.8	25.5	29.3	33.2	37.1	41.0
	6	2.39	4.93	7.69	10.7	13.9	17.2	20.7	24.3	28.0	31.8	35.6	39.5
	7	2.19	4.55	7.15	9.98	13.0	16.2	19.6	23.1	26.7	30.4	34.2	38.1
	8	2.01	4.21	6.66	9.34	12.2	15.3	18.6	22.0	25.5	29.2	32.9	36.7
	9	1.86	3.90	6.21	8.76	11.5	14.5	17.7	21.0	24.4	27.9	31.6	35.3
	10	1.72	3.63	5.82	8.24	10.9	13.8	16.8	20.0	23.3	26.8	30.4	34.0
	12	1.49	3.18	5.14	7.33	9.76	12.4	15.2	18.3	21.4	24.7	28.1	31.6
	14	1.32	2.82	4.59	6.58	8.81	11.3	13.9	16.7	19.7	22.8	26.1	29.5
	16	1.17	2.53	4.14	5.95	8.00	10.3	12.7	15.4	18.2	21.2	24.3	27.5
	18	1.06	2.29	3.76	5.43	7.32	9.44	11.7	14.2	16.9	19.7	22.7	25.7
	20	0.96	2.10	3.44	4.98	6.74	8.71	10.9	13.2	15.7	18.4	21.2	24.2
	24	0.82	1.79	2.94	4.26	5.81	7.53	9.43	11.5	13.8	16.2	18.7	21.4
	28	0.71	1.56	2.56	3.73	5.09	6.61	8.31	10.2	12.2	14.4	16.7	19.2
	32	0.63	1.38	2.26	3.31	4.52	5.89	7.42	9.11	11.0	12.9	15.1	17.3
	36	0.56	1.23	2.03	2.97	4.06	5.30	6.69	8.23	9.91	11.7	13.7	15.8
6	2	3.46	7.09	10.9	14.8	18.7	22.7	26.7	30.6	34.6	38.5	42.5	46.5
	3	3.15	6.58	10.3	14.1	18.1	22.0	26.0	30.0	33.9	37.9	41.9	45.9
	4	2.87	6.09	9.65	13.4	17.3	21.3	25.3	29.3	33.3	37.3	41.2	45.2
	5	2.61	5.66	9.07	12.8	16.6	20.6	24.5	28.5	32.5	36.5	40.5	44.5
	6	2.39	5.26	8.54	12.1	15.9	19.8	23.8	27.8	31.8	35.8	39.8	43.8
	7	2.19	4.91	8.07	11.6	15.3	19.1	23.0	27.0	31.0	35.0	39.0	43.0
	8	2.01	4.59	7.63	11.0	14.6	18.4	22.3	26.2	30.2	34.2	38.2	42.2
	9	1.86	4.30	7.23	10.5	14.0	17.7	21.5	25.5	29.4	33.4	37.4	41.4
	10	1.72	4.04	6.85	10.0	13.4	17.1	20.8	24.7	28.6	32.6	36.6	40.6
	12	1.49	3.59	6.19	9.14	12.4	15.9	19.5	23.3	27.2	31.1	35.1	39.1
	14	1.32	3.22	5.62	8.38	11.4	14.8	18.3	22.0	25.8	29.6	33.5	37.5
	16	1.17	2.91	5.13	7.71	10.6	13.8	17.2	20.8	24.4	28.2	32.1	36.0
	18	1.06	2.66	4.71	7.12	9.87	12.9	16.2	19.6	23.2	26.9	30.7	34.6
	20	0.96	2.44	4.35	6.61	9.22	12.1	15.3	18.6	22.1	25.7	29.4	33.2
	24	0.82	2.10	3.76	5.76	8.11	10.8	13.7	16.7	20.0	23.4	27.0	30.6
	28	0.71	1.83	3.30	5.08	7.22	9.64	12.3	15.2	18.3	21.5	24.9	28.4
	32	0.63	1.63	2.94	4.54	6.50	8.71	11.2	13.9	16.7	19.8	23.0	26.3
	36	0.56	1.46	2.64	4.11	5.90	7.93	10.2	12.7	15.4	18.3	21.3	24.5

Table 7–14 (continued)
Coefficients C for Eccentrically Loaded Bolt Groups
Angle = 60°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

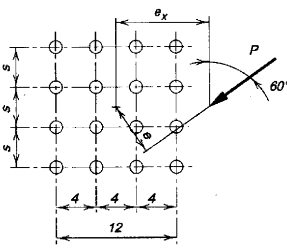
$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips
r_n = nominal strength per bolt, kips
e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)
e_x = horizontal component of e, in.
s = bolt spacing, in.
C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, n											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.74	7.46	11.2	14.9	18.6	22.4	26.2	30.0	33.9	37.7	41.6	45.5
	3	3.57	7.12	10.7	14.3	17.9	21.6	25.3	29.0	32.8	36.7	40.5	44.4
	4	3.38	6.75	10.2	13.6	17.1	20.7	24.3	28.0	31.8	35.6	39.4	43.2
	5	3.17	6.36	9.61	12.9	16.4	19.8	23.4	27.0	30.7	34.5	38.2	42.0
	6	2.97	5.99	9.09	12.3	15.6	19.0	22.5	26.1	29.7	33.4	37.1	40.9
	7	2.78	5.63	8.59	11.7	14.9	18.2	21.6	25.1	28.7	32.3	36.0	39.8
	8	2.60	5.29	8.13	11.1	14.2	17.5	20.8	24.3	27.8	31.4	35.0	38.7
	9	2.44	4.98	7.69	10.6	13.6	16.8	20.1	23.4	26.9	30.4	34.0	37.7
	10	2.28	4.69	7.28	10.1	13.0	16.1	19.3	22.7	26.1	29.5	33.1	36.7
	12	2.02	4.18	6.56	9.16	11.9	14.9	18.0	21.2	24.5	27.8	31.3	34.8
	14	1.80	3.76	5.95	8.38	11.0	13.8	16.7	19.8	23.0	26.3	29.6	33.1
	16	1.62	3.40	5.43	7.70	10.2	12.8	15.6	18.6	21.6	24.8	28.1	31.4
	18	1.47	3.10	4.99	7.11	9.42	11.9	14.6	17.4	20.4	23.5	26.7	29.9
	20	1.34	2.85	4.61	6.59	8.76	11.1	13.7	16.4	19.3	22.2	25.3	28.5
	24	1.15	2.45	3.99	5.73	7.67	9.82	12.2	14.6	17.3	20.1	23.0	26.0
	28	1.00	2.15	3.51	5.06	6.80	8.76	10.9	13.2	15.6	18.2	20.9	23.8
	32	0.88	1.91	3.13	4.52	6.11	7.89	9.83	11.9	14.2	16.6	19.2	21.8
	36	0.79	1.72	2.81	4.08	5.53	7.16	8.95	10.9	13.0	15.3	17.7	20.2
6	2	3.74	7.47	11.2	15.0	18.9	22.8	26.7	30.6	34.5	38.5	42.4	46.4
	3	3.57	7.16	10.8	14.6	18.4	22.2	26.1	30.0	33.9	37.9	41.8	45.8
	4	3.38	6.82	10.4	14.1	17.8	21.7	25.5	29.4	33.3	37.3	41.2	45.1
	5	3.17	6.47	9.94	13.6	17.3	21.1	24.9	28.8	32.7	36.6	40.5	44.5
	6	2.97	6.14	9.52	13.1	16.7	20.5	24.3	28.2	32.1	36.0	39.9	43.8
	7	2.78	5.82	9.11	12.6	16.2	19.9	23.7	27.6	31.5	35.3	39.3	43.2
	8	2.60	5.52	8.73	12.1	15.7	19.4	23.2	27.0	30.8	34.7	38.6	42.5
	9	2.44	5.24	8.37	11.7	15.2	18.9	22.6	26.4	30.2	34.1	38.0	41.9
	10	2.28	4.98	8.03	11.3	14.8	18.4	22.1	25.8	29.7	33.5	37.4	41.3
	12	2.02	4.51	7.41	10.6	14.0	17.5	21.1	24.8	28.5	32.3	36.2	40.1
	14	1.80	4.10	6.86	9.91	13.2	16.6	20.1	23.8	27.5	31.2	35.0	38.9
	16	1.62	3.76	6.37	9.29	12.4	15.8	19.2	22.8	26.5	30.2	33.9	37.7
	18	1.47	3.46	5.94	8.74	11.8	15.0	18.4	21.9	25.5	29.2	32.9	36.6
	20	1.34	3.21	5.56	8.23	11.2	14.3	17.6	21.0	24.6	28.2	31.9	35.6
	24	1.15	2.79	4.91	7.34	10.1	13.0	16.2	19.5	22.9	26.4	30.0	33.6
	28	1.00	2.47	4.38	6.61	9.13	11.9	14.9	18.1	21.4	24.7	28.2	31.8
	32	0.88	2.21	3.95	5.99	8.33	11.0	13.8	16.8	20.0	23.2	26.6	30.1
	36	0.79	2.00	3.58	5.46	7.65	10.1	12.8	15.7	18.7	21.9	25.1	28.5

Table 7-14 (continued)
Coefficients *C* for Eccentrically Loaded Bolt Groups
Angle = 75°

Available Strength of a bolt group, ϕR_n or R_n/Ω, is determined with

$$R_n = C \times r_n$$

$\phi = 0.75$ $\Omega = 2.00$

or

LRFD	ASD
$C_{min} = \dfrac{P_u}{\phi r_n}$	$C_{min} = \dfrac{\Omega P_a}{r_n}$

where

P = required force, P_u or P_a, kips

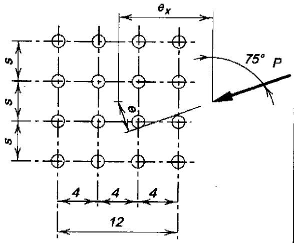
r_n = nominal strength per bolt, kips

e = eccentricity of P with respect to centroid of bolt group, in. (not tabulated, may be determined by geometry)

e_x = horizontal component of e, in.

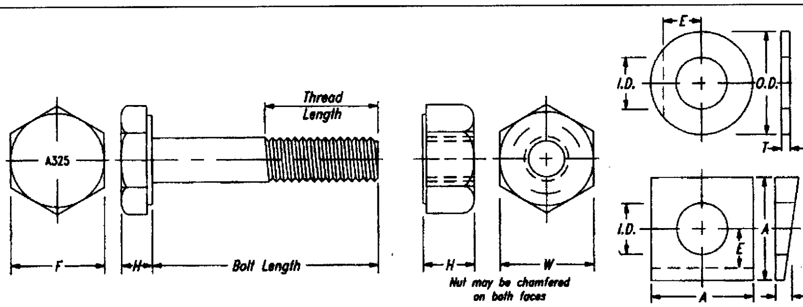
s = bolt spacing, in.

C = coefficient tabulated below



s, in.	e_x, in.	Number of Bolts in One Vertical Row, *n*											
		1	2	3	4	5	6	7	8	9	10	11	12
3	2	3.89	7.75	11.6	15.5	19.3	23.1	26.9	30.8	34.6	38.5	42.3	46.2
	3	3.84	7.66	11.5	15.2	19.0	22.7	26.5	30.3	34.1	37.9	41.7	45.5
	4	3.79	7.54	11.3	15.0	18.7	22.4	26.1	29.8	33.5	37.3	41.0	44.8
	5	3.72	7.40	11.1	14.7	18.3	21.9	25.6	29.3	32.9	36.7	40.4	44.1
	6	3.65	7.25	10.8	14.4	17.9	21.5	25.1	28.7	32.4	36.1	39.8	43.5
	7	3.56	7.08	10.6	14.1	17.6	21.1	24.6	28.2	31.8	35.5	39.1	42.8
	8	3.47	6.90	10.3	13.7	17.2	20.6	24.1	27.7	31.3	34.9	38.5	42.2
	9	3.37	6.71	10.0	13.4	16.8	20.2	23.7	27.2	30.7	34.3	37.9	41.6
	10	3.27	6.52	9.77	13.1	16.4	19.8	23.2	26.7	30.2	33.7	37.3	41.0
	12	3.07	6.14	9.23	12.4	15.6	18.9	22.3	25.7	29.1	32.6	36.2	39.8
	14	2.87	5.76	8.71	11.8	14.9	18.1	21.4	24.7	28.1	31.6	35.1	38.7
	16	2.68	5.40	8.22	11.1	14.2	17.3	20.5	23.8	27.2	30.6	34.1	37.6
	18	2.50	5.07	7.76	10.6	13.5	16.6	19.7	23.0	26.3	29.7	33.1	36.6
	20	2.34	4.76	7.33	10.0	12.9	15.9	19.0	22.2	25.5	28.8	32.2	35.6
	24	2.06	4.23	6.57	9.10	11.8	14.7	17.6	20.7	23.9	27.1	30.4	33.8
	28	1.82	3.78	5.94	8.30	10.9	13.5	16.4	19.3	22.4	25.5	28.7	32.0
	32	1.63	3.41	5.41	7.61	10.0	12.6	15.3	18.1	21.0	24.1	27.2	30.4
	36	1.48	3.11	4.95	7.01	9.26	11.7	14.3	17.0	19.8	22.8	25.8	28.9
6	2	3.89	7.74	11.6	15.4	19.3	23.1	27.0	30.9	35.2	39.1	43.0	47.0
	3	3.84	7.64	11.4	15.2	19.0	22.8	26.6	30.5	34.4	38.3	42.2	46.1
	4	3.79	7.52	11.2	14.9	18.7	22.5	26.3	30.1	34.0	37.8	41.7	45.6
	5	3.72	7.38	11.0	14.7	18.4	22.1	25.9	29.7	33.6	37.4	41.3	45.2
	6	3.65	7.23	10.8	14.4	18.1	21.8	25.6	29.3	33.2	37.0	40.8	44.7
	7	3.56	7.07	10.6	14.2	17.8	21.5	25.2	29.0	32.8	36.6	40.4	44.3
	8	3.47	6.90	10.4	13.9	17.5	21.2	24.9	28.6	32.4	36.2	40.0	43.9
	9	3.37	6.73	10.1	13.6	17.2	20.8	24.5	28.3	32.0	35.8	39.6	43.5
	10	3.27	6.56	9.92	13.4	16.9	20.5	24.2	27.9	31.7	35.5	39.3	43.1
	12	3.07	6.21	9.48	12.9	16.4	19.9	23.6	27.3	31.0	34.7	38.5	42.3
	14	2.87	5.88	9.07	12.4	15.9	19.4	23.0	26.6	30.3	34.1	37.8	41.6
	16	2.68	5.57	8.67	11.9	15.4	18.8	22.4	26.0	29.7	33.4	37.1	40.9
	18	2.50	5.27	8.29	11.5	14.9	18.3	21.9	25.5	29.1	32.8	36.5	40.2
	20	2.34	4.99	7.94	11.1	14.4	17.8	21.3	24.9	28.5	32.2	35.8	39.6
	24	2.06	4.50	7.29	10.3	13.6	16.9	20.4	23.9	27.4	31.0	34.7	38.3
	28	1.82	4.08	6.73	9.67	12.8	16.1	19.4	22.9	26.4	30.0	33.6	37.2
	32	1.63	3.73	6.25	9.06	12.1	15.3	18.6	22.0	25.4	29.0	32.5	36.1
	36	1.48	3.43	5.82	8.51	11.4	14.5	17.8	21.1	24.5	28.0	31.5	35.1

Table 7–15
Dimensions of High-Strength Fasteners, in.



	Measurement	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$
		Nominal Bolt Diameter, in.								
A325 and A490 Bolts[a]	Width Across Flats, *F*	$\frac{7}{8}$	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{7}{16}$	$1\frac{5}{8}$	$1\frac{13}{16}$	2	$2\frac{3}{16}$	$2\frac{3}{8}$
	Height, *H*	$\frac{5}{16}$	$\frac{25}{64}$	$\frac{15}{32}$	$\frac{35}{64}$	$\frac{39}{64}$	$\frac{11}{16}$	$\frac{25}{32}$	$\frac{27}{32}$	$\frac{15}{16}$
	Thread Length	1	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	2	$2\frac{1}{4}$	$2\frac{1}{4}$
	Bolt Length = Grip + Washer Thickness + →	$\frac{11}{16}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$
A563 Nuts[b]	Width Across Flats, *W*	$\frac{7}{8}$	$1\frac{1}{16}$	$1\frac{1}{4}$	$1\frac{7}{16}$	$1\frac{5}{8}$	$1\frac{13}{16}$	2	$2\frac{3}{16}$	$2\frac{3}{8}$
	Height, *H*	$\frac{31}{64}$	$\frac{39}{64}$	$\frac{47}{64}$	$\frac{55}{64}$	$\frac{63}{64}$	$1\frac{7}{64}$	$1\frac{7}{32}$	$1\frac{11}{32}$	$1\frac{15}{32}$
F436 Circular Washers[c]	Nom. Outside Diameter, *OD*	$1\frac{1}{16}$	$1\frac{5}{16}$	$1\frac{15}{32}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3
	Nom. Inside Diameter, *ID*	$\frac{17}{32}$	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$
	Thckns., *T* Min.	0.097	0.122	0.122	0.136	0.136	0.136	0.136	0.136	0.136
	Thckns., *T* Max.	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177
	Min. Edge Distance, *E*[d]	$\frac{7}{16}$	$\frac{9}{16}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{7}{8}$	1	$1\frac{3}{32}$	$1\frac{7}{32}$	$1\frac{5}{16}$
F436 Square or Rect. Washers[c,e]	Min. Side Dimension, *A*	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{4}$
	Mean Thickness, *T*	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{16}$
	Taper in Thickness	2:12	2:12	2:12	2:12	2:12	2:12	2:12	2:12	2:12
	Min. Edge Distance, *E*[d]	$\frac{7}{16}$	$\frac{9}{16}$	$\frac{21}{32}$	$\frac{25}{32}$	$\frac{7}{8}$	1	$1\frac{3}{32}$	$1\frac{7}{32}$	$1\frac{5}{16}$

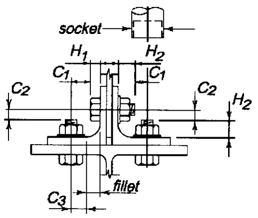
[a] Tolerances as specified in ASTM A325 and A490.
[b] Tolerances as specified in ASTM A563.
[c] ASTM F436 Washer Tolerances, in.:

Nominal Outside Diameter	–1/32; +1/32
Nominal Diameter of Hole	–0; +1/32
Flatness: max. deviation from straight-edge placed on cut side shall not exceed	0.010
Concentricity: center of hole to outside diameter (full indicator runout)	0.030
Burr shall not project above immediately adjacent washer surface more than	0.010

[d] For clipped washers only.
[e] For use with American standard beams (S) and channel (C).

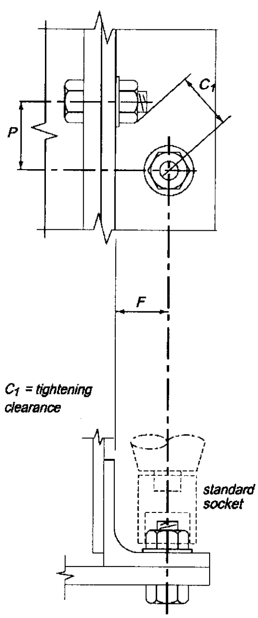
Table 7–16
Entering and Tightening Clearance, in. Conventional ASTM A325 and A490 Bolts

Aligned Bolts



Nominal Bolt Dia.	Socket Dia.	H_1	H_2	C_1	C_2	C_3 Circular	C_3 Clipped
5/8	1 3/4	25/64	1 1/4	1	1 11/16	11/16	9/16
3/4	2 1/4	15/32	1 3/8	1 1/4	3/4	3/4	11/16
7/8	2 1/2	35/64	1 1/2	1 3/8	7/8	7/8	13/16
1	2 5/8	39/64	1 5/8	1 7/16	15/16	1	7/8
1 1/8	2 7/8	11/16	1 7/8	1 9/16	1 1/16	1 1/8	1
1 1/4	3 1/8	25/32	2	1 11/16	1 1/8	1 1/4	1 1/8
1 3/8	3 1/4	27/32	2 1/8	1 3/4	1 1/4	1 3/8	1 1/4
1 1/2	3 1/2	15/16	2 1/4	1 7/8	1 5/16	1 1/2	1 5/16

Staggered Bolts



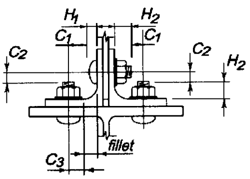
F	Stagger P, in. Nominal Bolt Diameter, in. 5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
1	1 5/8							
1 1/8	1 1/2							
1 1/4	1 1/2	1 15/16						
1 3/8	1 7/16	1 7/8	2 3/16					
1 1/2	1 1/4	1 13/16	2 1/8	2 5/16				
1 5/8	1 1/4	1 3/4	2 1/16	2 5/16	2 9/16			
1 3/4	1 3/16	1 11/16	2	2 1/4	2 9/16	2 13/16	3	
1 7/8	1 1/8	1 9/16	1 15/16	2 3/16	2 1/2	2 3/4	3	3 3/4
2	1	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	2 15/16	3 1/4
2 1/8	13/16	1 3/8	1 11/16	2	2 3/8	2 11/16	2 15/16	3 3/16
2 1/4		1 1/4	1 9/16	1 7/8	2 1/4	2 5/8	2 7/8	3 3/16
2 3/8		1 1/8	1 1/2	1 3/4	2 1/8	2 1/2	2 13/16	3 1/8
2 1/2		7/8	1 3/8	1 5/8	2	2 7/16	2 3/4	3 1/16
2 5/8			1 3/16	1 1/2	1 15/16	2 5/16	2 7/8	3
2 3/4			15/16	1 3/8	1 7/8	2 1/8	2 1/2	2 7/8
2 7/8				1 3/16	1 3/4	2 1/16	2 3/8	2 13/16
3				7/8	1 5/8	2	2 1/4	2 11/16
3 1/8					1 1/2	1 7/8	2 1/8	2 1/2
3 1/4					1 1/4	1 3/4	2	2 3/8
3 3/8					15/16	1 5/8	1 15/16	2 1/4
3 1/2						1 3/8	1 3/4	2 1/8
3 5/8						1 1/16	1 9/16	2
3 3/4							1 5/16	1 7/8
3 7/8								1 11/16
4								1 3/8

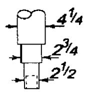
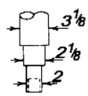
Notes:

H_1 = height of head
H_2 = maximum shank extension*
C_1 = clearance for tightening
C_2 = clearance for entering
C_3 = clearance for fillet*
P = bolt stagger
F = clearance for tightening staggered bolts
* Based on the use of one ASTM F436 washer.

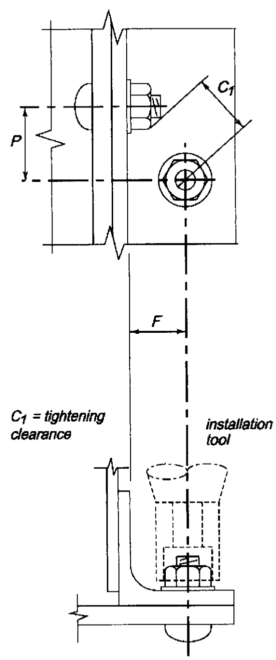
Table 7–17
Entering and Tightening Clearance, in. Tension Control ASTM F1852 and A490 Bolts

Aligned Bolts



Tools	Nominal Bolt Dia.	H_1	H_2	C_1	C_2	C_3 Circular	C_3 Clipped
Large Tools 	**4 1/4-in. Diameter Critical**						
	3/4	1/2	1 3/8	1 7/8	7/8	3/4	–
	7/8	9/16	1 1/2	1 7/8	1	7/8	–
	1	5/8	1 3/4	1 7/8	1 1/8	1	–
	2 3/4-in. Diameter Critical						
	3/4	1/2	1 3/8	1 3/8	7/8	3/4	–
	7/8	9/16	1 1/2	1 3/8	1	7/8	–
	1	5/8	1 3/4	1 3/8	1 1/8	1	–
Small Tools 	**3 1/8-in. Diameter Critical**						
	5/8	7/16	1 1/4	1 5/8	13/16	11/16	–
	3/4	1/2	1 3/8	1 5/8	7/8	3/4	–
	7/8	9/16	1 1/2	1 5/8	1	7/8	–
	2 1/8-in. Diameter Critical						
	5/8	7/16	1 1/4	1 1/4	13/16	11/16	–
	3/4	1/2	1 3/8	1 1/4	7/8	3/4	–
	7/8	9/16	1 1/2	1 1/4	1	7/8	–

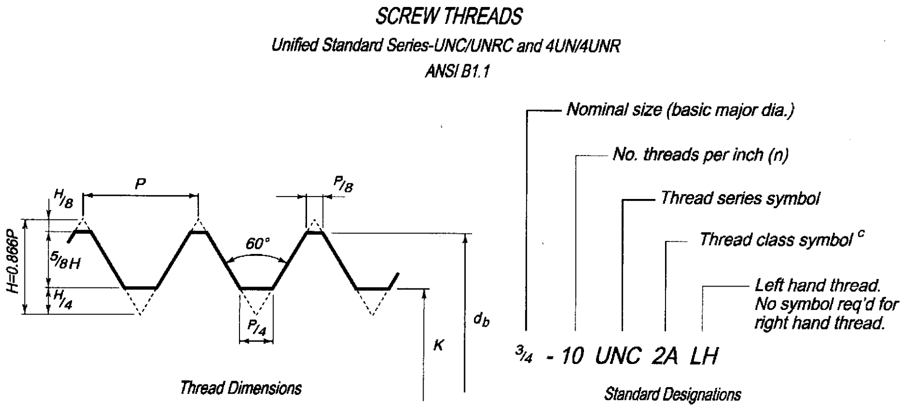
Staggered Bolts



F	Stagger *P*, in. Nominal Bolt Diameter, in. 5/8	3/4	7/8	1
1 1/4	1 13/16			
1 3/8	1 3/4	2 1/16		2 7/16
1 1/2	1 11/16	2	2 1/4	2 3/8
1 5/8	1 9/16	1 7/8	2 3/16	2 1/4
1 3/4	1 1/2	1 13/16	2 1/16	2 3/16
1 7/8	1 7/16	1 3/4	2	2 1/8
2	1 5/16	1 5/8	1 7/8	2
2 1/8	1 1/4	1 9/16	1 3/4	1 15/16
2 1/4	1 3/16	1 1/2	1 11/16	1 7/8
2 3/8	1 1/8	1 3/8	1 9/16	1 3/4
2 1/2	1	1 5/16	1 1/2	1 11/16
2 5/8		1 3/16	1 3/8	1 9/16
2 3/4		1 1/8	1 5/16	1 1/2
2 7/8		1 1/2	1 3/16	1 3/8
3		1 5/16	1 1/8	1 7/8
3 3/8				1 7/16

Notes:
H_1 = height of head
H_2 = maximum shank extension*
C_1 = clearance for tightening
C_2 = clearance for entering
C_3 = clearance for fillet*
P = bolt stagger
F = clearance for tightening staggered bolts
* Based on one standard hardened washer.

Table 7–18
Threading Dimensions for High-Strength and Non-High-Strength Bolts



Diameter		Area			
Bolt Diameter d_b, in.	Min. Root K, in.	Gross Bolt Area, in.^{2}	Min. Root Area, in.^{2}	Net Tensile Area[a], in.^{2}	Threads per inch, n[b]
1/4	0.196	0.0490	0.0301	0.0320	20
3/8	0.307	0.110	0.0742	0.0780	16
1/2	0.417	0.196	0.136	0.142	13
5/8	0.527	0.307	0.218	0.226	11
3/4	0.642	0.442	0.323	0.334	10
7/8	0.755	0.601	0.447	0.462	9
1	0.865	0.785	0.587	0.606	8
1 1/8	0.970	0.994	0.740	0.763	7
1 1/4	1.10	1.23	0.942	0.969	7
1 3/8	1.19	1.49	1.12	1.16	6
1 1/2	1.32	1.77	1.37	1.41	6
1 3/4	1.53	2.41	1.85	1.90	5
2	1.76	3.14	2.43	2.50	4.5
2 1/4	2.01	3.98	3.17	3.25	4.5
2 1/2	2.23	4.91	3.90	4.00	4
2 3/4	2.48	5.94	4.83	4.93	4
3	2.73	7.07	5.85	5.97	4
3 1/4	2.98	8.30	6.97	7.10	4
3 1/2	3.23	9.62	8.19	8.33	4
3 3/4	3.48	11.0	9.51	9.66	4
4	3.73	12.6	10.9	11.1	4

[a] Net tensile area = $0.7854 \times \left(d_b - \frac{0.9743}{n}\right)^2$

[b] For diameters listed, thread series is UNC (coarse). For larger diameters, thread series is 4UN.

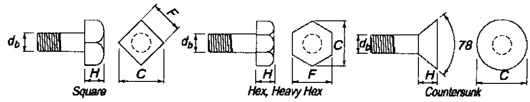
[c] 2A denotes Class 2A fit applicable to external threads;
2B denotes corresponding Class 2B fit for internal threads.

Table 7–19
Weights of High-Strength Fasteners, pounds per 100 count

	Bolt Length, in.	Nominal Bolt Diameter, in.								
		1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
100, Conventional A325 or A490 Bolts with A563 Nuts	1	16.5	29.4	47.0	—	—	—	—	—	—
	1 1/4	17.8	31.1	49.6	74.4	104	—	—	—	—
	1 1/2	19.2	33.1	52.2	78.0	109	148	197	—	—
	1 3/4	20.5	35.3	55.3	81.9	114	154	205	261	333
	2	21.9	37.4	58.4	86.1	119	160	212	270	344
	2 1/4	23.3	39.8	61.6	90.3	124	167	220	279	355
	2 1/2	24.7	41.7	64.7	94.6	130	174	229	290	366
	2 3/4	26.1	43.9	67.8	98.8	135	181	237	300	379
	3	27.4	46.1	70.9	103	141	188	246	310	391
	3 1/4	28.8	48.2	74.0	107	146	195	255	321	403
	3 1/2	30.2	50.4	77.1	111	151	202	263	332	416
	3 3/4	31.6	52.5	80.2	116	157	209	272	342	428
	4	33.0	54.7	83.3	120	162	216	280	353	441
	4 1/4	34.3	56.9	86.4	124	168	223	289	363	453
	4 1/2	35.7	59.0	89.5	128	173	230	298	374	465
	4 3/4	37.1	61.2	92.7	133	179	237	306	384	478
	5	38.5	63.3	95.8	137	184	244	315	395	490
	5 1/4	39.9	65.5	98.9	141	190	251	324	405	503
	5 1/2	41.2	67.7	102	146	196	258	332	416	515
	5 3/4	42.6	69.8	105	150	201	265	341	426	527
	6	44.0	71.9	108	154	207	272	349	437	540
	6 1/4	—	74.1	111	158	212	279	358	447	552
	6 1/2	—	76.3	114	163	218	286	367	458	565
	6 3/4	—	78.5	118	167	223	293	375	468	577
	7	—	80.6	121	171	229	300	384	479	589
	7 1/4	—	82.8	124	175	234	307	392	489	602
	7 1/2	—	84.9	127	179	240	314	401	500	614
	7 3/4	—	87.1	130	183	246	321	410	510	626
	8	—	89.2	133	187	251	328	418	521	639
	8 1/4	—	—	—	192	257	335	427	531	651
	8 1/2	—	—	—	196	262	342	435	542	664
	8 3/4	—	—	—	—	—	—	444	552	676
	9	—	—	—	—	—	—	453	563	689
	Per inch add'tl. Add	5.50	8.60	12.4	16.9	22.1	28.0	34.4	42.5	49.7
100, F436 Circular Washers		2.10	3.60	4.80	7.00	9.40	11.3	13.8	16.8	20.0
100, F436 Square Washers		23.1	22.4	21.0	20.2	19.2	34.0	31.6	31.2	32.9

This table conforms to weight standards adopted by the Industrial Fasteners Institute (IFI), updated for washer weights.

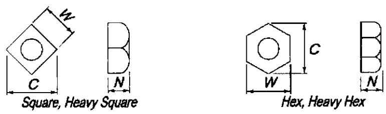
Table 7–20
Dimensions of Non-High-Strength Bolts, in.



Bolts Dia d_b, in.	Square			Hex			Heavy Hex			Countersunk		Min, Thrd. Length, in.	
	F, in.	*C*, in.	*H*, in.	*F*, in.	*C*, in.	*H*, in.	*F*, in.	*C*, in.	*H*, in.	*C*, in.	*H*, in.	*L* ≤ 6 in.	*L* > 6 in.
1/4	3/8	1/2	3/16	7/16	1/2	3/16	–	–	–	1/2	1/8	3/4	1
3/8	9/16	13/16	1/4	9/16	5/8	1/4	–	–	–	11/16	3/16	1	1 1/4
1/2	3/4	1 1/16	5/16	3/4	7/8	3/8	7/8	1	3/8	7/8	1/4	1 1/4	1 1/2
5/8	15/16	1 5/16	7/16	15/16	1 1/16	7/16	1 1/16	1 1/4	1 1/8	1 1/8	5/16	1 1/2	1 3/4
3/4	1 1/8	1 9/16	1/2	1 1/8	1 5/16	1/2	1 1/4	1 7/16	1/2	1 3/8	3/8	1 3/4	2
7/8	1 5/16	1 7/8	5/8	1 5/16	1 1/2	9/16	1 7/16	1 11/16	9/16	1 9/16	7/16	2	2 1/4
1	1 1/2	2 1/8	11/16	1 1/2	1 3/4	1 1/16	1 5/8	1 7/8	11/16	1 13/16	1/2	2 1/4	2 1/2
1 1/8	1 11/16	2 3/8	3/4	1 11/16	1 15/16	3/4	1 13/16	2 1/16	3/4	2 1/16	9/16	2 1/2	2 3/4
1 1/4	1 7/8	2 5/8	7/8	1 7/8	2 3/16	7/8	2	2 5/16	7/8	2 1/4	5/8	2 3/4	3
1 3/8	2 1/16	2 15/16	15/16	2 1/16	2 3/8	15/16	2 3/16	2 1/2	15/16	2 1/2	11/16	3	3 1/4
1 1/2	2 1/4	3 3/16	1	2 1/4	2 5/8	1	2 3/8	2 3/4	1	2 11/16	3/4	3 1/4	3 1/2
1 3/4	–	–	–	2 5/8	3	1 3/16	2 3/4	3 3/16	1 3/16	–	–	3 3/4	4
2	–	–	–	3	3 7/16	1 3/8	3 1/8	3 5/8	1 3/8	–	–	4 1/4	4 1/2
2 1/4	–	–	–	3 3/8	3 7/8	1 1/2	3 1/2	4 1/16	1 1/2	–	–	4 3/4	5
2 1/2	–	–	–	3 3/4	4 5/16	1 11/16	3 7/8	4 1/2	1 11/16	–	–	5 1/4	5 1/2
2 3/4	–	–	–	4 1/8	4 3/4	1 13/16	4 1/4	4 15/16	1 13/16	–	–	5 3/4	6
3	–	–	–	4 1/2	5 3/16	2	4 5/8	5 5/16	2	–	–	6	6 1/2
3 1/4	–	–	–	4 7/8	5 5/8	2 3/16	–	–	–	–	–	6	7
3 1/2	–	–	–	5 1/4	6 1/16	2 5/16	–	–	–	–	–	6	7 1/2
3 3/4	–	–	–	5 5/8	6 1/2	2 1/2	–	–	–	–	–	6	8
4	–	–	–	6	6 15/16	2 11/16	–	–	–	–	–	6	8 1/2

Notes:
For high-strength bolt and nut dimensions, refer to Table 7–15.
Square, hex, and heavy hex bolt dimensions, rounded to nearest 1/16 in., are in accordance with ANSI B18.2.1.
Countersunk bolt dimensions, rounded to the nearest 1/16 in., are in accordance with ANSI 18.5.
Minimum thread length = $2d_b$ + 1/4-in. for bolts up to 6 in. long, and $2d_b$ + 1/2-in. for bolts longer than 6 in.

Table 7–20 (continued)
Dimensions of Non-High-Strength Nuts, in.



Nut Size, in.		Square			Hex			Heavy Square			Heavy Hex		
		W, in.	C, in.	N, in.	W, in.	C, in.	N, in.	W, in.	C, in.	N, in.	W, in.	C, in.	N, in.
Nuts	1/4	7/16	5/8	1/4	7/16	1/2	3/16	1/2	11/16	1/4	1/2	9/16	1/4
	3/8	5/8	7/8	5/16	9/16	5/8	1/4	11/16	1	3/8	11/16	13/16	3/8
	1/2	4/5	1 1/8	7/16	3/4	7/8	3/8	7/8	1 1/4	1/2	7/8	1	1/2
	5/8	1	1 7/16	9/16	15/16	1 1/16	7/16	1 1/16	1 1/2	5/8	1 1/16	1 1/4	5/8
	3/4	1 1/8	1 9/16	11/16	1 1/8	1 5/16	1/2	1 1/4	1 3/4	3/4	1 1/4	1 7/16	3/4
	7/8	1 5/16	1 7/8	3/4	1 5/16	1 1/2	9/16	1 7/16	2 1/16	7/8	1 7/16	1 11/16	7/8
	1	1 1/2	2 1/8	7/8	1 1/2	1 3/4	11/16	1 5/8	2 5/16	1	1 5/8	1 7/8	1
	1 1/8	1 11/16	2 3/8	1	1 11/16	1 15/16	3/4	1 13/16	2 9/16	1 1/8	1 13/16	2 1/16	1 1/8
	1 1/4	1 7/8	2 5/8	1 1/8	1 7/8	2 3/16	7/8	2	2 13/16	1 1/4	2	2 5/16	1 1/4
	1 3/8	2 1/16	2 15/16	1 1/4	2 1/16	2 3/8	15/16	2 3/16	3 1/8	1 3/8	2 3/16	2 1/2	1 3/8
	1 1/2	2 1/4	3 3/16	1 5/16	2 1/4	2 5/8	1	2 3/8	3 3/8	1 1/2	2 3/8	2 3/4	1 1/2
	1 3/4	–	–	–	–	–	–	–	–	–	2 3/4	3 3/16	1 3/4
	2	–	–	–	–	–	–	–	–	–	3 1/8	3 5/8	2
	2 1/4	–	–	–	–	–	–	–	–	–	3 1/2	4 1/16	2 3/16
	2 1/2	–	–	–	–	–	–	–	–	–	3 7/8	4 1/2	2 7/16
	2 3/4	–	–	–	–	–	–	–	–	–	4 1/4	4 15/16	2 11/16
	3	–	–	–	–	–	–	–	–	–	4 5/8	5 5/16	2 15/16
	3 1/4	–	–	–	–	–	–	–	–	–	5	5 3/4	3 3/16
	3 1/2	–	–	–	–	–	–	–	–	–	5 3/8	6 3/16	3 7/16
	3 3/4	–	–	–	–	–	–	–	–	–	5 3/4	6 5/8	3 11/16
	4	–	–	–	–	–	–	–	–	–	6 1/8	7 1/16	3 15/16

Notes:
For high-strength bolt and nut dimensions, refer to Table 7–15.
Square, hex, and heavy hex bolt dimensions, rounded to nearest 1/16 in., are in accordance with ANSI B18.2.1.
Countersunk bolt dimensions, rounded to the nearest 1/16 in., are in accordance with ANSI 18.5.
Minimum thread length = $2d_b + 1/4$-in. for bolts up to 6 in. long, and $2d_b + 1/2$-in. for bolts longer than 6 in.

Table 7–21
Weights of Non-High-Strength Fasteners, pounds

100 Square Bolts with Hexagonal Nuts* — Bolt Length, in.	Nominal Bolt Diameter, in.								
	$^1/_4$	$^3/_8$	$^1/_2$	$^5/_8$	$^3/_4$	$^7/_8$	1	$1^1/_8$	$1^1/_4$
1	2.38	6.11	13.0	24.1	38.9	–	–	–	–
$1^1/_4$	2.71	6.71	14.0	25.8	41.5	–	–	–	–
$1^1/_2$	3.05	7.47	15.1	27.6	44.0	67.3	95.1	–	–
$1^3/_4$	3.39	8.23	16.5	29.3	46.5	70.8	99.7	–	–
2	3.73	8.99	17.8	31.4	49.1	74.4	104	143	–
$2^1/_4$	4.06	9.75	19.1	33.5	52.1	77.9	109	149	–
$2^1/_2$	4.40	10.5	20.5	35.6	55.1	82.0	114	155	206
$2^3/_4$	4.74	11.3	21.8	37.7	58.2	86.1	119	161	213
3	5.07	12.0	23.2	39.8	61.2	90.2	124	168	221
$3^1/_4$	5.41	12.8	24.5	41.9	64.2	94.4	129	174	229
$3^1/_2$	5.75	13.5	25.9	44.0	67.2	98.5	135	181	237
$3^3/_4$	6.09	14.3	27.2	46.1	70.2	103	140	188	246
4	6.42	15.1	28.6	48.2	73.3	107	145	195	254
$4^1/_4$	6.76	15.8	29.9	50.3	76.3	111	151	202	262
$4^1/_2$	7.10	16.6	31.3	52.3	79.3	115	156	208	271
$4^3/_4$	7.43	17.3	32.6	54.4	82.3	119	162	215	279
5	7.77	18.1	33.9	56.5	85.3	123	167	222	288
$5^1/_4$	8.11	18.9	35.3	58.6	88.4	127	172	229	296
$5^1/_2$	8.44	19.6	36.6	60.7	91.4	131	178	236	304
$5^3/_4$	8.78	20.4	38.0	62.8	94.4	136	183	242	313
6	9.12	21.1	39.3	64.9	97.4	140	188	249	321
$6^1/_4$	9.37	21.7	40.4	66.7	100	143	193	255	329
$6^1/_2$	9.71	22.5	41.8	68.7	103	147	198	262	337
$6^3/_4$	10.1	23.3	43.1	70.8	106	151	204	269	345
7	10.4	24.0	44.4	72.9	109	156	209	275	354
$7^1/_4$	10.7	24.8	45.8	75.0	112	160	214	282	362
$7^1/_2$	11.0	25.5	47.1	77.1	115	164	220	289	371
$7^3/_4$	11.4	26.3	48.5	79.2	118	168	225	296	379
8	11.7	27.0	49.8	81.3	121	172	231	303	387
$8^1/_2$	–	28.6	52.5	85.5	127	180	241	316	404
9	–	30.1	55.2	89.7	133	189	252	330	421
$9^1/_2$	–	31.6	57.9	93.9	139	197	263	343	438
10	–	66.1	60.6	98.1	145	205	274	357	454
$10^1/_2$	–	34.6	63.3	102	151	213	284	371	471
11	–	36.2	66.0	106	157	221	295	384	488
$11^1/_2$	–	37.7	68.7	110	163	230	306	398	505
12	–	39.2	71.3	115	170	238	316	411	522
$12^1/_2$	–	–	74.0	119	176	246	327	425	538
13	–	–	76.7	123	182	254	338	439	556
$13^1/_2$	–	–	79.4	127	188	263	349	452	572
14	–	–	82.1	131	194	271	359	466	589
$14^1/_2$	–	–	84.8	135	200	279	370	479	605
15	–	–	87.5	140	206	287	381	493	622
$15^1/_2$	–	–	90.2	144	212	296	392	507	639
16	–	–	92.9	148	218	304	402	520	656
Per inch add'tl. Add	1.3	3.0	5.4	8.4	12.1	16.5	21.4	27.2	33.6

Notes:
For weight of high-strength fasteners, see Table 7-20.
This table conforms to weight standards adopted by the Industrial Fasteners Institute (IFI).
*Square bolt per ANSI B 18.2.1, hexagonal nut per ANSI B18.2.2. For other non-high-strength fasteners, refer to Tables 7-22 and 7-23.

Table 7–22
Weight Adjustments
for Combinations of Non-High-Strength Fasteners Other than Tabulated in Table 7–21

Combinations of 100		Add or Subtr.	Nominal Bolt Diameter, in.								
			1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
Square Bolts With	Square Nuts	+	0.1	1.0	2.0	3.4	3.5	5.5	8.0	12.2	16.3
	Heavy Square Nuts	+	0.6	2.1	4.1	7.0	11.6	17.2	23.2	32.1	41.2
	Heavy Hex Nuts	+	0.4	1.5	2.8	4.6	7.6	10.7	14.2	18.9	24.3
100, Square Bolts with Hexagonal Nuts*	Square Nuts	+	0.1	0.6	1.1	1.4	0.2	0.5	-0.2	-0.1	-1.7
	Hex Nuts	–	0.0	0.4	0.9	2.0	3.3	5.0	8.2	12.3	18.0
	Heavy Square Nuts	+	0.6	1.7	3.2	5.0	8.3	12.2	15.0	19.8	23.2
	Heavy Hex Nuts	+	0.4	1.1	1.9	2.6	4.3	5.7	6.0	6.6	6.3
100, Hex Bolts	Heavy Square Nuts	+	–	–	4.7	7.3	11.3	16.5	20.7	27.0	33.6
	Heavy Hex Nuts	+	–	–	3.4	4.9	7.3	10.0	11.7	13.8	16.7

Notes:
For weights of high-strength fasteners, see Table 7–19.
This table conforms to weight standards adopted by the Industrial Fasteners Institute (IFI).
*Add or subtract value in this table to or from the value in Table 7–21.

Table 7–23
Weights of Non-High-Strength Bolts
of Diameter Greater Than 1¼ in., pounds

Weight of 100 Each		Nominal Bolt Diameter, in.											
		1 3/8	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4
Heads of:	Square Bolts	105	130	–	–	–	–	–	–	–	–	–	–
	Hex Bolts	84.0	112	178	259	369	508	680	900	1120	1390	1730	2130
	Heavy Hex Bolts	95.0	124	195	280	397	541	720	950	–	–	–	–
One Linear Inch, Unthreaded Shank		42.0	50.0	68.2	89.0	113	139	168	200	235	272	313	356
One Linear Inch, Threaded Shank		35.0	42.5	57.4	75.5	97.4	120	147	178	210	246	284	325
Square Nuts		94.5	122	–	–	–	–	–	–	–	–	–	–
Heavy Square Nuts		125	161	–	–	–	–	–	–	–	–	–	–
Heavy Hex Nuts		102	131	204	299	419	564	738	950	1190	1530	1810	2180

– Indicates that the bolt size is not available.

PART 8

DESIGN CONSIDERATIONS FOR WELDS

SCOPE

The specification requirements and other design considerations summarized in this Part apply to the design of welded joints. For the design of connecting elements, see Part 9. For the design of simple shear, moment, bracing, and other connections, see Parts 10 through 15. For welded joints that are part of a seismic force resisting system in which the seismic response modification factor, R, is taken greater than 3, the requirements in the AISC *Seismic Provisions for Structural Steel Buildings* also apply. The AISC *Seismic Provisions for Structural Steel Buildings* is available in Part 6 of the AISC *Seismic Design Manual* from the American Institute of Steel Construction, Inc. at www.aisc.org.

GENERAL REQUIREMENTS FOR WELDED JOINTS

The requirements for welded construction are given in AISC Specification Section M2.4, which requires the use of AWS D1.1, except as modified in AISC Specification Section J2. For further information see also Blodgett et al. (1997).

Welding in structural steel in performed in compliance with written welding procedure specifications (WPSs). WPSs are qualified by test or prequalified in AWS D1.1. WPSs are used to control base metal, consumables, joint geometry, electrical, and other essential variables for welded joints.

Consumables

Requirements for welding consumables are given in AISC Specification Sections A3.5, J2.6, and J2.7. Permissible filler metal strengths are shown in Table J2.5, based on matching filler metals shown in AWS D1.1 Table 3.1. Filler metal notch-toughness requirements are given in AISC Specification J2.6. Low-hydrogen electrodes for SMAW are required, as shown in AWS D1.1 Table 3.1. Low-hydrogen SMAW electrodes have a limited exposure time and rod ovens are necessary near the point of use for storage.

Requirements for the manufacture, classification, and packing of consumables are given in AWS A5.x specifications. Consumables vary based upon their welding process. Shielded Metal Arc Welding (SMAW), or 'stick' welding, is a manual process. Submerged Arc Welding (SAW) is a semiautomatic or automatic process. Consumables are classified as an electrode flux combination because the weld metal properties are dependant on both the electrode and the flux. SAW is suitable for long straight or circumferential welds but the work must be performed in horizontal or flat positions. Flux-Cored Arc Welding (FCAW) uses wire electrode that contains flux in the center. FCAW electrodes are provided for use with a gas shield or self shield. Gas for shielding is argon, carbon dioxide, or a combination of the two. Gas Metal Arc Welding (GMAW) uses wire electrodes that are solid or have a metal core. GMAW is performed with gas shielding.

Thermal Cutting

Oxygen-fuel gas cutting can be used to cut almost any commercially available plate thickness. If the plate being cut contains large discontinuities or non-metallic inclusions, turbulence may be created in the cutting stream, resulting in notches or gouges in the edge of the cut. Plasma-arc cutting is much faster and less susceptible to the effects of discontinuities or non-metallic inclusions, but leaves a slight taper in the cut as it descends and can be used only up to about $1^1/2$ in. thickness. Within the depth limits given in the AISC Specification and AWS D1.1, it is usually better practice to remove and fair-in notches or gouges by grinding than to weld repair and grind. In either case, however, a smooth transition should be provided.

Air-Arc Gouging

In this method, a carbon arc is used to melt a nugget-shaped area of the base metal, which is blown away with a jet of compressed air. Air-arc gouging can be used to remove weld defects, gouge the weld root to sound weld metal, form a U groove on one side of a square butt joint, and for similar operations.

Inspection

The five most commonly used methods for welding inspection are discussed below and in AWS Guide for the Non-Destructive Inspection of Welds (B1.0). The designer must specify in the contract documents the types of weld inspection required as well as the extent and application of each type of inspection. In the absence of instructions for weld inspection, the fabricator or erector is only responsible for those weld discontinuities found by visual inspection (see AWS D1.1). If additional inspection more stringent than visual is later required, the owner is normally responsible for the costs of inspection and of weld repairs other than those identified by the visual inspection requirements. Weld repairs which may be difficult to perform and which may potentially damage other aspects of the connection are best referred to the engineer of record to determine the necessity of the correction with due consideration of fitness for purpose.

Visual inspection is the most commonly required inspection process. The designer must realize that more stringent requirements for inspection can needlessly add significant cost to the project and should specify them only in those instances where they are essential to the integrity of the structure.

Visual Testing (VT)

Visual inspection provides the most economical way to check weld quality and is the most commonly used method. Joints are scrutinized prior to the commencement of welding to check fit-up, preparation bevels, gaps, alignment, and other variables. After the joint is welded, it is then visually inspected in accordance with AWS D1.1. If a discontinuity is suspected, the weld is either repaired or other inspection methods are used to validate the integrity of the weld. In most cases, timely visual inspection by an experienced inspector is sufficient and offers the most practical and effective inspection alternative to other, more costly methods.

Penetrant Testing (PT)

This test uses a red dye penetrant applied to the work from a pressure spray can. The dye penetrates any crack or crevice open to the surface. Excess dye is removed and white developer is sprayed on. Dye seeps out of the crack, producing a red image on the white developer (See Figure 8-1).

PT can be used to detect tight cracks as long as they are open to the surface. However, only surface cracks are detectable. Furthermore, deep weld ripples and scratches may give a false indication when PT is used.

Dye penetrant examination tends to be messy and slow, but can be helpful when determining the extent of a defect found by visual inspection. This is especially true when a defect is being removed by gouging or grinding for the repair of a weld to assure that the defect is completely removed.

Magnetic-Particle Testing (MT)

A magnetizing current is introduced with a yoke or contact prods into the weldment to be inspected, as sketched in Figure 8-2 (prods shown). This induces a magnetic field in the work, which will be distorted by any cracks, seams, inclusions, etc. located on or near (within approx. 0.1 in. of) the surface. A dry magnetic powder, blown lightly on the surface by a rubber squirt bulb, will be picked up at such discontinuities, making a distinct mark. The magnetically held particles show the location, size, and shape of the discontinuity.

The method will indicate surface cracks that might be difficult for liquid penetrant to enter and subsurface cracks to about 0.1-in depth, with proper magnetization. Records may be kept by picking up the powder pattern with clear plastic tape. Cleanup is easy, but demag-

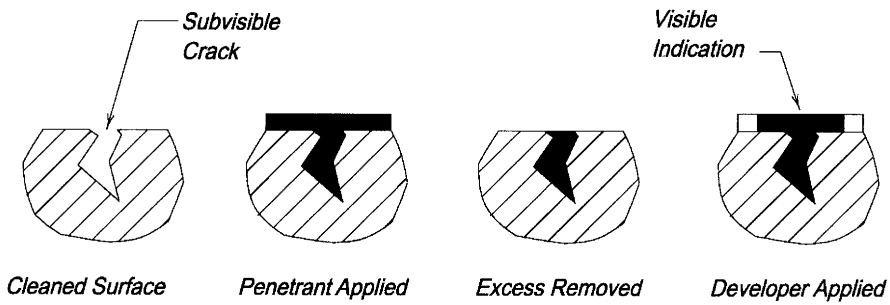


Figure 8–1. Schematic illustration of penetrant testing (PT).

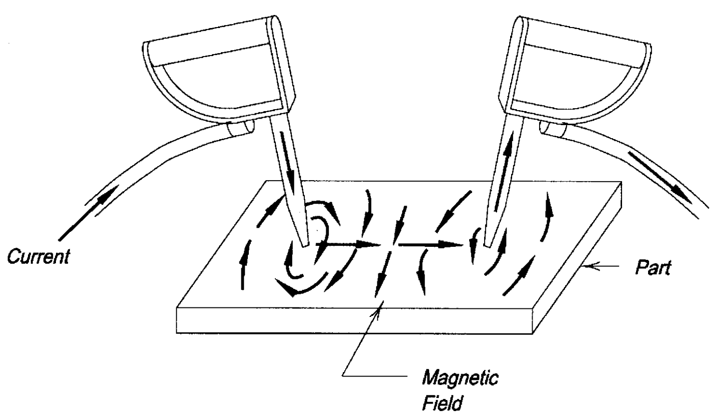


Figure 8–2. Schematic illustration of magnetic particle testing (MT).

netizing, if necessary, may not be. If the magnetizing prod is lifted from the work while the current is still on, an arc strike which could lead to cracking could result. If arc strikes occur, they should be ground out.

Magnetic particle examination can be useful when a defect is suspected from visual inspection or when the absence of cracking in areas of high restraint must be confirmed. Relatively smooth surfaces are required for MT and, while cleanup is easy, demagnetization, when necessary, may not be.

Ultrasonic Testing (UT)

The ultrasonic (UT) inspection process is analogous to radar. A short pulse of high-frequency sound is broadcast from a crystal into a metal, after which the crystal waits to receive reflections from the far end of the metal member and from any voids encountered on the way through. The technique is called pulse echo. The sound beam is produced by a piezoelectric transducer energized by an electric current which causes the crystal to vibrate and transmit through a liquid couplant into the metal. Any reflections are displayed as pips on a cathode ray tube (CRT) grid whose horizontal scale represents distance through the metal. The vertical scale represents the strength (or area) of the reflecting surface. The system is shown schematically in Figure 8-3.

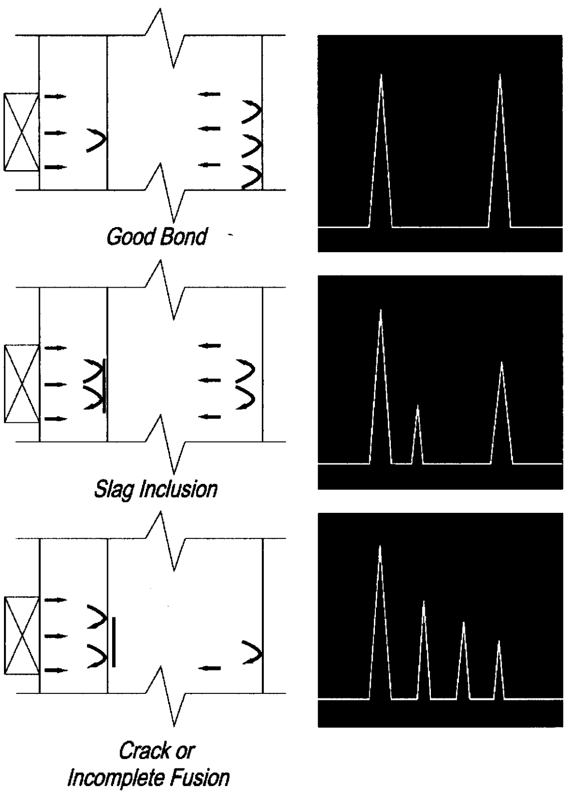


Figure 8–3. Variations in UT reflections caused by defects at the boundary.

The accuracy of ultrasonic inspection is highly dependent upon the skill and training of the operator and frequent calibration of the instrument. There is a "dead" area beneath most transducers that makes it difficult to inspect members less than $^5/_{16}$ in. in thickness. Austenitic stainless steels and extremely coarse-grained steels, e.g., electroslag welds, are difficult to inspect; but on structural carbon and low-alloy steels, the process can detect flat discontinuities (favorably oriented for reflection) smaller than $^1/_{64}$ in. The crystal, which is $^3/_8$ in. to 1 in. in size, can be readily moved about to check many orientations and can project the beam into the metal at angles of 90°, 70°, 60°, and 45°. With the latter three angles, the beam can be bounced around inside the metal, producing echoes from any discontinuity on the way. For more information see Krautkramer (1977) and Institute of Welding (1972).

Ultrasonic testing is a more versatile, rapid, and economical inspection method than radiography, but it does not provide a permanent record like the X-ray negative. The operator, instead, makes a written record of discontinuity indications appearing on his cathode ray tube (CRT). Certain joint geometry limits the use of the ultrasonic method.

Ultrasonic examination has limited applicability in some applications, such as HSS fabrication. Relatively thin sections and variations in joint geometry can lead to difficulties in interpreting the signals, although technicians with specific experience on weldments similar to those to be examined may be able to decipher UT readings in some instances. Similarly, UT is usually not suitable for use with fillet welds and smaller PJP groove welds. CJP groove welds with and without backing bars also give readings that are subject to differing interpretations. Ultrasonic examination may be specified to validate the integrity of CJP groove welds that are subject to tension. Ultrasonic examination has largely replaced radiographic examination for the inspection of critical CJP groove welds.

Radiographic Testing (RT)

Radiographic testing is basically an X-ray film process. To be detected by radiography, a crack must be oriented roughly parallel to the impinging radiation beam, and occupy about $1^1/_2$ percent of the metal thickness along that beam. There are problems with radiographs of fillets, tee, and corner joints, however, because the radiation beam must penetrate varying thicknesses.

Precautions for avoiding radiation hazards interfere with shop work, and equipment and film costs make it the most expensive inspection method. Ultrasonic systems have gradually supplemented and even supplanted radiography.

Radiographic examination has very limited applicability in some applications, such as for HSS fabrication, because of the irregular shape of common joints and the resulting variations in thickness of material as projected onto film. RT can be used successfully for butt splices, but can only provide limited information about the condition of fusion at backing bars near the root corners. The general inability to place either the radiation source or the film inside the HSS means that exposures must usually be taken through both the front and back faces of the section with the film attached to the outside of the back face. Several such shots progressing around the member are needed to examine the complete joint.

PROPER SPECIFICATION OF JOINT TYPE

Selection of Weld Type

The most common weld types are fillet and groove welds. Fillet welds are normally more economical than groove welds and generally should be used in applications for which groove welds are not required. Additionally, fillet welds around the inside of holes or slots require less weld metal than plug or slot welds of the same size, even though the diameters of holes and widths of slots for fillet welds must be larger to accommodate the necessary tilt of the electrode.

Partial joint penetration (PJP) groove welds are more economical than complete joint penetration (CJP) groove welds. When groove welds are required, bevel and V groove welds, which can be flame-cut, are usually more economical than J and U groove welds, which must be air-arc gouged or planed. Also, double-bevel, double-V, double-J, and double-U welds are typically more economical than welds of the same type with single-sided preparation because they use less weld metal, particularly as the thickness of the connection element(s) being welded increases. The symmetry also results in less rotational distortion strain. However, in thinner connection elements, the savings in weld-metal volume may not offset the additional cost of double edge preparation, weld-root cleaning and repositioning. As a general rule of thumb, double-sided joint preparation is normally less expensive than single-sided preparation above 1-in. thickness.

Weld Symbols

For guidance on the proper use of weld symbols, refer to Table 8–2. More extensive information on weld symbols may be found in AWS A2.4 *Standard Symbols for Welding, Brazing, and Nondestructive Examination.*

Available Strength

The available strength of a welded joint is determined in accordance with AISC Specification Section J2.4 and Table J2.5. The calculation of the available strength of a longitudinally loaded fillet weld can be simplified from that given in AISC Specification Table J2.5. For a fillet weld less than or equal to 100 times the weld size in length, the available strength, ϕR_n or R_n/Ω, may be calculated as follows:

$$R_n = 0.6F_{EXX} \times \frac{\sqrt{2}}{2} \times \frac{D}{16} \times l$$

$$\phi = 0.75 \qquad \Omega = 2.00$$

where

l = length, in.

D = weld size in sixteenths of an inch

for F_{EXX} = 70 ksi:

LRFD	ASD
$\phi R_n = 1.392Dl$	$R_n/\Omega = 0.928Dl$

When the fillet weld is not longitudinally loaded, the provisions in AISC Specification Section J2.4a may be used to take advantage of the increased strength due to load angle. The maximum strength increase will be for a transversely loaded fillet weld, which is 50 percent stronger than the same fillet weld longitudinally loaded.

Effect of Load Angle

When designing fillet welds, the increased strength due to loading angle may be accounted for by multiplying the available strength of the weld by the following expression:

$$(1.0 + 0.50\sin^{1.5}\theta)$$

where

θ = Loading angle

For transversely loaded welds, $\theta = 90°$. This accounts for a 50 percent increase in weld strength over a longitudinally loaded weld. However, this increased weld strength is accompanied by a decrease in ductility. For a single line weld, the decreased ductility is inconsequential for most applications. However, for weld groups composed of welds loaded at various angles, this change in ductility means that the designer must consider load-deformation compatibility.

CONCENTRICALLY LOADED WELD GROUPS

The load-deformation curves shown in Figure 8-5 highlight the need for consideration of deformation compatibility, since the transversely loaded weld will fracture before the longitudinally loaded weld obtains its full strength.

A simplified procedure for determining the available strength of concentrically loaded fillet weld groups is presented in Table 8–1. In lieu of using this procedure, it is permitted to sum the capacities of individual weld elements, neglecting load-deformation compatibility, when no increase in strength due to the loading angle is assumed.

ECCENTRICALLY LOADED WELD GROUPS

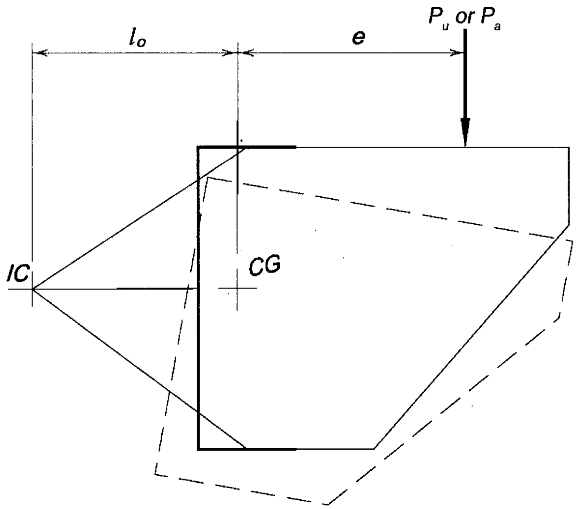
Eccentricity in the Plane of the Faying Surface

Eccentricity in the plane of the faying surface produces additional shear. The welds must be designed to resist the combined effect of the direct shear, P_u or P_a, and the additional shear from the induced moment, $P_u e$ or $P_a e$. Two methods of analysis for this type of eccentricity are the instantaneous center of rotation method and the elastic method.

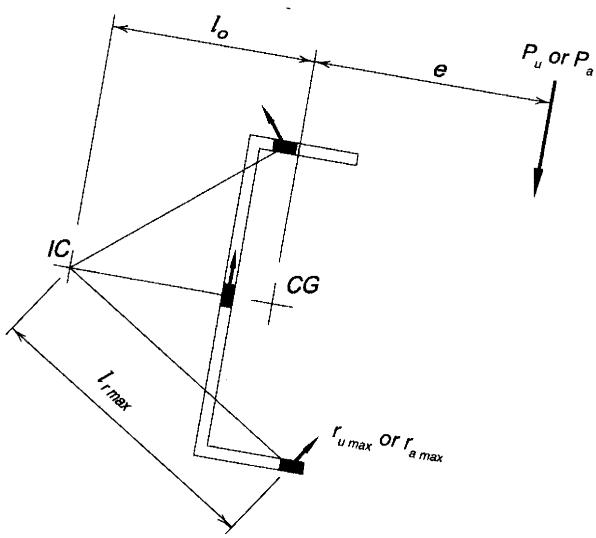
The instantaneous center of rotation method is more accurate, but generally requires the use of tabulated values or an iterative solution. The elastic method is simplified, but may be excessively conservative because it neglects the ductility of the weld group and the potential for load redistribution.

Instantaneous Center of Rotation Method

Eccentricity produces both a rotation and a translation of one connection element with respect to the other. The combined effect of this rotation and translation is equivalent to a rotation about a point defined as the instantaneous center of rotation (IC) as illustrated in Figure 8-4a. The location of the IC depends upon the geometry of the weld group as well as the direction and point of application of the load.



(a) Instantaneous center of rotation (IC)



(b) Forces on weld elements

Figure 8–4. Instantaneous center of rotation method.

The load-deformation relationship for a unit-length segment of the weld, as illustrated in Figure 8-5, is an approximation of the equation presented by Lesik and Kennedy (Lesik and Kennedy, 1990), where

$$P = 0.60F_{EXX}\,(1.0 + 0.50\sin^{1.5}\theta)\,[p\,(1.9 - 0.9p)]^{0.3}$$

where

P = nominal shear strength of the weld segment at a deformation Δ, kips.
F_{EXX} = weld electrode strength, ksi.
θ = load angle measured relative to the weld longitudinal axis, degrees.
p = ratio of element deformation to its deformation at maximum stress.

Unlike the load-deformation relationship for bolts, the strength and deformation of welds are dependent upon the angle θ that the resultant elemental force makes with the axis of the weld element. Load-deformation curves in Figure 8-5 for values of θ = 0°, 15°, 30°, 45°, 60°, 75°, and 90° are shown relative to $P_o = 0.6F_{EXX}$. For further information, see AISC Specification Section J2.4b and its Commentary.

The nominal shear strength of the weld group is governed by Δ_{max} of the weld segment that first reaches its limit, where

$$\Delta_{max} = 1.087w\,(\theta + 6)^{-0.65} \le 0.17w$$

where w is the weld leg size, in.

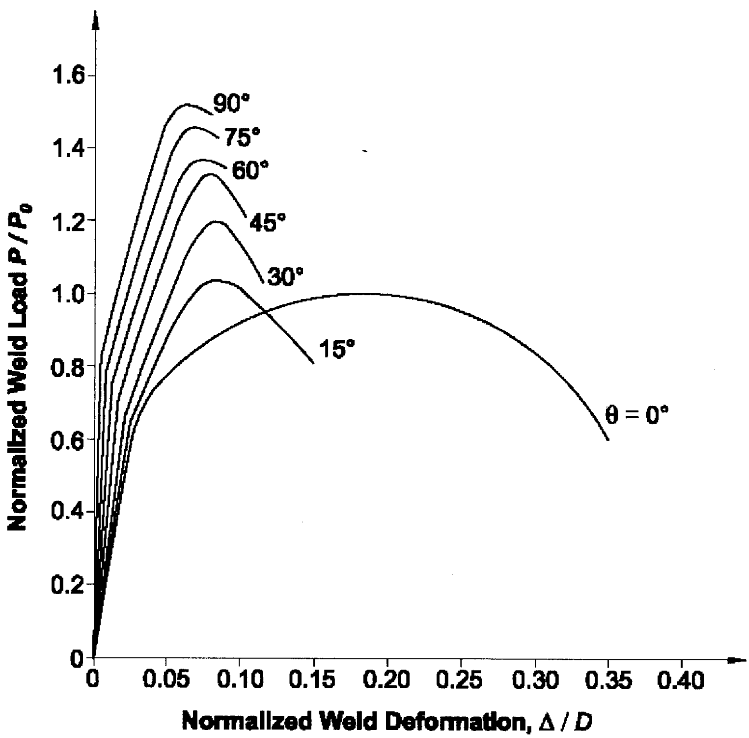


Figure 8–5. Fillet-weld strength as a function of load angle, θ.

The nominal shear strengths of the other unit-length weld segments in the joint can be determined by applying a deformation Δ that varies linearly with distance from the IC. The nominal shear strength of the weld group is, then, the sum of the individual strengths of all weld segments. Because of the non-linear nature of the requisite iterative solution, for sufficient accuracy, a minimum of twenty weld elements for the longest line segment is generally recommended.

The individual resistance of each weld segment is assumed to act on a line perpendicular to a ray passing through the IC and the centroid of that weld segment, as illustrated in Figure 8-4b. If the correct location of the instantaneous center has been selected, the three equations of in-plane static equilibrium ($\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma M = 0$) will be satisfied.

For further information, see Crawford and Kulak (1968) and Butler, Pal, and Kulak (1972).

Elastic Method

For a force applied as illustrated in Figure 8-4, the eccentric force, P_u or P_a, is resolved into a force, P_u or P_a, acting through the center of gravity (CG) of the weld group and a moment, P_ue or P_ae, where e is the eccentricity. Each weld element is then assumed to resist an equal share of the direct shear, P_u or P_a, and a share of the eccentric moment, P_ue or P_ae, proportional to its distance from the CG. The resultant vectorial sum of these forces, r_u or r_a, is the required strength for the weld.

The shear per linear inch of weld due to the concentric force, r_p, is determined as

LRFD	ASD
$r_p = \dfrac{P_u}{l}$	$r_p = \dfrac{P_a}{l}$

where

l is the total length of the weld in the weld group. To determine the resultant shear per linear inch of weld, r_p must be resolved into horizontal component r_{px} and vertical component r_{py}, where

$$r_{px} = r_p \sin\theta \text{ and } r_{py} = r_p \cos\theta$$

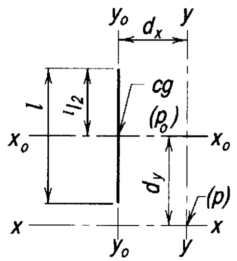
The shear per linear inch of weld due to the moment, P_ue or P_ae, is r_m, where

LRFD	ASD
$r_m = \dfrac{P_u ec}{I_p}$	$r_m = \dfrac{P_a ec}{I_p}$

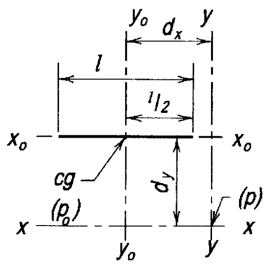
where

c = radial distance from CG to point in weld group most remote from CG, in.

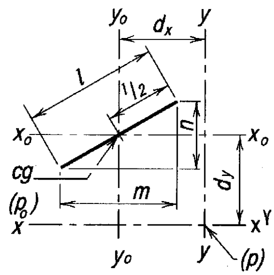
I_p = polar moment of inertia of the weld group, in.^{4} per in.^{2} ($I_p = I_x + I_y$). Refer to Figure 8-6. For section moduli and torsional constants of various welds treated as line elements, refer to Table 5 in Section 7 of Blodgett (1966).



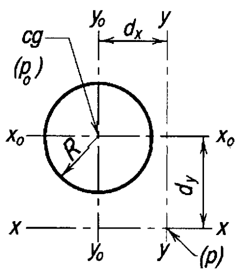
$$I_{xo}=\frac{l^3}{12}$$
$$I_x=\frac{l^3}{12}+l(d_y)^2$$
$$I_{yo}=0$$
$$I_y=l(d_x)^2$$



$$I_{xo}=0$$
$$I_x=l(d_y)^2$$
$$I_{yo}=\frac{l^3}{12}$$
$$I_y=\frac{l^3}{12}+l(d_x)^2$$

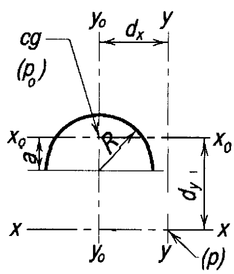


$$I_{xo}=\frac{ln^2}{12}$$
$$I_x=\frac{ln^2}{12}+l(d_y)^2$$
$$I_{yo}=\frac{lm^2}{12}$$
$$I_y=\frac{lm^2}{12}+l(d_x)^2$$



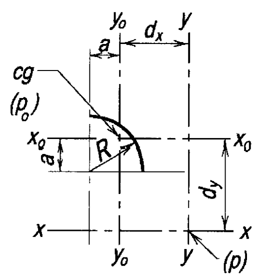
$l = 6.283R$

$$I_{xo}=\pi R^3$$
$$I_x=\pi R^3+l(d_y)^2$$
$$I_{yo}=\pi R^3$$
$$I_y=\pi R^3+l(d_x)^2$$



a = 0.637R
$l = 3.14R$

$$I_{yo}=\frac{\pi}{2}R^3$$
$$I_y=\frac{\pi}{2}R^3+l(d_x)^2$$
$$I_{xo}=\left(\frac{\pi}{2}-\frac{4}{\pi}\right)R^3$$
$$I_x=\left(\frac{\pi}{2}-\frac{4}{\pi}\right)R^3+l(d_y)^2$$



a = 0.637R
$l = 3.14R$

$$I_{xo}=\left(\frac{\pi}{4}-\frac{2}{\pi}\right)R^3$$
$$I_x=\left(\frac{\pi}{4}-\frac{2}{\pi}\right)R^3+l(d_y)^2$$
$$I_{yo}=\left(\frac{\pi}{4}-\frac{2}{\pi}\right)R^3$$
$$I_y=\left(\frac{\pi}{4}-\frac{2}{\pi}\right)R^3+l(d_x)^2$$

Figure 8–6. Moments of inertia of various weld segments.

To determine the resultant force on the most highly stressed weld element, r_m must be resolved into horizontal component r_{mx} and vertical component r_{my}, where

LRFD	ASD
$r_{mx} = \dfrac{P_u ec_y}{I_p}$ and $r_{my} = \dfrac{P_u ec_x}{I_p}$	$r_{mx} = \dfrac{P_a ec_y}{I_p}$ and $r_{my} = \dfrac{P_a ec_x}{I_p}$

In the above equations, c_x and c_y are the horizontal and vertical components of the radial distance c. Thus, the resultant force, r_u or r_a, is determined as

LRFD	ASD
$r_u = \sqrt{\left(r_{px} + r_{mx}\right)^2 + \left(r_{py} + r_{my}\right)^2}$	$r_a = \sqrt{\left(r_{px} + r_{mx}\right)^2 + \left(r_{py} + r_{my}\right)^2}$

which should be compared against the available strength, found in AISC Specification Table J2.5. For further information, see Higgins (1971).

Eccentricity Normal to the Plane of the Faying Surface

Eccentricity normal to the plane of the faying surface produces tension above and compression below the neutral axis, as illustrated in Figure 8-7 for a bracket connection. The eccentric force, P_u or P_a, is resolved into a direct shear, P_u or P_a, acting at the faying surface of the joint and a moment normal to the plane of the faying surface, $P_u e$ or $P_a e$, where e is the eccentricity. Each unit-length segment of weld is then assumed to resist an equal share of the concentric force, P_u or P_a, and the moment is resisted by tension in the welds above the neutral axis and compression below the neutral axis.

In contrast to bolts, where the interaction of shear and tension must be considered, for welds, shear and tension can be combined vectorially into a resultant shear. Thus, the solu-

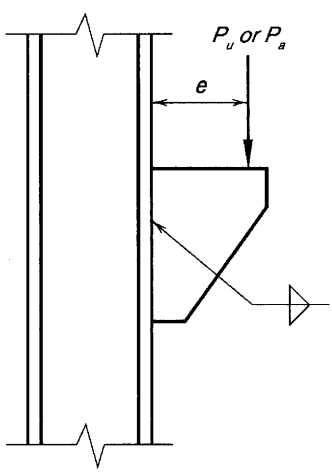


Figure 8–7. Welds subject to eccentricity normal to the plane of the faying surface.

tion of a weld loaded eccentrically normal to the plane of the faying surface is similar to that discussed previously for welds loaded eccentrically in the plane of the faying surface.

OTHER SPECIFICATION REQUIREMENTS AND DESIGN CONSIDERATIONS

The following other specification requirements and design considerations apply to the design of tension members.

Special Requirements for Heavy Shapes and Plates

For complete-joint-penetration groove welded joints in heavy shapes with a flange thickness exceeding 2 in. or built-up sections consisting of plates with a thickness exceeding 2 in., see AISC Specification Sections A3.1c and Section A3.1d.

Placement of Weld Groups

For the required placement of weld groups at the ends of axially loaded members, see AISC Specification Section J1.7.

Welds in Combination with Bolts or Rivets

For welds used in combination with bolts or rivets, see AISC Specification Section J1.8.

Fatigue

For applications involving fatigue, see AISC Specification Appendix 3.

One-Sided Fillet Welds

When lateral deformation is not otherwise prevented, a severe notch can result at locations of one-sided welds. For the fillet-welded joint illustrated in Figure 8-8, the unwelded side has no strength in tension and a notch may form from the unwelded side. Using one fillet weld on each side will eliminate this condition. This is also true with partial-joint penetration groove welds.

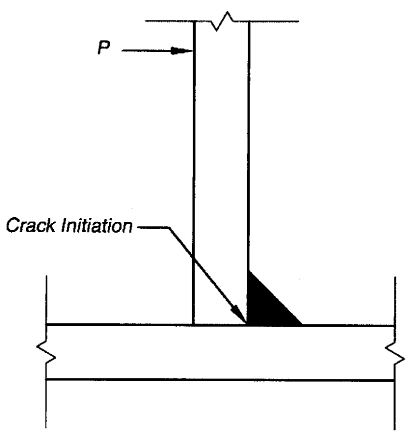


Figure 8–8. Notch effect at one-sided weld.

Welding Considerations and Appurtenances

Clearance Requirements

Clearances are required to allow the welder to make proper welds. Ample room must be provided so that the welder or welding operator may manipulate the electrode and observe the weld as it is being deposited.

In the SMAW process, the preferred position of the electrode when welding in the horizontal position is in a plane forming 30° with the vertical side of the fillet weld being made. However, this angle, shown as angle x in Figure 8-9, may be varied somewhat to avoid contact with some projecting part of the work. A simple rule to provide adequate clearance for the electrode in horizontal fillet welding is that the clear distance to a projecting element should be at least one-half its height (y); distance ($y/2$) in Figure 8-10b.

A special case of minimum clearance for welding with a straight electrode is illustrated in Figure 8-10. The 20° angle is the minimum that will allow satisfactory welding along the bottom of the angle and therefore governs the setback with respect to the end of the beam. If a $^1/_2$-in. setback and $^3/_8$-in. electrode diameter were used, the clearance between the angle and the beam flange could be no less than $1^1/_4$ in. for an angle with a leg dimension w of 3 in., nor less than $1^5/_8$ in. with a w of 4 in. When it is not possible to provide this clearance, the end of the angle may be cut as noted by the optional cut in Figure 8-11 to allow the necessary angle. However, this secondary cut will increase the cost of fabricating the connection.

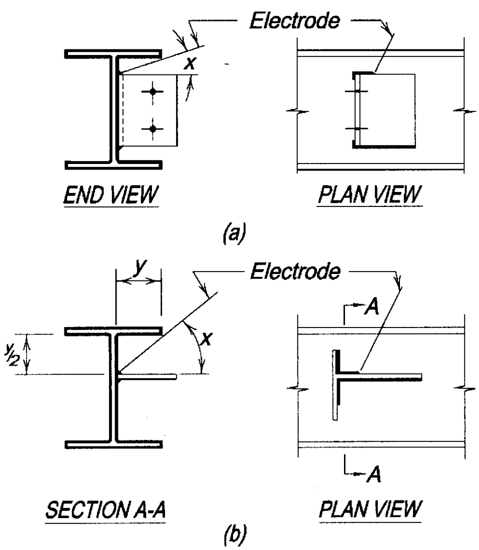


Figure 8–9. Clearances for SMAW welding.

Excessive Welding

The specification of over- or excessive welding will increase the amount of heat input into the parts joined and thereby add to distortion in the joint. Distortion of the joint is caused by three fundamental dimensional changes that occur during and after welding:

1. transverse shrinkage that occurs perpendicular to the weld line,
2. longitudinal shrinkage that occurs parallel to the weld line, and
3. angular change that consists of rotation around the weld line.

If these dimensional changes alter the joint so that it is no longer within fabrication tolerances, the joint may need to be repaired with additional heating to bring the joint back to within fabrication tolerances. This added work will result in expensive repair costs which could have been avoided with appropriately sized welds.

Over-specification of weld size also increases the cost of welding for no structural benefit.

Minimum Shelf Dimensions for Fillet Welds

The recommended minimum shelf dimensions for normal size SMAW fillet welds are summarized in Figure 8-11. SAW fillet welds would require a greater shelf dimension to contain the flux, although auxiliary material can be clamped to the member to provide for this. The dimension *b* illustrated in Figure 8-12 must be sufficient to accommodate the combined dimensional variations of the angle length, cope depth, beam depth, and weld size.

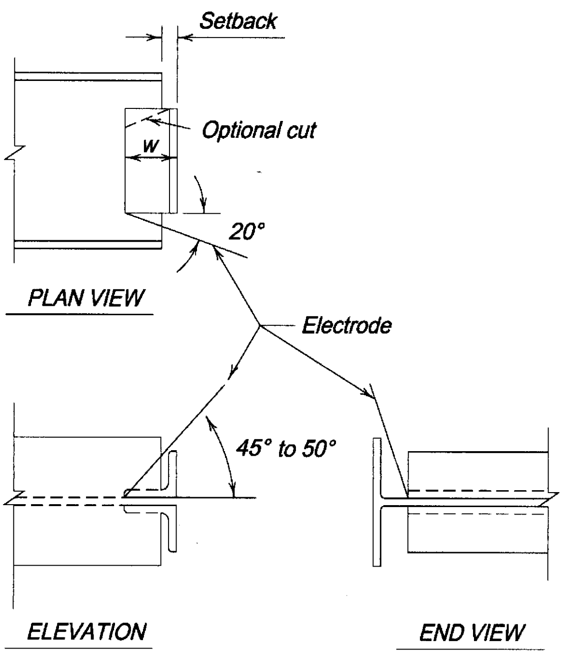


Figure 8–10. Clearances for SMAW welding.

Beam Copes and Weld Access Holes

Requirements for beam copes and weld access holes are given in AISC Specification Section J1.6. Weld access holes, as illustrated in Figure 8-14, are used to permit down-hand welding to the beam bottom flange, as well as the placement of a continuous backing bar under the beam top flange. Weld access holes also help to mitigate the effects of weld shrinkage strains and prevent the intersection or close juncture of welds in orthogonal directions. Weld access holes should not be filled with weld metal because doing so may result in a state of triaxial stress under loading.

Corner Clips

Corners of stiffeners and similar elements that fit into a corner should be clipped generously to avoid the lack of fusion that would likely result in that corner. In general, a 3/4-in. clip will be adequate, although this dimension can be adjusted to suit conditions, such as when the fillet radius is larger or smaller than that for which a 3/4-in. clip is appropriate. For further information, see Butler, Pal, and Kulak (1972) and Blodgett (1980).

Backing Bars

Backing bars, illustrated in Figure 8-13, should be of approved weldable material as specified in AWS D1.1 Section 5.2.2.2. Per AWS D1.1, backing bars on groove-welded joints

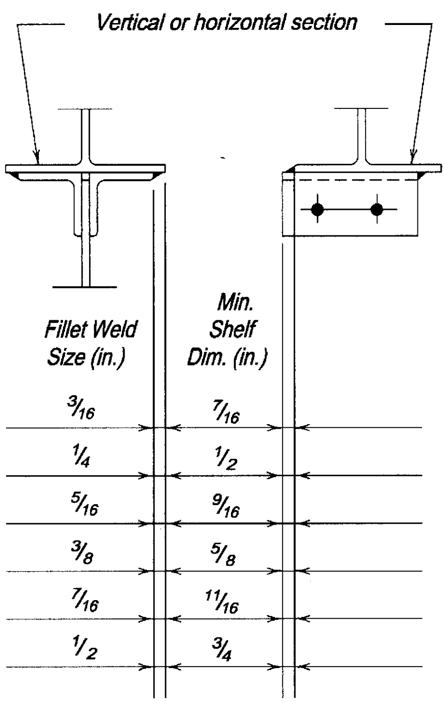


Figure 8–11. Recommended minimum shelf dimensions for SMAW fillet welds.

must be continuous or fully spliced to avoid stress concentrations or discontinuities and should be thoroughly fused with the weld metal. Backing bar removal is addressed in AISC Specification Section J2.6 and AWS D1.1.

Spacer Bars

Spacer bars, illustrated in Figure 8-13, must be of the same material specification as the base metal, per AWS D1.1 Section 5.2.2.3. This can create a procurement problem, since small tonnage requirements may make them difficult to obtain in the specified ASTM designation.

Weld Tabs

To obtain a fully welded cross section, the termination at either end of the joint must be of sound weld metal. Weld tabs, illustrated in Figure 8-13, should be of approved weldable material as specified in AWS D1.1 Section 5.2.2.1. Various configurations of weld tabs are illustrated in Figure 8-14, including flat-type weld tabs, which are normally used with bevel and V groove welds, and contour-type weld tabs, which are normally used with J and U groove welds. Weld-tab removal is addressed in AWS D1.1. Frequently, the backing bar can be extended to serve as the weld tab.

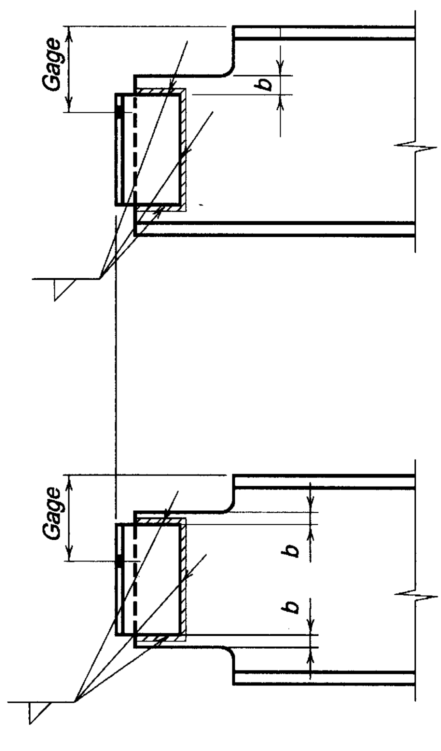


Figure 8–12. Illustration of shelf dimensions for fillet welding.

Tack Welds

Tack welds placed as shown in Figure 8-15a should be avoided as they may cause notches. An improved detail is as shown in Figure 8-15b, with the tack welds placed where they will be consumed in the final welded joint.

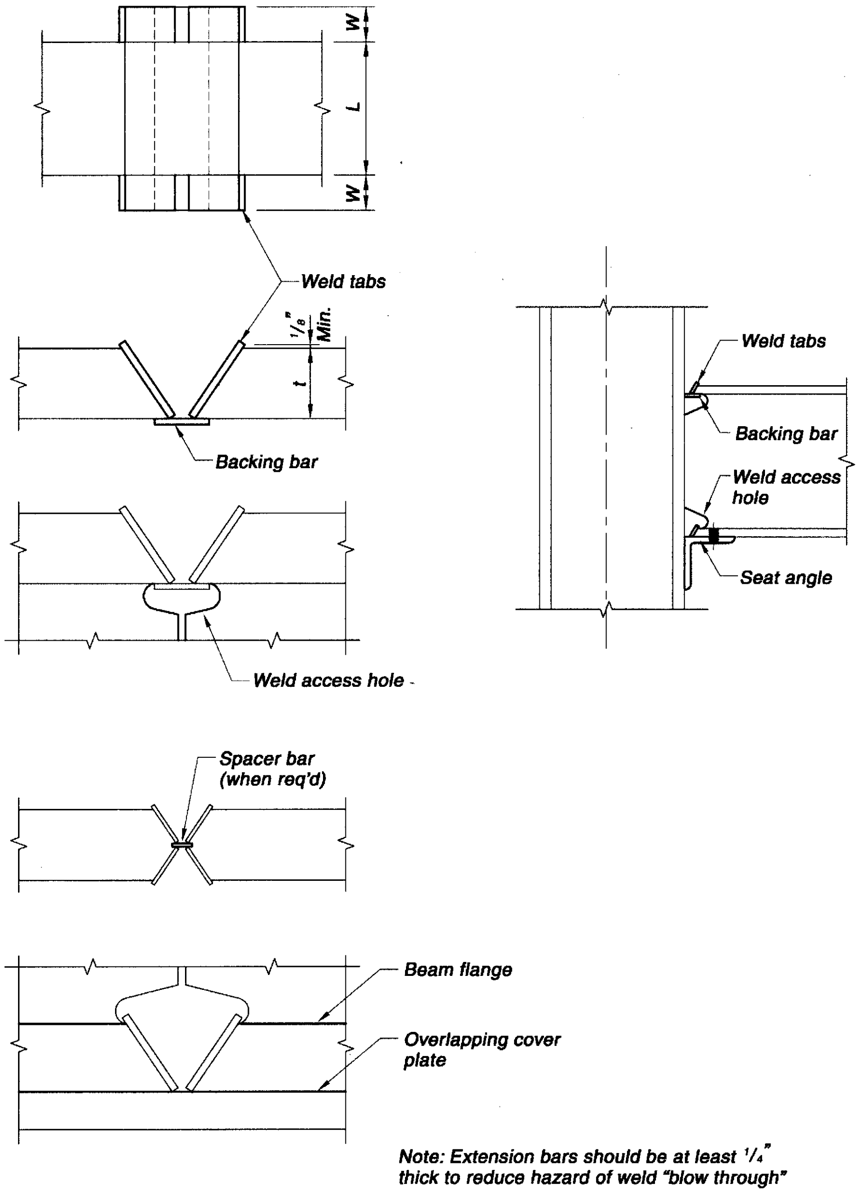


Figure 8–13. Illustration of backing bars, spacer bars, weld tabs, and other fittings for welding.

Lamellar Tearing

Figures 8-16 and 8-17 illustrate preferred welded joint selection and connection configurations for avoiding susceptibility to lamellar tearing. Refer to the discussion "Avoiding Lamellar Tearing" in Part 2.

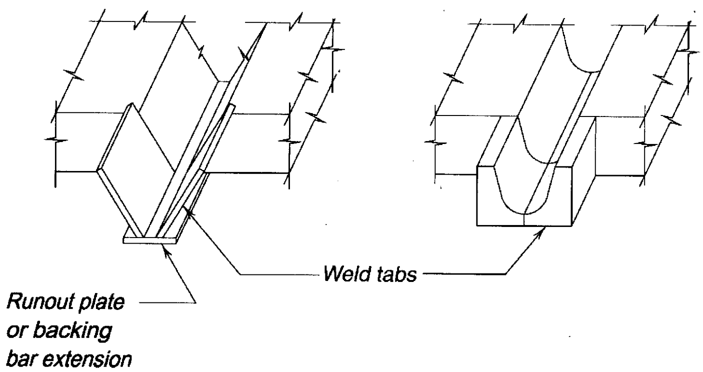


Figure 8–14. Illustration of weld tabs.

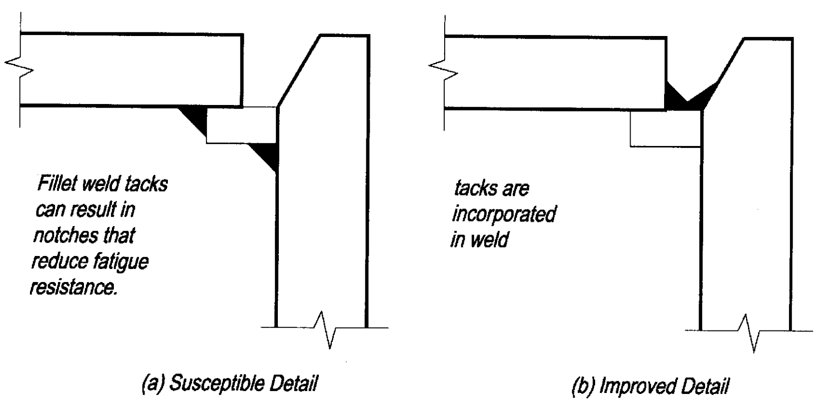


Figure 8–15. Backing bar tack welding.

Prior Qualification of Welding Procedures

Evidence of prior qualification of welding procedures, welders, welding operators, or tackers may be accepted at the discretion of the owner's designated representative for design, resulting in significant cost savings. Fabricators that participate in the AISC Quality Certification Program have the experience and documentation necessary to assure that such prior qualifications could be accepted. For more information about the AISC Quality Certification Program, visit www.aisc.org.

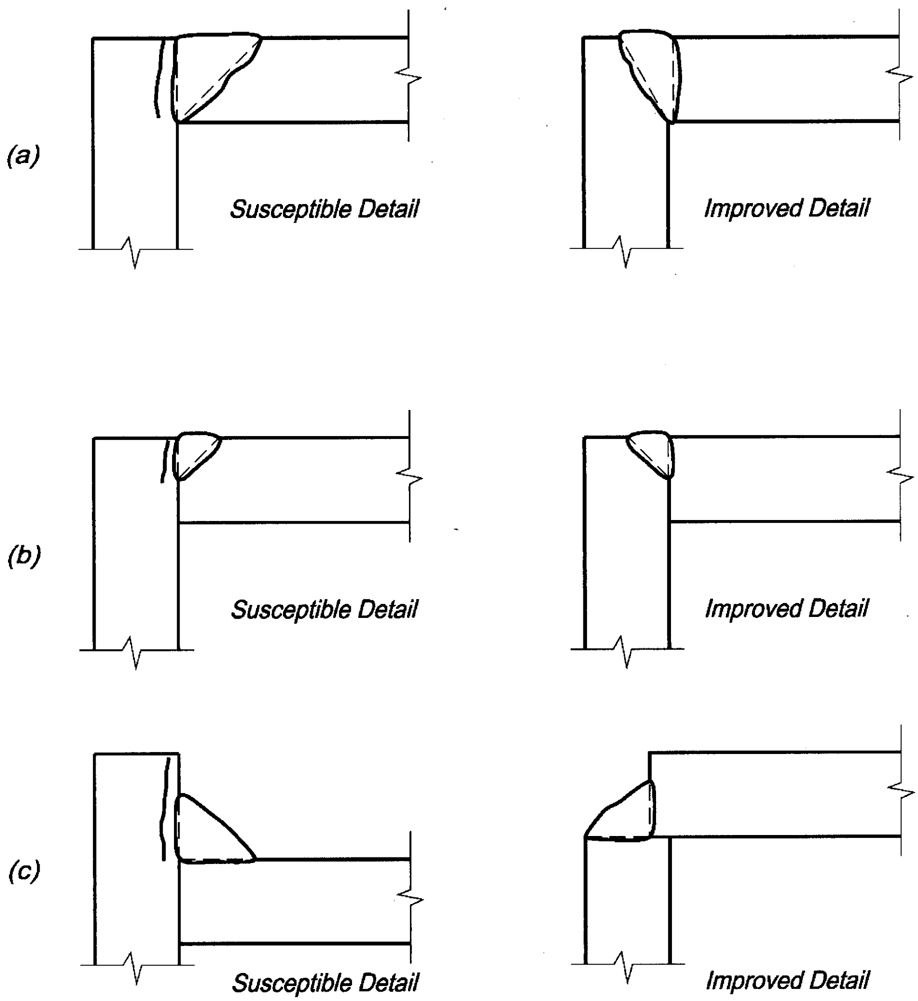


Figure 8–16. Susceptible and improved details to reduce the incidence of lamellar tearing.

Painting Welded Connections

Paint is normally omitted in areas to be field-welded, per AISC Specification Section M3.5. Note that this requirement does not generally apply to shop-assembled connections, because painting is normally done after the welds are made. When required, the small paint-free areas can generally be identified with a general note (e.g., "no paint on OSL of connection angles," where OSL stands for outstanding leg).

WELDING CONSIDERATIONS FOR HSS

Flare welds are more common in HSS because of the increasing likelihood that the HSS corner is a part of the welded joint. A common flare bevel configuration which occurs when equal width sections are joined is illustrated in Figure 8-18. The easiest arrangement for welding occurs with equal wall thickness sections. However, when the corner radius

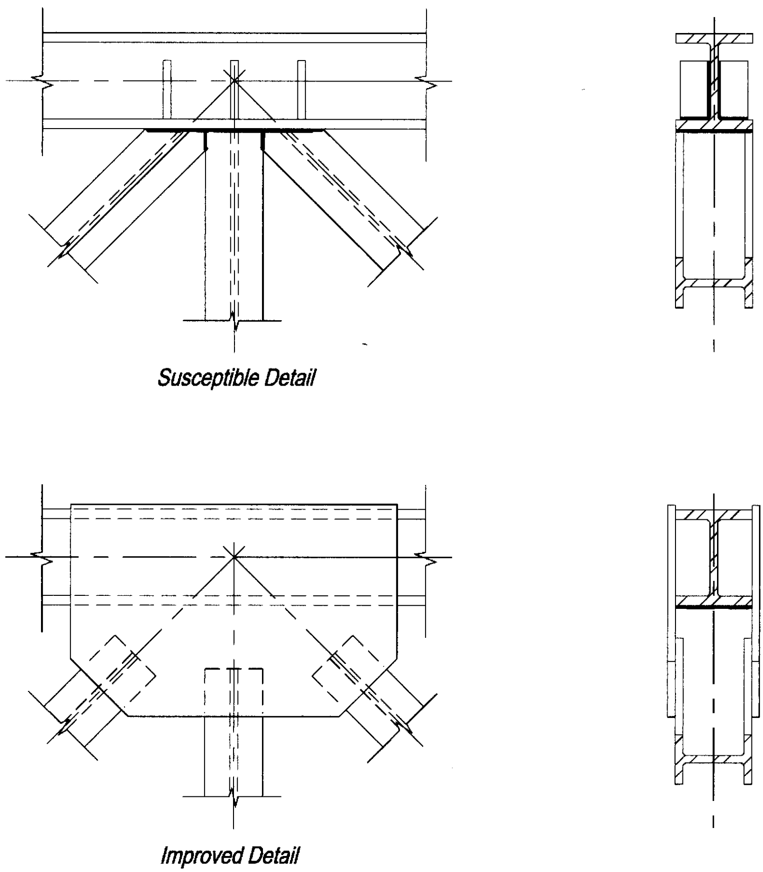


Figure 8–17. Susceptible and improved details to avoid intersecting welds with high restraint.

increases due to wall thickness or manufacturing tolerances, the root gap may need to be adjusted by profile shaping, building out with weld metal, or by use of backing. See Figures 8-18 and 8-19.

HSS Welding Requirements in AWS D1.1

AWS uses the terminology "tubular" for all hollow members including pipe, hollow structural sections, and fabricated box sections. The following sections in AWS D1.1 2004 apply to welded HSS to HSS connections:

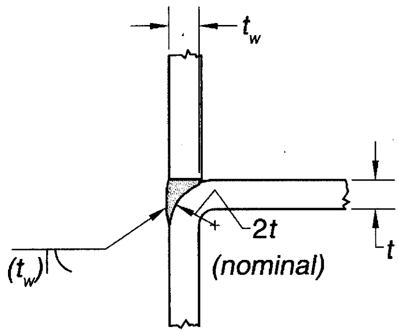


Figure. 8–18. Flare bevel weld, equal width HSS weld joint.

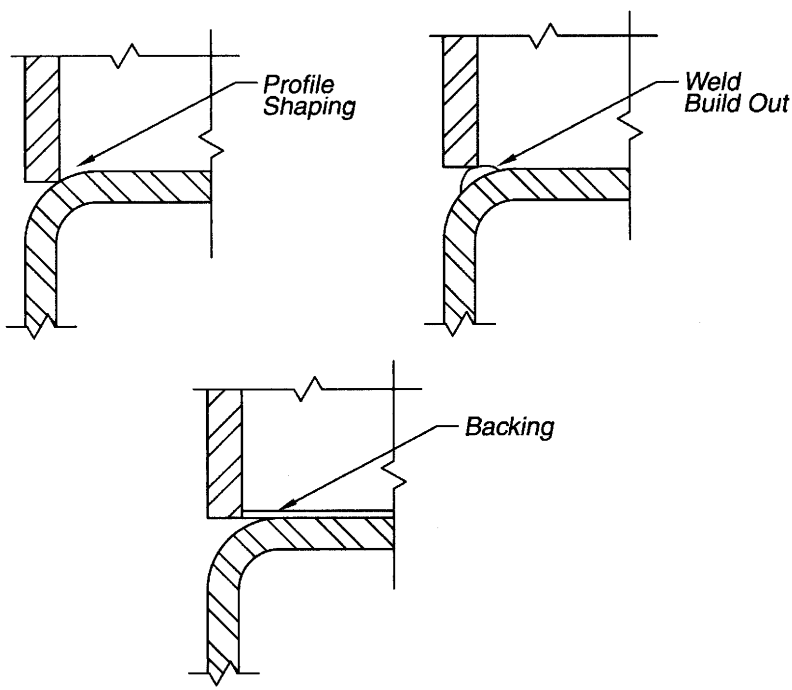


Figure 8–19. Welding methods accounting for the HSS corner radius.

Section 2, Part D

As explained in AWS D1.1 Commentary Section C2.20, "In commonly used types of tubular connections, the weld itself may not be the factor limiting the strength of the joint. Such limitations as local failure (punching shear), general collapse of the main member, and lamellar tearing are discussed because they are not adequately covered in other codes." Because of these various failure modes, the design of HSS-to-HSS connections must be part of the member sizing process. The members selected must be capable of transmitting the required strength or adequate reinforcement must be shown on the design documents.

Differences in the relative stiffness across HSS walls loaded normal to their surface can make the load transfer highly non-uniform. To prevent progressive failure and to ensure ductile behavior of the joint, minimum welds must be provided in T-, Y-, and K-connections to transmit the factored load in the branch or web member. For normal building applications, fillet welds and partial joint penetration welds (PJP) can be used.

While Part D deals primarily with HSS-to-HSS connections, some of these provisions are applicable to welded attachments that deliver a load normal to the wall of a tubular member.

Section 3

AWS Fig. 3.2 shows prequalified fillet weld details for tubular joints that differ from details for non-tubular skewed T-joints. These details will provide minimum weld strength needed to ensure ductile joint behavior.

AWS Fig. 3.3 (10) shows the joint detail and the effective throat for a flare bevel PJP groove weld that is commonly used for welding connection material to the face of an HSS. Groove weld joint details for HSS are designed to accommodate both the geometry of the section and the lack of access to the back side of the joint.

Table 8–2 (AWS Fig. 3.5) shows various PJP groove welded HSS joint details and AWS Figs. 3.6, 3.8, 3.9, and 3.10 show CJP groove welded HSS joint details. The joint preparation and weld sizing are complex and critical to obtain a sound weld. These details also provide the weld strength needed to ensure ductile joint behavior.

Section 4

Qualification covers the requirements for qualification testing of Welding Procedure Specifications (WPS, see p. 8-3) and performance testing of the welder's ability to produce sound welds. HSS connections may not always meet the requirements for a prequalified WPS because of unique geometry, connection access, or for other reasons. This section also gives the requirements for a Procedure Qualification Record (PQR), which is the basis for qualifying a WPS.

The performance testing of welders and welding operators considers process, material thickness, position, non-tubular, or tubular joint access. AWS Tables 4.9 and 4.10 list the required qualifications needed for each type of joint. Most welders are qualified for a particular process and position-in-plate (non-tubular) joints. These qualifications will allow the welder to make similar fillet, PJP groove, and backed CJP welds in tubular members. However, certain types of tubular connections, such as unbacked T-, Y-, and K-connections, require special welder certifications because the lack of access to the back of the joint, the position of the connection, and the access to the connection require special skill to produce a sound connection.

Section 5

Fabrication covers the requirements for the preparation, assembly, and workmanship of welded steel structures. AWS Table 5.5 Tubular Root Opening Tolerances gives the acceptable fitup for unbacked groove welds. AWS Table 5.8 Minimum Fillet Weld Size and Section 2.24.1.3 give the minimum weld pass size based on material thickness and process.

Section 6

Inspection contains all of the requirements for the inspector's qualifications and responsibilities, acceptance criteria for discontinuities, and procedures for non-destructive examination (NDE). AWS D1.1 considers fabrication/erection inspection and testing a separate function from verification inspection and testing. Fabrication/erection inspection and testing is usually the responsibility of the contractor and is performed as appropriate prior to assembly, during assembly, during welding, and after welding to ensure the requirements of the contract documents are met. Verification inspection and testing are the prerogatives of the owner. The extent of NDE and verification inspection must be specified in the contract documents.

If non-destructive testing other than visual is not specified in the contract documents, but is subsequently requested, the owner is responsible, per AWS D1.1, for all costs associated with this testing including handling, surface preparation, and repairs (if required).

The inspection covers WPS qualification, equipment, welder qualification, joint preparation, joint fitup, welding techniques, and weld size length and location. It is especially important when inspecting HSS-to-HSS joints that joint preparation and fitup be checked prior to welding.

In addition to inspecting the above items, AWS requires all welds to be visually inspected for conformance to the standards in AWS Table 6.1 Visual Acceptance Criteria.

Four types of non-destructive testing can be used to supplement visual inspection. They are penetrant testing (PT), magnetic particle testing (MT), radiographic testing (RT), and ultrasonic testing (UT).

The AWS UT acceptance criteria for non-HSS type groove welds starts at $^5/_{16}$-in. thick material. The procedures for HSS T-, Y-, and K- connections have a minimum applicable thickness of $^1/_2$ in, and diameter of $12^3/_4$ in. AWS does, however, make provision for qualifying UT procedures for smaller size applications. It is possible to UT portions of butt-type splices with backing bars using the non-HSS criteria, however, the corners of rectangular HSS cannot be inspected.

AWS D1.1 does make provision for using alternate acceptance criteria based upon an evaluation of suitability for service using past experience, experimental evidence, or engineering analysis. This can be especially important when deciding if and how to make any repairs.

Weld Sizing for Uneven Distribution of Loads

The connection strength for a member welded normal to a HSS wall is a function of the geometric parameters of the connected members and is often less than the full strength of the member. When limited by geometry, the available strength cannot be increased by increasing the weld strength. Due to the varying relative flexibility of the HSS wall loaded normal to its surface and the axial stiffness of the connected member, the transfer of load along the weld line is highly non-uniform. To prevent progressive failure, or "unzipping" of the weld, it is important to provide adequate welds to maintain ductile behavior of the joint.

Welds that satisfy this ductility requirement can be proportioned for the required strength using an effective width criteria similar to that used for checking the axial strength of the branch member or plate. For effective weld length of HSS-to-HSS connections, refer to AISC Specification Sections K2-2 and K2-3.

An alternative to the effective length procedure is the use of the prequalified fillet and PJP groove weld details in AWS D1.1 that are sized to ensure ductile behavior. In addition, fillet welds with an effective throat of 1.1 times the thickness of the branch member can be used. Either of these two alternatives will, in most cases, be conservative.

Detailing Considerations

1. Butt joints will require a groove weld detail. Where possible the joint should be a pre qualified PJP groove weld sized for actual load or a CJP groove weld with steel backing.
2. T-, Y-, and K-connections should, where possible, use either fillet welds or PJP groove welds sized for the design forces and checked for the minimum size needed to ensure duc tile joint behavior. Where CJP welds are required, joint details using steel backing should be used whenever possible. For a detailed discussion of various types of backing and the advantages of using backing, see J.W. Post (1990).

DESIGN TABLES

Table 8–1. Coefficients, *C*, for Concentrically Loaded Weld Group Elements

Concentrically loaded fillet weld groups must consider the effect of loading angle and deformation compatibility on weld strength.

By multiplying the appropriate values of *C* from Table 8–1 by the available strength of each weld element, an effective strength is determined for each weld element. The available strength of the weld group can be determined by summing the effective strengths of all of the elements in a weld group. It should be noted that this table is to be entered at the largest load angle on any weld in the weld group. For the weld group shown in Figure 8-20, this is calculated as:

LRFD	ASD
$\phi R_w = (D)(1.392)\left[1.5(1)+1.29(1.41)+0.825(1)\right]$ $= 5.77D$	$R_w/\Omega = (D)(0.928)\left[1.5(1)+1.29(1.41)+0.825(1)\right]$ $= 3.85D$

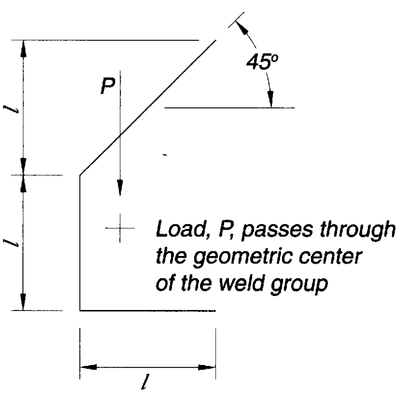


Figure 8–20. Concentrically loaded weld group.

Table 8–2. Prequalified Welded Joints

The prequalified welded joints details given in AWS D1.1 and Table 8–2 provide joint geometries, such as root openings, angles, and clearances (see Figures 8-21 and 8-22) that will permit the deposition of sound weld material. Prequalified welded joints are not, in themselves, adequate consideration of welded design details and the other provisions in AWS D1.1 must be satisfied as they are referenced in AISC Specification Section J2.2. The design and detailing for successful welded construction requires consideration of factors which include, but are not limited to, the magnitude, type, and distribution of forces to be transmitted, access, restraint against weld shrinkage, thickness of connected materials, residual stress, and distortion.

The designations such as B-L1a, B-U2, and B-P3 are those used in AWS D1.1. Note that lowercase letters (e.g., a, b, c, etc.) are often used to differentiate between joints that would otherwise have the same joint designation. These prequalified welded joints are limited to those made by the SMAW, SAW, GMAW (except short circuit transfer), and FCAW procedures. Small deviations from dimensions, angles of grooves, and variation in depth of groove joints are permissible within the tolerances given.

In general, all fillet welds are prequalified, provided they conform to the requirements in AWS D1.1. Groove welds are classified using the conventions indicated in the tables. Welded joints other than those prequalified by AWS may be qualified, provided they are tested and qualified in accordance with AWS D1.1.

Table 8–3. Electrode Strength Coefficient C_1

Electrode strength coefficients, C_1, which can be used to adjust the tabulated values of Tables 8-4 through 8-11 for electrodes other than E70XX, are given in Table 8–3. Note that this coefficient includes an additional reduction factor of 0.90 for E80 and E90 electrodes and 0.85 for E100 and E110; this accounts for the uncertainty of extrapolation to these higher-strength electrodes.

Tables 8–4 through 8–11. Coefficients *C* for Eccentrically Loaded Weld Groups

Tables 8-4 through 8-11 employ the instantaneous center of rotation method in accordance with AISC Specification Section J2.4 for the weld patterns and eccentric conditions indicated and inclined loads at 0°, 15°, 30°, 45°, 60°, and 75°. The tabulated non-dimensional coefficient, C, represents the effective strength of the weld group in resisting the eccentric shear force.

When Analyzing a Known Weld Group Geometry

For any of the weld group geometries shown, the available strength, ϕR_n or R_n/Ω, of the eccentrically loaded weld group is determined by

$$R_n = CC_1Dl$$

$$\phi = 0.75 \qquad \Omega = 2.00$$

where

C = tabular value

C_1 = electrode coefficient from Table 8–3

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

l = length of the reference weld, in.

In developing these tables, the instantaneous center of rotation method was used, with a convergence criterion of less than 1/2 percent and considering deformation compatibility of adjacent weld elements. The first row in each table (a = 0) gives the available strength of a concentrically loaded weld group in accordance with AISC Specification Section J2.4. Linear interpolation within a given table between adjacent a and k values is permitted.

Straight-line interpolation between values for loads at different angles may be significantly unconservative. Either a direct analysis should be performed or the values for the next lower angle increment in the tables should be used for design. For weld group patterns not treated in these tables, a direct analysis is required if the instantaneous center of rotation method is to be used.

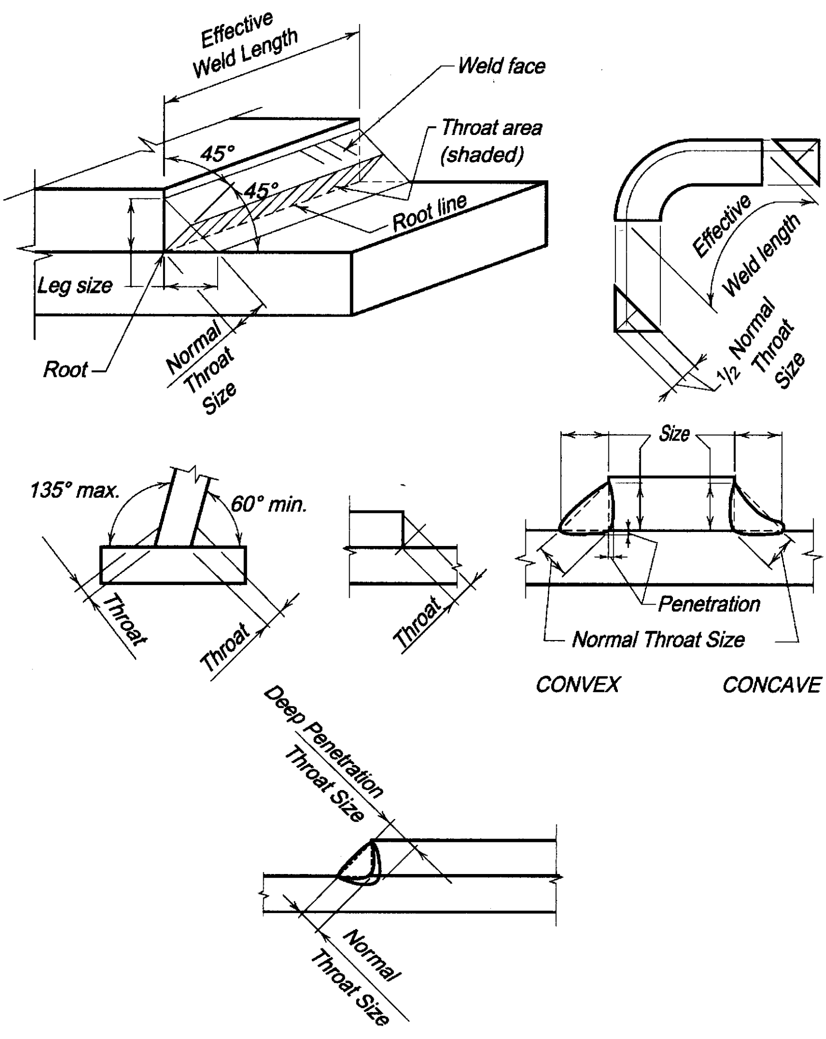


Figure 8–21. Fillet weld nomenclature.

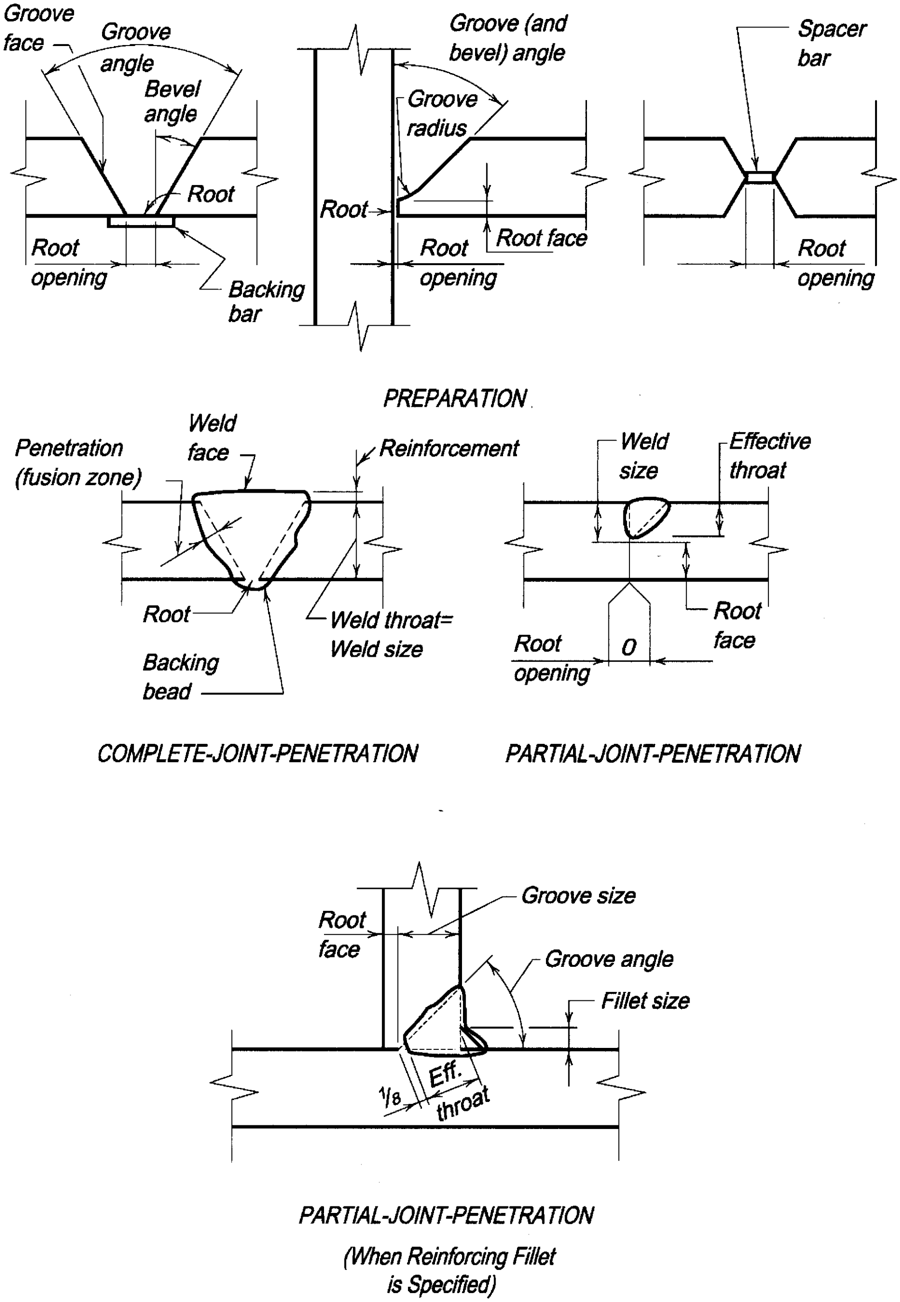


Figure 8–22. Groove weld nomenclature.

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Table 8–1
Coefficients, *C*, for Concentrically Loaded Weld Group Elements

Load angle on weld element, degrees	Largest load angle on and weld group element, degrees						
	90	75	60	45	30	15	0
0	0.825	0.849	0.876	0.909	0.948	0.994	1.00
15	1.02	1.04	1.05	1.07	1.06	0.883	
30	1.16	1.17	1.18	1.17	1.10		
45	1.29	1.30	1.29	1.26			
60	1.40	1.40	1.39				
75	1.48	1.47					
90	1.50						