manualwise

MAKING THE MOST OF THE *MANUAL*

A bevy of resources will help optimize your use of the latest AISC *Manual*, thus helping you optimize your steel-framed projects.

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IN CASE YOU HAVEN'T HEARD, the 15th Edition of the AISC *Steel Construction Manual* is here!

Accompanying its release are some useful, free resources that are at available at **www.aisc.org/manualresources**. These include the new Version 15.0 *Design Examples*, Shapes Database and Historical Shapes Database, Basic Design Values Cards and Interactive Reference list. These resources will help you make the most of the new 15th Edition *Manual* as well as the new 2016 AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360, available at **www.aisc.org/specifications**).

Design Examples

The AISC *Design Examples* publication (**www.aisc.org/designexamples**) is a companion resource to the AISC *Manual* that contains more than 1,600 pages of design examples and tables. Version 15.0 has been completely updated to illustrate the provisions of the 2016 AISC *Specification* and 15th Edition *Manual* for designing members, connections and structural systems. Several new examples and design tables have been added to this new version.

One of the new examples, geared toward plate girders, demonstrates how to apply the provisions of *Specification* Chapter F to the design of a built-up type flexural member. This example also covers the procedure for designing both continuous and intermittent welds between flanges and the web of a built-up section.

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In the 2016 *Specification* are new provisions to satisfy structural integrity requirements when they're required by the building code. There are five new design examples that demonstrate how to apply these provisions for some of the most commonly used shear connections, including: bolted double-angle connections, end-plate shear connections, unstiffened seated connections, single-plate connections and bolted single-angle connections.

The 15th Edition *Manual* includes several new high-strength materials, such as ASTM A913 Grades 65 and 70 W-shapes and ASTM A500 Grade C HSS shapes. In addition to covering these high-strength materials, *Design Examples* also includes ASTM A1085 HSS, which has recently been adopted into the 2016 *Specification*.

If you've already perused the 15th Edition *Manual*, you may have noticed that a few tables from the 14th Edition are missing. These tables are not gone for good but rather have been relocated to the Version 15.0 *Design Examples*. The Combined Flexure and Axial Force Table, previously found in Part 6 of the *Manual*, and the Available Strength in Compression for Filled HSS Members Tables, previously found in Part 4 of the *Manual*, can now be found in Part IV of *Design Examples*. A couple of things to note are that the material grade used for the composite tables has been updated to ASTM A500 Grade C, and additional tables are now provided for ASTM A1085.

The 15th Edition *Manual* also includes a new "Super Table" (Table 6-2; see page 18) that is essentially a one-stop member design aid that can be used to determine available compression, flexural and shear strength for W-shapes (for more on this table, see the July 2017 SteelWise, "One-Stop Shop," available at **www.modernsteel.com**). *Design Examples* further expands on this concept with several additional "super" tables for W-shapes in both ASTM A913 Grades 65 and 70 and rectangular, square and round HSS shapes in both ASTM A500 Grade C and ASTM A1085.

Another handy design aid found in *Design Examples* is a new Plastic Section Modulus, or "Z_{net}", table for W-shapes. This table is a useful companion to the "S_{net}" table, already included in the *Manual*, for checking the strength of coped W-shape beams.

1 Basic Design Values

This reference is based upon simplifying assumptions and arbitrarily selected limitations. Direct use of the 2016 AISC *Specification* (ANSI/AISC 360-16) may be less constrained and less conservative.

W-, S-, C- and MC Shapes

W-Shapes	ASTM A992	F_y = 50 ksi	F_u = 65 ksi
S-, C- and MC-Shapes	ASTM A36	F_y = 36 ksi	F_u = 58 ksi

Condition			ASD	LRFD	Related Info
Tension			$0.6F_yA_g \le 0.5F_uA_e$	$0.9F_yA_g \le 0.75F_uA_e$	For A_e, see AISC *Specification* Equation D3-1.
Bending	Strong Axis	$L_b \le L_p$	$0.66F_yS_x$	$0.99F_yS_x$	$L_p = \frac{300r_y}{\sqrt{F_y}}$ See Note 1.1. L_r and strength when $L_b > L_r$ are given in the AISC *Manual*.
		$L_p < L_b \le L_r$	Use linear interpolation between L_p and L_r.		
		$L_b = L_r$	$0.42F_yS_x$	$0.63F_yS_x$	
	Weak Axis		$0.9F_yS_y$	$1.35F_yS_y$	
Shear (in strong axis)			$0.4F_yA_w$	$0.6F_yA_w$	See Note 1.2.
Compression	$L_c/r \le 800/\sqrt{F_y}$		$0.6F_yA_g(0.658)^P$	$0.9F_yA_g(0.658)^P$	$P = \frac{F_y(L_c/r)^2}{286{,}000}$ See Note 1.3.
	$L_c/r > 800/\sqrt{F_y}$		$\frac{150{,}000A_g}{(L_c/r)^2}$	$\frac{226{,}000A_g}{(L_c/r)^2}$	

Notes

1.1 Multiply equations given for strong axis with $L_b \le L_p$, or weak axis, by values in parentheses for W21×48 (0.99), W14×90 (0.97), W12×65 (0.98), W10×12 (0.99), W8×10 (0.99), W6×15 (0.95) and W6×8.5 (0.98).

1.2 Multiply equations given by 0.9 for W44×230, W40×149, W36×135, W33×118, W30×90, W24×55, W16×26 and W12×14 and all C- and MC-shapes. In weak axis, equations can be adapted by using $A_w = 1.8b_ft_f$.

1.3 Not applicable to slender shapes. For slender shapes, use A_e from AISC *Specification* Section E7 in place of A_g. For C- and MC- shapes, see AISC *Specification* Section E4.

▲ Card 1 of the Basic Design Values resource.

One of the significant changes in the 2016 *Specification* involves the provisions for compression members with slender elements. The new provisions not only have a significant impact on the compressive strength for members, but also make the design process easier by providing a unified approach for both stiffened and unstiffened elements. In Chapter E of the new *Design Examples*, there are several updated examples that demonstrate how to apply these new provisions for a variety of shape types.

Shapes Databases

As with previous editions of the AISC Shapes Database, the updated Version 15.0 (available at **www.aisc.org/shapesdatabase**) compiles the dimensions and properties of all shapes found in Part 1 of the 15th Edition *Manual* into a single Microsoft Excel spreadsheet that includes both U.S. customary and SI units. Using the electronic database makes design and analysis calculations on a computer much more efficient by eliminating the need to manually enter values provided in the *Manual* Part 1 Tables.

The latest Shapes Database has some new features that will make it worth your while to use in place of previous versions. For starters, it includes the dimensions and properties for all 96 of the new shapes that have been added to the latest *Manual*. Several new dimensions have been added to the database, including all the "*T*" and "Workable Gage" values that are printed in the *Manual*. The updated database also provides some additional properties that are not found in the *Manual*, including properties for single angles and shape parameters for use with AISC Design Guide 19: *Fire Resistance of Structural Steel Framing* (available at **www.aisc.org/dg**). In addition to these new features, the database now also includes a built-in "Readme" file, which serves as the glossary for all the variables included in the database and provides a complete list of all the new shapes.

AISC has also updated the Historical Shapes Database with the new version V15.0H (available at: **www.aisc.org/historicshapesdatabase**). This resource contains the published dimensions and properties for all shapes since the 5th Edition AISC *Manual*, and also includes earlier shapes originally published in *Iron and Steel Beams 1873–1952*. The new version of the database also includes all the values published in the 14th Edition *Manual*. Basically, the Historical Shapes Database is a complete list of all shapes recorded by AISC from 1873 to 2010.

Basic Design Values Cards

With the printed copy of the 15th Edition *Manual*, AISC has included a separate laminated resource called Basic Design Values Cards (**www.aisc.org/designvaluecards**). The four cards include the most commonly used provisions of the AISC *Specification* in an abbreviated "pocket" format (see above for the first card). This resource can be kept on your desk or in your field notebook to be used as a reference for back-of-the-napkin calculations in situations where the available strengths for members and connections are needed quickly but you don't have access to your *Manual*.

▼ A sample page from Table 6-2.

➤ Available compression, flexural and shear strength for W-shapes are covered in a new "Super Table" in the 15th Edition *Manual.*

Table 6-2 (continued)
Available Strength for Members Subject to Axial, Shear, Flexural and Combined Forces
W-Shapes

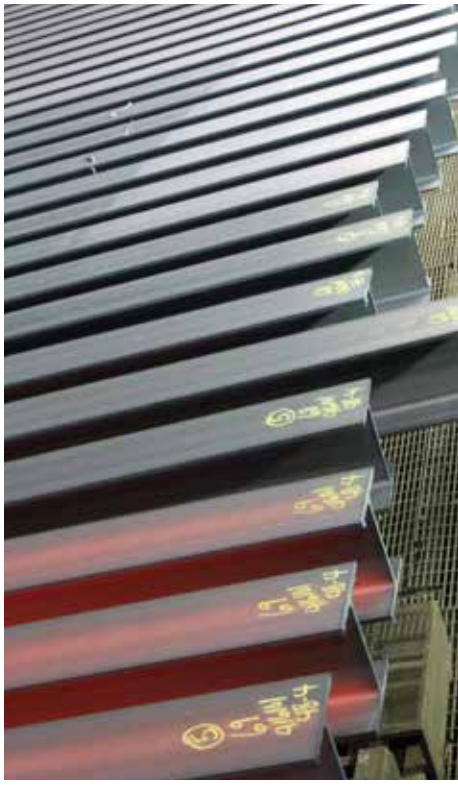
F_y = 50 ksi
F_u = 65 ksi

W12

W12×						Shape		W12×					
72		65		58		lb/ft		72		65[f]		58	
P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	Design		M_{nx}/Ω_b	$\phi_b M_{nx}$	M_{nx}/Ω_b	$\phi_b M_{nx}$	M_{nx}/Ω_b	$\phi_b M_{nx}$
Available Compressive Strength, kips								Available Flexural Strength, kip-ft					
ASD	LRFD	ASD	LRFD	ASD	LRFD			ASD	LRFD	ASD	LRFD	ASD	LRFD
632	949	572	859	509	765	Effective length, L_c, ft, with respect to least radius of gyration, r_y, or unbraced length, L_b, ft, for X-X axis bending	0	269	405	237	356	216	324
606	911	549	825	479	720		6	269	405	237	356	216	324
597	898	540	812	469	705		7	269	405	237	356	216	324
587	883	531	798	457	687		8	269	405	237	356	216	324
576	866	521	783	445	668		9	269	405	237	356	215	323
564	847	510	766	431	647		10	269	405	237	356	211	318
550	827	497	747	416	625		11	268	404	237	356	207	312
536	806	484	728	400	601		12	265	398	237	356	204	306
521	783	470	707	384	577		13	261	392	233	350	200	301
505	759	456	685	367	551		14	257	387	230	345	196	295
489	735	441	663	349	525		15	254	381	226	340	192	289
472	709	426	640	332	499		16	250	376	222	334	189	283
455	683	410	616	314	472		17	246	370	219	329	185	278
437	656	393	591	296	445		18	242	364	215	323	181	272
419	629	377	567	278	418		19	239	359	212	318	177	266
401	602	360	542	261	392		20	235	353	208	313	173	261
364	547	327	492	227	341		22	228	342	201	302	166	249
328	493	294	442	194	292		24	220	331	194	291	158	238
292	440	262	394	165	249		26	213	320	186	280	151	227
259	389	231	348	143	214		28	205	309	179	269	143	215
226	340	202	304	124	187		30	198	297	172	259	135	203
199	299	178	267	109	164		32	190	286	165	248	125	188
176	265	157	236	96.7	145		34	183	275	158	237	116	174
157	236	140	211	86.3	130		36	176	264	149	224	108	163
141	212	126	189	77.4	116		38	167	251	139	209	102	153
127	191	114	171	69.9	105		40	157	236	130	196	95.7	144
115	173	103	155				42	148	223	123	185	90.5	136
105	158	93.9	141				44	140	211	116	175	85.8	129
96.2	145	85.9	129				46	133	200	110	166	81.6	123
88.3	133	78.9	119				48	127	191	105	158	77.8	117
81.4	122	72.7	109				50	121	182	100	150	74.3	112

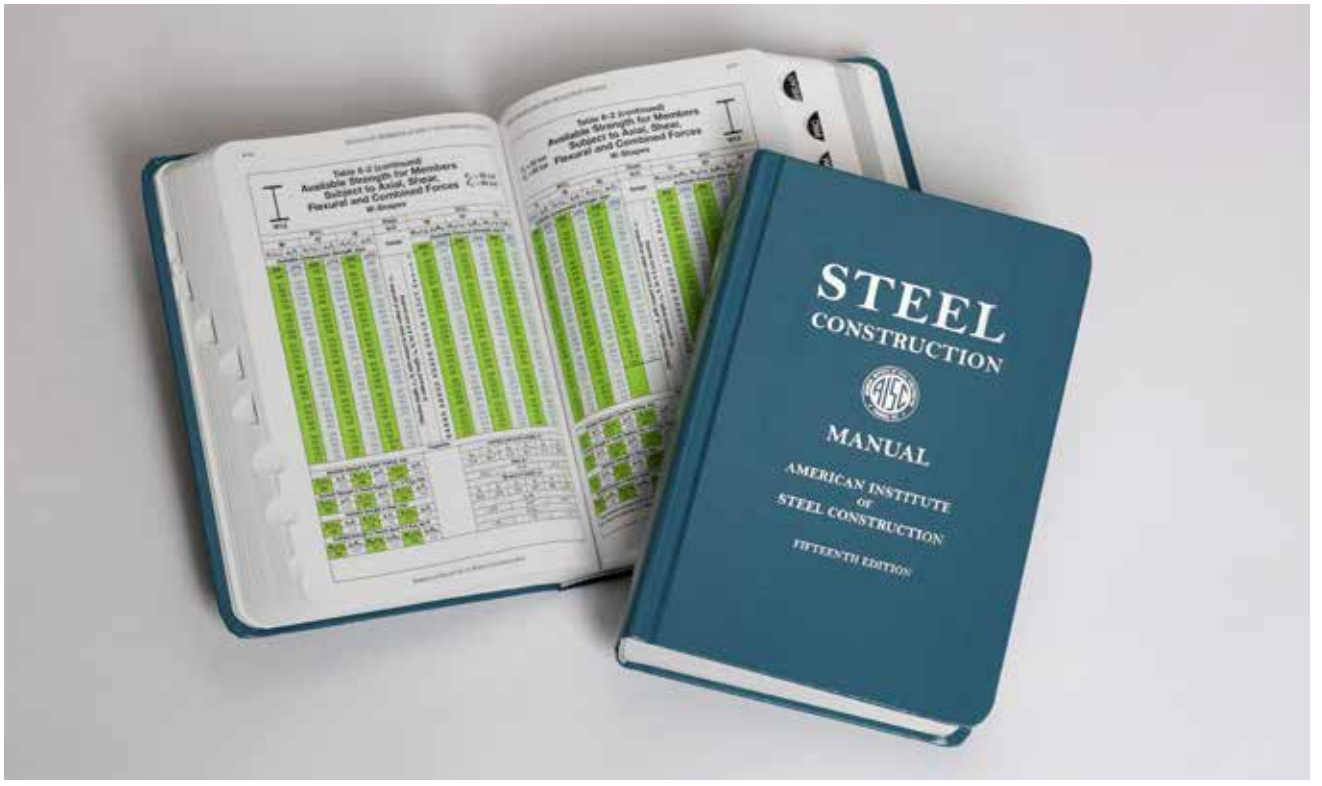
Properties													
Available Strength in Tensile Yielding, kips							Limiting Unbraced Lengths, ft						
P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$		L_p	L_r	L_p	L_r	L_p	L_r
632	950	572	860	509	765		10.7	37.5	11.9	35.1	8.87	29.8
Available Strength in Tensile Rupture ($A_e = 0.75A_g$), kips							Area, in.^{2}					
P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$		21.1		19.1		17.0	
514	770	465	697	416	624		Moment of Inertia, in.^{4}					
Available Strength in Shear, kips							I_x	I_y	I_x	I_y	I_x	I_y
V_n/Ω_v	$\phi_v V_n$	V_n/Ω_v	$\phi_v V_n$	V_n/Ω_v	$\phi_v V_n$		597	195	533	174	475	107
106	159	94.4	142	87.8	132		r_y, in.					
Available Strength in Flexure about Y-Y Axis, kip-ft							3.04		3.02		2.51	
M_{ny}/Ω_b	$\phi_b M_{ny}$	M_{ny}/Ω_b	$\phi_b M_{ny}$	M_{ny}/Ω_b	$\phi_b M_{ny}$		r_x/r_y					
123	185	107	161	81.1	122		1.75		1.75		2.10	

[f] Shape exceeds compact limit for flexure with F_y = 50 ksi.
Note: Heavy line indicates L_c/r equal to or greater than 200.



- Card 1 contains equations to calculate the available strength of W-, S-, C-, and MC-shapes in tension, shear, flexure and compression.
- Card 2 provides equations for determining the available strengths of bolted or welded connections and connected parts.
- Card 3 is similar to Card 1 except it covers the available strength for square, rectangular and round HSS shapes.
- Card 4 gives a summary for stability design of structures using either the first order, effective length, or direct analysis methods. This card also provides a simplified method that is based on the effective length method.

The information on these cards follows the equations in the AISC *Specification* but is presented in condensed format with fewer variables by incorporating the ϕ- or Ω-factors and setting the modulus of elasticity, E, to 29,000 ksi. The equations for flexure are further condensed through the use of a shape factor (which is determined



➤ The new *Manual* features several new high-strength materials, including various grades of HSS.

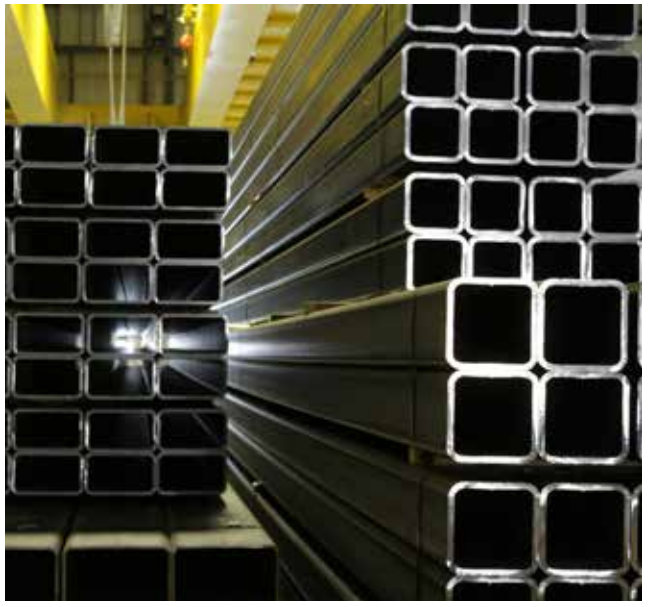
by dividing the plastic section modulus, *Z*, by the elastic section modulus, *S*). All W-, S-, C- and MC-shapes have shape factors that are greater than or equal to 1.1. By setting this factor equal to 1.1—it is used to convert *Z* to *S* in the flexural strength equations—only a single variable needs to be referenced in order to perform these calculations.

To further enhance the ease of use, the strength properties are provided for the most commonly used grades of material for W-, S-, C-, MC- and HSS shapes. The strengths are provided for all grades of bolts (Groups A, B and C) along with the E70 weld electrode.

Due to their condensed format, these cards have limitations and are not intended to be solely relied upon as a replacement to the *Manual* or *Specification*. Some solutions obtained using the cards may be more conservative than those provided by the *Specification* as a result of some conservative assumptions integrated into the equations, while others will provide identical solutions. In certain situations, the equations on these design cards may not be applicable, or the solution may require a modification factor, so be sure to check the "Related Info" and the "Notes" sections on the cards.

Interactive References

The AISC website also includes an updated version of the Interactive Reference List (available at **www.aisc.org/interactivereferences**), a complete list of all the references found in both the 15th Edition *Manual* and 2016 *Specification*. AISC members will be able to access all references published



by AISC, including Design Guides and *Engineering Journal*, directly from this page. For non-AISC references, a link is provided to the homepage of the entity or the organization that publishes the reference. You will find these references are useful in providing further background information on a variety of topics found in the *Manual*.

Investing in the 15th Edition *Manual* and spending time with the various resources will be very beneficial to your designs moving forward. The new provisions included in the *Manual* can significantly reduce the cost and increase the efficiency of a structure, and these resources are great guidance tools and references to help you accurately follow the new provisions. ■