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Course Description

Designing in Structural Steel: 2017
September 15, 2017

This webinar highlights the most significant changes in the 2016 AISC *Specification for Structural Steel Buildings* and *Code of Standard Practice* as well as the 15th Edition *Steel Construction Manual*.
Topics include:

- Member design for tension and compression
- Connection design
- New material standards and steel shapes
- New Super Table for members subject to axial, shear, flexure and combined forces
- Inclusion of digital models in contract documents
- New and improved provisions for architecturally exposed structural steel

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Learning Objectives

- Identify key changes to the AISC *Specification*
- Identify key changes to the AISC *Code of Standard Practice*
- Identify key changes to the AISC *Steel Construction Manual*
- Locate additional AISC resources including additional steel section properties and design examples

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Designing in Structural Steel: 2017

Larry Kruth, PE
Vice President of Engineering and Research
AISC
Chicago, IL

structural
STEEL

AISC 15th Edition Steel Construction Manual

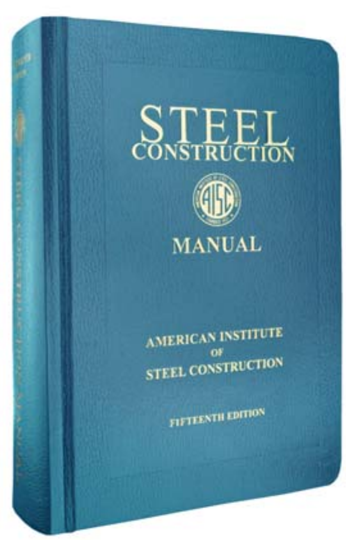
Specification for Structural Steel Buildings
&
Code of Standard Practice for Steel Buildings and Bridges

Lawrence F. Kruth, PE

September 15, 2017

11

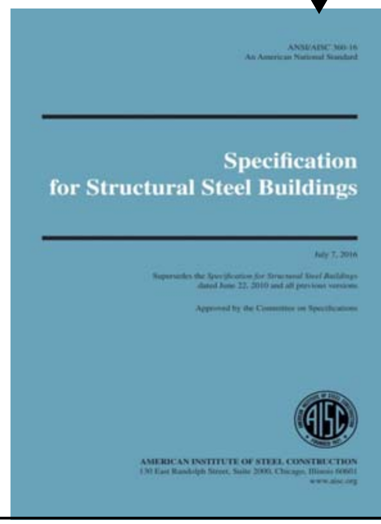
15th Edition
AISC Steel Construction Manual



12

2016 AISC Standards

2018 *INTERNATIONAL BUILDING CODE*



13

2016 AISC Standards

AISC

Specification for Structural Steel Buildings

(ANSI/AISC 360-16)

14

2016 AISC Standards: AISC 360-16

Specification for Structural Steel Buildings

Chapter A. General Provisions

Chapter B. Design Requirements

Chapter C. Design for Stability

Chapter D. Design of Members for Tension

Chapter E. Design of Members for Compression

Chapter F. Design of Members for Flexure

Chapter G. Design of Members for Shear

Chapter H. Design of Members for Combined Forces and Torsion

15

2016 AISC Standards: AISC 360-16

Specification for Structural Steel Buildings

Chapter I. Design of Composite Members

Chapter J. Design of Connections

Chapter K. ~~Design of HSS and Box Members Connections~~Additional Requirements for HSS and Box-Section Connections

Chapter L. Design for Serviceability

Chapter M. Fabrication and Erection

Chapter N. Quality Control and Quality Assurance

16

2016 AISC Standards: AISC 360-16

Specification for Structural Steel Buildings

Appendix 1. Design by ~~Inelastic~~ Advanced Analysis

Appendix 2. Design for Ponding

Appendix 3. ~~Design for~~ Fatigue

Appendix 4. Structural Design for Fire Conditions

Appendix 5. Evaluation of Existing Structures

Appendix 6. Member Stability Bracing ~~for Columns and Beams~~

Appendix 7. Alternative Methods of Design for Stability

Appendix 8. Approximate Second-Order Analysis

17

2016 AISC Standards: AISC 360-16

Section A2

REFERENCED SPECIFICATIONS, CODES AND STANDARDS

New Referenced Standards:

- 2016 ASCE 7
- 2015 AWS D1.1
- 2014 RCSC Specification
- 2014 ACI 318

18

2016 AISC Standards: AISC 360-16

Section A2

REFERENCED SPECIFICATIONS, CODES AND STANDARDS

New HSS Standards:

- **ASTM 1065 – New HSS material**
- **ASTM 1085 – New HSS material**

19

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Section A2

REFERENCED SPECIFICATIONS, CODES AND STANDARDS

ASTM F3125 – New bolt standard

Encompasses Grades:

A325, A325M, A490, A490M,

F1852 & F2280

ASTM F3043 – 200 ksi TC bolt

ASTM F3111 – 200 ksi heavy hex bolt

AWS A5.36 – Flux cored & metal cored electrodes

20

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Chapter D

DESIGN OF MEMBERS FOR TENSION

Revision to Table D3.1, Shear Lag Factors, *U*

21

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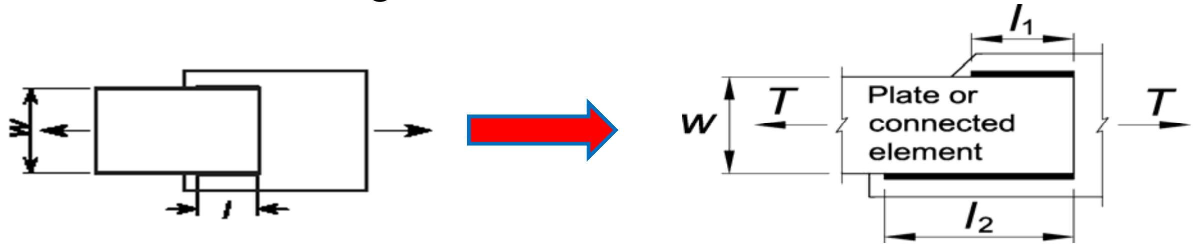
TABLE D3.1

Shear Lag Factors for Connections to Tension Members

U = shear lag factor from Table D3.1, Case 4



2010 **2016**

22

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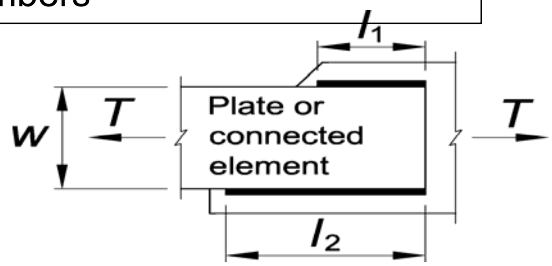
TABLE D3.1

Shear Lag Factors for Connections to Tension Members

Revised Case 4:

$$U = \left(\frac{3l^2}{3l^2 + w^2}\right)\left(1 - \frac{\bar{x}}{l}\right)$$



$$\text{where } l = \frac{l_1 + l_2}{2} \geq 4 \times (weld\ \ size)$$

P. Fortney & W. Thornton,
AISC Engineering Journal, 2012

23

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Chapter E

DESIGN OF MEMBERS FOR COMPRESSION

- ***KL, effective length*** → ***L_c***
- **Slender element members:**

  revised procedure → **no more *Q* factor**

24

L_c Replaces K-Factor

- *K*-factor
  - First introduced in the 1963 Specification
  - Set equal to 1.0 when using the direct analysis method of Chapter C (since 2005)
  - For 2016, *KL,* the effective length, has been replaced with L_c . This makes the designation of effective length simpler since in some instances, such as for torsion, the traditional definition of *K* is not helpful.
  - This has been implemented throughout the 2016 Specification

25

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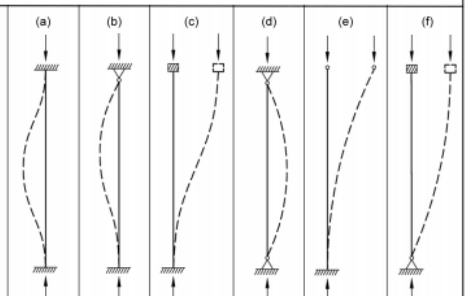
TABLE C-A-7.1
Approximate Values of Effective Length Factor, *K*

	(a)	(b)	(c)	(d)	(e)	(f)
Buckled shape of column is shown by dashed line						
Theoretical *K* value	0.5	0.7	1.0	1.0	2.0	2.0
Recommended design value when ideal conditions are approximated	0.65	0.80	1.2	1.0	2.1	2.0
End condition code	Rotation fixed and translation fixed Rotation free and translation fixed Rotation fixed and translation free Rotation free and translation free					

26

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Chapter J

DESIGN OF CONNECTIONS

- ❑ Bolts in Combination with Welds (Sect. J1.8)
- ❑ New ASTM bolt standards (Sect. J3)
- ❑ New Group C bolts (Sect. J3)

27

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Section J3

BOLTS AND THREADED PARTS

- New high-strength bolt spec: ASTM F3125
  Group A: ASTM F3125 Grades A325, A325M, F1852 and ASTM A354 Grade BC
  Group B: ASTM F3125 Grades A490, A490M, F2280 and ASTM A354 Grade BD
  Group C: ASTM F3043 and F3111

28

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Chapter J

DESIGN OF CONNECTIONS

- ❑ Increase in pretension for bolts (Sect. J3)
- ❑ Change in minimum bolt hole size (Sect. J3)

29

2016 AISC Standards: AISC 360-16

Section J3

BOLTS AND THREADED PARTS

- Table J3.1: Increased min. bolt pretension for Group A bolts for $d_b \geq 1\ 1/8$ in.
- Table J3.3: Nominal hole sizes of std., SS & LS width when ≥ 1 in. ⟶ increase to 1/8 in. oversize

30

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31

2016 AISC Standards: AISC 360-16

Chapter J

DESIGN OF CONNECTIONS

- ❑ New minimum bolt hole clear spacing, *d* (Sect. J3.3)
- ❑ Revised presentation of bearing and tearout equations (Sect. J3.10)
- ❑ Incorporated HSS connections into Sect. J10
- ❑ Washer requirements moved to RCSC

32

2016 AISC Standards

AISC
Code of
Standard Practice for Steel
Buildings and Bridges

(ANSI/AISC 303-16)

33

2016 AISC Standards: AISC 303-16

Code of Standard Practice

ANSI/AISC 303-16

Balanced committee
- Fabricators - 7
- Engineers - 7
- Others – 9
  - General Contractor
  - Code Official
  - Quality Consultant
  - Erector
  - Detailer
  - Architect
  - Attorney

Rigorous public review process

34

2016 AISC Standards: AISC 303-16

Code of Standard Practice for Steel Buildings and Bridges

1. General Provisions
2. Classification of Materials
3. **Design Documents ~~Drawings~~ and Specifications**
4. **Approval Documents ~~Shop and Erection Drawings~~**
5. Materials
6. Shop Fabrication and Delivery
7. Erection
8. Quality Control
9. Contracts
10. Architecturally Exposed Structural Steel

~~**Appendix A. Digital building Product Models**~~

35

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Code of Standard Practice

Three Major Revisions in 2016

1: Models

2: Stiffening

3: Architectural Exposed Structural Steel (AESS)

36

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Code of Standard Practice

1: Models

37

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38

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1: Models

~~2010—design drawings~~

2016 – design documents

- *design documents*. The *design drawings*, or where the parties have agreed in the *contract documents* to provide digital model(s), the *design model*. A combination of drawings and digital models also may be provided.
- *design model*. *A* dimensionally accurate 3D digital model of the structure that conveys the *structural steel* requirements given in Section 3.1 for the building.

39

2016 AISC Standards: AISC 303-16

1: Models

~~2010—shop drawings~~

2016-fabrication documents

- *fabrication documents.* The *shop drawings*, or where the parties have agreed in the *contract documents* to provide digital model(s), the *fabrication model*. A combination of drawings and digital models also may be provided.
- *fabrication model.* A dimensionally accurate 3D digital model produced to convey the information necessary to fabricate the *structural steel*. This may be the same digital model as the *erection model*, but it is not required to be.

40

2016 AISC Standards: AISC 303-16

1: Models

~~2010—erection drawings~~

2016-erection documents

- *erection documents.* The *erection drawings*, or where the parties have agreed in the *contract documents* to provide digital model(s), the *erection model*. A combination of drawings and digital models also may be provided.

- *erection model.* A dimensionally accurate 3D digital model produced to convey the information necessary to erect the structural steel. This may be the same digital model as the *fabrication model*, but it is not required to be.

41

2016 AISC Standards: AISC 303-16

1: Models

~~2010—shop and erection drawings~~

2016- approval documents

- *approval documents*. The *structural steel shop drawings*, *erection drawings*, and *embedment drawings*, or where the parties have agreed in the *contract documents* to provide digital model(s), the *fabrication* and *erection models*. A combination of drawings and digital models also may be provided.

42

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2: Stiffening

43

2016 AISC Standards: AISC 303-16

2: Stiffening

2010

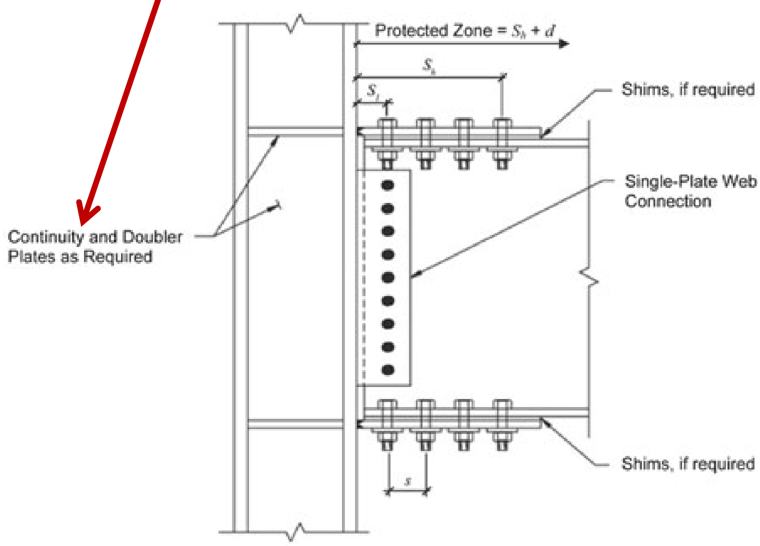
Section 3.1.1: Column stiffeners, bearing stiffeners, doublers, etc., must be designed and clearly shown on drawings

Section 3.1.2: Three options for connection design indicated by owner's designated rep. for design (ODRD)

44

2016 AISC Standards: AISC 303-16

Often missed in connection design when bidding



45

2016 AISC Standards: AISC 303-16

2016

Section 3.1.1

Connection Design Responsibility

Option 1:

ODRD (EOR) provides complete connection design

Option 2:

Steel detailer selects or completes connection design

Option 3:

Licensed engineer working for fabricator provides complete connection design

46

2016 AISC Standards: AISC 303-16

2016

Section 3.1.2

Connection Stiffening

If Option 1 or 2, ODRD designs stiffening and shows on structural design bid documents

If Option 3A, ODRD designs stiffening and shows on structural design bid documents

If Option 3B, ODRD provides bidding quantity of items for stiffening (an estimate). If no estimate provided, stiffening will not be included in bid.

47

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3: Architecturally Exposed Structural Steel (AESS)

48

2016 AISC Standards: AISC 303-16

49

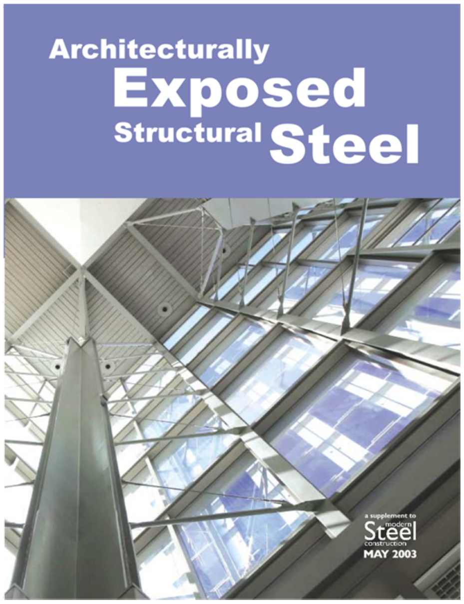
2016 AISC Standards: AISC 303-16

3: AESS

Section 10 completely changed

50

2016 AISC Standards: AISC 303-16



RMSCA

51

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52

2016 AISC Standards: AISC 303-16

3: AESS

Section 10 completely changed

AESS 1: Basic elements

AESS 2: Feature elements > 20 ft

AESS 3: Feature elements ≤ 20 ft

AESS 4: Showcase elements w/special surface & edge treatment

AESS C: Custom

53

2016 AISC Standards: AISC 303-16

3: AESS

Section 10 completely changed

AESS 1: $

AESS 2: $$

AESS 3: $$$

AESS 4: $$$$

AESS C: $$$$$

54

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Some Additional Revisions:

- Lack of tolerances
- Identifying protected zones
- Handling cost of revisions
- Anchor rod placement tolerances

55

2016 AISC Standards: AISC 303-16

Section 1.10

No zero tolerance.

1.10. Tolerances

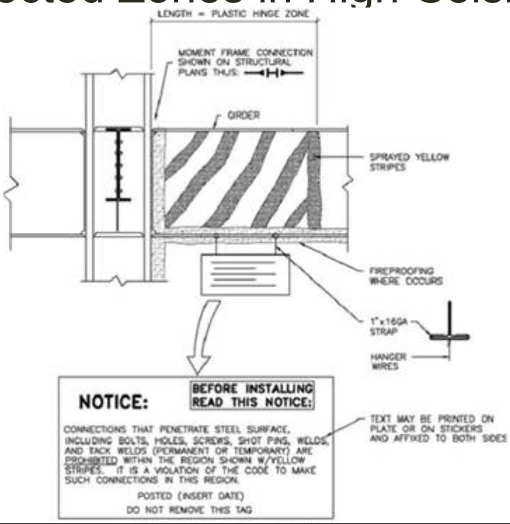
Tolerances for materials, fabrication and erection shall be as stipulated in Sections 5, 6, 7, and 10. Tolerances absent from this Code or the contract documents shall not be considered zero by default.

56

2016 AISC Standards: AISC 303-16

Section 1.11

Marking of Protected Zones in High-Seismic Applications



57

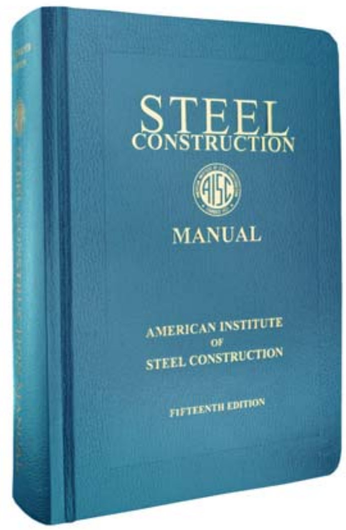
2016 AISC Standards: AISC 303-16

Section 7.5.1

Tolerances for anchor-rod placement have been revised for consistency with the hole sizes provided in the AISC *Manual* and tolerances given in ACI 117.

58

15th Edition AISC Steel Construction Manual



59

Table of Contents

60

Table of Contents (continued)

61

Table of Contents (continued)

62

Part 1. Dimensions and Properties

- New shapes:
  - W-shapes (& corresponding WT-shapes)
  - HP-shape
  - Angles
  - HSS
  - Pipe

63

Part 1. Dimensions and Properties

W-Shapes	HP-Shapes	Angles
W40x655	HP12x89	L12x12x1-3/8
W36x925		L12x12x1-1/4
W36x853		L12x12x1-1/8
W36x802		L12x12x1
W36x723		L10x10x1-3/8
W21x275		L10x10x1-1/4
W21x248		L10x10x1-1/8
W21x223		L10x10x1
W14x873		L10x10x7/8
W14x808		L10x10x3/4

& corresponding WT-shapes

64

Part 1. Dimensions and Properties

HSS22x22x7/8, 3/4
HSS20x20x7/8, 3/4, 5/8, 1/2
HSS18x18x7/8, 3/4, 5/8, 1/2
HSS16x16x7/8, 3/4
HSS14x14x7/8, 3/4
HSS16x16x7/8, 3/4
HSS14x14x7/8, 3/4
HSS12x12x3/4
HSS10x10x3/4

HSS24x12x3/4, 5/8, 1/2
HSS20x12x3/4
HSS16x12x3/4

Pipe 26, 24, 20, 18, 16, 14 (std and x-strong)
& Pipe 12, 10 (xx-strong)

65

Part 1. Dimensions and Properties

- New shapes
- Updated fillet radii ⟶ k_{det}, k_1, T affected

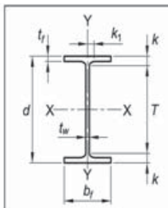


Table 1-1
W-Shapes
Dimensions

Shape	Area, A	Depth, d		Web Thickness, t_w		Web $\frac{t_w}{2}$	Flange Width, b_f		Flange Thickness, t_f		Distance k k_{des}	Distance k k_{det}	Distance k_1	Distance T	Distance Workable Gage
	in.²	in.		in.		in.	in.		in.		in.	in.	in.	in.	in.
W44×335^c	98.5	44.0	44	1.03	1	1/2	15.9	16	1.77	1 3/4	2.56	3	1 3/4	38	5 1/2
×290^c	85.4	43.6	43 5/8	0.865	7/8	7/16	15.8	15 7/8	1.58	1 9/16	2.36	2 13/16	1 5/8	↓	↓
×262^c	77.2	43.3	43 1/4	0.785	13/16	7/16	15.8	15 3/4	1.42	1 7/16	2.20	2 5/8	1 5/8	↓	↓
×230^c,v	67.8	42.9	42 7/8	0.710	11/16	3/8	15.8	15 3/4	1.22	1 1/4	2.01	2 7/16	1 9/16	↓	↓

66

Part 1. Dimensions and Properties

- New shapes
- Updated fillet radii ⟶ k_{det}, k_1, T affected
- Larger separation for new double angles (2L12 and 2L10)

67

Part 1. Dimensions and Properties

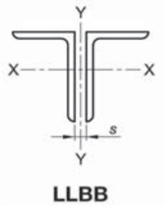
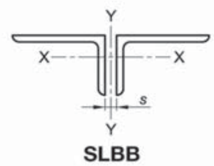


Table 1-15
Double Angles
Properties



Shape	Area, A	Radius of Gyration: LLBB r_y, Separation, s, in. 0	LLBB r_y 3/4	LLBB r_y 1 1/2	LLBB r_x	SLBB r_y, Separation, s, in. 0	SLBB r_y 3/4	SLBB r_y 1 1/2	SLBB r_x
	in.^{2}	in.	in.	in.	in.	in.	in.	in.	in.
2L12×12×1 3/8	62.2	5.06	5.32	5.60	3.64	5.06	5.32	5.60	3.64
×1 1/4	56.8	5.04	5.29	5.57	3.66	5.04	5.29	5.57	3.66
×1 1/8	51.6	5.02	5.28	5.55	3.68	5.02	5.28	5.55	3.68
×1	46.0	5.00	5.25	5.54	3.70	5.00	5.25	5.54	3.70

68

Part 2. General Design Considerations

- Table 2-4: Applicable ASTM Specifications for Various Structural Shapes
- Table 2-5: Applicable ASTM Specifications for Plates and Bars
- Table 2-7: Summary of Surface Preparation Standards

69

Part 2. General Design Considerations

Table 2-4
Applicable ASTM Specifications for Various Structural Shapes

Steel Type	ASTM Designation		F_y Yield Stress[a] (ksi)	F_u Tensile Stress[a] (ksi)	W	M	S	HP	C	MC	L	HSS Rect.	HSS Round	Pipe
	A36		36	58–80[b]										
	A53 Gr. B		35	60										
	A500	Gr. B	42	58										
			46	58										
		Gr. C	46	62										
			50	62										
		Gr. A	36	58										

70

Part 2. General Design Considerations

Table 2-5
Applicable ASTM Specifications for Plates and Bars

Steel Type	ASTM Designation		F_y Yield Stress[a] (ksi)	F_u Tensile Stress[a] (ksi)	Plates and Bars, in.									
					to 0.75 incl.	over 0.75 to 1.25 incl.	over 1.25 to 1.5 incl.	over 1.5 to 2 incl.	over 2 to 2.5 incl.	over 2.5 to 4 incl.	over 4 to 5 incl.	over 5 to 6 incl.	over 6 to 8 incl.	over 8
Carbon	A36		32	58–80										
			36	58–80										
	A283[e]	Gr. C	30	55–75					d					
		Gr. D	33	60–80					d					
	A529	Gr. 50	50	65–100		b	b	b	b	b				
		Gr. 55	55	70–100		c	c	c	c	c				
	A709	Gr. 36	36	58–80										
High-	A572	Gr. 42	42	60										
		Gr. 50	50	65										
		Gr. 55	55	70										
		Gr. 60	60	75										
		Gr. 65	65	80										

Part 4. Design of Compression Members

- Eliminated K factor in tables/discussion → L_c
- Clarifies $C_w = 0$ is used in WT column tables
- Chapter E revisions reflected in tables
  - Slender members
  - Double angles use more general F_{cry} equation
- Removed Tables 4-13 to 4-20: Composite Columns
- W-shape column tables: added 65 and 70 ksi for some

Part 4. Design of Compression Members

- W-shape column tables: added 65 and 70 ksi for some

Table 4-1b — Available Strength in Axial Compression, kips — W-Shapes (F_y = 65 ksi) W14

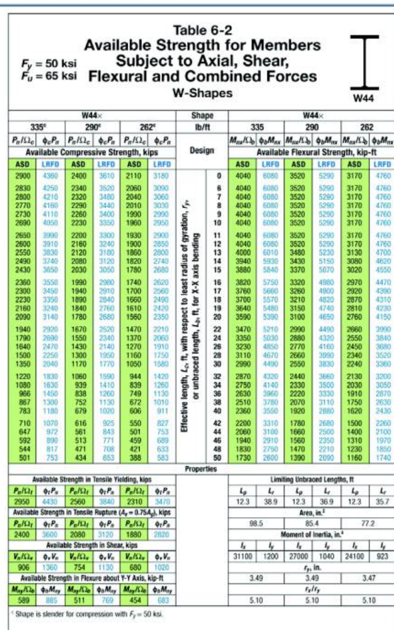
Shape	W14×							
lb/ft	873[h]		808[h]		730[h]		665[h]	
Design	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$	P_n/Ω_c	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	10000	15000	9260	13900	8370	12600	7630	11500

Table 4-1c — Available Strength in Axial Compression, kips — W-Shapes (F_y = 70 ksi) W14

Shape	W14×							
lb/ft	873[h]		808[h]		730[h]		665[h]	
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	$\phi_c P_n$
	ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
0	10800	16200	9980	15000	9010	13500	8220	12300

73

The Super Table



74

Example—Table 6-2

Given: W14x99, ASTM A992, pinned ends (K = 1.0),

$L_{cx} = L_{cy} = L_b$ = 14 ft

Check shape for combined loading using LRFD, with required strengths as follows:

LRFD
P_u = 400 kips M_{ux} = 250 kip-ft M_{uy} = 80.0 kip-ft

75

Example— Table 6-2

Solution:

$\phi_c P_n = 1130$ kips

$\phi_b M_{nx} = 642$ kip-ft

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

W14

Shape	W14×							W14×					
lb/ft	109		99		90			109		99[f]		90[f]	
	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
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	923	1390	839	1260	764	1150	7	479	720	430	646	382	574
	913	1370	830	1250	755	1140	8	479	720	430	646	382	574
	901	1350	819	1230	745	1120	9	479	720	430	646	382	574
	888	1340	807	1210	735	1100	10	479	720	430	646	382	574
	874	1310	794	1190	723	1090	11	479	720	430	646	382	574
	859	1290	780	1170	710	1070	12	479	720	430	646	382	574
	843	1270	766	1150	697	1050	13	479	720	430	646	382	574
	826	1240	750	1130	682	1030	14	475	714	427	642	382	574
	808	1210	733	1100	667	1000	15	470	706	422	635	382	574
	789	1190	716	1080	652	979	16	465	699	417	627	378	568
	770	1160	698	1050	635	955	17	460	691	413	620	373	560
	750	1130	680	1020	618	929	18	455	684	408	613	368	553
	729	1100	661	994	601	903	19	450	676	403	605	363	546
	708	1060	642	964	583	877	20	445	669	398	598	358	539
	664	998	602	904	547	822	22	435	654	388	583	349	524
	620	931	561	843	509	766	24	425	639	378	569	339	510
	574	863	519	781	472	709	26	415	623	369	554	329	495
	529	796	478	719	434	653	28	405	608	359	539	320	481
	485	729	438	658	397	597	30	395	593	349	524	310	466
	441	663	398	598	361	543	32	385	578	339	510	300	452
	399	600	360	541	326	490	34	375	563	329	495	291	437
	359	539	323	485	292	439	36	365	548	320	480	281	423
	322	484	290	435	262	394	38	355	533	310	466	271	408
	290	437	261	393	237	356	40	345	518	300	451	262	394
	263	396	237	356	215	323	42	335	503	290	436	252	379
	240	361	216	325	196	294	44	325	488	280	422	239	359

76

Example—Table 6-2

Given: W14x99, ASTM A992, pinned ends (K = 1.0),

$L_{cx} = L_{cy} = L_b = 14$ ft

Check shape for combined loading using LRFD, with required strengths as follows:

LRFD
P_u = 400 kips M_{ux} = 250 kip-ft M_{uy} = 80.0 kip-ft

77

Example—Table 6-2

Solution:

$$\phi_b M_{ny} = 311 \text{ kip-ft}$$

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

W14

Shape	W14×					
lb/ft	109		99		90	
	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	Available Compressive Strength, kips					
	ASD	LRFD	ASD	LRFD	ASD	LRFD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Properties						
	Available Strength in Tensile Yielding, kips					
	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	958	1440	871	1310	793	1190
	Available Strength in Tensile Rupture ($A_e = 0.75A_g$), kips					
	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$	P_n/Ω_t	$\phi_t P_n$
	780	1170	709	1060	647	970
	Available Strength in Shear, kips					
	V_n/Ω_v	$\phi_v V_n$	V_n/Ω_v	$\phi_v V_n$	V_n/Ω_v	$\phi_v V_n$
	150	225	138	207	123	185
	Available Strength in Flexure about Y-Y Axis, kip-ft					
	M_{ny}/Ω_b	$\phi_b M_{ny}$	M_{ny}/Ω_b	$\phi_b M_{ny}$	M_{ny}/Ω_b	$\phi_b M_{ny}$
	231	348	207	311	181	273

Shape	W14×					
lb/ft	109		99[f]		90[f]	
	M_{nx}/Ω_b	$\phi_b M_{nx}$	M_{nx}/Ω_b	$\phi_b M_{nx}$	M_{nx}/Ω_b	$\phi_b M_{nx}$
Design	Available Flexural Strength, kip-ft					
	ASD	LRFD	ASD	LRFD	ASD	LRFD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Properties						
	Limiting Unbraced Lengths, ft					
	L_p	L_r	L_p	L_r	L_p	L_r
	13.2	48.5	13.5	45.3	15.1	42.5
	Area, in.[2]					
	32.0		29.1		26.5	
	Moment of Inertia, in.[4]					
	I_x	I_y	I_x	I_y	I_x	I_y
	1240	447	1110	402	999	362
	r_y, in.					
	3.73		3.71		3.70	
	r_x/r_y					
	1.67		1.66		1.66	

[f] Shape exceeds compact limit for flexure with F_y = 50 ksi.

78

Example—Table 6-2

Given: W14x99, ASTM A992, pinned ends (K = 1.0),

$L_{cx} = L_{cy} = L_b = 14$ ft

Check shape for combined loading using LRFD, with required strengths as follows:

LRFD
P_u = 400 kips M_{ux} = 250 kip-ft M_{uy} = 80.0 kip-ft

Example—Table 6-2

Solution:

$$\frac{P_u}{P_c} = \frac{400 \text{ kips}}{1130 \text{ kips}}$$

$$= 0.354$$

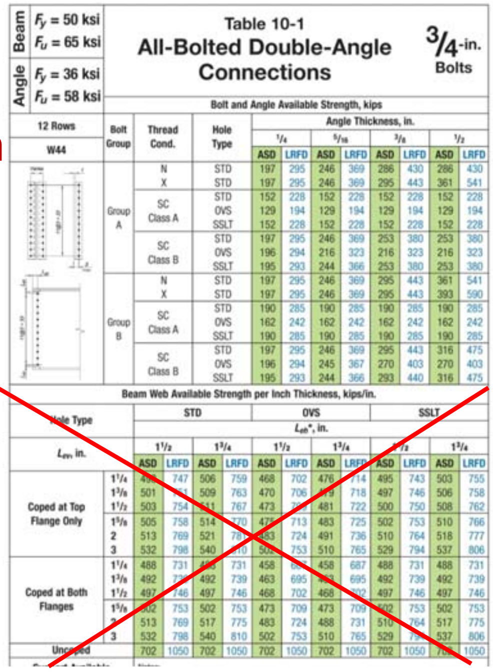
Because $\frac{P_u}{P_c} \geq 0.2$, use *Spec.* Eq. H1-1a:

$$\frac{P_r}{P_c} + \frac{8}{9}\left(\frac{M_{rx}}{M_{cx}} + \frac{M_{ry}}{M_{cy}}\right) \leq 1.0$$

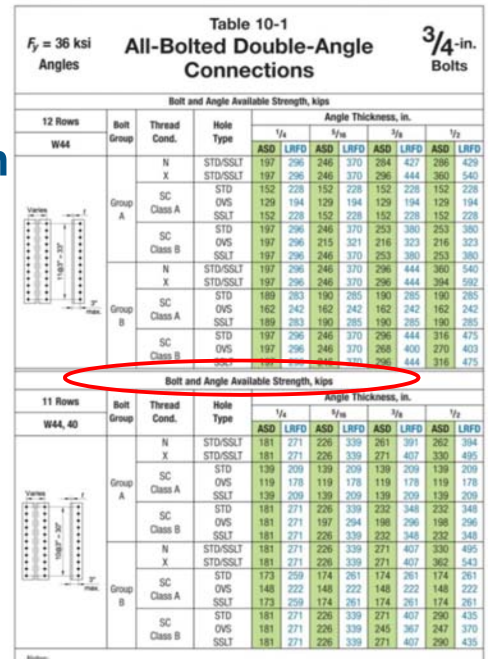
$$\frac{400 \text{ kips}}{1130 \text{ kips}} + \frac{8}{9}\left(\frac{250 \text{ kip-ft}}{642 \text{ kip-ft}} + \frac{80.0 \text{ kip-ft}}{311 \text{ kip-ft}}\right) = 0.928 < 1.0 \quad \textbf{o.k.}$$

Table 10 - 1

14th Ed.



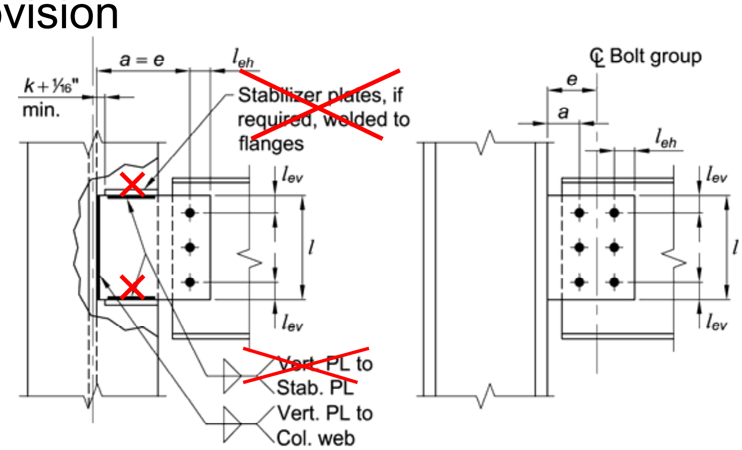
15th Ed.



81

Part 10. Design of Simple Shear Connections

- Table 10-1 revised
- Extended single-plate connections: Removed stabilizer plate provision



Thornton and Fortney, *Engineering Journal*, 2011, 2016

82

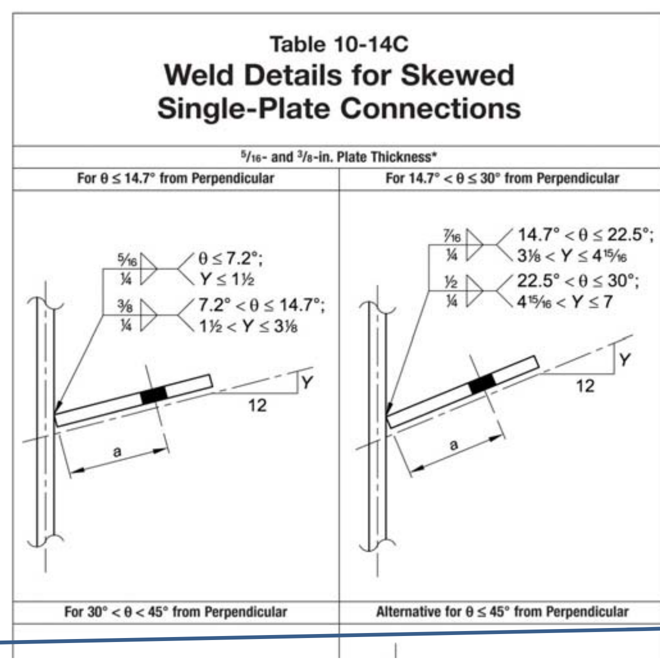
Part 10. Design of Simple Shear Connections

- Table 10-1 revised
- Single-plate connections: Stabilizer plate requirement
- Table 10-14C: Weld details for skewed single-plate connections

83

Part 10. Design of Simple Shear Connections

- This is “One acceptable design aid for skewed welds….”
- Works for 36- or 50-ksi plates
- Added 5/8-in. plate



84

Part 14. Design of Beam Bearing Plates, Column Base Plates, Anchor Rods and Column Splices

Table 14-2
Recommended Sizes for Washers and Anchor Rod Holes in Base Plates

Anchor Rod Diameter	Hole Diameter	Washer Size	Min. Washer Thickness	Anchor Rod Diameter	Hole Diameter	Washer Size	Min. Washer Thickness
in.	in.	in.	in.	in.	in.	in.	in.
3/4	1 5/16	2	1/4	1 1/2	2 3/8	4	1/2
7/8	1 9/16	2 1/2	5/16	1 3/4	2 7/8	4 1/2	5/8
1	1 7/8	3	3/8	2	3 1/4	5	3/4
1 1/4	2 1/8	3 1/2	1/2	2 1/2	3 3/4	5 1/2	7/8

14th Ed:
3

14th Ed:
1 13/16
2 1/16

14th Ed:
3 1/2
4

14th Ed:
2 5/16
2 3/4

85

Part 14. Design of Beam Bearing Plates, Column Base Plates, Anchor Rods and Column Splices

Table 14-2 Notes:

1. Hole sizes provided are based on anchor rod size and correlate with ACI 117 (ACI, 2010).

…

4. ASTM F844 washers are permitted instead of plate washers when hole clearances are limited to 5/16 in. for rod diameters up to 1 in., 1/2 in. for rod diameters over 1 in. up to 2 in., and 1 in. for rod diameters over 2 in. This exception should not be used unless the general contractor has agreed to meet smaller tolerances for anchor rod placement than those permitted in ACI 117.

86

In Summary

Part 1…New shape sizes and detailing dimensions
Part 2…ASTM A500 Grade C is preferred for HSS
Part 3…New footnotes
Part 4…W-Shape column tables for 65 and 70 ksi
Part 6…New Super Table 6-2
Part 7…Table 7-14 includes TC bolts dimensions
Part 8…New plastic method for eccentrically loaded bolt groups
Part 9…Increased permitted tributary length for prying
Part 10…Removal of stabilizer plate provisions
Part 13…Additional considerations for HSS-to-HSS truss connections
Part 14…Updated Table 14-2 for improved anchor-rod installation

87

Design Examples V15.0

Part I: Examples based upon the AISC Specification

- Design of Tension Members
- Design of Compression Members
- Etc.

Part II: Examples based upon the AISC Steel Construction Manual

- Simple Shear Connections
- Fully Restrained Moment Connections
- Etc.

Part III: System Design Examples

- Design of Selected Four Story Building Members

88

Design Examples V15.0

Part IV: Additional Resources

- Combined Flexure and Axial Force, W-shapes (Table 6-1, 14th Ed. Manual)
- Filled HSS Column Tables, A500 Gr. C (Tables 4-13 to 4-20, 14th Ed. Manual)
- New Super Table 6-2: W-Shapes, 65 and 70 ksi; HSS, ASTM A1085; HSS, A500 Gr. C; Pipe
- New Z_{net} Table for Coped W-shapes

89

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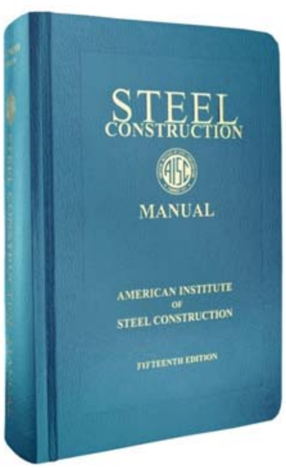

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90

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November 1, 2017	Atlanta, GA	AISC	W. Samuel Easterling
December 8, 2017	New York, NY	SINY	Louis F. Geschwindner

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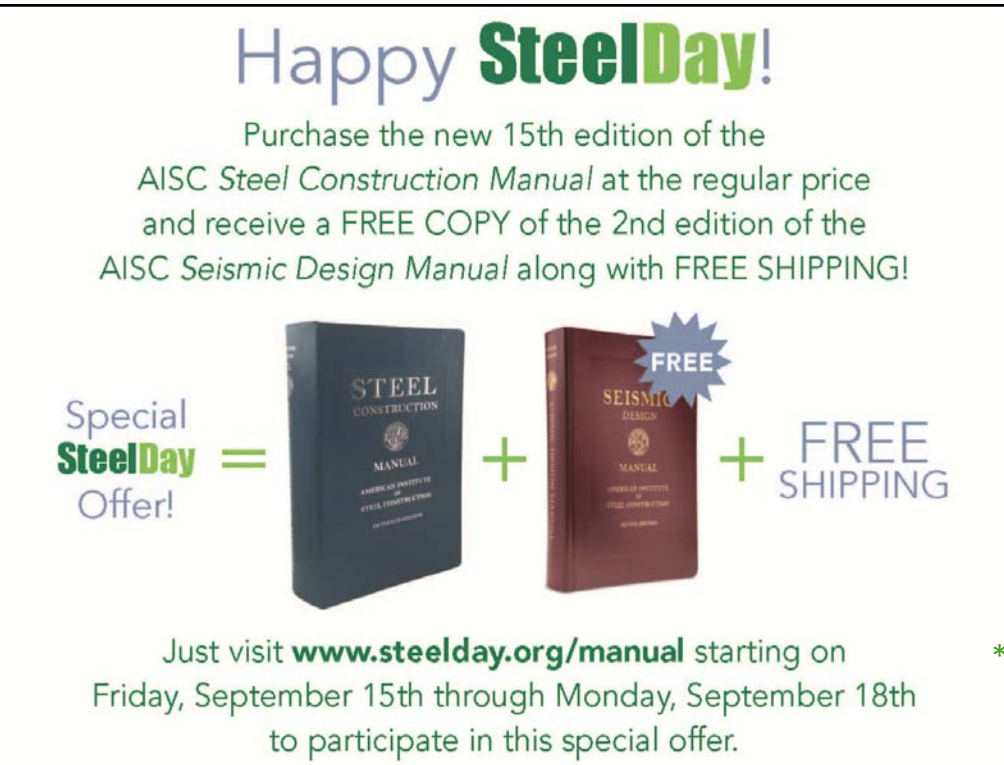
91



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92

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Polling Question

Which of the following is NOT new to the 15th Edition Manual and 2016 standards?

a. W-shape column tables for 65 + 70ksi

b. Complete change to AESS provisions

c. Increased hole size for all bolts

d. Effective length is now L_c, not KL

e. Larger HSS sizes added to Manual

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