Changes to the 2015 Wood Frame Construction Manual

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Figure 1. 2015 WFCM in 2015 IBC/IRC.

Figure 2. ASCE 7-10 wind, seismic, and snow loads used.

The 2015 Edition of the *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings* (ANSI/AWC WFCM-2015) was approved on October 10, 2014 as an ANSI American National Standard (*Figure 1*). The 2015 WFCM was developed by the American Wood Council's (AWC) Wood Design Standards Committee and is referenced in the 2015 *International Residential Code* (IRC) and 2015 *International Building Code* (IBC).

Primary changes to the 2015 WFCM are listed here and are subsequently covered in more detail:

- Tabulated spans for lumber framing members now reflect changes to design values for visual grades of Southern Pine as referenced in the 2015 *National Design Specification® (NDS®) for Wood Construction Supplement: Design Values for Wood Construction*.
- New tables provide prescriptive wood-frame solutions for rafters and ceiling joists in response to new live load deflection limits for ceilings using flexible finishes (including gypsum wallboard) or brittle finishes (including plaster and stucco) as adopted in the 2015 IRC.
- Header spans revised to reflect L/240 live load deflection limits for members supporting only a roof and ceiling as shown in IRC and IBC tables.

The WFCM includes prescriptive and engineered design provisions for wood wall, floor, and roof systems and their connections. A range of structural elements are covered, including sawn lumber, structural glued laminated timber, wood structural sheathing, I-joists, and trusses.

ASCE 7-10 Load Provisions

Tabulated engineered and prescriptive design provisions in WFCM Chapters 2 and 3, respectively, are based on the following loads from ASCE 7-10 *Minimum Design Loads for Buildings and Other Structures* (*Figure 2*):

- 0-70 psf ground snow loads
- 110-195 mph 700-year return period 3-second gust basic wind speeds
- Seismic Design Categories A-D

Additional information concerning changes to snow, wind, and seismic loads in ASCE 7-10 compared to ASCE 7-05 is discussed in a paper titled *2012 WFCM Changes* (STRUCTURE® magazine, August 2014).

Lumber Framing Spans

Tabulated spans for lumber framing members now reflect changes to design values referenced in the 2015 *National Design Specification® for Wood Construction Supplement: Design Values for Wood Construction*. Notably, the 2015 NDS *Supplement* incorporates new design values for visually-graded Southern Pine. The American Lumber Standard Committee (ALSC) Board of Review approved changes to these design values for all grades and all sizes of visually-graded Southern Pine and Mixed Southern Pine lumber, with a recommended effective date of June 1, 2013.

Rafters and Ceiling Joists with Brittle Finishes

Tables for ceiling joist spans/capacities, rafter spans/capacities, and hip and valley beam capacity requirements have been revised to clarify the live load deflection basis of these deflection criteria, and to associate live load deflection limits to cases with "no ceiling attached" and ceilings with "flexible finishes" and "brittle finishes." Tables are added to address deflection criteria of $L/\Delta_{LL}=360$ for brittle finishes (*Figure 3*). Flexible finishes are denoted as "(including gypsum board)" and brittle finishes are denoted as "(including plaster and stucco)."

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Header Spans Supporting Roof and Ceiling

Roof header span tables have been revised to be based on $L/\Delta_{LL}=240$ instead of $L/\Delta_{LL}=360$. The $L/\Delta_{LL}=240$ deflection limit basis is consistent with deflection limits for members supporting roofs and ceilings as shown in IRC Table R802.5.1 and IBC Table 2308.7.2 for rafters with ceilings attached to rafters and IRC Table R802.4 and IBC Table 2308.7.2 for ceiling joists, respectively.

Applicability to Non-Residential Structures

New language in IBC 2309 allows for use of the WFCM for non-residential structures within its scoping limitations:

> **(IBC) 2309.1 Wood Frame Construction Manual.** Structural design in accordance with the AWC WFCM shall be permitted for buildings assigned to Risk Category I or II subject to the limitations of Section 1.1.3 of the AWC WFCM and the load assumptions contained therein. Structural elements beyond these limitations shall be designed in accordance with accepted engineering practice.

WFCM 1.1.3 references Table 1 Applicability Limitations (*Figure 4*) which outlines building dimensions and load assumptions. While WFCM provisions are intended primarily for detached one-and two-family dwellings due to the floor live load assumption associated with those occupancies, many of the WFCM provisions for specific geographic wind, seismic, and snow loads may be applicable for other buildings. For example, wind provisions for sizing of roof sheathing, wall sheathing, fastening schedules, uplift straps, shear anchorage, shear wall lengths, and wall studs for out of plane wind loads are included in the WFCM and are applicable for other use groups within the load limitations of the WFCM tables. Similarly, roof rafter size and spacing for heavy snow, and shear wall lengths and anchorage for seismic, are applicable within the load limitations of the WFCM tables. Examples of non-residential applications include single-story wood structures or top stories in mixed use structures in Risk Categories I or II.

Applications outside the scope of the WFCM tabulated requirements, such as floor joist design for floor live loads greater than 40 psf and design of supporting gravity elements for the additional floor live load is beyond the applicability of the WFCM and must be designed in accordance with accepted engineering practice. This parallels the approach taken in Section R301.1.3 of the IRC, which permits unconventional elements of one and two-family dwellings to be designed per the IBC.

WFCM Availability

The 2015 WFCM is currently available for purchase in electronic format (PDF) only. Once the WFCM *Commentary* is updated (which is to be included with the WFCM) printed copies will be available for purchase. Once the WFCM *Commentary* is complete, those who purchased

Table 3.25B2 Ceiling Joist Spans for Common Lumber Species **LL = 20 psf**
(Uninhabitable Attics With Limited Storage) Live Load = 20 psf, $L/\Delta_{LL}=360$, **L/Δ_{LL} = 360**
Dead Load = 10 psf, Brittle Finish (including plaster and stucco)

			Dead Load = 10 psf			
			2x4	2x6	2x8	2x10
			Maximum Ceiling Joist Spans[1,2]			
Joist Spacing (in.)	Species	Grade	(ft-in.)	(ft-in.)	(ft-in.)	(ft-in.)
12	Douglas Fir-Larch	SS	9 - 1	14 - 4	18 - 10	24 - 1
	Douglas Fir-Larch	No.1	8 - 9	13 - 9	18 - 2	23 - 2
	Douglas Fir-Larch	No.2	8 - 7	13 - 6	17 - 10	22 - 9
	Douglas Fir-Larch	No.3	7 - 10	11 - 6	14 - 7	17 - 9
	Hem-Fir	SS	8 - 7	13 - 6	17 - 10	22 - 9
	Hem-Fir	No.1	8 - 5	13 - 3	17 - 5	22 - 3
	Hem-Fir	No.2	8 - 0	12 - 7	16 - 7	21 - 2
	Hem-Fir	No.3	7 - 8	11 - 2	14 - 2	17 - 4
	Southern Pine	SS	8 - 11	14 - 1	18 - 6	23 - 8
	Southern Pine	No.1	8 - 7	13 - 6	17 - 10	22 - 9
	Southern Pine	No.2	8 - 3	12 - 11	17 - 0	20 - 11
	Southern Pine	No.3	7 - 2	10 - 6	13 - 3	16 - 1
	Spruce-Pine Fir	SS	8 - 5	13 - 3	17 - 5	22 - 3
	Spruce-Pine Fir	No.1	8 - 3	12 - 11	17 - 0	21 - 9
	Spruce-Pine Fir	No.2	8 - 3	12 - 11	17 - 0	21 - 9
	Spruce-Pine Fir	No.3	7 - 8	11 - 2	14 - 2	17 - 4
16	Douglas Fir-Larch	SS	8 - 3	13 - 0	17 - 2	21 - 10
	Douglas Fir-Larch	No.1	8 - 0	12 - 6	16 - 6	21 - 1
	Douglas Fir-Larch	No.2	7 - 10	12 - 3	16 - 2	20 - 2
	Douglas Fir-Larch	No.3	6 - 10	9 - 11	12 - 7	15 - 5
	Hem-Fir	SS	7 - 10	12 - 3	16 - 2	20 - 8
	Hem-Fir	No.1	7 - 8	12 - 0	15 - 10	20 - 2
	Hem-Fir	No.2	7 - 3	11 - 5	15 - 1	19 - 3
	Hem-Fir	No.3	6 - 8	9 - 8	12 - 4	15 - 0
	Southern Pine	SS	8 - 1	12 - 9	16 - 10	21 - 6
	Southern Pine	No.1	7 - 10	12 - 3	16 - 2	20 - 8
	Southern Pine	No.2	7 - 6	11 - 9	15 - 3	18 - 1
	Southern Pine	No.3	6 - 2	9 - 2	11 - 6	14 - 0
	Spruce-Pine Fir	SS	7 - 8	12 - 0	15 - 10	20 - 2
	Spruce-Pine Fir	No.1	7 - 6	11 - 9	15 - 6	19 - 9
	Spruce-Pine Fir	No.2	7 - 6	11 - 9	15 - 6	19 - 9
	Spruce-Pine Fir	No.3	6 - 8	9 - 8	12 - 4	15 - 0
19.2	Douglas Fir-Larch	SS	7 - 9	12 - 3	16 - 1	20 - 7
	Douglas Fir-Larch	No.1	7 - 6	11 - 9	15 - 6	19 - 5
	Douglas Fir-Larch	No.2	7 - 4	11 - 7	15 - 1	18 - 5
	Douglas Fir-Larch	No.3	6 - 2	9 - 1	11 - 6	14 - 1
	Hem-Fir	SS	7 - 4	11 - 7	15 - 3	19 - 5
	Hem-Fir	No.1	7 - 2	11 - 4	14 - 11	19 - 0
	Hem-Fir	No.2	6 - 10	10 - 9	14 - 2	17 - 10
	Hem-Fir	No.3	6 - 1	8 - 10	11 - 3	13 - 8
	Southern Pine	SS	7 - 8	12 - 0	15 - 10	20 - 2
	Southern Pine	No.1	7 - 4	11 - 7	15 - 3	18 - 11
	Southern Pine	No.2	7 - 0	11 - 0	13 - 11	16 - 6
	Southern Pine	No.3	5 - 8	8 - 4	10 - 6	12 - 9
	Spruce-Pine Fir	SS	7 - 2	11 - 4	14 - 11	19 - 0
	Spruce-Pine Fir	No.1	7 - 0	11 - 1	14 - 7	18 - 2
	Spruce-Pine Fir	No.2	7 - 0	11 - 1	14 - 7	18 - 2
	Spruce-Pine Fir	No.3	6 - 1	8 - 10	11 - 3	13 - 8
24	Douglas Fir-Larch	SS	7 - 3	11 - 4	15 - 0	19 - 1
	Douglas Fir-Larch	No.1	7 - 0	10 - 11	14 - 2	17 - 4
	Douglas Fir-Larch	No.2	6 - 10	10 - 8	13 - 6	16 - 5
	Douglas Fir-Larch	No.3	5 - 7	8 - 1	10 - 3	12 - 7
	Hem-Fir	SS	6 - 10	10 - 9	14 - 2	18 - 0
	Hem-Fir	No.1	6 - 8	10 - 6	13 - 10	17 - 1
	Hem-Fir	No.2	6 - 4	10 - 0	13 - 1	16 - 0
	Hem-Fir	No.3	5 - 5	7 - 11	10 - 0	12 - 3
	Southern Pine	SS	7 - 1	11 - 2	14 - 8	18 - 9
	Southern Pine	No.1	6 - 10	10 - 9	14 - 2	16 - 11
	Southern Pine	No.2	6 - 6	9 - 10	12 - 6	14 - 9
	Southern Pine	No.3	5 - 1	7 - 5	9 - 5	11 - 5
	Spruce-Pine Fir	SS	6 - 8	10 - 6	13 - 10	17 - 8
	Spruce-Pine Fir	No.1	6 - 6	10 - 3	13 - 3	16 - 3
	Spruce-Pine Fir	No.2	6 - 6	10 - 3	13 - 3	16 - 3
	Spruce-Pine Fir	No.3	5 - 5	7 - 11	10 - 0	12 - 3

1 Bracing shall be provided in accordance with 3.3.1.4.
2 Spans checked for live load deflection only.
NOTE: Spans are limited to 26 feet in length. Check sources for availability of lumber in lengths greater than 20 feet.

Figure 3. Excerpt from 2015 WFCM Table 3.25B2 for common lumber ceiling joist spans.

electronic versions of the 2015 WFCM will receive the WFCM *Commentary* in electronic format at no additional charge.

Conclusion

With more governmental focus placed on "community resiliency," design tools such as the *Wood-Frame Construction Manual* become more relevant. The Manual equips designers with engineered construction methods that result in buildings better able to withstand damage, and protect occupants should disaster strike. Since the WFCM was first published in 1995, AWC has been providing a solution for design of wood-frame structures to resist natural disasters. Each successive edition of the standard continues to provide solutions to more severe events as required by building codes.

The 2015 WFCM represents the state-of-the-art for design of one- and two-family dwellings for high wind, high seismic, and high snow loads. Its reference in the 2015 IBC and 2015 IRC will allow for its use in those jurisdictions adopting the latest building code. However, building officials often accept designs prepared in accordance with newer reference standards even if the latest building code has not been adopted in their jurisdiction. IBC 104.11 and IRC R104.11 for alternate materials and design provides the authority having jurisdiction with that leeway.▪

Table 1 Applicability Limitations

Attribute	Limitation	Reference Section	Figures
BUILDING DIMENSIONS			
Mean Roof Height (MRH)	33'	1.1.3.1a	1.2
Number of Stories	3	1.1.3.1a	-
Building Length and Width	80'	1.1.3.1b	-
LOAD ASSUMPTIONS (See Chapter 2 or Chapter 3 tables for load assumptions applicable to the specific tabulated requirement)			
Load Type	**Load Assumption**		
Partition Dead Load	0-8 psf of floor area		
Wall Assembly Dead Load	11-18 psf		
Floor Dead Load	10-20 psf		
Roof/Ceiling Assembly Dead Load	0-25 psf		
Floor Live Load	30-40 psf		
Roof Live Load	20 psf		
Ceiling Live Load	10-20 psf		
Ground Snow Load	0-70 psf		
Wind Load	110-195 mph wind speed (700-yr. return period, 3-second gust) Exposure B, C, and D		
Seismic Load	Seismic Design Category (SDC) SDC A, B, C, D_0, D_1, and D_2		

Figure 4. Reproduction of 2015 WFCM Table 1 Applicability Limitations.

References

American Society of Civil Engineers. ASCE/SEI Standard 7-10 *Minimum Design Loads for Buildings and Other Structures*. Reston, VA. 2010.

American Wood Council. 2015 *National Design Specification® (NDS®) for Wood Construction*. Leesburg, VA. 2014.

American Wood Council. 2015 *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings*. Leesburg, VA. 2015.

International Code Council. 2015 *International Building Code*. Washington, DC. 2014.

International Code Council. 2015 *International Residential Code*. Washington, DC. 2014.

Showalter, John, Bradford Douglas, Philip Line, Peter Mazikins, and Loren Ross. *2012 WFCM Changes*. STRUCTURE magazine. August 2014.