# *2012 WFCM* Changes

John "Buddy" Showalter, P.E., Bradford K. Douglas, P.E.,
Philip Line, P.E., Peter J. Mazikins, P.Eng., and Loren Ross, E.I.T.

## Introduction

The 2001 Edition of the *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings* (*ANSI/AF&PA WFCM-2001*) was recently updated. The updated standard designated *ANSI/AWC WFCM-2012* was approved November 29, 2011 (Figure 1). The *2012 WFCM* was developed by the American Wood Council's (AWC) Wood Design Standards Committee and is referenced in the *2012 International Residential Code (IRC)* and *2012 International Building Code (IBC)*.

Primary changes to the *2012 WFCM* are listed here and are subsequently covered in more detail:

- Design load provisions are updated per *ASCE/SEI 7-10 Minimum Design Loads for Buildings and Other Structures*
- Wood structural panels are permitted to resist wind uplift
- Shear wall story offset provisions are clarified
- Design values for lumber, structural glued laminated timber, and fasteners are in accordance with the *2012 National Design Specification® (NDS®) for Wood Construction* and *2012 NDS Supplement: Design Values for Wood Construction*
- Engineering design of horizontal diaphragm assemblies and vertical wall assemblies are in accordance with *Special Design Provisions for Wind and Seismic, ANSI/AWC SDPWS-2008*
- Wind exposure categories B and C are incorporated together in Chapter 3 prescriptive provisions
- Header tables include both "dropped" and "raised" header conditions

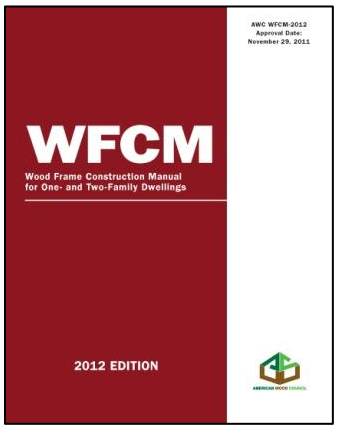


**Figure 1. *Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings*, *2012 Edition***

## *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*:

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

Ground snow loads in the *WFCM* take into account both balanced and unbalanced snow load conditions. Unbalanced snow load provisions were revised in *ASCE 7-05* which resulted in reduced loads (O'Rourke 2006). Those provisions are relatively unchanged in *ASCE 7-10*, resulting in net reductions to snow loads where unbalanced cases govern.

All seismic-related tables in the *2012 WFCM* are updated to new *ASCE 7-10* seismic provisions. New risk-based maps generally reduce areas of highest seismic risk along the New Madrid fault and in the Charleston, SC area. Revised map contours will influence Seismic Design Categories of some geographic areas.

All wind-related tables in the *2012 WFCM* are updated to 700-year return, 3-second gust wind speeds. Revised wind speed maps are on a "strength design" basis. Wind speeds are higher, but load factors for design are also adjusted so that the net effect will be a reduction of wind pressures in some regions (Line 2011). There are separate wind speed maps for each Risk Category in the code, and Exposure D will become applicable again in hurricane prone regions.

When basic wind speeds from *ASCE 7-05* are used, the value shall be converted to the *ASCE 7-10* basis using Table 1.

**Table 1. Wind Speed Conversion**

| ASCE 7-05 Basic Wind Speeds based on 50 yr. return period 3 second gust (mph) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 85 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
| **Equivalent ASCE 7-10 Basic Wind Speeds based on 700 yr. return period 3 second gust (mph)** | | | | | | | |
| 110 | 116 | 129 | 142 | 155 | 168 | 181 | 194 |

While the 90 mph wind speed zone from *ASCE 7-05* and the *2012 IRC* covers approximately the same geographical area as the 115 mph wind speed zone in *ASCE 7-10*, Table 1 shows a slight difference of 116 mph versus 115 mph due to rounding in the direct conversion from the *ASCE 7-05* basis to the *ASCE 7-10* basis. The local authority having jurisdiction should be consulted to determine whether conversion to a 115 mph basis is permissible.

**Wood Structural Panels Resisting Wind Uplift**

Wood structural panels can be used to resist uplift alone or simultaneously resist uplift and shear from wind forces. These provisions were adapted from *the 2008 SDPWS* (Coats 2010). Section 3.2.3 of the *2012 WFCM* now contains provisions for the use of certain wood structural panel shear walls, with a list of requirements for installation and illustrations for nailing. Capacities are based on provisions in the *2005 NDS* and have been verified by full scale testing.

The primary characteristic of this method is increased nailing of panels to framing to provide a continuous load path and enabling uplift loads to be transferred to existing wall anchorage at the foundation. A desire to investigate the inherent uplift capacity of nailed wood structural panel shear walls was the impetus for development of this design method. In the last two decades, as design standards have evolved to address losses associated with high-wind events, designers and home builders have been challenged by the substantially "beefed up" methods and equipment required to resist wind forces. Among the concerns is the number of tie-downs required for shear walls, which can present both cost increases and practical construction challenges. Traditional methods of providing for uplift resistance with additional tie-downs at shear walls can be cumbersome and expensive.

An integral Appendix of the *2012 WFCM* still contains uplift strap and ridge strap capacity tables for those wishing to maintain that option.

**Shear Wall Story Offsets**

Shear wall story offset provisions were clarified in the *2012 WFCM*. Shear wall segments are permitted to be offset out-of-plane from the story below by a maximum distance equal to the depth, d, of the floor joists (Figure 2) where all of the following conditions are met:

- Upper and lower story shear wall segments are attached to the floor diaphragm through wall plate-to blocking connection and wall plate-to band joist connections
- Floor diaphragm wood structural panel sheathing is nailed to blocking and band joist at 6” o.c.
- Allowable unit shear capacity for the shear wall above does not exceed 436 plf for wind or 239 plf for seismic
- Floor joists supporting the shear wall are nominal 2x8 or larger, tripled at ends of shear walls, and provide support for loads from roof and ceiling only
- Continuous load path is provided for uplift and overturning.

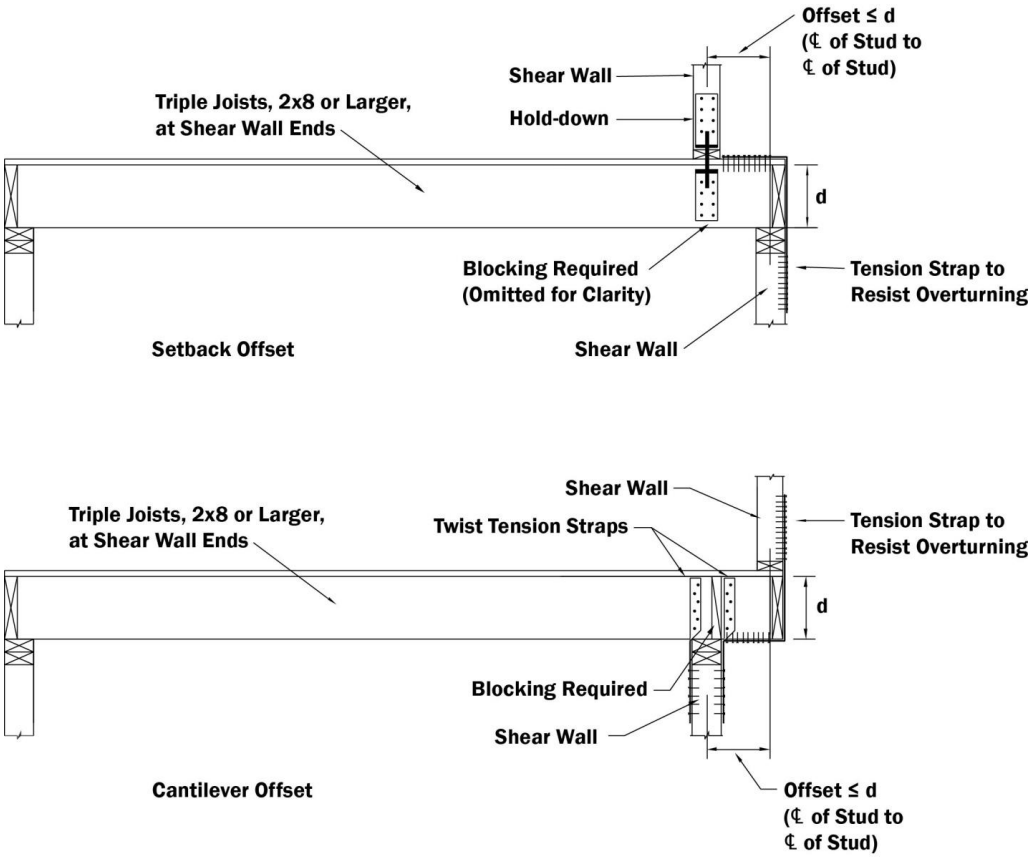


**Figure 2. Shear Wall Story Offset Limits.**

**Design Values**

Design values for structural lumber, structural glued laminated (glulam) timber, and fasteners were incorporated in the integral Supplement of the *2001 WFCM*. The *2012 WFCM* now references the *2012 NDS Supplement* for lumber and glulam design values. For fastener design values, the *2012 NDS* is the reference standard.

**Shear Wall and Diaphragm Design**

Design properties for horizontal diaphragms and shear walls were incorporated in the integral Supplement of the *2001 WFCM*. The *2012 WFCM* now references the *2008 SDPWS* for engineered design of shear walls and diaphragms. Prescriptive tables in *WFCM* Chapter 3 still contain shear wall and diaphragm tables similar to the *2001 WFCM*.

**Wind Exposure B and C Tables**

Wind Exposure C tables were incorporated in a separate Appendix in the *2001 WFCM*. The *2012 WFCM* now integrates Exposure B and C tables together in the prescriptive provisions of Chapter 3.

**More Details**

A comprehensive table listing section by section changes to the *WFCM*, including modifications to Supplement and Appendix material, is included as an appendix to this document.

***WFCM* Availability**

The *2012 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. Check the AWC website (www.awc.org) for status updates on the *2012 WFCM*. Once the

*WFCM Commentary* is complete, those who purchased electronic versions of the *2012 WFCM* will receive the *WFCM Commentary* in electronic format at no additional charge.

**Conclusion**

The *2012 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 *2012 IBC* and *2012 IRC* will allow for its use in those jurisdictions adopting the latest building code. However, building officials are also apt to 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.

**Authors**

John "Buddy" Showalter, P.E. is Vice President of Technology Transfer, Bradford K. Douglas, P.E. is Vice President of Engineering, Philip Line, P.E. is Director of Structural Engineering, Peter J. Mazikins is Senior Manager of Engineering Standards, and Loren Ross is Manager of Engineering Research with the American Wood Council. Contact Mr. Showalter (bshowalter@awc.org) with questions.

**References**

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

American Wood Council. 2012 National Design Specification® (NDS®) for Wood Construction. Leesburg, VA. 2012.

American Wood Council. 2008 Special Design Provisions for Wind and Seismic. Leesburg, VA. 2008.

American Wood Council. 2012 Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings. Leesburg, VA. 2012.

American Wood Council. 2001 Wood Frame Construction Manual (WFCM) for One- and Two-Family Dwellings. Leesburg, VA. 2001.

Coats, Paul. Use of Wood Structural Panels to Resist Combined Shear and Uplift from Wind. *Wood Design Focus*. Vol. 20, No. 2. 2010.

International Code Council. 2012 International Building Code. Washington, DC. 2012.

International Code Council. 2012 International Residential Code. Washington, DC. 2012.

Line, Philip and Bill Coulbourne. ASCE 7-10 Wind Provisions and Effects on Wood Design and Construction. *STRUCTURE Magazine*. January 2011.

O'Rourke, Michael, Peter Mazikins, and John "Buddy" Showalter. Snow Provisions of ASCE 7-05. *STRUCTURE Magazine*. December 2006.

# Appendix – 2012 WFCM Summary of Changes

| Section | Description |
|---|---|
| Chapter 1 | 1) Replaced reference to 2000 IBC with reference to ASCE 7-10 for all loading conditions addressed in the WFCM. All tabulated values adjusted to new loading requirements.<br>2) Added ASCE 7-10 Wind Map for Category II (Residential) structures.<br>3) Moved mean roof height (MRH) adjustments for building heights and exposure conditions from Chapter 1 to Chapter 2. These adjustments only apply to Chapter 2 and were moved to avoid misapplication to Chapter 3 tables and provisions.<br>4) Removed provision for separate check of minimum vertical projected area load for MWFRS as this provision has been reduced from 10 psf to 5 psf roof/10 psf wall in ASCE 7-10 and is now directly checked in the affected WFCM tables.<br>5) Added provision to clarify that special design requirements for torsional load cases have not been checked. WFCM assumes that the lateral force resisting system is in the exterior envelop of the building.<br>6) Added provision to clarify that sliding snow requirements have not been checked since loading condition will be building specific.<br>7) Deleted building aspect ratio limits to avoid confusion with diaphragm aspect ratio limits in Chapters 2 and 3.<br>8) Moved limitations on floor, wall, and roof assemblies and coordinated with specific limitations in Chapters 2 and 3 to avoid confusion.<br>9) Added provision to clarify that design of ancillary structures such as decks, balconies, carports, and porches are not addressed in this standard.<br>10) Updated reference standards.<br>11) Updated definitions to be consistent with the 2012 NDS, 2008 SDPWS, and ASCE 7-10 standards.<br>12) Revised notation to match variable names used in this versions of the standard.<br>13) Moved figures describing Chapter 2 and 3 applicability limits from Chapter 1 to respective chapters and updated references to all figures. |
| Chapter 2 | 1) Moved mean roof height (MRH) adjustments for building heights and exposure conditions from Chapter 1 to Chapter 2. These adjustments only apply to Chapter 2 and were moved to avoid misapplication to Chapter 3 tables and provisions. Added column for Exposure B to clarify that the MRH adjustment is 1.0 for all cases up to 33 feet.<br>2) Added provisions that require additional loading from habitable attics to be considered in design.<br>3) Deleted shear walls from all floor joist cantilever and setback limits in 2.1.3.2c and 2.1.3.2d to clarify that these provisions are for gravity design only. Offsets |

| Section | Description |
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| | for shear walls are covered in 2.1.3.3d.<br>4) Modified shear wall offset provisions to prohibit upper story shear wall segments from being offset in-plane or out-of-plane from lower story shear wall segments unless designed (2.1.3.3.d).<br>5) Replaced shear wall aspect ratio limit with reference to SDPWS to incorporate sheathing-type specific limits.<br>6) Replaced lumber, glulam, and SCL design provisions and WFCM Supplement design values with reference to 2012 NDS and 2012 NDS Design Value Supplement, respectively, to ensure proper design and that framing design values are current.<br>7) Replaced shear wall and diaphragm design provisions and WFCM Supplement design values with reference to 2008 SDPWS to ensure proper design and that shear wall and diaphragm design values are current.<br>8) Replaced nail design provisions and WFCM Supplement design values with reference to 2012 NDS to ensure proper design and that fastener design values are current.<br>9) Updated Tables 2.5A and 2.5B for wind perpendicular and parallel to ridge respectively, and Table 2.6 for seismic motion to meet new provisions in ASCE 7-10.<br>10) Replaced reference to TPI's *Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses, HIB-91* with SBCA/TPI's *Building Component Safety Information (BCSI) – Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses.*<br>11) Clarified that rafter spans in Tables 2.14A-D are based on horizontal projected length.<br>12) Moved figures describing Chapter 2 applicability limits from Chapter 1 to Chapter 2 and updated references to all figures.<br>13) Updated tables to use new design loads per ASCE 7-10. |
| Chapter 3 | 1) Limited prescriptive designs in Chapter 3 to Wind Exposures B and C only. Tables for both exposures are now included in Chapter 3.<br>2) Replaced provision that required an attic to be considered a separate story when the roof slope is greater than 6 in 12 with a) new requirement that habitable attics be considered an additional floor for purposes of determining gravity and seismic loads, and b) new footnotes to all lateral wind design tables (diaphragm, shear wall, and shear connection tables) that adjust bracing requirements for increased roof slopes and eave-to-ridge heights.<br>3) Deleted shear walls from all floor joist cantilever and setback limits in 3.1.3.2c and 3.1.3.2d to clarify that these provisions are for gravity design only. Offsets for shear walls are covered in 3.1.3.3d.<br>4) Clarified provisions in 3.1.3.3c for shear wall line offsets exceeding 4 feet. Added language to exception providing guidance on distribution of shear loads |

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| | into shear wall lines proportional to the diaphragm area tributary to each shear wall line or by other accepted engineering practice.<br>5) Modified shear wall offset provision to prohibit upper story shear wall segments from being offset in-plane or out-of-plane from lower story shear wall segments (3.1.3.3.d) with an exception that permits out-of-plane offsets up to the floor joist depth when designed in accordance with specific limits.<br>6) Moved prescriptive uplift strap connection table (3.4B), which is based on generic steel strapping values, to the appendix (A-3.4).<br>7) Added provisions requiring roof-to-top plate connections to be on the same side of the wall as top plate to stud connections unless other methods are used to prevent twisting of the top plate due to eccentric loading.<br>8) Added provisions permitting wood structural panels (WSPs) to be used to resist uplift when designed in accordance with a new section (3.2.3) on design of WSPs to resist uplift. The provisions of and figures in the new WSP uplift section were taken directly from the 2008 SDPWS standard.<br>9) Moved prescriptive ridge strap connection table (3.6A), which is based on generic steel strapping values, to the appendix (A-3.6).<br>10) Moved stud height limit from Tables 3.23A-B footnote to a new Table 3.23C and referenced the table directly in the provisions.<br>11) Revised the reference shear wall configuration to wall studs spaced at a maximum of 16" o.c., sheathed with 3/8 inch wood structural panels on the exterior attached with 8d common nails at 6 inch o.c. at panel edges and 12 inches o.c. in the field, and 1/2 inch gypsum wallboard on the interior attached with 5d cooler nails at 7 inches o.c. at panel edges and 10 inches o.c. in the field. All affected tables revised.<br>12) Deleted requirement for adding an extra story to the building design when the bottom floor is elevated above grade. The new seismic shear wall, diaphragm and connection tables have been increased by the loads from the out-of-plane foundation walls. The foundations are assumed to be rigid and not contribute to the vertical redistribution of forces in the structure.<br>13) Replaced complicated interior shear wall geometry requirements with simpler provisions that require the structure to be designed as separate structures attached in the plane of the interior shear wall and clarifying that the shear wall length of the shared wall (interior shear wall) shall be the sum of the lengths required for the shear wall of each attached structure.<br>14) Added clarification that the shear wall length requirements in both Tables 3.17A and 3.17C must be multiplied by the appropriate full-height sheathing length adjustment factors in Table 3.17E.<br>15) Added clarification that hold-down capacities in Table 3.17F must be divided by the appropriate length adjustment factor in Table 3.17D.<br>16) Clarified that rafter spans in Tables 3.26A-H are based on horizontal projected length.<br>17) Moved figures describing Chapter 3 applicability limits from Chapter 1 to |

| Section | Description |
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| | Chapter 3 and updated references to all figures.<br>18) Updated tables to use new design loads per ASCE 7-10 and resistances per 2012 NDS and 2008 SDPWS. Specific revisions to tables include the following:<br>1. All lateral wind bracing tables (diaphragm, shear wall, and shear connection tables) have been calculated assuming an eave-to-ridge height of 10 feet and a wall height of 10'. Tabulated requirements are based on the wind perpendicular to ridge condition (worst case) rather than providing separate tables for parallel and perpendicular to ridge removing need to specify parallel and perpendicular to ridge directionality and addressing effects of dormers, Dutch hips, etc. New footnotes to all lateral wind design tables adjust bracing requirements for increased roof slopes and eave-to-ridge heights.<br>2. All lateral seismic bracing tables (diaphragm, shear wall, and shear connection tables) have been calculated assuming a reference condition with the following dead load assumptions:<br>a. Roof/Ceiling Assembly = 15 psf<br>b. Floor Assembly = 12 psf<br>c. Exterior Wall Assembly = 18 psf<br>d. Partition Wall = 8 psf<br>Adjustment factors are used to adjust for various combinations of other dead load conditions:<br>a. Roof/Ceiling Assembly = 25 psf<br>b. Floor Assembly = 20 psf<br>*c.* Exterior Wall Assembly = 11 psf<br>3. New table added (Table 3.4A) that provides maximum roof spans for each wind speed that can utilize wood structural panels to resist uplift.<br>4. Roof sheathing attachment requirements for wind loads (Table 3.10) has been expanded to address two specific gravity ranges directly in tabular values rather than in complicated footnotes.<br>5. Shear wall design values and adjustment factors for various shear wall configurations were updated for consistency with 2008 SDPWS.<br>6. Exterior stud design tables (Table 3.20A&B) for wind were modified to cover h/180, h/240, and h/360 deflection limits as required in current model codes for flexible finishes (with gypsum wallboard on the interior), brittle finishes, and very brittle finishes (plaster or stucco), respectively. The 2001 WFCM limited deflection to h/120, previously the only code-required wall deflection limit for wind. After review of test data and analysis, it was determined that the Wall Stud Repetitive Member factor ($C_r$) for wind design from 2008 SDPWS is applicable to wall studs up to 24" o.c. and that a composite action factor at least equal to the $C_r$ factor is applicable to bending stiffness calculations. These changes were incorporated into the new tables.<br>7. Header tables were expanded to include single-ply headers consistent with |

| Section | Description |
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| | new energy code provisions, spans up to 20' to accommodate double-car garage doors, and new glulam header sizes. Also, header tables were calculated for dropped headers and raised header support conditions.<br>8. Rafter live load span tables were separated from rafter snow load span tables to clarify that design for wind loading of rafters can be addressed by adjusting the live load tables with simple factors covered in the footnotes. |
| Appendix | 1) Removed Exposure C prescriptive wind design tables from Appendix since they are now included in Chapter 3.<br>2) Moved prescriptive uplift strap connection table (3.4B), which is based on generic steel strapping values, to the appendix (A-3.4).<br>3) Moved prescriptive ridge strap connection table (3.6A), which is based on generic steel strapping values, to the appendix (A-3.6). |
| Supplement | WFCM design value supplement tables were previously based on the 2001 NDS or other sources. With direct reference to these standards, this duplication is no longer necessary or warranted. Only those tables which are not referenced in the 2012 NDS or 2008 SDPWS are included in the WFCM Supplement section. These tables include:<br>1) Table S-1 Maximum Spans and Allowable Total Uniform Loads for Floor Sheathing<br>2) Table S-2 Maximum Spans and Allowable Total Uniform Loads for Roof Sheathing (live and snow loads)<br>**3)** Table S-3 Shear Capacities for Horizontal Diaphragm Assemblies (for gypsum wallboard ceiling diaphragms) |