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Changes to California's Building Code for Construction in Wildfire Prone Areas: Impact on Wood and Wood-based Materials

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Abstract

Since 2008 a new chapter in the California Building Code (CBC) has been in effect for new construction, both residential and commercial, in designated wildfire prone areas in the state. The requirements for the affected exterior building materials and assemblies consist of a limited number of performance and prescriptive options, one of which must be met for a given component to comply. Performance options are based on meeting minimum heat release requirements or those related to flame penetration restrictions into underlying building cavities. Currently the applicable standard test methods are designated as either California State Fire Marshal standards or American Society of Testing and Materials (ASTM) standards. Low-rise residential construction in the United States is still largely wood-framed, and combustible building materials, including wood and wood-based materials, are commonly used. These materials can currently comply for use in the new building code by one of the performance options, and in the future will be able to via certain prescriptive options. A review of the building code, including those related to vegetation management requirements near the building, and the prescriptive options and test methods that can be used for complying with the code requirements will be reviewed. Changes in product use, particularly as related to wood and wood-based materials, will be reviewed.

Keywords wildfire, building standard, test methods

Introduction

Since 2008, Chapter 7A, a new chapter in the California Building Code (CBC) has been in effect for new construction, applying to both residential and commercial buildings, in designated wildfire prone areas in the state. The requirements for the affected exterior building materials and assemblies consist of a limited number of performance and prescriptive options, one of which must be met for a given component to comply. Ignition resistant construction, as implemented

and defined in this code, allows for the use of combustible materials that exhibit some minimum heat release rate and/or fire resistant property (i.e, an ability to resist flame penetration when subjected to a defined fire exposure). Wood and wood-based materials comply prescriptively by meeting the criteria for "heavy timber", or via passing standard fire tests that evaluate heat release rate, flame spread, or fire resistance.

The building code incorporates the vegetation management requirements mandated in California Public Resources Code Section 4291, thereby making an explicit link between vegetation management (i.e., the "defensible space" surrounding a building) and the construction materials and building design features when mitigating potential loss to buildings during wildfires.

Overview of Chapter 7A of the California Building Code

Chapter 7A of the California Building Code applies to most exterior components found on the building exterior. These include the roof covering and eave, attic, wall and foundation vents (if present), deck surfaces, windows, exterior siding and doors (including vehicle access doors) and any floor projections. Certain components were not been included, including skylights, trim and fascia. In addition, the structural support members of a deck are not restricted (i.e., they only need to comply with structural and, if required, any other (non-wildfire) performance related requirements).

The building code provides two or more prescriptive and/or performance-based options for a material to comply for use as a given component. For example, a deck board can comply for use in wildfire prone areas by meeting the code definition of "noncombustible" (e.g., concrete or stone surface), or by meeting the minimum heat release rate requirement set forth in a California Office of the State Fire Marshal (OSFM) test standard.

Chapter 7A makes an explicit link between vegetation management requirements (typically referred to as "defensible space") and building survival during wildfires. Therefore, even though Chapter 7A nominally requires ignition resistant construction, combustible materials are approved for use as long as they meet one of the prescriptive or performance requirements. As already stated, these requirements include meeting minimum heat release rates during testing, or complying with a fire test that evaluate resistance to flame penetration through the exterior cladding material into the adjoining cavity (e.g., the stud cavity or eave/attic space).

An example poor vegetation management is shown in Figure 1. Vegetation management requirements are given in the California Public Resources Code (PRC) 4291 and Government Code Section 51182. A link to the most recent version of this code can be found at the OSFM website at http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes.php.
The goal of the defensible space requirements is to minimize the opportunity for the wildfire to reach the building by disrupting the continuity of vegetative fuel. The continuity is disrupted by managing the horizontal distance between vegetation (or groups of vegetation) and vertical distance between the surface fire and vegetation (i.e., eliminating ladder fuels). Because of the proximity to the building, and amount of vegetation, the vegetation shown in Figure 1 would not comply with the defensible space requirements.

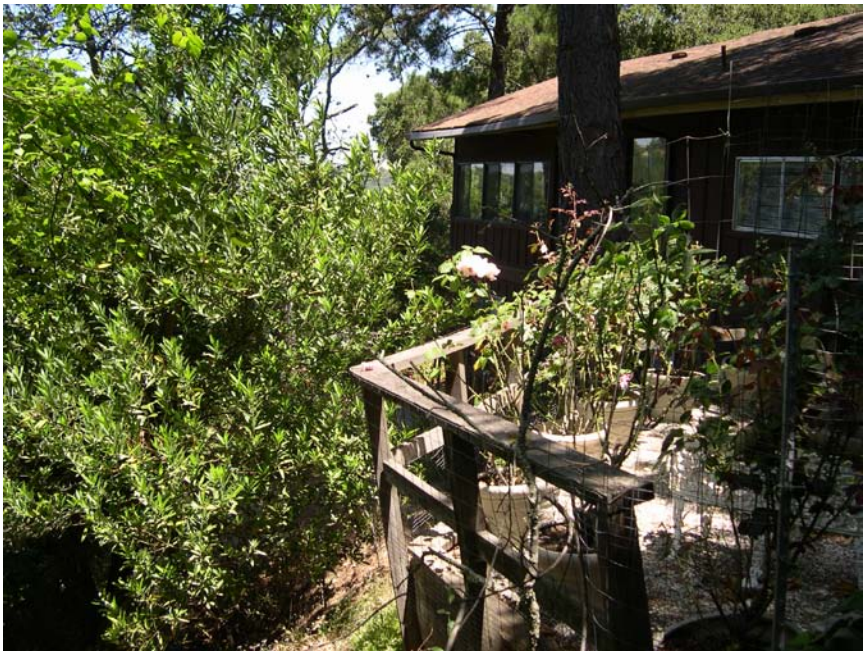

Figure 1. Chapter 7A of the California Building Code assumes compliance with the vegetation management requirements outlined in California Public Resources Code 4291 (for more rural areas) and Government Code Section 51182 (for wildfire prone areas in more urban areas. These documents provide "defensible space" requirements for the building.

Summary of Test Standards Referenced in the Building Code

Chapter 7A in the California Building Code references already established ASTM standards and State Fire Marshal (SFM) Standards that were specifically approved for use with this code (California Building Code Test Standards 2010). These standards are summarized in Table 1.

The roofing requirements reference ASTM E 108 and the minimum fire rating is the same as that indicated in Chapter 15 (Roof Assemblies and Rooftop Structures) of the building code. Chapter 15 requires a Class A roof covering in Very High Fire Hazard Severity Zones, Class B in High Fire Hazard Severity Zones and Class C in High Fire Hazard Severity Zones. Fire retardant treated shakes and shingles that have complied with the OSFM natural weathering requirements (prior to fire testing) are allowed.

Chapter 7A states that vents shall resist the intrusion of embers (firebrands) and flames, however, a standard test procedure is not currently available to evaluate vent performance under these exposures. The OSFM has accepted certain vents for use based on testing performed by certified fire test laboratories. It is likely that once a standard test procedure has been approved, these "accepted" vents will have to test to the approved standard.

Table 1. A summary of the standard test methods referenced in Chapter 7A.

Component	Standard		Exposure and Evaluation Criteria	
	ASTM	OSFM[1]	ASTM	OSFM
Roofing	E 108	-----	Criteria used for Class A, B or C fire rating.	-----
Decking	-----	SFM Standard 12-7A-4	-----	Under-deck flame contact exposure with minimum heat release and other requirements; Burning Class A brand on top of deck, meeting requirements.
Decking – Alternate Method	-----	SFM Standard 12-7A-4A	-----	Under-deck flame contact exposure, minimum heat release requirement.
Siding	E 2707[2]	SFM 12-7A-1	----	Flame contact exposure; flame cannot penetrate through siding.
Eave	-----	SFM 12-7A-3	-----	Flame contact exposure; flame cannot penetrate into enclosed space.
Window	-----	SFM 12-7A-2[3]	-----	Flame contact exposure; flame cannot penetrate though glass or frame.
Ignition Resistant Material	E 84 and D 2898	SFM 12-7A-5[4]	----	After weathering, pass flame spread requirement after 30-minute test.

[1] SFM designation used in this document will become effective January 1, 2011.
[2] ASTM E 2707 is based on SFM SFM 12-7A-1 and was recently approved as an ASTM standard. The 2011 version of Chapter 7A only references the SFM standard.
[3] This far, window manufacturers have not used this test. The prescriptive method, incorporating a minimum of one tempered glass pane in a dual-pane window has been the preferred way to comply.
[4] This standard will be referenced beginning in the 2011 code. It is based on the weathering exposure given in ASTM D 2898 and horizontal flame spread test given in ASTM E 84.

Chapter 7A only applies to the walking surfaces of the deck (including stair treads and landings). The structural support system is not restricted in Chapter 7A, and deck enclosure is not required. Standard SFM 12-7A-4 incorporates an under-deck flame impingement exposure component and a top-of-deck burning brand exposure. An under-deck is shown in Figure 2. Conditions of acceptance for the under-deck exposure include a maximum allowable net heat release rate of 269 kW/m^2, absence of sustained flaming or glowing combustion of any kind at the conclusion of a 40-min observation period, and absence of falling particles that are burning when they reach the floor. The top-of-deck test calls for an ASTM E 108 burning Class A brand to be placed on the deck, with the deck placed at the end of an ASTM E 108 wind tunnel. The conditions of acceptance include absence of sustained flaming or glowing combustion of any kind at the conclusion of a 40-min observation period and absence of falling particles that are burning when they reach the floor.

Figure 2. A plastic deck product subjected to the under-deck flame contact exposure test described in SFM 12-7A-4. The flame exposure lasts three minutes. As formulated, this decking product would not meet the heat release rate requirement and therefore would not be approved for use in wildfire prone areas.

The window, siding, and eave test use the same test apparatus, and are all a flame penetration test. The flame contact exposure is generated by a gas diffusion burner positioned at the base of the wall containing the window, wall, or eave assembly. The burner output for the window and siding test is 150 kW, and is based in part on vegetation testing done at the University of California Fire Research Laboratory (Etlinger and Beall 2004). These plants were considered typical of those that could be placed near the building, adjacent to siding and windows. The burner output for the eave test is 300 kW, set higher in order for the burner flames to reach the eave. Flame penetration into the enclosed space behind the wall, window or eave during the test would constitute failure, and therefore would not comply for use in these designated wildfire prone areas. In the case of the siding and eave tests, underlying sheathing materials is allowed and can improve performance of the exterior material.

Chapter 7A introduced a definition for an “ignition resistance material” that relies on a building code developed procedure to determine whether a fire retardant treated wood product could be considered exterior-rated. Chapter 7A took the adopted procedure to determine whether or not a material can be called “ignition resistant”. The procedure includes exposing the material to an accelerated weathering regime described in ASTM D 2898, followed by testing to an extended [30-minute] horizontal flame spread test following ASTM E 84. The code allows materials that comply as ignition resistant to be used as a number of components (e.g., siding and soffit material).

Implication for Wood and Wood-based Building Products

Wood and wood-based building products have not been excluded from use as a result of the adoption of Chapter 7A, but they have had to demonstrate compliance but testing to one of the required test standards. Untreated redwood (*Sequoia sempervirens*) and ipe (*Tabebuia* spp.) can comply to the code requirements for decking without being treated with a fire-retardant and therefore exterior-rated fire retardant decking is not widely used. Many wood-plastic composite decking product manufacturers had to redesign and reformulate their product in order to comply (Quarles et al. 2004), and most have done that. Figure 3 shows a demonstration of the fire performance of decking that both comply and do not comply with Chapter 7A provisions. The ignition source for each was the same. The performance of the non-compliant deck is noticeably different than the others.

As already stated, fire retardant treated shakes and shingles that have complied with the OSFM natural weathering requirements (prior to fire testing) are allowed to be used in a roof covering. However, some local jurisdictions in the will not allow these products because of concerns regarding the durability of the treatment.

Figure 3. A photograph of a fire demonstration showing differences in performance between three different decks. From right to left, a solid untreated redwood deck (complies with code requirements), a wood plastic composite product (complies with code requirements), and a wood plastic composite product (non-compliant). All decks were initially subjected to a burning ASTM Class B placed on top of the deck. This photograph was taken approximately 30 minutes after the start of the test.

Most solid wood siding products with an integral lap joint (e.g., ship-lap and tongue and groove) have passed the required test that evaluates flame penetration into the underlying stud cavity. Because of seismic requirements in California, structural sheathing (plywood or oriented strand board) is commonly used. This sheathing contributes to the resistance to penetration into the underlying cavity. Wood composite siding (oriented strand board and hardboard) have complied, but they also incorporate a gypsum sheathing panel in the wall assembly. As shown in Figure 4,

the siding test standard does not directly evaluate flame spread, and therefore use of combustible siding can result in a flame contact exposure at a window, or eave area.

Trim and fascia are not directly addressed in Chapter 7A and therefore any product can be used in this location. Given that untreated wood siding and decking products can comply with the code, marketing opportunities for exterior-rated wood products is limited. Use of treated trim products, particularly at reentrant corners, would seem like a good opportunity, given the potential vulnerability of this area. Given that code is "silent" on this component, the incentive to pay the added cost for a fire-retardant-treated product is not present. Surface coatings (paints and stains) are not allowed as a way to comply with Chapter 7A.

Figure4. A photograph of a fire demonstration using a wall corner section. A hardboard siding product (left, burning) and fiber cement product (right, not burning) were subjected to a burning American Society of Testing and Materials (ASTM) E-108 Class A brand, placed at the base of the wall. The test standard for siding does not directly evaluate flame spread.

Summary

The building code makes and explicit link between vegetation management ("defensible space") and construction materials and building design and building survival during wildfires. Ignition resistant construction, as implemented in this code, allows for use of combustible materials that exhibit some minimum heat release rate and/or fire resistant property (i.e, ability to resist flame penetration).

Most wood and wood-based building products have complied for use in the wildfire zones. Some have had to reformulate by adding fire-retardants, and others need to incorporate additional sheathing materials in the installed assembly. As a result of compliance of non-treated solid wood products, use of exterior rated fire-retardant treated products has been minimal.

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