

Wood I-Joist Floors, Firefighters and Fire

Prefabricated wood I-joists are used in approximately 50 percent of new raised-floor wood-frame construction. When compared to sawn lumber, wood I-joists are stronger, stiffer, and lighter in weight. They are considered a “premium” floor joist and are typically the preferred design choice in larger rooms and open designs favored by many homebuyers and designers. They are also environmentally friendly by making optimum use of a renewable forest resource and are manufactured to exacting industry quality standards.

1. CODE REQUIREMENTS

Life safety of the occupants has traditionally been the focus of building codes, both for structural safety and fire safety. Occupants of single-family homes nearly always have numerous paths of egress (doors and windows) from fire available to them. In addition, the requirement for smoke detectors in all new homes has been a requirement in the first edition of International Building Code (IBC) and the International Residential Code (IRC) since 2000. Burning materials typically emit smoke prior to combustion. It has been estimated that smoke detectors give most occupants three to five minutes to escape from a burning home before smoke and flame become life threatening. Since the introduction of smoke detectors into homes, fire deaths have been reduced by nearly 50 percent. They are considered the homeowners’ primary means of defense against injury or death from fire. Section 907.2.11 of the 2015 IBC, Section R314.2 of the 2015 IRC, and Section 3.2.4.21 of the 2010 National Building Code of Canada (NBC) require single-family homes to have smoke detectors.

Starting from January 1, 2011, one- and two-family dwellings are required by the IBC and IRC to be sprinklered (2009, 2012, and 2015 IBC Section 903.2.8, and 2009, 2012, and 2015 IRC Section R313.2). However, not all local jurisdictions in the U.S. have adopted these provisions. In the 2012 IRC, new fire protective membrane provisions were introduced, requiring the following:

R501.3 Fire protection of floors. *Floor assemblies, not required elsewhere in this code to be fire resistance rated, shall be provided with a 1/2-inch (12.7 mm) gypsum wallboard membrane, 5/8-inch (16 mm) wood structural panel membrane, or equivalent on the underside of the floor framing member.*

Exceptions:

1. *Floor assemblies located directly over a space protected by an automatic sprinkler system in accordance with Section P2904, NFPA13D, or other approved equivalent sprinkler system.*
2. *Floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances.*
3. *Portions of floor assemblies can be unprotected when complying with the following:*
 - 3.1 *The aggregate area of the unprotected portions shall not exceed 80 square feet per story.*
 - 3.2 *Fire blocking in accordance with Section R302.11.1 shall be installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.*
4. *Wood floor assemblies using dimension lumber or structural composite lumber equal to or greater than 2-inch by 10-inch (50.8 mm by 254 mm) nominal dimension, or other approved floor assemblies demonstrating equivalent fire performance.*

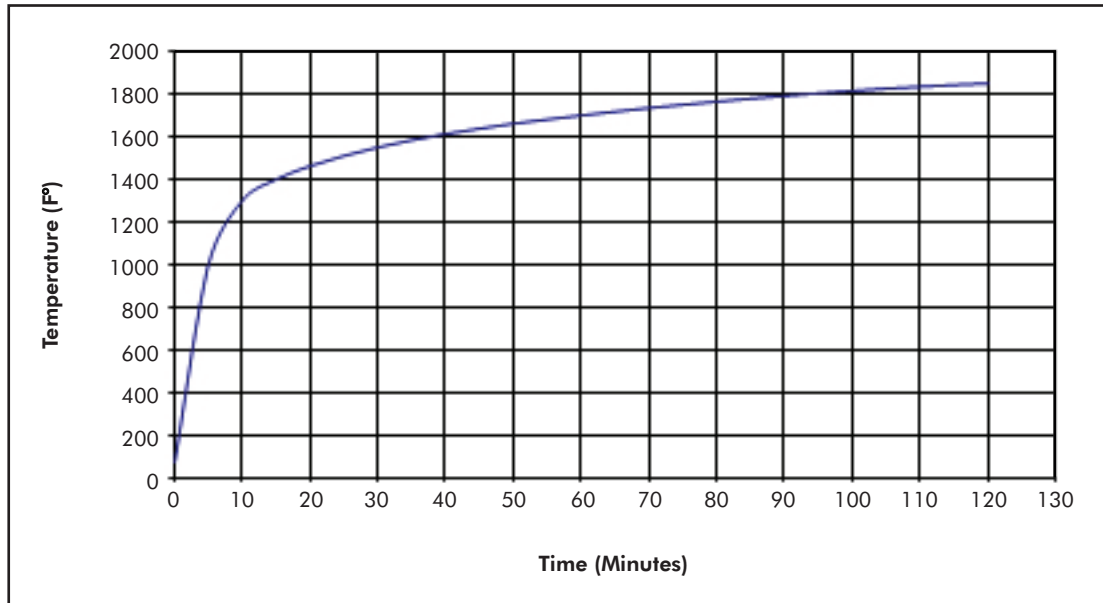
In the 2015 IRC, these provisions are located in Section R302.13.

It should be noted that these fire protective membrane provisions apply to not only I-joint floors, but all residential floor assemblies, including floor trusses, light-gauge steel framing, and dimension lumber and structural composite lumber less than 2-inch-by-10-inch nominal dimension. This provision becomes effective when adopted by the local jurisdiction.

2. FIRE TESTS

The standard fire tests used to evaluate floor assembly performance are ASTM E119, NFPA 251, or CAN/ULC-S101 (in Canada). In the full-sized version of these tests, a constructed floor assembly that is approximately 14 feet x 17 feet is placed on a furnace cavity fired by natural gas. The underside of the assembly is directly exposed to flame and supported only by the edges of the furnace walls. The rate of temperature rise is carefully controlled to follow the standard's time-temperature curve, as shown in Figure 1. The value of the standard test fire is that it is repeatable from test to test and lab to lab. This permits a direct, consistent way of comparing the fire endurance of one assembly to another.

Figure 1. Standard Time-Temperature Curve for Control of Fire Tests



3. FLOOR BEHAVIOR DURING FIRES

It is widely recognized that real structure fires, unlike the standard ASTM, NFPA or CAN/ULC test fires, are highly variable in their size, rate of growth and intensity. Responding firefighters are unlikely to know when a given fire started, how hot it has been prior to arrival, how long it has been at any given temperature, the design capacity and actual loads on the floors over the fire or the amount of actual damage that the fire may have done to the joists. All of these factors make it impossible to predict the remaining capacity of a floor by even the most knowledgeable fire experts.

Firefighters should be aware that while floor sag may be a widely accepted warning of an impending structural failure, floor sag is not always present or visible prior to catastrophic collapse in a fire, regardless of the joist type, due to the fire's intensity, the combination of joist spans and loads present, the location of serious structural fire damage or simply because it is too dark and/or smoky to see sag in the floor. This is true for all types of structural joists, including combustible materials such as sawn lumber, wood I-joists, and open web wood trusses, and noncombustible members such as lightweight steel joists.

When unprotected, any lightweight residential floor assembly, either combustible or noncombustible, may fail within just a few minutes of the fire's ignition. Therefore, when there is a serious fire beneath a floor, there is no "safe" amount of time that anyone can remain on that floor. Even a protected floor system can fail unpredictably when exposed to a substantial fire beneath.

4. GYPSUM WALLBOARD PROVIDES ADDITIONAL FLOOR PROTECTION

Millions of homes have been built and are still being built with exposed wood floor joists—typically over some type of habitable basement area. The lack of a code-mandated fire-resistance requirement, such as a requirement for a one-hour fire-rated floor, means that the floor framing may not be protected on the underside.

A simple, inexpensive, yet significant increase in fire resistance can be achieved in any type of joist or truss system by simply adding a single layer of gypsum wallboard to the underside of the floor joists. The use of 1/2-inch-thick ordinary, unrated gypsum wallboard will very likely more than double the fire-endurance time for all commonly used wood floor joist systems, including sawn lumber, open web wood trusses, and I-joists.

Based on this, APA supports the addition of a 1/2-inch gypsum wall board or 5/8-inch wood structural panel fire protective membrane or equivalent to the underside of floor framing, as required by Section R501.3 of the 2012 IRC and Section R302.13 of the 2015 IRC (see Section 1 of this document). The designer and builder shall consult with the local building department or authority having jurisdiction for specific requirements of fire protection in any building construction.

5. APA SYSTEM REPORT SR-405

APA System Report 405: Fire Protection of Floors Constructed with Prefabricated Wood I-Joists for Compliance with the International Residential Code, Form SR-405, www.apawood.org, provides several practical options for design and construction for fire protection of floor assemblies built with prefabricated wood I-joists that satisfy the 2012 IRC Section R501.3 or 2015 IRC Section R302.13 requirements. The report was developed based on the results of fire tests that met the stringent criteria established by the International Code Council Evaluation Service (ICC-ES) Acceptance Criteria for Prefabricated Wood I-Joists, AC14. These options include:

- Gypsum board or wood structural panel ceiling membranes
- Gypsum board applied directly to I-joist flanges and webs
- Gypsum board applied to entire I-joist depth
- Mineral wool insulation batt
- Ceramic fiber blanket
- Gypsum board installed on top of the bottom flange
- Fire protective coatings

For complete information on all of these options, refer to *APA System Report SR-405*.

6. SUMMARY

It is important for everyone (homeowner, building official, firefighter and others) to remain aware that no amount of additional protection will make any floor “safe” for any predictable minimum length of time when the underside of that floor is exposed to an intense fire. All floor assemblies, however, will endure a severe fire longer if protected, regardless of the type of floor framing.

Thus, firefighter and occupant safety can be addressed by early evacuation of occupants through the use of smoke detectors, by adding fire suppression (sprinkler) systems, and by the use of gypsum wall board and/or other products designed to protect the floor assemblies. Also important is firefighter education and pre-planning. The wood industry has been actively involved with the United States Fire Administration (USFA) in providing educational materials for the fire service and this effort is continuing.

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:

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