APA

Fire Protective Options for I-Joist Floor Systems

CONSTRUCTION GUIDE

O.K.
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10-30-17

Wood: The Natural Choice

Engineered wood products are among the most beautiful and environmentally friendly building materials. In manufacture, they are produced efficiently from a renewable resource. In construction, the fact that engineered wood products are available in a wide variety of sizes and dimensions means there is less jobsite waste and lower disposal costs. In completed buildings, engineered wood products are carbon storehouses that deliver decades of strong, dependable structural performance. Plus, wood's natural properties, combined with highly efficient wood-frame construction systems, make it a top choice in energy conservation.

A few facts about wood:

We're growing more wood every day. For the past 100 years, the amount of forestland in the United States has remained stable at a level of about 755 million acres. Forests and wooded lands cover over 40 percent of North America's land mass. Net growth of forests has exceeded net removal since 1952; in 2011, net forest growth was measured at double the amount of resources removed. American landowners plant more than two-and-a-half billion new trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 13 percent of forestland ownership, plants more than one-and-a-half billion trees a year—about four million trees planted every day.

U.S. Forest Growth and All Forest Product Removals

Billions of cubic feet/year

Source: USDA - Forest Service, 2013

Manufacturing wood is energy efficient. Over 50 percent of the energy consumed in manufacturing wood products comes from bioenergy such as tree bark, sawdust, and other harvesting by-products. Very little of the energy used to manufacture engineered wood comes from fossil fuels. Plus, modern methods allow manufacturers to get more out of each log, ensuring that very little of the forest resource is wasted.

Life Cycle Assessment measures the long-term green value of wood. Studies by CORRIM (Consortium for Research on Renewable Industrial Materials) give scientific validation to the strength of wood as a green building product. In examining building products' life cycles—from extraction of the raw material to demolition of the building at the end of its long lifespan—CORRIM found that wood had a more positive impact on the environment than steel or concrete in terms of embodied energy, global warming potential, air emissions, water emissions and solid waste production. For the complete details of the report, visit www.CORRIM.org.

Wood adds environmental value throughout the life of a structure. When the goal is energy-efficient construction, wood's low thermal conductivity makes it a superior material. As an insulator, wood is six times more efficient than an equivalent thickness of brick, 15 times more efficient than concrete, and 206 times more efficient than steel.

Good news for a healthy planet. For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood is the natural choice for the environment, for design, and for strong, resilient construction.

Better Floors. Better Fire Protection.

Wood I-joist floor assemblies are a superior choice in residential construction because the I-joists give builders and homeowners a high-quality floor system that is reliable, flatter and quieter. In fact, I-joists are now the floor framing material of choice in approximately 50 percent of framed floors in U.S. single-family homes.

Builders like I-joists because they provide consistent performance and reduce the cost of callbacks for squeaks and bouncy floors. They are readily available and easy to install, especially for long spans, including continuous spans over intermediate supports. Plus, builders have many options when it comes to constructing I-joist floor assemblies that comply with code requirements.

Some states and jurisdictions have updated their requirements related to floor system performance. Both the 2012 and 2015 versions of the International Residential Code (IRC) include provisions to enhance the fire performance of floor systems. For example, the IRC requires that all residential floor assemblies, with a few exceptions, be covered with gypsum board or have some other means of fire protection.

Better fire protection is essential—not only in meeting code but for homeowners' peace of mind. Code agencies and I-joist manufacturers are dedicated to safe construction and the protection of buildings and residents. The code-compliant options described in this guide give builders alternatives for design and construction of high-quality floor systems that deliver superior structural performance and improved fire resistance that protects both home occupants and firefighters.

EXCEPTIONS TO THE IRC FIRE PROTECTION REQUIREMENTS

Designers and builders should also note that there are some exceptions to 2012 IRC Section R501.3 and 2015 IRC Section R302.13 that make enhanced fire protection unnecessary, such as floors constructed with 2x10 dimension lumber, structural composite lumber, or their equivalent. Also, floor assemblies located directly over a space protected by an automatic sprinkler system do not require a fire protective membrane. Home sprinkler systems are currently not the norm but are gaining traction in some regions. According to the National Fire Protection Association (NFPA), residential fire sprinkler ordinances have been adopted by several hundred U.S. communities for use in single-family homes. While cost is a factor for sprinkler systems, NFPA reports that costs have been decreasing in communities where sprinklers are required.

Another exception is when only a small area of the floor is unprotected (less than or equal to 80 square feet per story), provided code-required fire blocking is in place to separate the unprotected portion from the remainder of the floor assembly.

Enhanced fire protection is not required for floors over crawl spaces, provided the crawl space is not intended for storage or contains fuel-fired appliances. If the crawl space is intended for storage or fuel-fired appliances, builders may want to consider installing a durable membrane, such as 5/8-inch wood structural panels, which are recognized in the code.

STRATEGIES TO MEET FLOOR ASSEMBLY FIRE-PROTECTION PROVISIONS

The eight methods in this guide can be used in jurisdictions where 2012 IRC Section R501.3 or 2015 IRC Section R302.13 has been adopted and implemented. In each of these methods, the I-joists must meet the provisions of ASTM D5055, and be installed and constructed in accordance with codes, APA Product Reports or code evaluation reports, and manufacturer's instructions.

Of these methods, APA recommends two simple systems that make it easier for builders to provide code-compliant fire protection for I-joist floor systems. These systems use gypsum board set on top of the bottom flanges of the joists. Both options are easy to install, do not require fasteners or adhesives and are easy to temporarily remove when necessary to access mechanical systems.

One option uses 1/2-inch gypsum board installed on top of the bottom flange for joists spaced 19.2 inches or less on center (FP-06). The second option calls for 5/8-inch gypsum board where joists are spaced up to 24 inches on center (FP-07).

These and additional assemblies that meet the requirements of the 2012 and 2015 IRC are detailed in this guide and in APA System Report SR-405, available for free download from the APA website, www.apawood.org.

The code-compliant options covered in this brochure include:

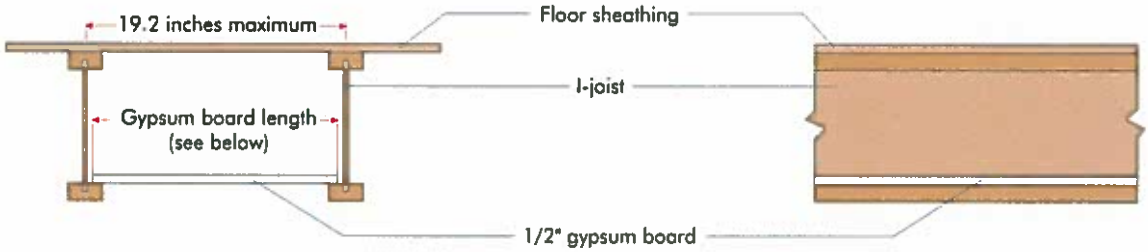
- Gypsum board installed on top of the bottom flange
- Gypsum board or wood structural panel ceiling membranes
- Gypsum board attached to I-joist webs
- Gypsum board attached to the entire depth of I-joists
- Mineral wool insulation on the top of the bottom flanges
- Ceramic fiber blanket attached to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

See page 5 for details on this assembly.

1/2-inch Gypsum Board Installed on Top of the Bottom Flange for I-joist Spacing 19.2 inches or less on center. *(FP-06 in System Report SR-405)*

FIGURE 1

1/2-INCH GYPSUM BOARD



Joist spacing (in.)	Required length for gypsum boards (in.)
12	11-1/8 ± 1/8
16	15-1/8 ± 1/8
19.2	18-3/8 ± 1/8

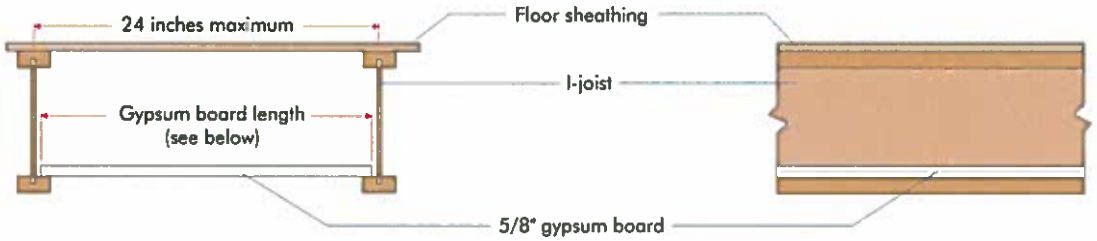
Note:
Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 1/4-inch bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

Installers can add one layer of 1/2-inch gypsum board cut to fit between the I-joist webs and sized to lie on the top of the bottom flange of the I-joist. The minimum I-joist flange dimension must be 1-1/8 inches thick by 2 inches wide and minimum web thickness must be 3/8 inch. No fasteners or adhesives are required to secure the gypsum. Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. Penetrations of I-joist webs for ducts, vents, electrical outlets, wiring, piping and the like are the same as those shown in the typical hole chart recommended by the manufacturer. This method works well for unfinished basements where builders or homeowners prefer not to have a finished gypsum membrane covering the ceiling. It complies with the IRC provisions and makes it easier to access or add mechanicals in the ceiling later, should the need arise. This option can be used when joist spacing is 19.2 inches on center or less.

5/8-inch Gypsum Board Installed on Top of the Bottom Flange for I-joist Spacing up to 24-inch I-joist on center. *(FP-07 in System Report SR-405)*

FIGURE 2

5/8-INCH GYPSUM BOARD



Joist spacing (in.)	Required length for gypsum boards (in.)
12	11-1/8 ± 1/8
16	15-1/8 ± 1/8
19.2	18-3/8 ± 1/8
24	23-1/8 ± 1/8

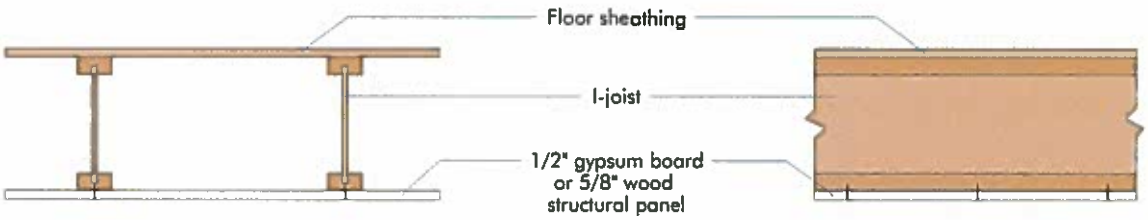
Note:
Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 1/4-inch bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

Similar to FP-06 (Figure 1), this option calls for a layer of 5/8-inch gypsum board cut to fit between the I-joist webs and sized to lie on the top of the bottom flange of the I-joist, where joists are spaced up to 24 inches on center. The minimum I-joist flange dimension must be 1-1/8 inches thick by 2 inches wide and minimum web thickness must be 3/8 inch. No fasteners or adhesives are required to secure the gypsum. Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. Penetrations of I-joist webs for ducts, vents, electrical outlets, wiring, piping and the like are the same as those shown in the typical hole chart recommended by the manufacturer. This method also works well for unfinished basements where builders or homeowners prefer not to have a finished gypsum membrane covering the ceiling. It complies with the IRC provisions and makes it easier to access or add mechanicals in the ceiling later, should the need arise. This option can be used when joist spacing is up to 24 inches on center.

1/2-Inch Gypsum Board or 5/8-inch Wood Structural Panel Ceiling Membranes *(FP-01 in System Report SR-405)*

FIGURE 3

1/2-INCH GYPSUM BOARD ATTACHED TO BOTTOM OF FLANGE



Installers can add a layer of 1/2-inch gypsum board or a 5/8-inch wood structural panel to the bottom of the flange. There are several benefits to installing drywall to the underside of I-joists. Because basement insulation is now required by energy codes in most climate zones, framed basement exterior walls are becoming more common, increasing the likelihood of a finished basement. While the IRC does not require this gypsum board to be finished, combining drywall on a basement ceiling, along with framing on the basement walls, provides homeowners with opportunities to easily upgrade to a finished basement option. The addition of drywall also increases the mass of the floor and acts as a damper to floor vibrations, increasing homeowner comfort. Noise transmission is also reduced.

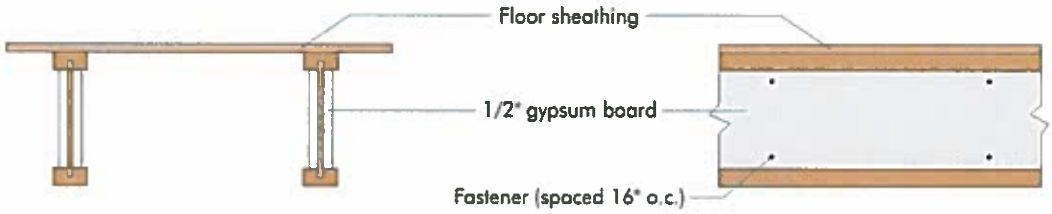
There are some significant advantages to finished basements. Basements can be transformed into home theaters, home office spaces, children's play rooms, libraries, craft rooms, music rooms or in-home workshops, provided builders account for proper conditioning of finished rooms by providing correctly sized heating and cooling equipment and ductwork. Care should also be taken to provide electrical outlets, lighting and smoke detectors in accordance with the codes. With appropriate HVAC, plumbing and egress, basements can become additional bedrooms or apartments, creating more living space in the same house footprint. A finished basement will also bring increased value to a home.

The IRC does not require the gypsum board applied to the underside of the I-joist floor systems to be covered with tape and joint compound.

1/2-Inch Gypsum Board Attached to I-joist Web Only *(FP-02 in System Report SR-405)*

FIGURE 4

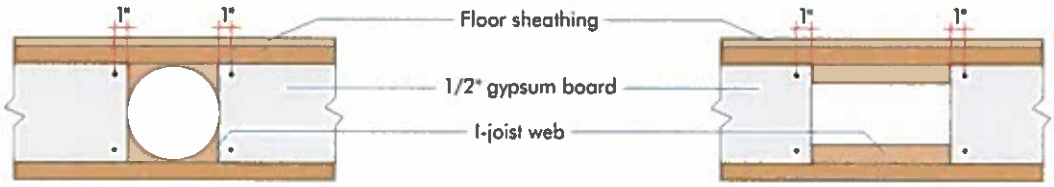
1/2-INCH GYPSUM BOARD ATTACHED TO WEB



Attach gypsum to the I-joist web where the joist has a minimum flange dimension of 1-1/2 inches thick by 2 inches wide. Most lumber flanged I-joists and some LVL-flanged I-joists meet this flange dimension requirement. There are two rows of fasteners near the top and the bottom flanges. Fasteners in each row are spaced 16 inches apart.

FIGURE 5

1/2-INCH GYPSUM BOARD ATTACHED TO WEB WITH WEB HOLES



This solution only requires the web to be covered. Fasteners (Type W or Type S screws or nails) should be 1 inch from the edge and end of the gypsum. Gypsum is not required above or below openings, no matter what the opening size is. Round, square and rectangular web holes are permitted, provided the requirements for hole placement and size meet the I-joist manufacturer's APA Product Report or code evaluation report.

Installers can add a layer of 1/2-inch gypsum board directly to both sides of the I-joist webs (see Figure 4). The minimum flange size for this option is 1-1/2 inches thick by 2 inches wide and the minimum web thickness is 3/8 inch.

This method works well for unfinished basements where builders or homeowners prefer not to have a gypsum membrane covering the ceiling. It complies with the IRC provisions, and makes it easier to add mechanicals in the ceiling later, should the need arise. It also accommodates drop ceilings or other options in the finished space while meeting the IRC provisions. Drop ceiling options have expanded dramatically in recent years, and homeowners can now choose from a variety of new options for finished ceilings.

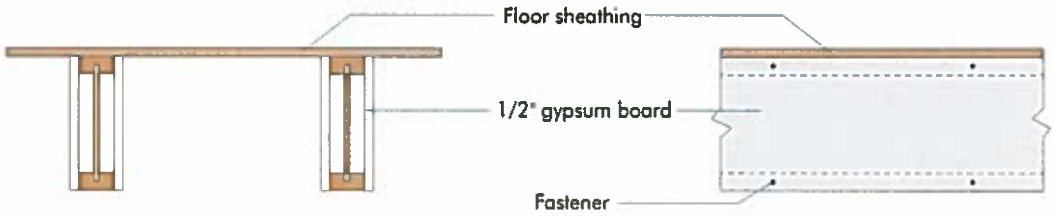
Installing 1/2-inch gypsum board to I-joist webs is one of several methods builders and installers can use to meet the IRC provisions.

This solution only requires the web to be covered and does not require gypsum to be covered with tape and joint compound (see Figures 4 and 5). Fasteners shall be, at a minimum, 1-inch screws (Type W or Type S) or nails installed 1 inch from edges and 16 inches on center, top and bottom. Fasteners may be staggered from top to bottom. Gypsum is not required above or below web openings, no matter what the opening size is, provided that the web holes meet the structural requirements of the I-joists. See *APA Performance Rated I-Joists*, Form Z725, or I-joist manufacturer's recommendations for general guidelines on cutting holes in I-joists.

1/2-Inch Gypsum Board Attached to Entire I-joist Depth *(FP-03 in System Report SR-405)*

FIGURE 6

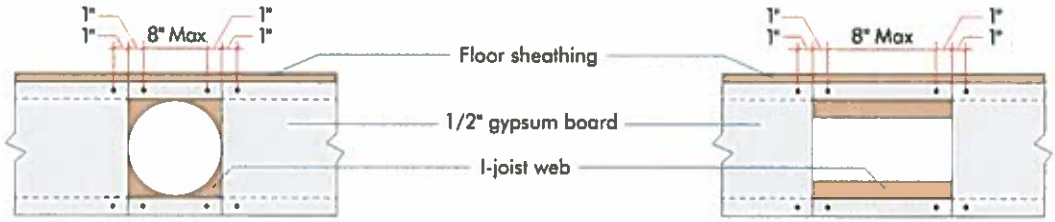
1/2-INCH GYPSUM BOARD ATTACHED TO FLANGE



The option for attaching the gypsum to the joist flanges is applicable to I-joists made with smaller flanges—a minimum flange dimension of 1-1/8 inches thick by 1-3/4 inches wide. Most I-joists meet this minimum flange dimension requirement.

FIGURE 7

1/2-INCH GYPSUM BOARD ATTACHED TO FLANGE WITH WEB HOLE



Flanges must be covered above and below web holes in this option. Fasteners (Type W or Type S screws or nails) shall be installed 1/2 inch from edges and 1 inch from ends and 16 inches on center. At hole location, fasteners shall be installed on the top and bottom flanges 1/2 inch from the edge and 1 inch from the end of the gypsum board. Gypsum at the hole location is required to be installed to protect the flanges only, but not the web. As with the round hole option, square or rectangular holes are permitted per the manufacturer's APA Product Report or code evaluation report.

Installers can add a layer of 1/2-inch gypsum board directly to both sides of the flange to cover the entire I-joist depth (see Figure 6). This method can be used with I-joists that have a relatively small flange size (minimum 1-1/8 inches thick by 1-3/4 inches wide) and web thickness (minimum 3/8 inch). Most I-joists meet this minimum flange dimension requirement.

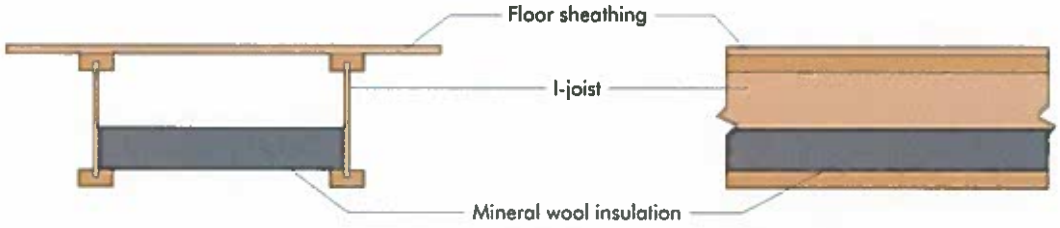
Fasteners shall be the same as shown in Figure 4 except that the fasteners shall be installed 1/2 inch from gypsum edges and 16 inches on center, top and bottom. At the hole location, fasteners shall be installed 1 inch from the edge of the gypsum board (see Figure 7). Maximum fastener spacing shall be no more than 8 inches on gypsum board above and below the hole.

This method also works well for unfinished basements, where builders or homeowners do not want a gypsum membrane covering the ceiling for any reason but need to comply with the IRC provisions. It also maintains the ability to add mechanicals in the ceiling later should the need arise and accommodates drop ceilings or other options in the finished space.

Mineral Wool Batts Installed on Top of the Bottom Flange *(FP-04 in System Report SR-405)*

FIGURE 8

2-INCH MINERAL WOOL INSULATION



Installers can add a 2-inch-thick or thicker layer of 2.9 lb/ft^3 nominal mineral wool fiber insulation to the top of the bottom flange between I-joists with a minimum flange size of 1-1/8 inches thick by 1-3/4 inches wide and a minimum web thickness of 3/8 inch at a maximum spacing of 19.2 inches on center (see Figure 8). Minimum 2.5 lb/ft^3 (nominal) and 2-inch thick mineral wool insulation is permitted if the I-joists are spaced no more than 16 inches on center. In this method, the insulation is secured with insulation stay wires spaced no more than 24 inches apart and no more than 4 inches from ends of the batts. Use minimum 15-1/4-inch and 18-1/2-inch-wide batts when I-joist spacing is 16 inches and 19.2 inches on center, respectively.

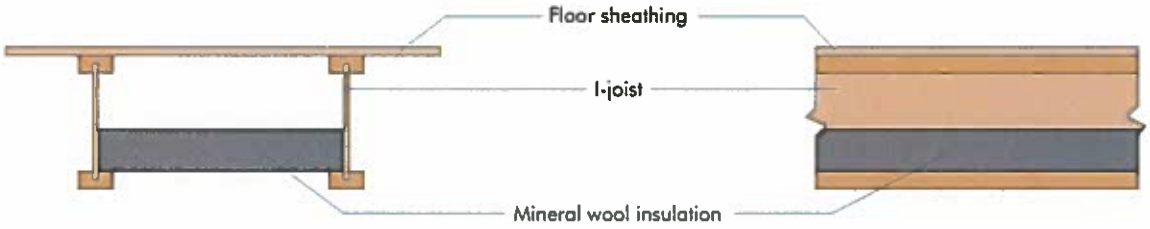
Installing mineral wool between I-joists is one of several methods builders and installers can use to meet the IRC provisions.

As an option for unfinished basements, this method has some advantages in that it does not affix any other material directly to the I-joists with any kind of fasteners. Installation is simple, requiring minimal tools. While essentially closing up the cavities between the I-joists, it is relatively easy to remove the batts to add mechanical system components in the future. Mineral wool batts are readily available from a variety of manufacturers. This option also helps to minimize noise transfer between the basement and the first floor living space.

Mineral Wool Batts Installed on Top of the Bottom Flange *(FP-09 in System Report SR-405)*

FIGURE 9

ROCKWOOL (ROXUL) SAFE'n'SOUND® MINERAL WOOL INSULATION

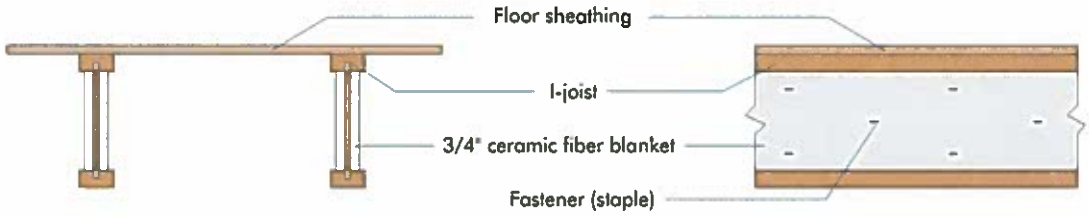


Similar to FP-04 (Figure 8), installers can add a 3-inch-thick or thicker layer of Rockwool (Roxul) SAFE'n'SOUND® 2.5 lb/ft^3 nominal mineral wool fiber insulation to the top of the bottom flange between I-joists with a minimum flange size of 1-1/8 inches thick by 1-3/4 inches wide and minimum web thickness of 3/8 inch at a maximum I-joist spacing of 24 inches on center (see Figure 9). In this method, the insulation is secured with insulation stay wires spaced no more than 24 inches apart and no more than 4 inches from ends of the batts. Use minimum 15-1/4-inch and 18-1/2-inch wide batts when I-joist spacing is 16 inches and 19.2 inches on center, respectively. This method has the same advantage as FP-04 (Figure 8) in ease of installation without any kind of fasteners and has an easy access to the floor cavity.

Ceramic Fiber Blanket Insulation Attached to I-joist Web Only *(FP-05 in System Report SR-405)*

FIGURE 10

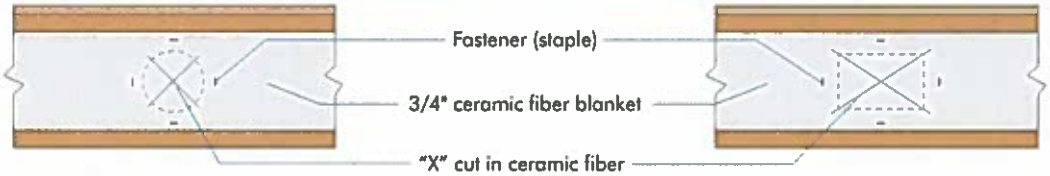
3/4-INCH PROPRIETARY[a] CERAMIC FIBER BLANKET ATTACHED TO WEB



The fabric only needs to be installed to the web and must be placed with no gaps and a snug fit inside the faces of the flanges. It is fastened with 7/8-inch-long crown staples spaced 16 inches on center and 1-3/4 inches from the flanges. The vertical staple-to-staple distance between adjacent rows of staples must be 3 inches maximum with additional rows of staples added when the I-joist depths exceed 9-1/2 inches (For example, 2 rows for 9-1/2-inch, 3 rows for 11-7/8-inch, 4 rows for 14-inch, and 5 rows for 16-inch deep I-joists).

FIGURE 11

3/4-INCH PROPRIETARY[a] CERAMIC FIBER BLANKET ATTACHED TO WEB WITH WEB HOLES



At each hole location, the fiber blanket over the web opening is cut in an "X" shape, 1 inch past the edge of the opening. Cutting can be done with a knife. Four staples are added a distance of 1 inch from the edges of the web opening, as shown. The cutting process and fastening requirements are the same for rectangular holes, with cuts made from corner to corner as shown. Cuts can be 1 inch larger than the opening.

Installers can add a proprietary 3/4-inch ceramic fiber blanket insulation at a minimum of 4 lb/ft^3 nominal, in compliance with ASTM C892 Type III or higher (see Figures 10 and 11). This assembly can be used with I-joists having a minimum flange size of 1-1/2 inches thick by 2.3 inches wide and a minimum web thickness of 3/8-inch. The fiber insulation is installed to the web and must be placed with no gaps and a snug fit inside the faces of the flanges. It is fastened with 7/8-inch long crown staples spaced 16 inches on center and staggered in two rows that are 1-3/4 inches from the I-joist flanges. The vertical staple-to-staple distance between adjacent rows of staples must be 3 inches maximum with additional rows of staples added for I-joist depths greater than 9-1/2 inches (For example, 2 rows for 9-1/2-inch, 3 rows for 11-7/8-inch, 4 rows for 14-inch, and 5 rows for 16-inch-deep I-joists).

A proprietary ceramic fiber blanket insulation can be attached to the web of the I-joists to comply with IRC provisions. *Photo courtesy of Mei Guo International, LLC (USA) FireBreak™.*

a. Mei Guo International, LLC (USA) FireBreak™

This is a solution that works well for unfinished basements where builders or homeowners do not want to use gypsum but need to comply with the IRC provisions. The ability to add mechanicals in the ceiling later is maintained, should the need arise. It also accommodates drop ceilings or other options in the finished space while meeting the IRC provisions.

Additional Options

I-joists with approved factory-applied or a field-applied fire-protective coating are also code compliant. APA has not evaluated generic factory- or field-applied coatings being sold in the U.S. A factory-applied coating must meet ICC-ES Acceptance Criteria AC14, which includes fire endurance and durability provisions. If field-applied, the coating must meet the fire endurance provisions, and the I-joist must be re-certified by the coating company or its certification agency.

ADDITIONAL RESOURCES

Additional resources are available at www.apawood.org, including:

- *APA System Report SR-405, Fire Protection of Floors Constructed with Prefabricated Wood I-Joists for Compliance with the International Residential Code*, Form SR-405

APA publications specifically related to I-joists include:

- *Technical Topics: Wood I-Joist Floors, Firefighters and Fire*, Form TT-015
- *APA Performance Rated I-Joists*, Form Z725
- APA Product Reports
- Builder Tips on describing I-joist installation details

The AWC Partial Sprinkler Guide for details on sprinkler installations:

- http://www.awc.org/pdf/codes-standards/publications/archives/awc-sprinklerguide-1404.pdf

Fire Protective Options for I-Joist Floor Systems

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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www.apawood.org

Form No. R425B/Revised October 2017

APA

REPRESENTING THE ENGINEERED WOOD INDUSTRY

APA

System Report

SR-405F JULY 2017

Fire Protection of Floors Constructed with Prefabricated Wood I-Joists for Compliance with the International Residential Code

1. BASIS OF THE SYSTEM REPORT

- 2015 International Residential Code (IRC): Sections R502.1.2 Prefabricated wood I-joists and R302.13 Fire Protection of Floors
- 2012 IRC: Sections R502.1.4 Prefabricated wood I-joists and R501.3 Fire Protection of Floors
- ASTM D5055-13 and ASTM D5055-09 recognized by the 2015 and 2012 IRC, respectively
- International Code Council Evaluation Service, LLC (ICC-ES) Acceptance Criteria for Prefabricated Wood I-joists (AC14), dated October 2013 (editorially revised February 2014)
- ICC-ES Evaluation Report ESR-1405

2. SYSTEM DESCRIPTION

Starting with the 2009 IBC and IRC, one- and two-family dwellings are required to install an automatic fire sprinkler system (IBC Section 903.2.8 and IRC Section R313.2). However, not all local jurisdictions in the U.S. have adopted these provisions for the use of sprinkler systems as an active home fire protection system. In May 2010, the International Code Council (ICC) approved the following new fire protective membrane provisions for the 2012 IRC (The same wording applies to the 2015 IRC Section R302.13):

> ***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 gypsum wallboard membrane, 5/8 inch 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 nominal dimension, or other approved floor assemblies demonstrating equivalent fire performance.*

These fire protective membrane provisions apply to not only I-joist floors but all residential floor assemblies, including all floor trusses and light-gauge steel framing, and less than 2-inch by 10-inch nominal dimension lumber and structural composite lumber. They will become effective when adopted by the local jurisdiction. However, not all local jurisdictions have elected to adopt these provisions. The project designer should consult with the local jurisdiction for code requirements.

The purpose of this document is to provide prescriptive fire assemblies for fire protection of floors constructed with prefabricated wood I-joists when the 2012 IRC Section R501.3 or 2015 IRC Section R302.13 requirements are adopted by the local jurisdiction.

3. METHODOLOGY

After the publication of the 2012 IRC, ICC-ES developed methodologies for determining the equivalency to Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13 for I-joists, as documented in ICC-ES AC14. Full-scale fire tests at an accredited laboratory in accordance with the standard ASTM E119 time-temperature exposure are required to demonstrate the equivalency, which is determined by the test duration that is equal to or in excess of the required minimum duration calculated using the methodology specified in Chapter 16 of the National Design Specification for Wood Construction (NDS), assuming unprotected solid-sawn 2x10 floor joists, a 3-sided fire exposure, a nominal char rate of 1.5 inches/hour, a load corresponding to 50 percent of the full allowable stress design (ASD) bending design load, and a bending strength to ASD ratio of 2.85.

The failure of the tested fire assembly is defined by the occurrence of the following conditions, whichever occurs first:

a. An individual member within an assembly fails,

b. Multiple members within an assembly fail,

c. Center span deflection exceeds 1/40 of the clear span,

d. The deflection rate of change exceeds 0.10 in./min./ft of the clear span, or

e. The deflection rate of change decreases.

Exception: Item "e" does not apply when the decrease in deflection rate of change was not due to a change in the load-carrying mechanism.

In addition to the 1/2-inch gypsum or 5/8-inch wood structural panel protection (see FP-01, page 3), this document provides prescriptive fire assemblies for prefabricated wood I-joists that have demonstrated equivalency to Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, in accordance with ICC-ES AC14 requirements (see FP-02 through FP-07, pages 4-15).

4. LIMITATIONS

a. The prefabricated wood I-joists shall meet the requirements of ASTM D5055, and be installed and constructed in accordance with the codes, product evaluation reports, and manufacturer's recommendations.

b. The fire assemblies shall be installed as prescribed in this document.

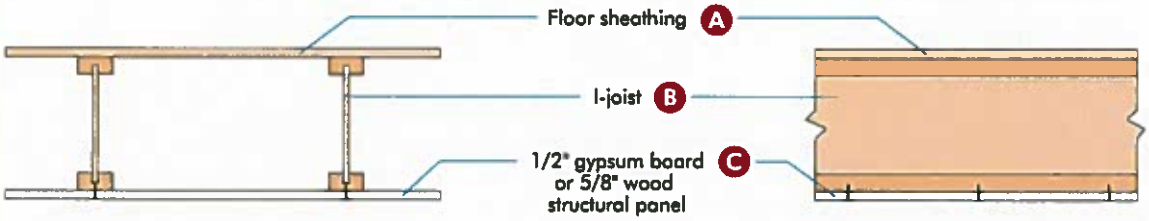
c. This report is subject to periodic review. The latest version of this report is available for free download at www.apawood.org/resource-library.

FIRE PROTECTION OF FLOORS FP-01

Fire Protection: 1/2-inch Gypsum Board Attached to Bottom of Flange

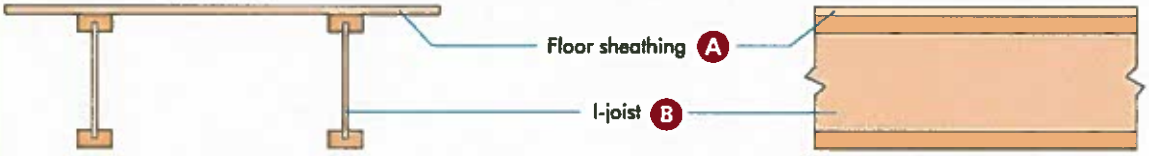
The following fire resistance design is in compliance with the 2012 IRC Section R501.3 and 2015 IRC Section R302.13.

1/2-INCH GYPSUM BOARD ATTACHED TO BOTTOM OF FLANGE[a,b,d]



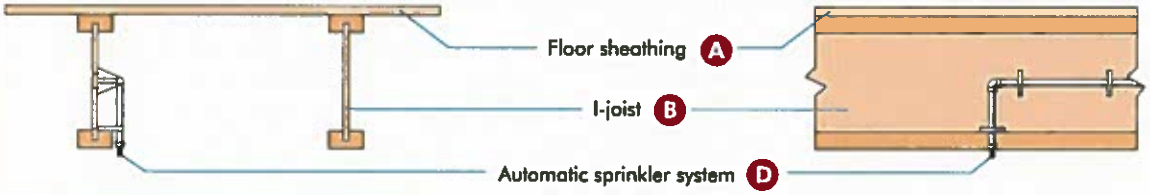
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require membrane protection.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require membrane protection.



A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Applicable to all flange sizes. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA.

C 1/2-inch gypsum board: Materials and installation in accordance with the 2012 and 2015 IRC Section R702.3.1 or equivalent. 1x3 (nominal) wood furring strips are permitted to be installed perpendicular to the bottom flange of the I-joists at 16 inches on center provided that the gypsum boards are directly attached to the furring strips using 1-1/4-inch Type W drywall screws at 12 inches on center. Gypsum board not required to be finished with tape and joint compound; or

5/8-inch wood structural panel: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.2 or equivalent. Wood structural panel not required to be finished with wood filler or sanded.

D Automatic sprinkler system: System in accordance with the 2012 and 2015 IRC Section P2904, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

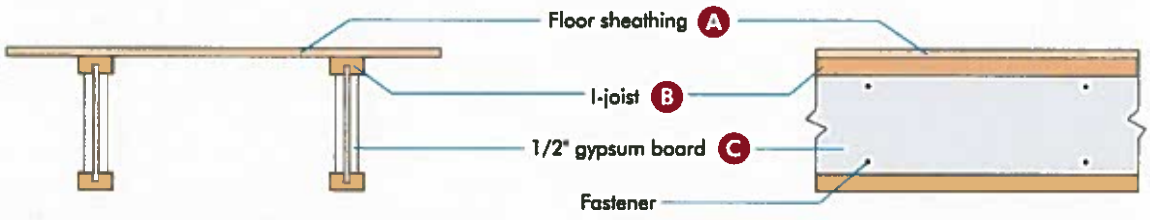
c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

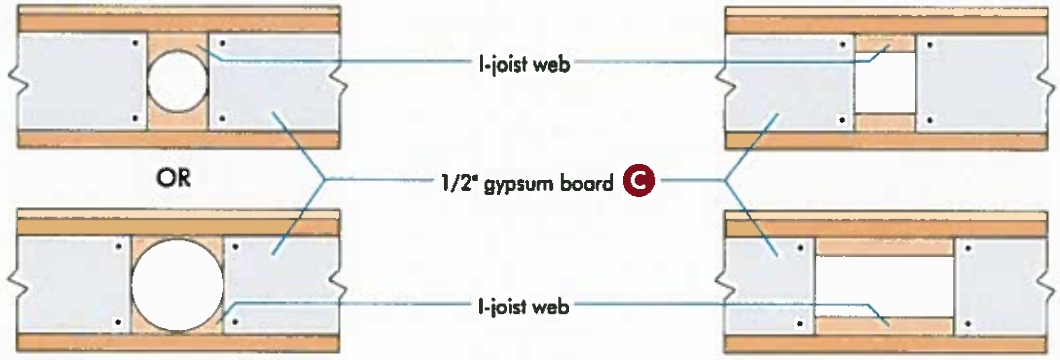
Fire Protection: 1/2-inch Gypsum Board Attached Directly to Web

The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

1/2-INCH GYPSUM BOARD ATTACHED TO WEB[a,b,d]

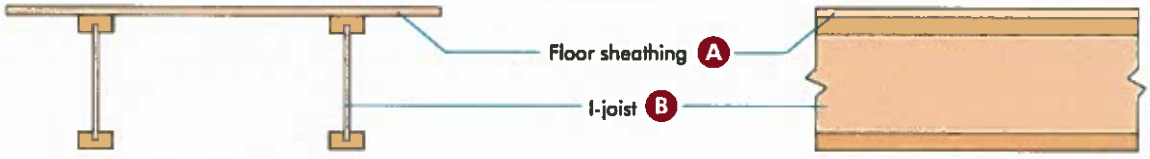


INSTALLATION REQUIREMENTS AT WEB HOLES



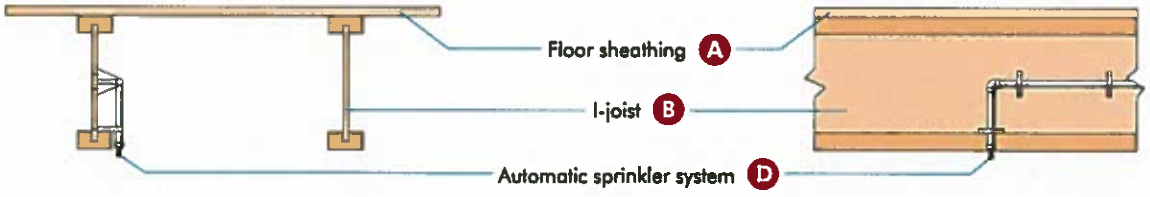
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require 1/2-inch gypsum board attached to web.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require 1/2-inch gypsum board attached to web.



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A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/2 inches thick x 2 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA. At hole location, fasteners shall be installed 1 inch from the edge and end of the gypsum board.

C 1/2-inch gypsum board: Materials (entire length of I-joist) in accordance with the 2012 and 2015 IRC Section R702.3.1 (not required to be finished with tape and joint compound). Fasteners: Minimum 1-inch screws (Type W or Type S) or nails installed 1 inch from edges and ends, and 16 inches on center, top and bottom. Fasteners may be staggered from top to bottom.

D Automatic sprinkler system: System in accordance with the 2012 and 2015 IRC Section P2904, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

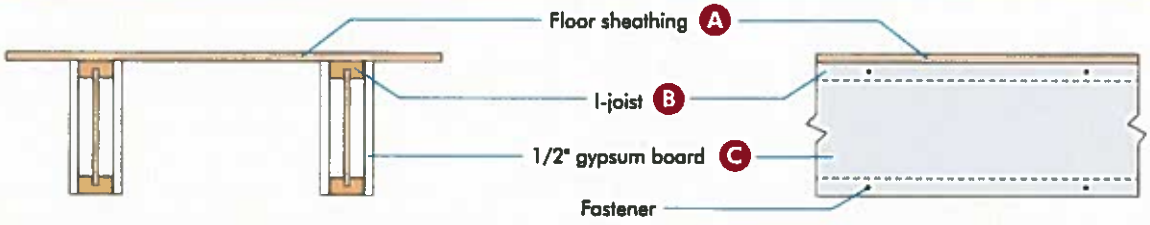
c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

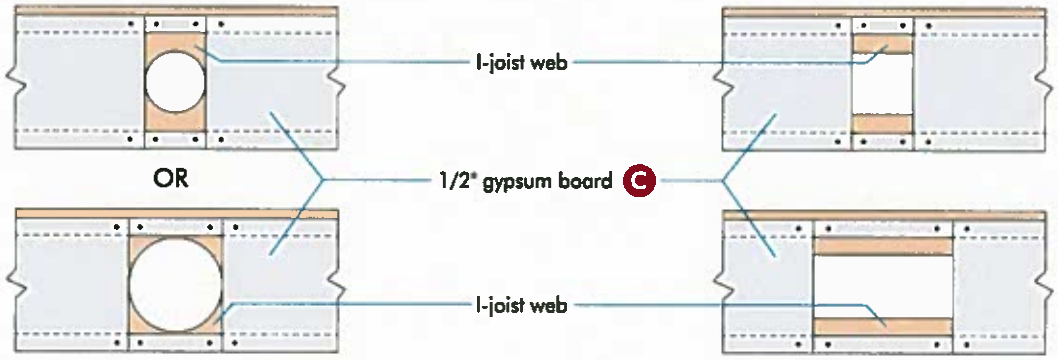
Fire Protection: 1/2-inch Gypsum Board Attached Directly to Sides of Flange

The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

1/2-INCH GYPSUM BOARD ATTACHED TO SIDES OF FLANGE[a,b,d]

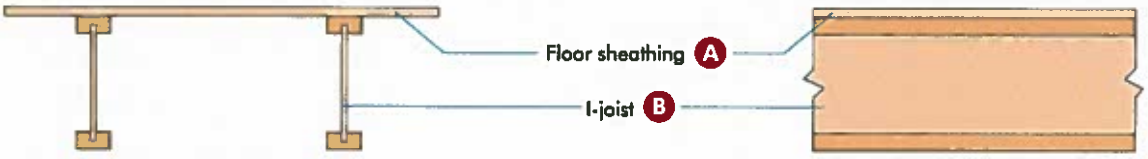


INSTALLATION REQUIREMENTS AT WEB HOLES



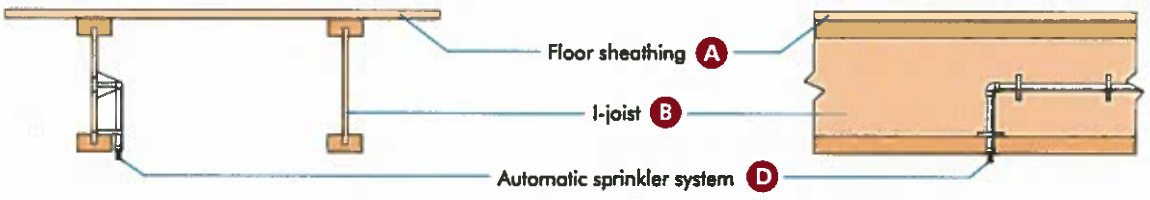
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require 1/2-inch gypsum board attached to sides of flange.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require 1/2-inch gypsum board attached to sides of flange.



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A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 1-3/4 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA. At hole location, fasteners shall be installed 1/2 inch from the edge and 1 inch from the end of the gypsum board. Maximum fastener spacing shall be no more than 8 inches on gypsum board above and below the hole.

C 1/2-inch gypsum board: Materials (entire length of I-joist) in accordance with the 2012 and 2015 IRC Section R702.3.1 (not required to be finished with tape and joint compound). Fasteners: Minimum 1-inch screws (Type W or Type S) or nails installed 1/2 inch from edges and 1 inch from ends, and 16 inches on center, top and bottom. Fasteners may be staggered from top to bottom.

D Automatic sprinkler system: System in accordance with the 2012 and 2015 IRC Section P2904, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

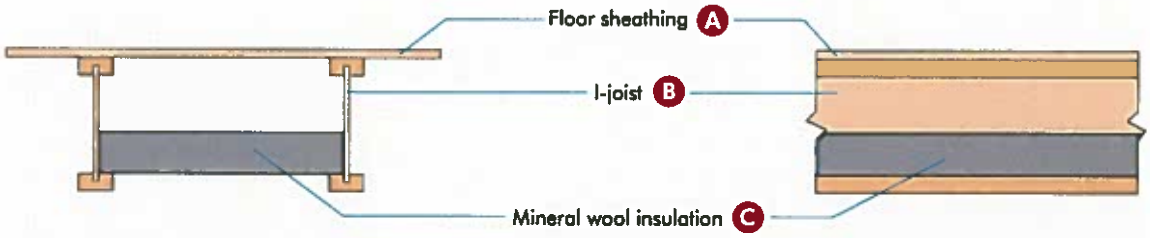
d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

FIRE PROTECTION OF FLOORS FP-04

Fire Protection: Mineral Wool Insulation

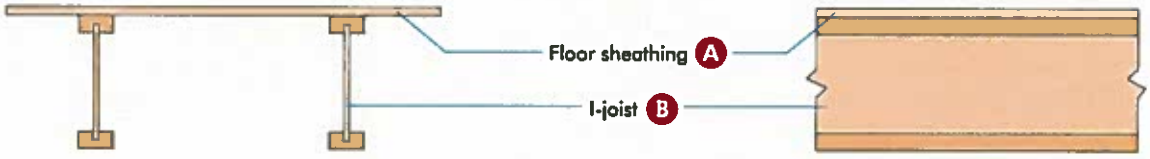
The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

MINERAL WOOL INSULATION[a,b,e]



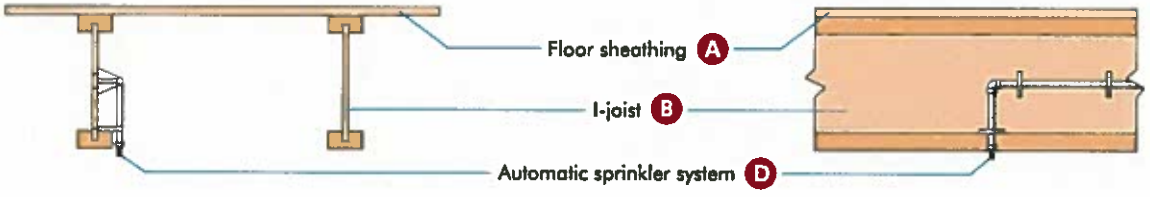
CRAWL SPACE EXCEPTION[c]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require mineral wool insulation for fire protection.



AUTOMATIC SPRINKLER EXCEPTION[d]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require mineral wool insulation for fire protection.



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A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4 of this report. Maximum 19.2 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 1-3/4 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA.

C Mineral wool insulation: Minimum 2.9 lb/ft^3 (nominal) and 2-inch thick mineral wool insulation installed without gaps between individual batts as shown with stay wire insulation supports, spaced no more than 24 inches apart and no more than 4 inches from ends of batts. Minimum 2.5 lb/ft^3 (nominal) and 2-inch thick mineral wool insulation shall be permitted if the I-joists are spaced no more than 16 inches on center. Use minimum 15.25-inch and 18.5-inch wide batts when I-joist spacing is 16 inches and 19.2 inches on center, respectively.

D Automatic sprinkler system: System in accordance with the 2012 and 2015 IRC Section P2904, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Thicker insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

c. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

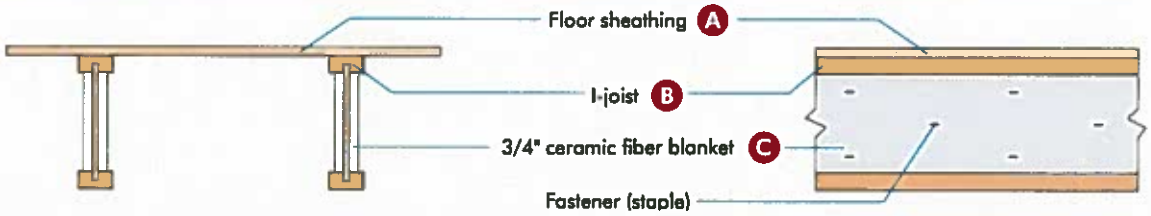
d. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

e. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

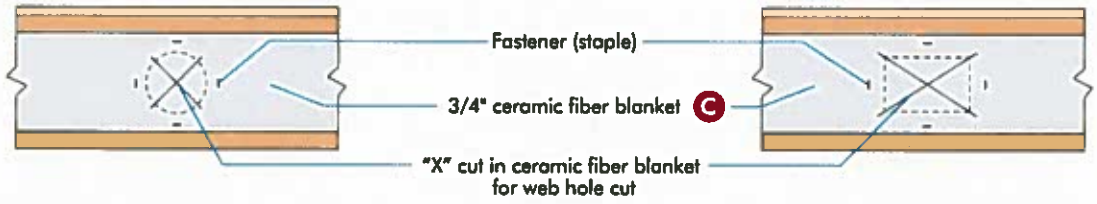
Fire Protection: Ceramic Fiber Blanket Insulation

The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

FIREBREAK™ PROPRIETARY CERAMIC FIBER BLANKET INSULATION[a,b,d]

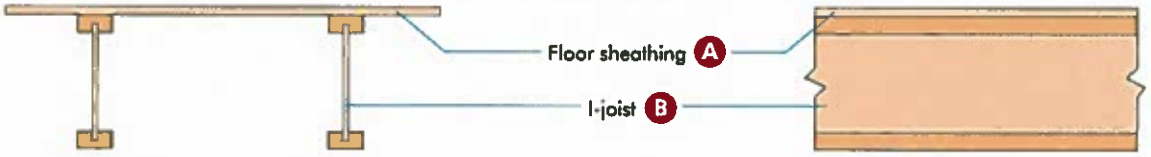


INSTALLATION REQUIREMENTS AT WEB HOLES



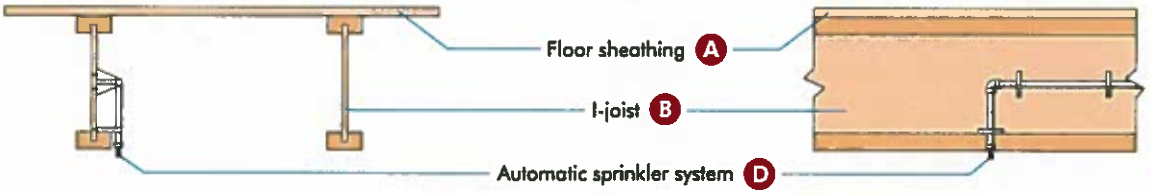
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require ceramic fiber blanket insulation for fire protection.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require ceramic fiber blanket insulation for fire protection.



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A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/2 inches thick x 2.3 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA. At each hole location, an "X" cut that is 1 inch larger than the web hole on both sides of the I-joist shall be made in the ceramic fiber blanket to allow the passage of a wire, pipe, or duct.

C Mei Guo International, LLC (USA) FireBreak™ proprietary ceramic fiber blanket insulation (entire length of I-joist): Minimum 4.0 lb/ft^3 (nominal) and 3/4-inch thick full width ceramic fiber blanket made of aluminum oxide (Al_2O_3) and silicon dioxide (SiO_2) in compliance with ASTM C892 Type III or higher. The ceramic fiber blanket must fill the web space with no gaps and a snug fit within inside faces of the flanges. Fasteners: 7/8-inch long crown staples spaced 16 inches on center and staggered in 2 rows with 1-3/4 inches from both top and bottom of the web, as shown. The vertical staple-to-staple distance between adjacent rows of staples must be 3 inches maximum with additional rows of staples added for I-joist depths greater than 9-1/2 inches (i.e., 2 rows for 9-1/2-inch, 3 rows for 11-7/8-inch, 4 rows for 14-inch, and 5 rows for 16-inch deep I-joists). At each hole location, 4 staples shall be added at 1 inch from the top, bottom, left, and right edges of the web hole.

D Automatic sprinkler system: System in accordance with the 2012 and 2015 IRC Section P2904, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

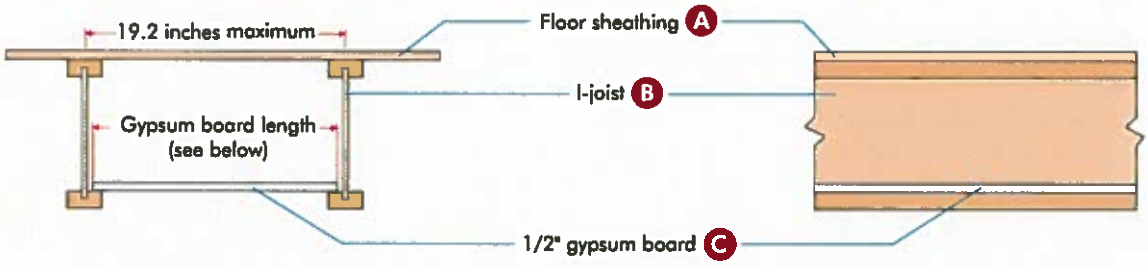
c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

Fire Protection: 1/2-inch Gypsum Board Installed on Top of the Bottom Flange

The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

1/2-INCH GYPSUM BOARD[a,d]

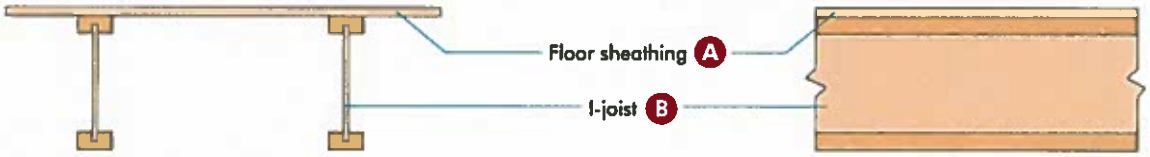


Joist spacing (in.)	Required length for gypsum boards (in.)
12	11-1/8 ± 1/8
16	15-1/8 ± 1/8
19.2	18-3/8 ± 1/8

Note:
Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 1/4-inch bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

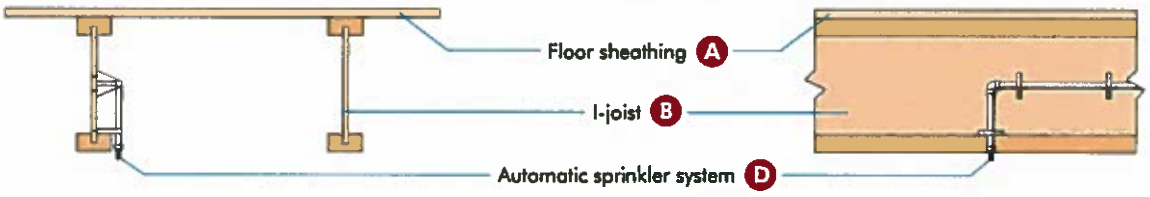
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require gypsum board for fire protection.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require gypsum board for fire protection.



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A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 19.2 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 2 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA.

C One layer of 1/2-inch lightweight or normal weight (nominal 1.5 psf minimum) gypsum wall board meeting ASTM C1396 Section 5. Installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required.

D Automatic sprinkler system: System in accordance with Section P2904 of the 2012 and 2015 IRC, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

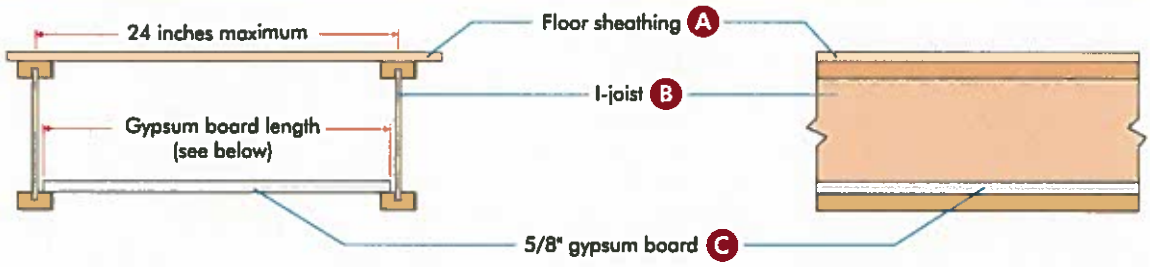
c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

Fire Protection: 5/8-inch Gypsum Board Installed on Top of the Bottom Flange

The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in Exception 4 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13 with demonstrated equivalent fire performance.

5/8-INCH GYPSUM BOARD[a,d]

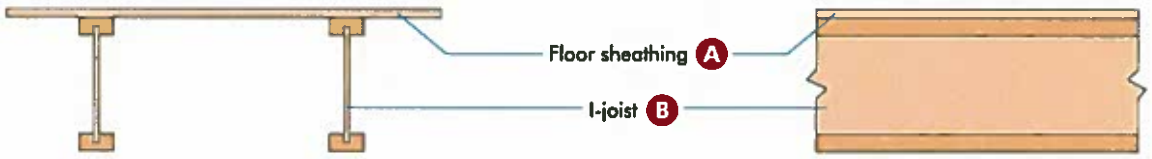


Joist spacing (in.)	Required length for gypsum boards (in.)
12	11-1/8 ± 1/8
16	15-1/8 ± 1/8
19.2	18-3/8 ± 1/8
24	23-1/8 ± 1/8

Note:
Gypsum board lengths shown above provide at least a 1/4-inch bearing on the top of the bottom flange in each I-joist as installed. For other joist spacings, the required gypsum board lengths shall be adjusted so that the required gypsum board lengths are determined based on a full bearing on the flange at one end of the joist spacing, while maintaining at least a 1/4-inch bearing at the other end. If double joists are used, the required gypsum board lengths shall be reduced from the table above by a length equal to the flange width.

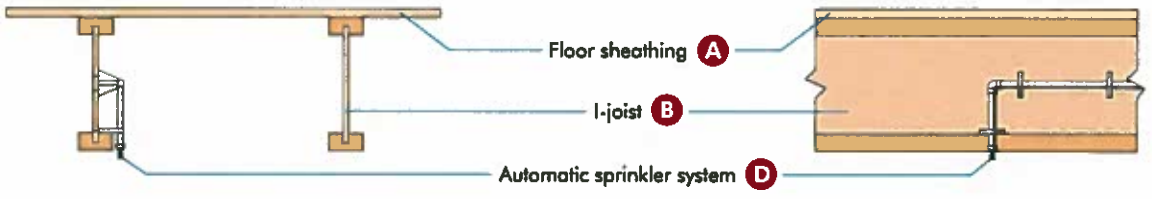
CRAWL SPACE EXCEPTION[b]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require gypsum board for fire protection.



AUTOMATIC SPRINKLER EXCEPTION[c]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require gypsum board for fire protection.



Continued on Next Page

A Floor sheathing: Materials and installation in accordance with the 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 2 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA.

C One layer of 5/8-inch lightweight or normal weight (nominal 1.9 psf minimum) gypsum wall board meeting ASTM C1396 Section 5: Installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required.

D Automatic sprinkler system: System in accordance with Section P2904 of the 2012 and 2015 IRC, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with the 2012 and 2015 IRC 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.

b. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

c. In accordance with the 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

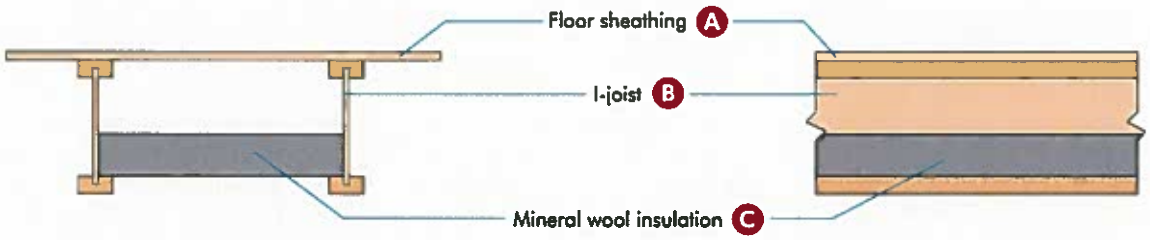
d. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping, and similar openings or penetrations shall be permitted.

FIRE PROTECTION OF FLOORS FP-09 FOR COMPLIANCE WITH 2012 IRC SECTION R501.3 AND 2015 IRC SECTION R302.13

Fire Protection: Roxul SAFE'n'SOUND® Mineral Wool Insulation

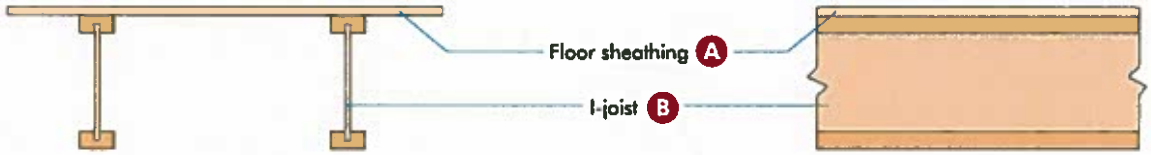
The following fire resistance design is an alternative to the 2-by-10 dimensional lumber prescribed in 2012 IRC Section R501.3 and 2015 IRC Section R302.13 Exception 4, with demonstrated equivalent fire performance.

ROXUL SAFE'n'SOUND® MINERAL WOOL INSULATION[a,b,c]



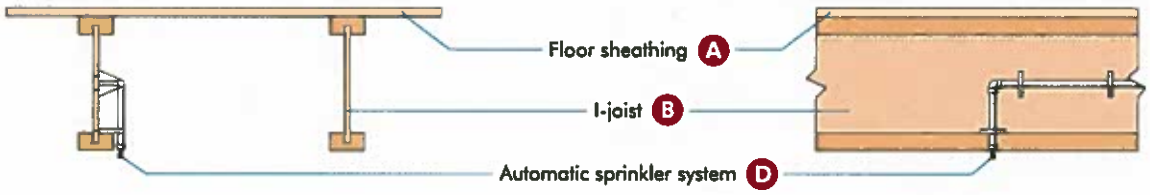
CRAWL SPACE EXCEPTION[c]

In accordance with Exception 2 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require mineral wool insulation for fire protection.



AUTOMATIC SPRINKLER EXCEPTION[d]

In accordance with Exception 1 of the 2012 IRC Section R501.3 and 2015 IRC Section R302.13, floor assemblies located directly over a space protected by an automatic sprinkler system do not require mineral wool insulation for fire protection.



Continued on Next Page

A Floor sheathing: Materials and installation in accordance with 2012 and 2015 IRC Section R503.

B I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 2 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA.

C Mineral wool insulation: Roxul SAFE'n'SOUND® minimum 2.5 lb/ft³ (nominal) and 3 inches thick mineral wool batt insulation made of rock or furnace slag (ASTM C665 Type 1 compliant) installed as shown with insulation stay wire supports, spaced no more than 24 inches apart and no more than 4 inches from ends of batts. Use minimum 15.25 inches, 18.5 inches, and 23 inches wide batts when I-joist spacing is 16 inches, 19.2 inches, and 24 inches on center, respectively.

D Automatic sprinkler system: System in accordance with Section P2904 of the 2012 and 2015 IRC, NFPA 13D, or other equivalent sprinkler systems.

Notes:

a. In accordance with Exception 3 of 2012 IRC Section R501.3 and 2015 IRC Section R302.13, portions of floor assembly can be unprotected when complying with the following:
   1. The aggregate area of the unprotected portions shall not exceed 80 square feet.
   2. Fire blocking in accordance with 2012 and 2015 IRC 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.

b. Thicker insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

c. Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

d. In accordance with 2012 and 2015 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

e. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

Fire Protection of Floors Constructed with Prefabricated Wood I-Joists for Compliance with the International Residential Code

APA – The Engineered Wood Association is an accredited certification body under ISO/IEC 17065 by Standards Council of Canada (SCC) and an accredited inspection agency by the International Code Council (ICC) International Accreditation Service (IAS) under ISO/IEC 17020. APA is also a testing organization accredited by IAS under ISO/IEC 17025. APA is a recognized testing laboratory by Miami-Dade County, and a Product Testing Laboratory, Product Quality Assurance Entity, and Product Validation Entity by the Florida Department of Business and Professional Regulation.

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
SECTION: 06 17 33—WOOD I-JOISTS

REPORT HOLDER:

APA—THE ENGINEERED WOOD ASSOCIATION

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TACOMA, WASHINGTON 98466

EVALUATION SUBJECT:

PERFORMANCE RATED I-JOISTS

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
Section: 06 17 33—Wood I-joists

REPORT HOLDER:

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(253) 565-6600
www.apawood.org
help@apawood.org

EVALUATION SUBJECT:

PERFORMANCE RATED I-JOISTS

ADDITIONAL LISTEES:

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SAULT STE. MARIE, ONTARIO P6C 3W7
CANADA

BOISE CASCADE WOOD PRODUCTS, LLC
POST OFFICE BOX 2400
WHITE CITY, OREGON 97503-0400

INTERNATIONAL BEAMS
240 SOUTH PINEAPPLE AVENUE, SUITE 510
SARASOTA, FLORIDA 34236

NORDIC STRUCTURES
1100 DE LA GAUCHETIERE STREET WEST, SUITE 504
MONTREAL, QUEBEC H3B 2S2
CANADA

ROSEBURG FOREST PRODUCTS
POST OFFICE BOX 1088
ROSEBURG, OREGON 97470

STARK TRUSS COMPANY, INC.
6855 CHESTNUT RIDGE ROAD NW
BEACH CITY, OHIO 44608

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2015, 2012 and 2009 *International Building Code®* (IBC)
- 2015, 2012 and 2009 *International Residential Code®* (IRC)

Properties evaluated:

- Structural
- Fire resistance

2.0 USES

The prefabricated wood I-joists described in this report are used as floor joists, roof rafters and blocking to support code-required loads. The wood I-joists comply with Section 2303.1.2 of the IBC; and Section R502.1.2 of the 2015 IRC and Section R502.1.4 of the 2012 and 2009 IRC, for allowable stress design.

3.0 DESCRIPTION

3.1 General:

The prefabricated wood I-joists described in this report comply with the "PRI-400 Performance Standard for APA EWS I-joists," dated April 2012, for the performance rating of prefabricated, performance-rated I-joists (PRI) used in floors of residential construction. The standard is promulgated by APA—The Engineered Wood Association. The standard complies with the requirements of the codes specifically referenced in Section 1.0 of this report, and with ASTM D5055 and the ICC-ES Acceptance Criteria for Prefabricated Wood I-joists (AC14). PRI-400 also complies with the code sections referenced in Section 2.0 of this report.

3.2 Materials:

3.2.1 Flanges: The flanges are sawn lumber or structural composite lumber (SCL), with both flanges having a minimum net width and thickness of $1^1/_2$ inches (38 mm), except the minimum flange thickness can be $1^5/_{16}$ inches (33.3 mm) for structural composite lumber. The structural composite lumber used as flanges are recognized in an ICC-ES evaluation report issued to the manufacturer of the structural composite lumber, or are recognized in the ICC-ES evaluation report issued to the I-joist manufacturer. The structural composite lumber has a minimum equivalent specific gravity of 0.42, as it relates to fastener capacity. Sawn lumber flanges have a minimum specific gravity of 0.42. The top flange is the same size, type, grade and species as the bottom flange.

3.2.2 Webs: The webs have a minimum thickness of $^3/_8$ inch (9.5 mm) and are Exposure 1, exterior-grade, plywood or oriented strand board panels, and comply with DOC PS-1 or DOC PS-2.

3.2.3 Adhesive: The webs are adhered to the flanges with exterior-type adhesive complying with ASTM D2559 and Section 5.4.3 of ASTM D5055.

4.0 DESIGN AND INSTALLATION

4.1 Design:

Designed installations of the I-joists must be based on the allowable design properties in Table 1. Holes in webs of joists must comply with Figure 1 and Table 2. Where required by Table 1 and the notes to Figure 2, web stiffeners at joist supports must comply with Figure 2.

4.2 Installation:

4.2.1 General: I-joists produced by manufacturers listed in this report, or those complying with the requirements of PRI-400 and recognized in a separate ICC-ES evaluation report issued to the I-joist manufacturer, must be installed in accordance with this report. The separate evaluation report issued to the I-joist manufacturer must indicate the I-joists have been evaluated for compliance with this report, and that they are to be installed in accordance with this evaluation report and the separate report.

The I-joist properties in this evaluation report are based on I-joists installed such that the in-service moisture content of the joists does not exceed 16 percent.

The compression flange of the joists must have continuous lateral support. In single-span, simply supported conditions, the compression flange is the top flange of the joist, and lateral support is normally provided by the floor sheathing attached to the top flange. Lateral support for the I-joist bottom flange must be provided at interior supports of multiple-span joists, and the support adjacent to the unsupported end of cantilevered joists.

The ends of joists must be restrained to prevent rollover. This restraint is normally provided by diaphragm sheathing attached to the top flange and to an end wall or a shear-transfer panel capable of transferring a force of 50 pounds per foot (730 N/m). Blocking with equivalent strength is permitted to be used.

Concentrated loads in excess of 1,500 pounds (6672 N), applied to the top flange of the I-joist, require installation of web stiffeners in accordance with Figure 2, except the gap must be at the bottom flange. Blocking or squash blocks must be installed where concentrated loads occur at I-joist supports.

Spacing for nails installed in sawn lumber flanges of I-joists must be sufficient to prevent splitting of the wood. Allowable loads for nails in solid-sawn-lumber flanges must be in accordance with the allowable loads specified in the applicable code for spruce-pine-fir with a specific gravity of 0.42.

Spacing for nails installed in SCL flanges of joists must be sufficient to prevent splitting of the wood. Allowable loads for nails installed in SCL flanges must be in accordance with those in the applicable code for solid-sawn lumber with a specific gravity of 0.42. Fastener type and fastener penetration into the top flange of the I-joist, for fasteners attaching subfloor sheathing or combination subfloor/underlayment to the I-joist, must comply with the requirements of the applicable code. For engineered design, the designer must specify the proper I-joist designation and flange configuration to match the calculation assumptions.

4.2.2 One-hour Fire-resistive Floor-ceiling Assemblies: I-joists produced by manufacturers listed in this report, or complying with the requirements of PRI-400 and recognized in a separate ICC-ES evaluation report issued to the I-joist manufacturer, may be used as wood structural framing members in one-hour fire-resistive floor-ceiling assemblies when the assemblies are constructed in accordance with Sections 4.2.2.1 through 4.2.2.4 of this report.

4.2.2.1 Assembly 1: The assembly must be as described in Figure 3.

4.2.2.2 Assembly 2: The I-joists are permitted to be used in lieu of the wood joists or trusses in the one-hour floor-ceiling assemblies described in ICC-ES evaluation report ESR-1338, and described in item 21-1.1 of 2015 and 2012 IBC Table 721.1(3) and 2009 IBC Table 720.1(3). Minimum flange dimensions for the joists are 1.5 inches (38 mm) for width and $1^{5}/_{16}$ inches (33 mm) for thickness. The thickness of wood structural panels for the floor must not be less than $^{1}/_{2}$ inch (12.7 mm), nor less than required by the applicable code.

4.2.2.3 Assembly 3: The assembly must consist of a single-layer floor of minimum $^{3}/_{4}$-inch (19.1 mm) tongue-and-groove plywood, or minimum $^{23}/_{32}$-inch (18.3 mm) tongue-and-groove APA wood structural panels (exposure 1 or exterior-grade), conforming to DOC PS-1 or PS-2, or an ICC-ES evaluation report, with I-joists spaced up to 24 inches (610 mm) on center; and a ceiling of two layers of $^{1}/_{2}$-inch-thick (12.7 mm), Type C gypsum board [two layers of $^{5}/_{8}$-inch-thick (15.9 mm), Type X gypsum board must be used for installations using I-joists flanges smaller than $1^{1}/_{2}$ by $1^{3}/_{4}$ inches (38 by 44.5 mm)] applied to the bottom chord. Minimum flange dimensions of the I-joists are $1^{5}/_{16}$ inches by $1^{1}/_{2}$ inches (33 mm by 38 mm).

The floor sheathing must be installed in accordance with code requirements or with applicable ICC-ES evaluation reports, with all butt joints located on framing members.

The first layer of gypsum board must be attached with $1^{5}/_{8}$-inch-long (41.3 mm), Type W screws spaced up to 12 inches (305 mm) on center. The second layer of gypsum board must be installed with the joints staggered from the first layer and must be fastened with 2-inch-long (51 mm) [$2^{1}/_{4}$ inches (57 mm) long for $^{5}/_{8}$-inch (15.9 mm) gypsum board], Type W screws spaced up to 12 inches (305 mm) on center in the field and up to 8 inches (203 mm) on center at the butt joints. Type G screws, $1^{1}/_{2}$ inches (38 mm) long [$1^{3}/_{4}$ inches (44.5 mm) long for $^{5}/_{8}$-inch (15.9 mm) gypsum board], must be spaced up to 8 inches (203 mm) on center and up to 6 inches (152 mm) each side of the butt joint. The second layer must be finished with joint tape and compound.

Resilient channels are permitted to be used as part of the ceiling attachment system, provided they are spaced up to 16 inches (406 mm) on center. The resilient channels are permitted to be spaced up to 24 inches (610 mm) on center, if I-joists are spaced up to 16 inches (406 mm) on center. The channels are fastened perpendicular to joists with 1-inch-long (25.4 mm), case-hardened-steel, 0.15-inch-diameter-shank (0.38 mm), self-drilling, self-tapping, Phillips-head screws. The ceiling must be attached to the resilient channels as described above, except 1-inch (25.4 mm), Type S screws and $1^{5}/_{8}$-inch (41.3 mm), Type S screws must be used for the first and second layers, respectively, spaced at up to 12 inches (305 mm) on center.

When used as a roof-ceiling assembly, the decking is permitted to be any wood deck specified in the code, and the I-joist spacing is permitted to exceed 24 inches (610 mm) on center. However, when the I-joist spacing exceeds 24 inches (610 mm), the ceiling attachment system, including the resilient channels, must be applied to

stripping spaced up to 24 inches (610 mm) on center. The attachment to the stripping is similar to the previously described attachment to the joists. The stripping must be either nominal 2-by-4-inch, construction-grade Douglas fir lumber [for spans of up to 5 feet (1524 mm)] attached to the bottom chord with two 10d box nails, or material and attachment of equivalent strength.

4.2.2.4 Other Fire-resistive Assemblies: The I-joists described in this report may be used in the assemblies described in 2015 and 2012 IBC Table 721.1(3) and 2009 IBC Table 720.1(3), Item Numbers 23-1.1 through 28.1.1, and Item Number 30-1.1 (2015 IBC only), provided the I-joists used meet the criteria described in the table's "Floor or Roof Construction" column. For the purposes of the minimum flange area requirement of 2.3 square inches (1480 mm^2) in Item Number 23-1.1, a $1^1/_2$-by-$1^1/_2$-inch (38 mm by 38 mm) flange having a cross-sectional area of 2.25 square inches (1450 mm^2) may be consideredsufficient.

4.3 Fire Protection of Floors:

The I-joists described in this report, when installed and protected as specified in Figure 4, meet the provisions of 2015 IRC Section R302.13 and 2012 IRC Section R501.3. The I-joists described in this report, when installed and protected as specified in Figures 5 through 9, are alternatives to the 2-by-10 dimensional lumber prescribed in 2015 IRC Section R302.13 and 2012IRC Section R501.3 Exception 4, and have met the requirements for a floor assembly demonstrating equivalent floor performance.

5.0 CONDITIONS OF USE

The Performance Rated I-joists described in this report comply with, or are a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The I-joists must be produced by a manufacturer listed in this report or must be evaluated in a current ICC-ES evaluation report issued to the I-joist manufacturer.

5.2 The design and installation must comply with this report and the wood design provisions noted in the applicable edition of the NDS referenced in the applicable code.

5.3 Drawings and design calculations demonstrating compliance with this report must be submitted to the building official. The drawings and calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 No cutting of I-joist flanges is permitted.

5.5 The I-joists must be produced at the manufacturing plants noted in Table 3, under a quality-control program with inspections by ICC-ES and APA—The Engineered Wood Association (AA-649).

6.0 EVIDENCE SUBMITTED

6.1 PRI-400 Performance Standard for APA–EWS I-joists, dated April 2012.

6.2 Data verifying compliance with the ICC-ES Acceptance Criteria for Prefabricated Wood I-joists (AC14), dated October 2013 (Editorially revised January 2016).

6.3 Vertical uniform load transfer data in accordance with Section 3.2 of the ICC-ES Acceptance Criteria for Rim Board Products (AC124), dated February 2015 (Editorially revised January 2016).

6.4 Reports of fire tests conducted in accordance with ASTM E119.

7.0 IDENTIFICATION

The I-joists must be identified by a stamp indicating the product designation, the evaluation report number (ESR-1405), the manufacturer's name, and the name and logo of the inspection agency (ICC-ES and APA—The Engineered Wood Association).

TABLE 1—DESIGN PROPERTIES FOR *APA EWS* PERFORMANCE-RATED I-JOISTS[1]

JOIST DEPTH (in)	JOIST SERIES	EI[2] x10^6 (lbf-in^2)	M_r[3] (lbf-ft)	V_r[4] (lbf)	R_r[5] (lbf)					VLC[8] (lbf/ft)	K[9] x10^6 (lbf)
					Intermediate Reaction[6]	End Reaction[7]					
						1-3/4" Bearing		4" Bearing			
						Web Stiffeners?					
						No	Yes	No	Yes		
9-1/2"	PRI-20	132	2,520	1,120	1,700	830	830	1,120	1,120	2,000	4.94
	PRI-30	159	3,225	1,120	1,905	945	945	1,120	1,120	2,000	4.94
	PRI-40	184	2,735	1,120	2,160	1,080	1,080	1,120	1,120	2,000	4.94
	PRI-50	186	3,800	1,120	2,040	1,015	1,015	1,120	1,120	2,000	4.94
	PRI-60	219	3,780	1,120	2,160	1,080	1,080	1,120	1,120	2,000	4.94
11-7/8"	PRI-20	225	3,265	1,420	1,700	830	830	1,420	1,420	2,000	6.18
	PRI-30	271	4,170	1,420	1,905	945	945	1,420	1,420	2,000	6.18
	PRI-40	313	3,545	1,420	2,500	1,200	1,200	1,420	1,420	2,000	6.18
	PRI-50	316	4,915	1,420	2,040	1,015	1,015	1,420	1,420	2,000	6.18
	PRI-60	371	4,900	1,420	2,500	1,200	1,200	1,420	1,420	2,000	6.18
	PRI-70	416	6,595	1,420	2,335	1,160	1,160	1,420	1,420	2,000	6.18
	PRI-80	518	6,940	1,420	2,760	1,280	1,280	1,420	1,420	2,000	6.18
	PRI-90	571	8,770	1,925	3,355	1,400	1,400	1,885	1,925	2,000	6.18
14"	PRI-40	459	4,270	1,710	2,500	1,200	1,200	1,550	1,710	2,000	7.28
	PRI-50	463	5,860	1,710	2,040	1,015	1,015	1,550	1,710	2,000	7.28
	PRI-60	544	5,895	1,710	2,500	1,200	1,200	1,550	1,710	2,000	7.28
	PRI-70	609	7,865	1,710	2,335	1,160	1,160	1,550	1,710	2,000	7.28
	PRI-80	756	8,360	1,710	3,020	1,280	1,280	1,550	1,710	2,000	7.28
	PRI-90	832	10,460	2,125	3,355	1,400	1,400	1,885	2,125	2,000	7.28
16"	PRI-40	625	4,950	1,970	2,500	1,200	1,200	1,550	1,970	2,000	8.32
	PRI-50	630	6,715	1,970	2,040	1,015	1,015	1,550	1,970	2,000	8.32
	PRI-60	739	6,835	1,970	2,500	1,200	1,200	1,550	1,970	2,000	8.32
	PRI-70	826	9,010	1,970	2,335	1,160	1,160	1,550	1,970	2,000	8.32
	PRI-80	1,024	9,690	1,970	3,020	1,280	1,280	1,550	1,970	2,000	8.32
	PRI-90	1,126	11,985	2,330	3,355	1,400	1,400	1,885	2,330	2,000	8.32

For SI: 1 ft = 305 mm; 1 inch = 25.4 mm; 1 lbf = 4.448 N.

[1]The tabulated values are design values for normal duration of load (10 years). All values, except for EI, VLC and K, are permitted to be adjusted for other load durations in accordance with the NDS. The VLC values must be decreased for permanent loads per the NDS, but are not permitted to be increased for shorter durations.
[2]Reference design bending stiffness (EI) of the I-joist.
[3]The reference design moment (M_r) of the I-joist must not be increased by any repetitive member use factor.
[4]Reference design shear (V_r) of the I-joist.
[5]The reference design reactions (R_r), after being adjusted by the load duration factor, C_D, must meet the following requirement:

$$R_r(C_D) \le F_{c\perp}(C_b)(b_{brg})(L_{brg})$$

Where: $F_{c\perp}$ = Reference compression design value perpendicular to grain (lbf/in^2). Use the lesser of the $F_{c\perp}$ for the I-joist flange (refer to manufacturer) or the $F_{c\perp}$ for the supporting member.
C_b = Bearing area factor as defined in Section 3.10.4 of the NDS, if applicable.
b_{brg} = Bearing width of the I-joist (in). Typically equal to the flange width minus 0.15 inch edge easing (refer to manufacturer).
L_{brg} = Bearing length of the I-joist (in).

[6]Intermediate reaction design values are based on a minimum bearing length of 3-1/2 inches, without web stiffeners.
[7]Interpolation of end reaction design values between tabulated bearing lengths is permitted, with or without bearing stiffeners.
[8]Vertical load capacity (VLC), for transfer of vertical uniform loads when I-joists are used as continuously-supported blocking.
[9]Deflection calculations must account for shear deformation, using the tabulated reference shear stiffness coefficient (K). For example, deflections of I-joists under uniform load or center-point load in simple-span applications are calculated as follows:

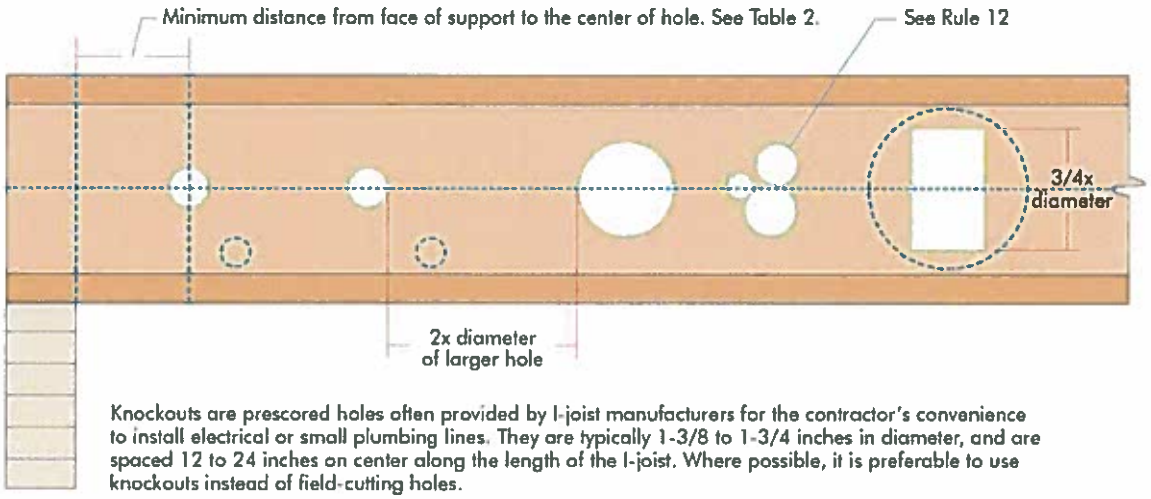
Uniform Load: $$\delta = \frac{5\omega\ell^4}{384EI'} + \frac{\omega\ell^2}{K'}$$

Center-Point Load: $$\delta = \frac{P\ell^3}{48EI'} + \frac{2P\ell}{K'}$$

Where: δ = Calculated deflection at center span (inches).
EI' = Bending stiffness, adjusted per NDS Section 7.3 (lbf-in^2).
K' = Shear stiffness coefficient, adjusted per NDS Section 7.3 (lbf).
ℓ = Design span (inches)
ω = Uniform load (lbf/in).
P = Center point load (lbf).

Rules for cutting holes in the webs of PRI Joists:

1. The distance between the inside edge of the support and the centerline of any hole must be in compliance with the requirements of Table 2.
2. I-joist top and bottom flanges must NEVER be cut, notched, or otherwise modified.
3. Whenever possible, field-cut holes should be centered vertically along the depth of the web.
4. The maximum size hole that can be cut into an I-joist web must equal the clear distance between the flanges of the I-joist minus $^1/_4$ inch. A minimum of $^1/_8$ inch should always be maintained between the top or bottom of the hole and the adjacent I-joist flange.
5. The sides of square holes or longest sides of rectangular holes must not exceed three fourths of the diameter of the maximum round hole permitted at that location.
6. Where more than one hole is necessary, the distance between adjacent hole edges must exceed twice the diameter of the largest round hole or twice the size of the largest square hole (or twice the length of the longest side of the longest rectangular hole) and each hole must be sized and located in compliance with the requirements of Table 2.
7. Knockouts may be utilized anywhere they occur, and may be ignored for purposes of calculating minimum distances between holes.
8. A maximum $1^1/_2$-inch-diameter hole can be placed anywhere in the web (including along cantilevered spans) provided that it meets the requirements of 6 above.
9. Except for factory knockouts and maximum $1^1/_2$-inch-diameter holes (see note 8 above), the near edge of web holes must be at least 6 inches away from the nearest edge of a reaction (measured horizontally along the I-joist).
10. All holes must be cut in a workman-like manner in accordance with the restrictions listed above and as illustrated in Figure 1.
11. Limit 3 maximum size holes per span.
12. A group of round holes at approximately the same location is permitted if they meet the requirements for a single round hole circumscribed around them.



Knockouts are prescored holes often provided by I-joist manufacturers for the contractor's convenience to install electrical or small plumbing lines. They are typically 1-3/8 to 1-3/4 inches in diameter, and are spaced 12 to 24 inches on center along the length of the I-joist. Where possible, it is preferable to use knockouts instead of field-cutting holes.

FIGURE 1—TYPICAL HOLES

TABLE 2—LOCATION OF CIRCULAR HOLES IN PRI JOIST WEBS, SIMPLE OR MULTIPLE SPAN FOR DEAD LOADS UP TO 10 PSF AND LIVE LOADS UP TO 40 PSF[1,2,3,4,5]

JOIST DEPTH (In)	JOIST SERIES	SAF[6]	MINIMUM DISTANCE FROM INSIDE FACE OF ANY SUPPORT TO CENTER OF HOLE (ft - in.)														
			Round Hole Diameter (In.)														
			2	3	4	5	6	6 1/4	7	8	8 5/8	9	10	10 3/4	11	12	12 3/4
9 1/2"	PRI-20	13'-1"	0'-7"	0'-11"	2'-2"	3'-6"	5'-0"	5'-5"									
	PRI-30	13'-9"	0'-9"	2'-0"	3'-3"	4'-7"	6'-1"	6'-6"									
	PRI-40	14'-4"	0'-7"	1'-8"	3'-0"	4'-4"	5'-9"	6'-3"									
	PRI-50	14'-5"	1'-1"	2'-4"	3'-8"	5'-0"	6'-6"	6'-11"									
	PRI-60	15'-0"	1'-7"	2'-10"	4'-2"	5'-7"	7'-1"	7'-6"									
11 7/8"	PRI-20	13'-5"	0'-7"	0'-8"	0'-8"	0'-9"	1'-11"	2'-4"	3'-7"	5'-8"	7'-0"						
	PRI-30	15'-0"	0'-7"	0'-8"	0'-8"	1'-9"	3'-4"	3'-9"	5'-0"	6'-10"	8'-0"						
	PRI-40	16'-7"	0'-7"	0'-8"	1'-2"	2'-5"	3'-9"	4'-1"	5'-1"	6'-8"	7'-11"						
	PRI-50	16'-1"	0'-7"	0'-8"	0'-11"	2'-5"	4'-1"	4'-6"	5'-9"	7'-7"	8'-10"						
	PRI-60	17'-10"	0'-7"	1'-9"	3'-0"	4'-4"	5'-9"	6'-1"	7'-2"	8'-9"	9'-10"						
	PRI-70	18'-5"	0'-7"	1'-2"	2'-5"	3'-9"	5'-2"	5'-7"	6'-11"	8'-10"	10'-1"						
	PRI-80	19'-7"	1'-8"	3'-0"	4'-3"	5'-7"	7'-1"	7'-5"	8'-7"	10'-2"	11'-4"						
	PRI-90	20'-2"	0'-7"	0'-8"	1'-1"	2'-9"	4'-6"	5'-0"	6'-5"	8'-5"	9'-9"						
14"	PRI-40	18'-3"	0'-7"	0'-8"	0'-8"	0'-9"	1'-10"	2'-2"	3'-2"	4'-7"	5'-5"	6'-0"	7'-7"	9'-4"			
	PRI-50	16'-1"	0'-7"	0'-8"	0'-8"	0'-9"	0'-9"	1'-0"	2'-5"	4'-4"	5'-7"	6'-5"	8'-7"	10'-5"			
	PRI-60	19'-9"	0'-7"	0'-8"	0'-8"	1'-7"	2'-10"	3'-3"	4'-6"	6'-3"	7'-4"	8'-1"	10'-0"	11'-8"			
	PRI-70	18'-6"	0'-7"	0'-8"	0'-8"	0'-11"	2'-6"	2'-11"	4'-2"	5'-11"	7'-0"	7'-10"	10'-1"	12'-0"			
	PRI-80	22'-2"	0'-7"	1'-9"	3'-0"	4'-4"	5'-8"	6'-1"	7'-1"	8'-7"	9'-7"	10'-3"	11'-11"	13'-5"			
	PRI-90	22'-10"	0'-7"	0'-8"	0'-8"	2'-1"	3'-8"	4'-1"	5'-4"	7'-1"	8'-3"	9'-0"	11'-0"	12'-7"			
16"	PRI-40	19'-8"	0'-7"	0'-8"	0'-8"	0'-9"	0'-9"	0'-10"	1'-5"	2'-9"	3'-7"	4'-1"	5'-6"	6'-7"	7'-0"	8'-9"	10'-9"
	PRI-50	16'-1"	0'-7"	0'-8"	0'-8"	0'-9"	0'-9"	0'-10"	0'-10"	0'-10"	1'-9"	2'-6"	4'-6"	6'-0"	6'-7"	9'-3"	11'-7"
	PRI-60	19'-9"	0'-7"	0'-8"	0'-8"	0'-9"	0'-9"	0'-10"	1'-10"	3'-6"	4'-6"	5'-2"	6'-11"	8'-6"	9'-1"	11'-5"	13'-4"
	PRI-70	18'-6"	0'-7"	0'-8"	0'-8"	0'-9"	0'-9"	0'-10"	1'-0"	2'-11"	4'-1"	4'-10"	6'-11"	8'-7"	9'-1"	11'-6"	13'-5"
	PRI-80	23'-11"	0'-7"	0'-8"	0'-8"	1'-7"	2'-11"	3'-3"	4'-6"	6'-2"	7'-3"	7'-11"	9'-9"	11'-3"	11'-9"	13'-11"	15'-7"
	PRI-90	25'-3"	0'-7"	0'-8"	0'-8"	0'-10"	2'-3"	2'-8"	3'-10"	5'-5"	6'-5"	7'-1"	8'-10"	10'-2"	10'-8"	12'-11"	14'-10"

For SI: 1 ft = 305 mm; 1 inch = 25.4 mm.

[1]Tabulated values apply where I-joists are spaced 24 inches on center or less.
[2]Hole location distance is measured from inside face of supports to center of hole.
[3]Distances in this chart are based on uniformly loaded joists.
[4]Tabulated values are based on the allowable spans given in PRI-400, which assume the I-joists act compositely with glued and nailed floor sheathing (See APA PRI-400). For multiple-span applications, the lengths of end spans must be at least 40% of the adjacent span length.
[5]Joists with web hole locations and/or sizes that fall outside of the scope of this table must be analyzed based on the actual hole size, joist spacing, span and loading conditions. The I-joist shear capacity at the location of a circular web hole, V_{rh}, is calculated using the following equation: V_{rh} = Published Shear Value x [(Joist Depth – Hole Diameter) / Joist Depth].
[6]SAF = Span Adjustment Factor, used as defined below.

OPTIONAL:

Table 2 is based on the I-joists being used at their maximum span. If the I-joists are placed at less than their full allowable span, the minimum distance from the centerline of the hole to the face of any support (D) as given above may be reduced as follows:

$$D_{reduced} = \frac{L_{actual}}{SAF} \times D$$

Where: $D_{reduced}$ = Distance from the inside face of any support to center of hole, reduced for less-than-maximum span applications (ft). The reduced distance must not be less than 6-inches from the face of support to edge of the hole.
L_{actual} = The actual measured span distance between the inside faces of supports (ft).
SAF = Span Adjustment Factor given in Table 2.
D = The minimum distance from the inside face of any support to center of hole from Table 2 above.

If $\frac{L_{actual}}{SAF}$ is greater than 1, use 1 in the above calculation for $\frac{L_{actual}}{SAF}$.

Requirements for web stiffeners:

1. Wood Structural Panel web stiffeners must be placed on each side of the I-joist web at:
   a) Hangers with side nailing
   b) Hangers with a side, which do not support top flanges of I-joist.
   c) Locations where concentrated loads in excess of 1,500 pounds are applied to the top flange of the I-joist between supports, or in the case of cantilever, anywhere between the cantilever tip and the support.
   d) At exterior supports in engineered applications where concentrated loads cause exterior reaction loads to exceed 1,550 pounds.
2. Web stiffeners must be made of Utility grade SPF (south) or better for lumber and/or Sheathing grade or better for wood structural panels.

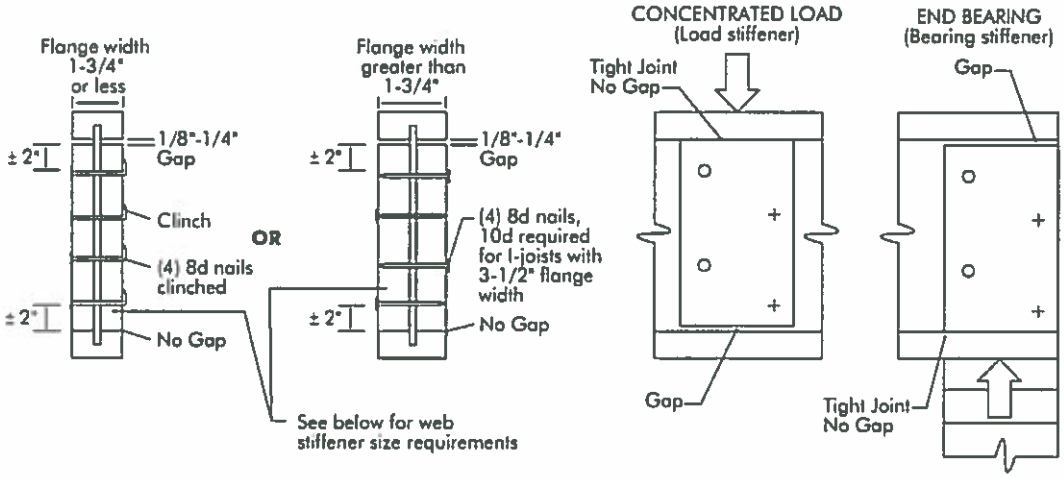


FIGURE 2—PRI I-JOIST WEB STIFFENER CONSTRUCTION DETAILS

Web stiffener size required

I-JOIST FLANGE WIDTH	WEB STIFFENER SIZE REQUIRED ON EACH SIDE OF WEB
$1^1/_2$"	$^{15}/_{32}$" x $2^5/_{16}$" minimum width
$1^3/_4$"	$^{19}/_{32}$" x $2^5/_{16}$" minimum width
$2^5/_{16}$"	1" x $2^5/_{16}$" minimum width
$2^1/_2$"	1" x $2^5/_{16}$" minimum width
$3^1/_2$"	$1^1/_2$" x $2^5/_{16}$" minimum width

For SI: 1 inch = 25.4 mm.

TABLE 3—MANUFACTURERS AND THEIR LOCATIONS

MANUFACTURER	LOCATION
EACOM Timber Corporation	1195 Peoples Road, Sault Ste. Marie, Ontario P6C 3W7, Canada
Boise Cascade Wood Products, LLC	1000 North Park Drive, Roxboro, North Carolina 27573 70 Rue Industrielle, St. Jacques, New Brunswick E7B 1T1, Canada
International Beams	480, Rue Jocelyn-Bastille, CP 10, Pohenegamook, Quebec G0L 1J0, Canada 10 Rouse Street, Tillsonburg, Ontario N4G 5W8, Canada
Nordic Structures	521, Chemin Merrill, C.P. 216, Chibougamau, Quebec G8P 2K7, Canada
Roseburg Forest Products	4500 Riddle By-Pass Road, Riddle, Oregon 97469
Stark Truss Company, Inc.	6855 Chestnut Ridge Road NW, Beach City, OH 44608

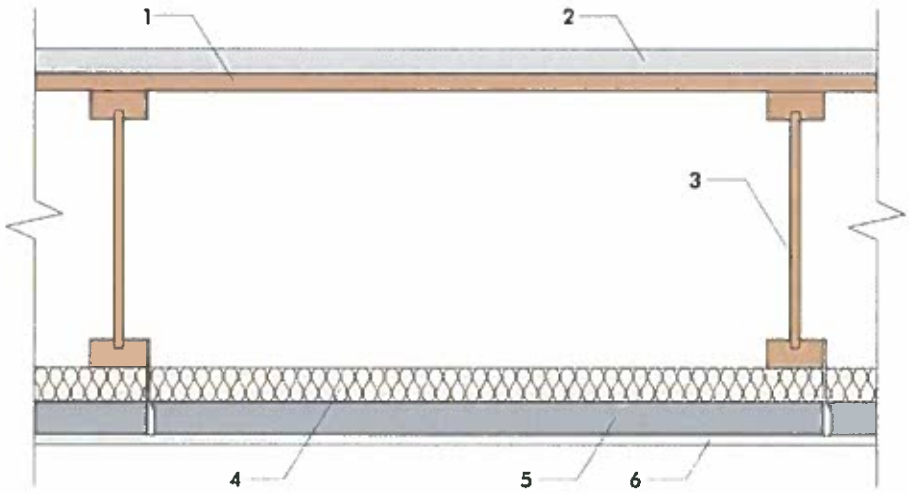


FIGURE 3—ONE-HOUR FIRE-RESISTANCE-RATED FLOOR-CEILING ASSEMBLY (Ceiling—one layer of ½-inch or $^{5}/_{8}$-inch gypsum wallboard, attached to furring channels spaced 24 inches on center)

1. Single Floor – APA Rated Sturd-I-Floor wood structural panels (Exposure 1 or Exterior) with tongue-and-groove edges and conforming to APA Standard PRP-108, PS 1 or PS2, with thickness, span rating and fastening in accordance with code requirements or ICC-ES evaluation reports (minimum $^{23}/_{32}$-inch nominal thickness). Installed with long dimension of panel (strength axis) or face grain of plywood perpendicular to joists with end joints staggered. The panels must be nailed in addition to being glued to framing with construction adhesive conforming to ASTM D3498 (APA Specification AFG-01). The construction adhesive must be applied to the top flanges of I-joists and perimeter framing using a nominal $^{1}/_{4}$-inch diameter bead of adhesive, with double beads applied where panel end joints butt. A nominal ¼-inch diameter bead of adhesive also is applied in the groove of tongue-and-groove edges of panels before joining panels together.

2. Finish Flooring – Approved lightweight concrete floor topping ($1^{1}/_{2}$ inches) or proprietary gypsum concrete floor topping optional over single floor, installed in accordance with an ICC-ES Evaluation Report. Minimum thickness of gypsum concrete topping is $^{3}/_{4}$ inch with I-joists spaced maximum 19.2 inches on center, or 1 inch with I-joists spaced 24 inches on center.

3. Wood Structural Members – Minimum $9^{1}/_{2}$-inch deep wood I-joists spaced maximum of 24 inches on center, installed in accordance with requirements of this report. Top and bottom flanges, minimum size $1^{1}/_{2}$-inch x $2^{1}/_{2}$-inch LVL or $1^{1}/_{2}$-inch x $2^{1}/_{2}$-inch lumber; minimum web thickness $^{3}/_{8}$ inch. Minimum 2 inches bearing on supports. Holes may be cut in web of I-joist as permitted by this report.

4. Insulation – 1-inch-thick unfaced mineral wool batt insulation (minimum 6 pounds per cubic foot density) must be placed under the bottom flange of I-joists and supported on furring channels. Edges of the insulation batts must be tightly buffed against the furring channel support clips and adjoining insulation batts, and ends must be located over furring channels.

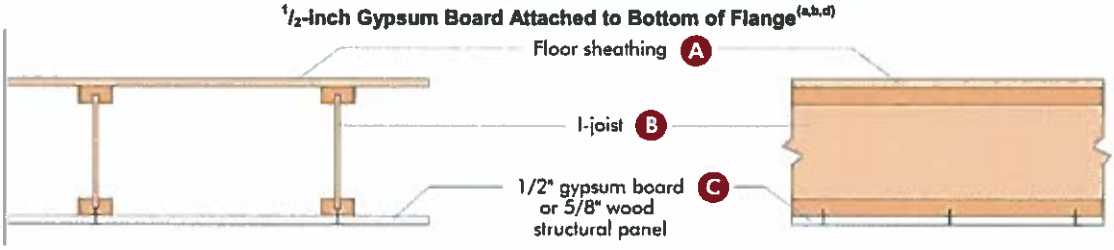
5. Furring Channels – Inverted hat-type channels, $^{7}/_{8}$-inch deep x $2^{5}/_{8}$-inches wide, formed of minimum 0.021-inch thick (25 gage) galvanized steel. Channels must be installed perpendicular to I-joists in continuous rows spaced 24 inches on center. Channels must be attached to the bottom flange of each I-joist with one support clip (Simpson Strong-Tie Co. Type CSC) at each crossing. Support clips must be nailed to I-joist flange with one 11 gage (0.1205-inch diameter) x $1^{1}/_{2}$-inch nail. At locations of end joints of gypsum wallboard, install double row of channels, centered $1^{1}/_{2}$ inches from panel ends. Ends of channel must extend a minimum of 6 inches beyond the edge joint of adjoining panels. Channel splices must be centered under the I-joists and overlapped a minimum of 6 inches, and tied together with double strand of No. 18 SWG galvanized steel wire near each end of overlap.

6. Wallboard, Gypsum – Approved $^{1}/_{2}$-inch or $^{5}/_{8}$-inch proprietary Type X gypsum wallboard, 48 inches wide, installed perpendicular to furring channels (parallel to I-joists) with end joints continuous or staggered. Fasten to furring channels with 1-inch or $1^{1}/_{8}$-inch Type S drywall screws spaced 12 inches on center. Drywall screws must be driven so that they are flush with the face and do not damage the core of the wallboard, and must be located $1^{1}/_{2}$ inches from panel ends and a maximum of 6 inches from panel edges. The wallboard must be:

   - National Gypsum Fire-Shield Type C gypsum wallboard,
   - U. S. Gypsum Fire Code C gypsum wallboard.

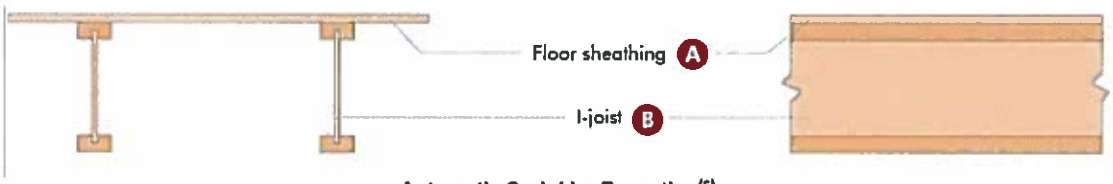
7. Finishing System (not shown) – Exposed face layer joints must be covered with tape and joint compound, and screw heads must be covered with joint compound.

$^1/_2$-Inch Gypsum Board Attached to Bottom of Flange[a,b,d]



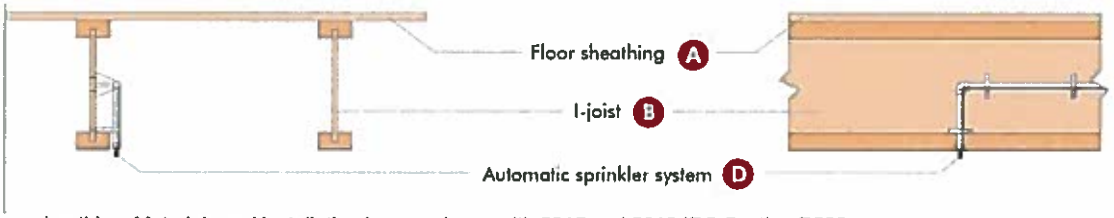
Crawl Space Exception[b]

In accordance with Exception 2 of the 2015 IRC Section R302.13 and 2012 IRC Section R501.3, floor assemblies located directly over a crawl space not intended for storage or fuel-fired appliances do not require membrane protection.



Automatic Sprinkler Exception[c]

In accordance with Exception 1 of the 2015 IRC Section R302.13 and 2012 IRC Section R501.3, floor assemblies located directly over a space protected by an automatic sprinkler system do not require membrane protection.



(A) Floor sheathing: Materials and installation in accordance with 2015 and 2012 IRC Section R503.

(B) I-joist: Installation in accordance with Section 4.0 of this report. Max. 24 inches on center spacing. Applicable to all flange sizes. Minimum web thickness of $^3/_8$ inch. Adhesives used shall be as described in the quality manual approved by APA.

(C) 1/2-inch gypsum board: Materials and installation in accordance with 2015 and 2012 IRC Section R702.3.1 or equivalent. 1x3 (nominal) wood furring strips are permitted to be installed perpendicular to the bottom flange of the I-joists at 16 inches on center provided that the gypsum boards are directly attached to the furring strips using 1-$^1/_4$-inch (32-mm) Type W drywall screws at 12 inches (305 mm) on center. Gypsum board not required to be finished with tape and joint compound; or
$^5/_8$-inch wood structural panel: Materials and installation in accordance with 2015 and 2012 IRC Section R503.2 or equivalent. Wood structural panel not required to be finished with wood filler or sanded.

(D) Automatic sprinkler system: System in accordance with Section P2904 of the 2015 and 2012 IRC, NFPA 13D, or other equivalent sprinkler systems.

Notes: (a) In accordance with Exception 3 of the 2015 IRC Section R302.13 and the 2012 IRC Section R501.3, portions of floor assembly can be unprotected when complying with the following:
1) The aggregate area of the unprotected portions shall not exceed 80 square feet.
2) Fire blocking in accordance with 2015 and 2012 IRC 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.

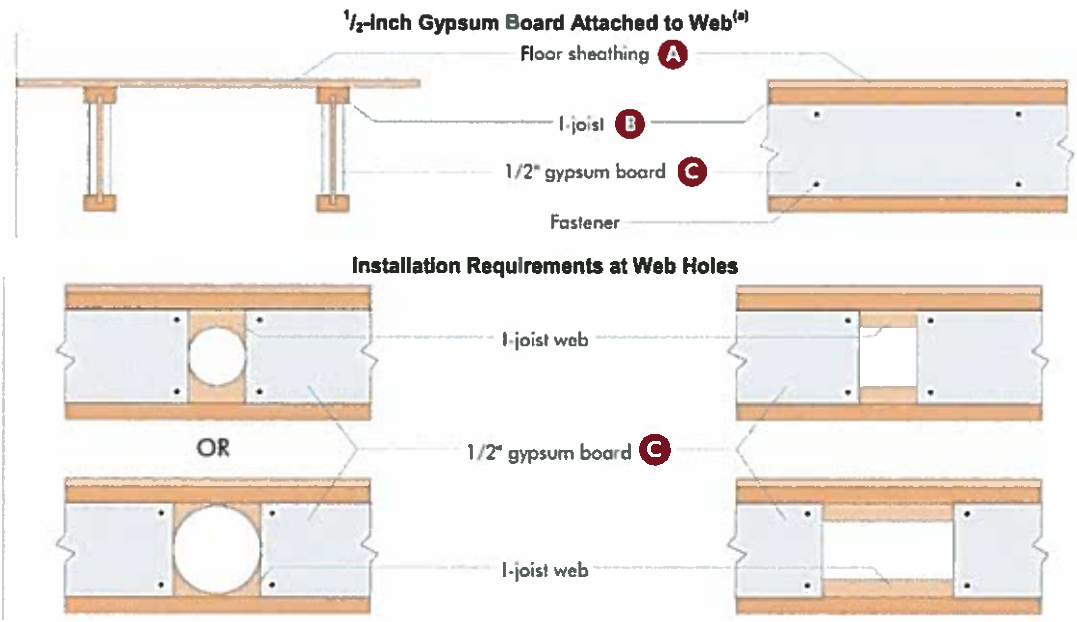
(b) Insulation may be required for energy code compliance purposes. Check with the local building official for specific jurisdictional requirements.

(c) In accordance with 2015 and 2012 IRC Section P2904, partial residential sprinkler systems are permitted to be installed only when the entire dwelling unit is not required to be equipped with a residential sprinkler system. Check with the local building official for specific jurisdictional requirements.

(d) Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

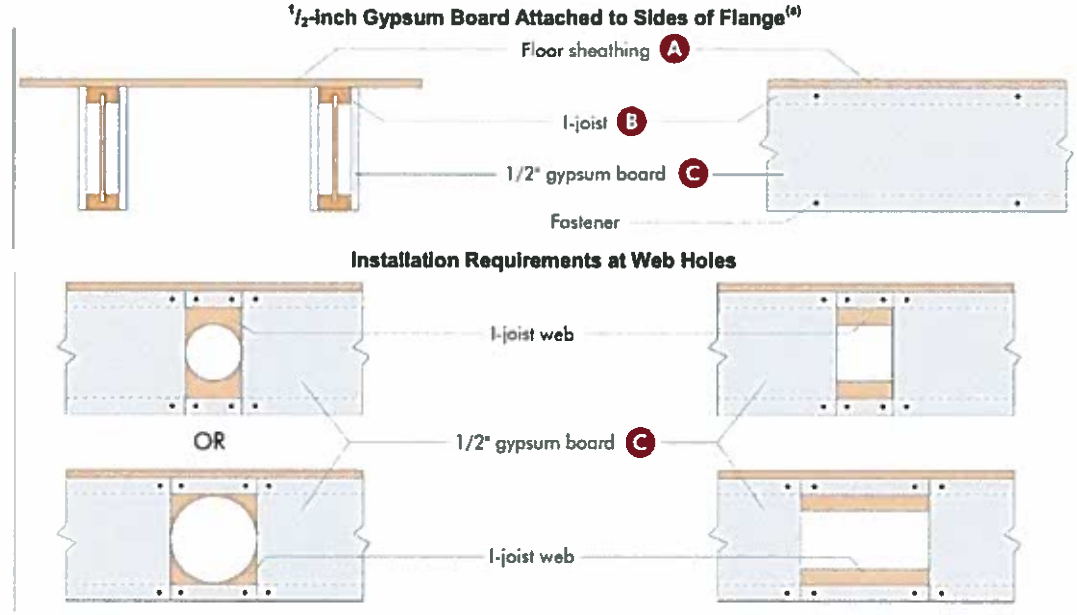
FIGURE 4—2015 AND 2012 IRC FLOOR ASSEMBLY DETAILS

For SI: 1 inch = 25.4 mm



(A) Floor sheathing: Materials and installation in accordance with 2015 and 2012 IRC Section R503.
(B) I-joist: Installation in accordance with Section 4 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/2 inches thick x 2 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA. At hole location, fasteners shall be installed 1 inch from the edge of the gypsum board.
(C) 1/2-inch gypsum board: Materials (entire length of I-joist) in accordance with 2015 and 2012 IRC Section R702.3.1 (not required to be finished with tape and joint compound). Fasteners: Minimum 1-inch screws (Type W or Type S) or nails installed 1 inch from edges and 16 inches on center, top and bottom. Fasteners may be staggered from top to bottom.
Note: (a) Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

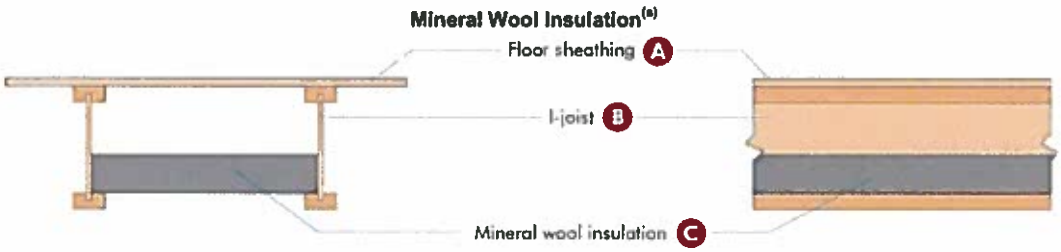
FIGURE 5—FIRE PROTECTION: ½-INCH GYPSUM BOARD DIRECTLY ATTACHED TO WEB



(A) Floor sheathing: Materials and installation in accordance with 2015 and 2012 IRC Section R503.
(B) I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-1/8 inches thick x 1-3/4 inches wide. Minimum web thickness of 3/8 inch. Adhesives used shall be as described in the quality manual approved by APA. At hole location, fasteners shall be installed ½ inch from the edge and 1 inch from the end of the gypsum board. Maximum fastener spacing shall be no more than 8 inches on gypsum board above and below the hole.
(C) 1/2-inch gypsum board: Materials (entire length of I-joist) in accordance with 2015 and 2012 IRC Section R702.3.1 (not required to be finished with tape and joint compound). Fasteners: Minimum 1-inch screws (Type W or Type S) or nails installed 1/2 inch from edges and 1 inch from ends, and 16 inches on center, top and bottom. Fasteners may be staggered from top to bottom.
Note: (a) Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

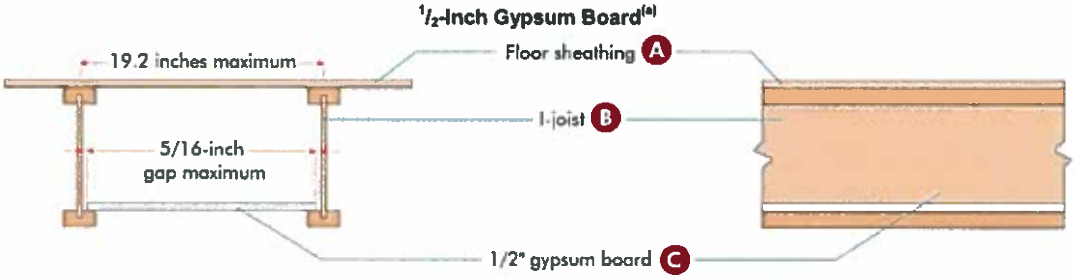
FIGURE 6—FIRE PROTECTION: ½-INCH GYPSUM BOARD DIRECTLY ATTACHED TO SIDES OF FLANGE

For SI: 1 inch = 25.4 mm



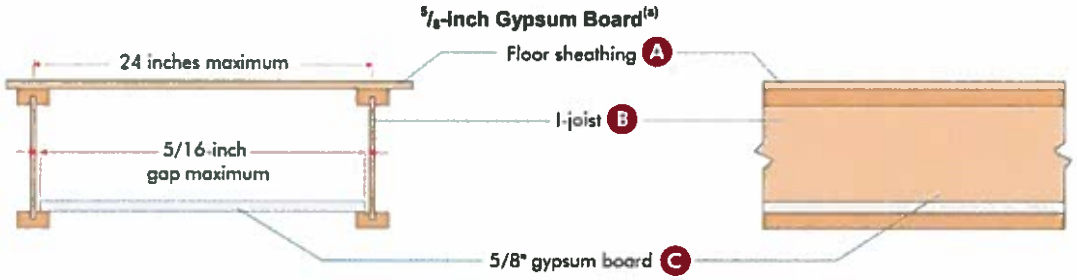
(A) Floor sheathing: Materials and installation in accordance with 2015 and 2012 IRC Section R503.
(B) I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-$^1/_8$ inches thick x 2 inches wide. Minimum web thickness of $^3/_8$ inch. Adhesives used shall be as described in the quality manual approved by APA.
(C) Mineral wool batt insulation: Minimum 2.5 lb/ft^3 (nominal) and 3-inch-thick mineral wool batt insulation made of rock or furnace slag (ASTM C665 Type 1 compliant) installed as shown with insulation stay wire supports spaced no more than 24 inches apart and no more than 4 inches from ends of batts. Use minimum of 15$^1/_4$-inch-, 18$^1/_2$-, and 23-inch-wide insulaton batt when I-joist spacing is 16 inches, 19.2 inches and 24 inches on center, respectively.
Note: (a) Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

FIGURE 7—FIRE PROTECTION: MINERAL WOOL INSULATION



(A) Floor sheathing: Materials and installation in accordance with 2015 and 2012 IRC Section R503.
(B) I-joist: Installation in accordance with Section 4.0 of this report. Maximum 19.2 inches on center spacing. Minimum flange size of 1-$^1/_8$ inches thick x 2 inches wide. Minimum web thickness of $^3/_8$ inch. Adhesives used shall be as described in the quality manual approved by APA.
(C) 1-layer of $^1/_2$-inch-thick gypsum board complying to ASTM C1396 provisions for gypsum wallboards, installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required. A maximum gap of $^5/_{16}$ inch between the edge of the gypsum and the I-joist web shall be permiited.
Note: Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

FIGURE 8—FIRE PROTECTION: ½-INCH GYPSUM BOARD INSTALLED ON TOP OF THE BOTTOM FLANGE



(A) Floor sheathing: Materials and installation in accordance with 2012 and 2015 IRC Section R503.
(B) I-joist: Installation in accordance with Section 4.0 of this report. Maximum 24 inches on center spacing. Minimum flange size of 1-$^1/_8$ inches thick x 2 inches wide. Minimum web thickness of $^3/_8$ inch. Adhesives used shall be as described in the quality manual approved by APA.
(C) 1-layer of $^5/_8$-inch-thick gypsum board complying to ASTM C1396 provisions for gypsum wallboards, installed on the top of the bottom flange. Mechanical fastener or adhesive attachment to the top of the bottom flange is not required. A maximum gap of $^5/_{16}$ inch between the edge of the gypsum and the I-joist web shall be permiited.
Note: (a) Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

FIGURE 9—FIRE PROTECTION: $^5/_8$-INCH GYPSUM BOARD INSTALLED ON TOP OF THE BOTTOM FLANGE

For SI: 1 inch = 25.4 mm