Fire-Rated Systems

DESIGN AND CONSTRUCTION GUIDE

WOOD:
THE NATURAL CHOICE



Engineered wood products are among the most beautiful and environmentally friendly building materials. They are produced efficiently from a renewable, sustainable, biological resource. Their various sizes and dimensions mean less construction jobsite waste and lower disposal costs. In completed buildings, they store carbon and 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.

Forest land comprises about **33% of the total land** area of the United States[a].

Only about **one-third** of that forest land is open to logging[b].

The volume of annual net timber **growth in the U.S. is 36% higher** than the volume of annual timber removals[c].

American landowners **plant more than 2.5 billion trees** every year[d].

A young, growing forest **produces 1 ton of oxygen** and **absorbs 1.4 tons of CO_2** for every 1 ton of wood[e].

Forests in the United States continue to sequester more carbon than they emit each year, and combined with urban forests and harvested wood products, **offset nearly 15%** of total greenhouse gas emissions in 2012[a].

A FEW FACTS ABOUT WOOD:

Life Cycle Assessment (LCA) measures the long-term green value of wood.

Studies by Consortium for Research on Renewable Industrial Materials (CORRIM) scientifically validate the environmental credentials of wood as a green building product. LCAs examine building products' life cycle—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 benign environmental footprint than steel or concrete in energy use, climate change, air emissions, water emissions and solid waste production. Report details are available at www.CORRIM.org.

Environmental Product Declarations (EPDs) verify specific products.

The American Wood Council and Canadian Wood Council have published declarations and transparency briefs for engineered wood products, including I-joists, plywood, oriented strand board, glulam, laminated veneer lumber and laminated strand lumber. Use of products with verifiable EPDs may be used toward LEED v4 credit. Similar incentives may be found in Green Globes, the International Green Construction Code and the Architecture 2030 Challenge. EPDs and transparency briefs are available from www.awc.org.

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

a. *U.S. Forest Resource Facts and Historical Trends*, U.S. Department of Agriculture, U.S. Forest Service, 2014
b. Consortium for Research on Renewable Industrial Materials (CORRIM)
c. Alvarez, M. The State of America's Forests: Society of American Foresters, 2007
d. Jones, S. *Creating a Sustainable Supply for Woody Biomass*, Forest Landowners Association, 2011
e. The American Hardwood Information Center, Hardwood Manufacturers Association

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INTRODUCTION

Planning and designing buildings that provide good fire protection, don't cost too much to build or insure, meet the codes, make the best use of materials and strike a balance between form and function is complicated.

This challenge arises from the lack of standardized construction and insurance rating practices and partly from the rapid advance of construction technology itself. Many of these advances have changed and improved wood construction's acceptance by building codes and insurance rating agencies.

This brochure from APA – The Engineered Wood Association is designed to bring you up to date on what are considered today among the most cost-effective fire-rated construction systems you can design or build—wood and wood structural panel systems. It provides hard facts about what's available, what's acceptable and what's best practice. Contact APA for additional information or assistance with specific design considerations.

FIREPROOF VS. FIRESAFE

The first step of designing or building for fire protection is to recognize that fireproof buildings simply do not exist. The contents are the critical factor. Almost any building's contents will burn, and the smoke and heat thus generated can cause extensive damage and loss of life long before the building itself begins to burn, regardless of the type of construction.

The Forest Products Laboratory (FPL) has convincingly documented this fact for residential construction. After studying dwelling-room fires involving combustible contents, FPL concluded that "wall and ceiling materials, whether combustible or noncombustible, had little or no effect on the time or temperature of the critical point"—the point at which human life is untenable [25]. In the FPL studies, the critical point was reached in four to seven

minutes. Other tests have shown untenable conditions can occur in as little as two minutes.

Nor are so-called "fireproof" building materials a guarantee of human or property safety. One classic demonstration of this was the 1953 fire in General Motors' huge plant in Livonia, Michigan (photo right). The plant was considered completely noncombustible, yet was a complete loss due to the collapse of unprotected metal construction [20].

General Motors plant in Livonia, Michigan was unprotected metal construction (see text).

Another was the 1967 disaster at McCormick Place, Chicago's exhibition hall. All of its structural members, including interior nonbearing walls, were noncombustible. Yet a small fire that began in the contents spread with such heat that the entire ceiling fell as steel beams, girders and trusses buckled and collapsed.

The type of construction is, of course, important. But to protect the occupants and firefighters—always the first concern—as well as to safeguard property, the presence of a prompt detection and alarm system and the accessibility of numerous exits are far more vital. Also of importance are the type of contents and furnishings, interior finishes, degree of sprinkler protection and the availability of adequate fire-fighting equipment.

With proper construction in conformance with code regulations, and with recognition of the above factors, a **firesafe** building can be designed with both combustible and noncombustible materials. This puts wood and wood structural panel systems in perspective and explains why they have been widely used for both low-rise and medium-rise (four to six stories) construction.

THE BASICS OF FIRE PROTECTION

Safety Criteria

In order to evaluate fire safety of a structure, building authorities consider many factors, including flame spread and fire-resistance ratings.

Flame Spread in general means spread of fire within a room and is measured by the performance of the materials used for interior finish on walls, ceilings and partitions.

Flame spread is a property of the surface material once fire has started, not the structure.

The best known flame spread test is the tunnel test, ASTM E84 or UL 723 (CAN/ULC S102 in Canada). In this test, a sample of the material, 20 inches wide and 24 feet long, is installed as ceiling of a test chamber and exposed to a gas flame at one end. The rate at which flame spreads across the specimen is compared on a scale of 0 for inorganic reinforced cement board and 100 for red oak.

Another property measured in the ASTM E84 or UL 723 test is the opacity of the smoke generated by the burning material. This measurement provides an indication of the amount of smoke released, which also is compared on a scale of 0 for inorganic reinforced cement board and 100 for red oak.

International Building Code (IBC) interior finish classifications are summarized in Table 1. Materials with the lowest rate of flame spread (0 to 25) are classed as Class A (or I), and are permitted for areas where fire hazard is most severe, such as vertical exitways of unsprinklered buildings for public assembly.

TABLE 1

INTERIOR FINISH CLASSIFICATIONS [5,10]

Interior Finish or Flame Spread Classification	Flame Spread Rating or Index	Smoke Developed Rating or Index
Class A (or I)	0 to 25	
Class B (or II)	26 to 75	450 max.
Class C (or III)	76 to 200	

Examples:

Material	Flame Spread Rating	Smoke Developed Rating
Inorganic reinforced cement board	0	0
Fire-retardant-treated construction plywood	0 to 25	0 to 80
Fire-retardant-coated construction wood structural panels[a]	0 to 45	0 to 200
Fire-retardant-treated lumber	0 to 25	10 to 360
Red oak lumber	100	100
APA wood structural panels[a,b]	35 to 200	25 to 270

a. Wood structural panels include structural plywood certified under DOC PS 1 or PS 2, or CSA O121, O151 or O153, and oriented strand board (OSB) certified under DOC PS 2 or CSA O325.

b. The flame spread indexes and smoke developed indexes for wood structural panels of various thicknesses are listed in DCA1 [10].

Materials with ratings from 26 to 75 are Class B (or II) and are permitted in areas of intermediate severity: for example, corridors providing exitway access in business and industrial buildings. Materials rated from 76 to 200 are Class C (or III).

APA trademarked panels such as plywood and oriented strand board (OSB) fall generally in Class B or C and are permitted in rooms of most occupancies. (Exceptions: hospitals, or institutions where occupants are restrained.) For exitways and for most interiors where Class A or Class B flame spread performance is required, fire-retardant-treated plywood (which falls in Class A) is permitted.

Table 1 also shows ratings of some commonly used construction materials. Table 2 shows typical flame spread requirements as called for under the IBC.

Fire Resistance. Though codes are concerned with how fast fire can spread on a room's surface, they are even more specific about fire resistance: the measure of containment of fire within a room or building. It is defined as protection against fire penetrating a wall, floor or roof, either directly or through a high rate of heat transfer that might cause combustible materials to be ignited on the side of the wall or floor away from the actual fire. Thus, it is a property of an assembly of several materials, including fastenings, and of the workmanship.

A fire-resistive construction gives time to discover a fire, to suppress it before it spreads and to evacuate the building if need be.

The standard test for measuring fire resistance is ASTM E119 or UL 263 (CAN/ULC S101 in Canada). Ratings of assemblies are determined by fire test procedures approximating actual fire conditions. Floor-ceilings and roof-ceilings are tested flat, while loaded to their full allowable stress. Walls are tested vertically, either as bearing walls, under axial load, or as nonbearing walls, under no load. The resistance rating is expressed in hours or minutes that the construction withstands the test. So it approximates the time the assembly would be expected to withstand actual structure-fire conditions.

A one-hour rating, for example, is taken to mean that an assembly similar to that tested will not collapse, nor transmit flame or a high temperature, while supporting its full load, for at least one hour after the fire commences.

TABLE 2

TYPICAL FLAME SPREAD CLASSIFICATION REQUIREMENTS FOR INTERIOR FINISH BASED ON THE 2021 INTERNATIONAL BUILDING CODE (TABLE 803.13)[k]

	Sprinklered[l]			Nonsprinklered		
Group	Interior exit stairways and ramps and exit passageways[a,b]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[c]	Interior exit stairways and ramps and exit passageways[a,b]	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces[c]
A-1 & A-2	B	B	C	A	A[d]	B[e]
A-3[f], A-4, A-5	B	B	C	A	A[d]	C
B, E, M, R-1	B	C[m]	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B	C[g]	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B[h, i]	A	A	B
I-3	A	A[j]	C	A	A	B
I-4	B	B	B[h, i]	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m^2.

a. Class C interior finish materials shall be permitted for wainscotting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by IBC Section 803.15.1.

b. In other than Group I-3 occupancies in buildings less than three stories above grade plane, Class B interior finish for non-sprinklered buildings and Class C interior finish for sprinklered buildings shall be permitted in interior exit stairways and ramps.

c. Requirements for rooms and enclosed spaces shall be based on spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered enclosing spaces and the rooms or spaces on both sides shall be considered one room or space. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.

d. Lobby areas in A-1, A-2, and A-3 occupancies shall not be less than Class B materials.

e. Class C interior finish materials shall be permitted in places of assembly with an occupant load of 300 persons or less.

f. For places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be permitted.

g. Class B material is required where the building exceeds two stories.

h. Class C interior finish materials shall be permitted in administrative spaces.

i. Class C interior finish materials shall be permitted in rooms with a capacity of four persons or less.

j. Class B materials shall be permitted as wainscotting extending not more than 48 inches above the finished floor in exit access corridors.

k. Finish materials as provided for in other sections of the IBC.

l. Applies when protected by an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

m. Corridors in ambulatory care facilities shall be provided with Class A or B materials.

Protection Methods

In many cases, ordinary wood-frame construction with wood structural panel sheathing provides ample fire safety and is completely acceptable. When unusual circumstances require additional protection, the designer's options include protected construction, Mass Timber Construction (Type IV-A, IV-B, or IV-C) or Heavy Timber Construction (Type IV-HT).

Protected Construction is simply any normal wood construction assembly, such as floor-ceiling or wall, with a fire-resistive material added to give primary protection to the wood members. The material may be gypsum wallboard, plaster or acoustical tile. The panel prevents flame passage and temperature rise while reinforcing framing against collapse under load. Table 3 is an example of typical fire-resistive requirements, which is based on Table 601 of the 2021 IBC.

TABLE 3

TYPICAL FIRE-RESISTIVE REQUIREMENTS FOR STRUCTURAL COMPONENTS (IN HOURS) BASED ON THE 2021 INTERNATIONAL BUILDING CODE

	Type I		Type II		Type III		Type IV				Type V	
Building Element	**A**	**B**	**A**	**B**	**A**	**B**	**A**	**B**	**C**	**HT**	**A**	**B**
Primary structural frame[e] (includes columns, girders, trusses)	3[a,b]	2[a,b,c]	1[b,c]	0[c]	1[b,c]	0	3[a]	2[a]	2[a]	HT	1[b,c]	0
Bearing walls Exterior[d,e]	3	2	1	0	2	2	3	2	2	2	1	0
Bearing walls Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/ HT[f]	1	0
Floor construction and associated structural members (including supporting beams and joists)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (including supporting beams and joists)	1-1/2[b]	1[b,c]	1[b,c]	0c	1[b,c]	0	1-1/2	1	1	HT	1[b,c]	0

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. Heavy timber shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating based on fire separation distance.

e. Not less than the fire-resistance rating as referenced in the IBC Section 704.10.

f. Heavy timber bearing walls supporting more than two floors or more than a floor and a roof shall have a fire resistance rating of not less than 1 hour.

Mass Timber Construction provides the fire protection by using mass timber, which is defined in the IBC as structural elements of Type IV construction, primarily of solid, built-up, panelized or engineered wood products that meet minimum cross-section dimensions of Type IV construction. Mass timber, such as cross-laminated timber (CLT) in compliance with ANSI/APA PRG 320, is required for Types IV-A, IV-B and IV C construction, provided that the fire-resistance ratings of the mass timber meet the fire-resistance-rating requirements of the IBC based on either the fire-resistance rating of the noncombustible protection, the mass timber or a combination of both.

The minimum dimensions and permitted materials for building elements shall comply with the IBC and Table 4 of this publication (Table 2304.11 of the 2021 IBC). Mass timber elements of Types IV-A, IV-B and IV-C construction shall be protected with noncombustible protection applied directly to the mass timber in accordance with Sections 602.4.1 through 602.4.3 of the 2021 IBC. The time assigned to the noncombustible protection shall be determined in accordance with Section 703.6 of the 2021 IBC and comply with Section 722.7 of the 2021 IBC.

Heavy Timber Construction implies the protection provided by massive wood members. The name comes from early New England textile mills, where it was known as "mill construction," "plank-on-timber" or "slow-burning." In such construction, though the outside may char during exposure to fire, the surface char acts as insulation, while the strength of wood is such that it continues to support its load, so the chance of building collapse is greatly diminished.

Based on comparative fire tests, 1-3/32- or 1-1/8-inch-thick wood structural panels are permitted for heavy timber roof decks. See Figure 1 for typical construction. Wood structural panels must have tongue-and-groove edges. (See IBC Section 2304.11.4 and ICC Evaluation Service Inc., Evaluation Report ESR-2586.)

The minimum dimension required by the code for heavy timber is shown in Table 4 (Table 2304.11 of the 2021 IBC).

FIGURE 1

WOOD STRUCTURAL PANEL HEAVY TIMBER ROOF CONSTRUCTION

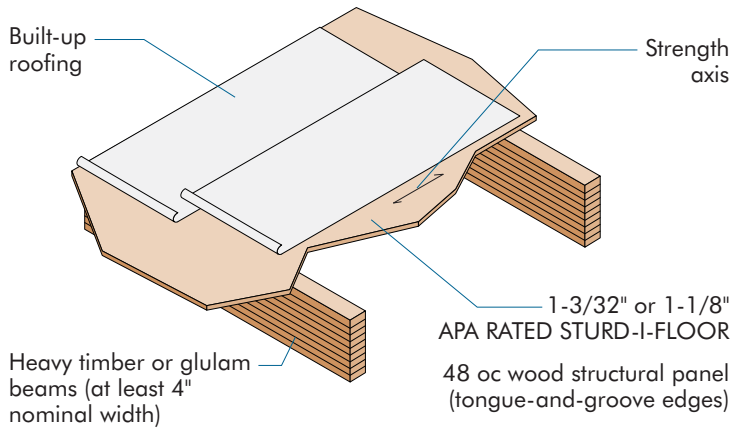


TABLE 4

DIMENSIONS OF COMPONENTS FOR HEAVY TIMBER CONSTRUCTION (TYPICAL CODE PROVISIONS)
Type IV (Mass Timber and Heavy Timber) Construction is Defined in the IBC by the Following Minimum Sizes for the Various Members or Portions of a Building.

Supporting	Minimum Nominal Solid-Sawn Size (in.)	Minimum Glue Laminated Timber or Cross-Laminated Timber Net Size (in.)	Minimum Structural Composite Lumber Net Size (in.)
COLUMNS			
Supporting floor loads or combined floor and roof loads	8 (width) x 8 (depth)	6 3/4 (width) x 8 1/4 (depth)	7 (width) x 7 1/2 (depth)
Supporting roof and ceiling loads only	6 (width) x 8 (depth)	5 (width) x 8 1/4 (depth)	5 ¼ (width) x 7 1/2 (depth)
FLOOR FRAMING			
Beams and girders	6 (width) x 10 (depth)	5 (width) x 10 1/2 (depth)	5 ¼ (width) x 9 1/2 (depth)
Arches and trusses	8 (width) x 8 (depth)	6 3/4 (width) x 8 1/4 (depth)	7 (width) x 7 1/2 (depth)
ROOF FRAMING – NOT SUPPORTING FLOOR LOADS			
Arches springing from grade	6 (width) x 8 (depth) lower half 6 (width) x 6 (depth) upper half	5 (width) x 8 1/4 (depth) lower half 5 (width) x 6 (depth) lower half	5 1/4 (depth) x 7 1/2 (depth) lower half 5 1/4 (width) x 5 1/2 (depth) lower half
Arches, trusses, other framing springing from top of walls, etc.	4[a] (width) x 6 (depth)	3[a] (width) x 6 7/8 (depth)	3 1/2[a] (width) x 5 1/2 (depth)
FLOOR[b]			
Splined or tongue-and-groove plank	3 (thickness)	2 1/2[c] (thickness)	2 1/2 (thickness)
Planks set on edge	4 (thickness)	3 1/2[c] (thickness)	3 1/2 (thickness)
ROOF DECKS[d]			
Splined or tongue-and-groove plank	2 (thickness)	1 1/2[e] (thickness)	1 1/2 (thickness)
Planks set on edge	3 (thickness)	2 1/2[e] (thickness)	2 1/2 (thickness)

a. Where protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches nominal in width.

b. Covered with 1-inch nominal flooring, 15/32-inch wood structural panel, or 1/2-inch particleboard.

c. CLT floor net thickness shall be not less than 4 inches.

d. 1-1/8-inch-thick wood structural panel (exterior bond) shall be permitted.

e. CLT roof nominal thickness shall be not less than 3 inches.

This code recognition can simplify roof construction practices while providing fire protection. Performance of Heavy Timber Construction is markedly superior to most unprotected "noncombustible" (metal) structures under fire conditions. There are no concealed spaces where fire can spread, making fire fighting simpler and safer.

The IBC and other model codes also recognize 15/32-inch or thicker wood structural panels over nominal 3-inch planks for heavy timber floors.

Fire-Retardant-Treated (FRT) Wood does not increase fire resistance beyond the untreated members. FRT wood is pressure-impregnated with chemicals in water solution or other means during manufacture to inhibit combustion. This qualifies it for lower flame spread (FRT wood must meet a flame spread index of 25 or less when tested in accordance with ASTM E84 or UL 723) and smoke-generation ratings and reduces its fire-hazard classification. When it is identified as such by a code-recognized testing agency label, it is rated on a parity with noncombustible constructions by many insurance rating bureaus, but not by building codes.

Precisely defined, FRT plywood complies with American Wood Protection Association (AWPA) Standard U1. When tested under ASTM E84 or UL 723, the flame spread test shall be continued for a 20-minute period and the flame front shall not progress more than 10-1/2 feet beyond the centerline of the burners at any time during the test. The FRT plywood shall have a flame spread index of 25 or less.

Note that the span ratings and load capacities for APA-trademarked plywood are based on untreated panels, and may not apply following fire-retardant treatment. Obtain structural performance characteristics and use recommendations for FRT plywood from the company providing the treatment and redrying service.

Fire-Retardant (FR) Paints can be used on plywood for nonstructural interior finish applications, such as wall and ceiling paneling, to reduce flame spread ratings, depending on the paint selected. FR paints are tested per ASTM E84 or UL 723 for ten minutes, as compared to thirty minutes for FRT plywood. FR paints are proprietary and can be applied as interior finish coats over new or existing plywood surfaces. Some FR paints are available with proprietary topcoat finishes for exterior use.

Sprinklers are another option to improve the fire performance of floor-ceiling assemblies. With sprinkler protection, code requirements for flame spread and fire-resistance ratings may be relaxed. It may be possible to add another story or increase building area. Reduced insurance premiums for buildings and contents mean that sprinklers generally will pay for themselves in a few years, depending on the value of the building and its contents.

Meeting the Building Codes

All buildings must meet code specifications as to maximum permissible heights and floor areas. These specifications are based on certain characteristics of the building, including the fire zone, type of occupancy, construction materials and systems, setbacks from property lines, exits and automatic extinguishing systems. For further discussion of how to adjust these characteristics in order to achieve area increases, see "How Building Areas Can Be Increased" later in this publication.

Calculated Fire Resistance. The IBC permits the determination of one-hour fire-rated wood-framed floors, roofs and load-bearing and non-bearing walls by calculation, as an alternate to tested assemblies. Section 722.6 of the 2021 IBC provides tables of assigned times for components, which have been developed empirically from extensive studies of assemblies tested in accordance with ASTM E119 or UL 263. A one-hour fire-rated assembly can be determined by combining the individual component times of the assembly in accordance with the method and limitations in the codes, thereby providing additional choices for the designer.

HOW TO BUILD FOR FIRE PROTECTION

Wall Systems

Possible wood wall systems for light-frame construction include ordinary stud-wall with sheathing or as single wall as "protected" construction or incorporation of fire-retardant treatment or paint.

Protected Walls. Examples of protected construction are shown in Figures 2 and 3.

The gypsum sheathing is not required in the exterior wall under Section 705.5 of the 2021 IBC where the fire separation distance is greater than 10 feet, since the fire-resistive rating only applies to the interior face of the wall. See Systems 2D through 2G of Figure 2 for one-hour fire-rated wall constructions that are applicable under the IBC. In this case, the protected wall constructions qualify for the same ratings if other materials, such as siding, are attached to the outside of a rated wall to add shear-wall value, without impairing the fire rating.

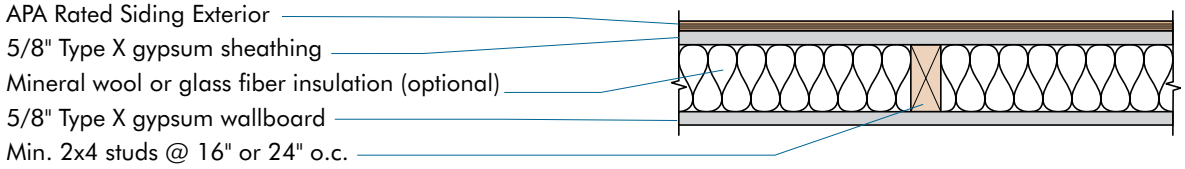
FIGURE 2

ONE-HOUR COMBUSTIBLE LOAD-BEARING WALL ASSEMBLIES[a]

Some rated assemblies incorporate proprietary products. When designing and specifying, check the appropriate reference for complete details on a particular assembly. A change in details may affect the fire resistance of the assembly.

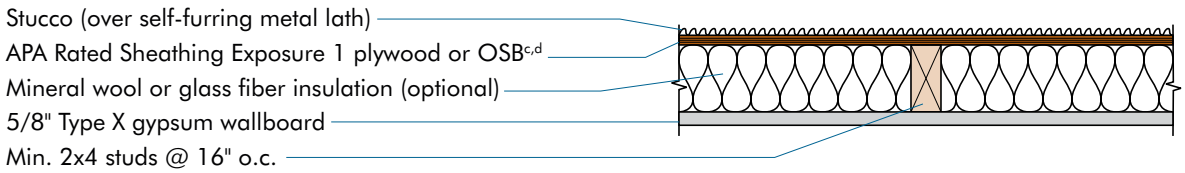
2A – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on GA File No. WP8105 in Gypsum Association (G.A.) Fire Resistance Design Manual or Item 15.1.15 of Table 721.1(2) of the 2021 IBC[b].



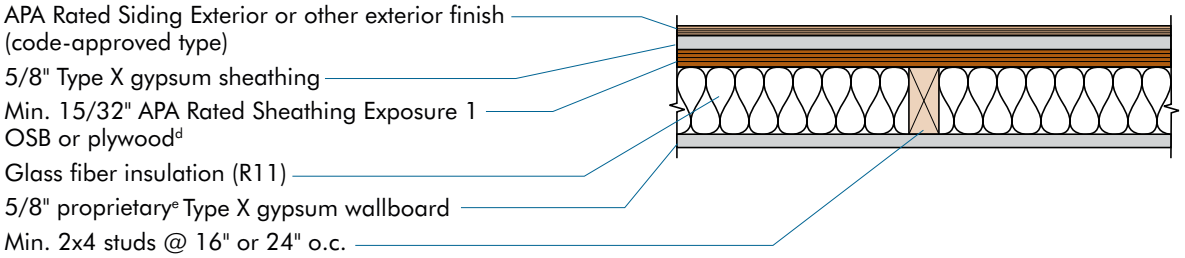
2B – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on combining Items 15-1.2 and 15-1.3 and Footnote (*l*) of Table 721.1(2) of the 2021 IBC.



2C – LOAD-BEARING EXTERIOR WALL SYSTEM

Based on U.L. Design No. U344 in Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.



2D – LOAD-BEARING EXTERIOR WALL SYSTEM

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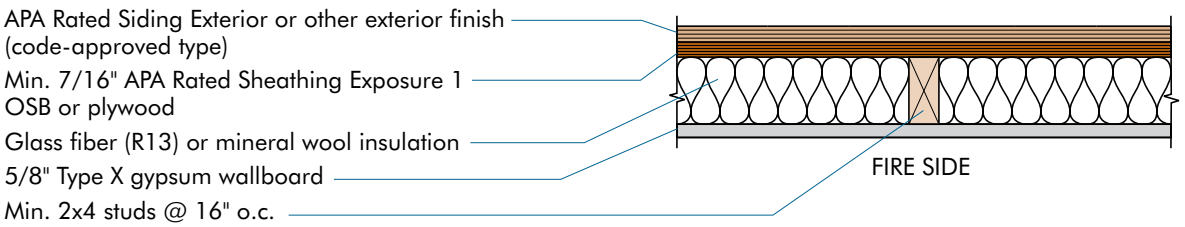

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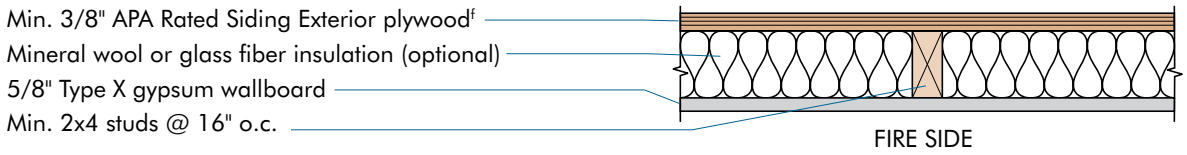
FIGURE 2 (Continued)

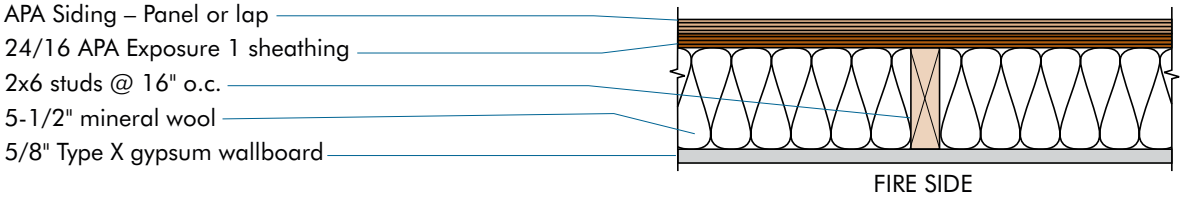
ONE-HOUR COMBUSTIBLE LOAD-BEARING WALL ASSEMBLIES

2E – LOAD-BEARING EXTERIOR WALL SYSTEM

Generic, nonproprietary assembly based on provisions for calculated fire resistance rating in accordance with Section 722.6 of the 2021 IBC.

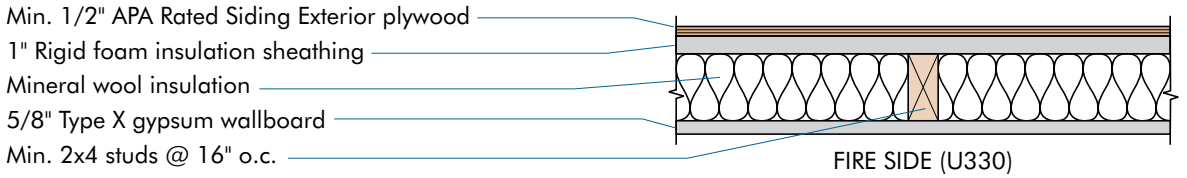


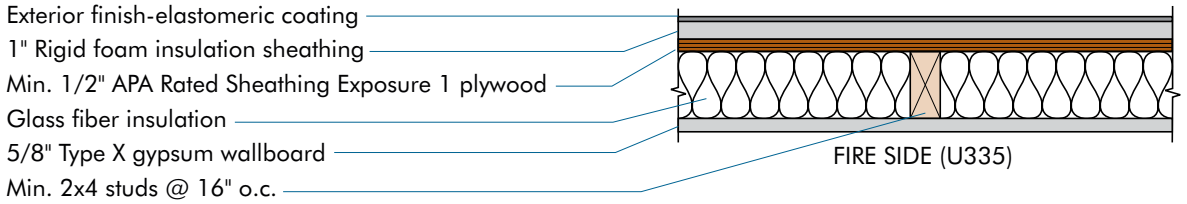
2F – LOAD-BEARING EXTERIOR WALL SYSTEM



2G – LOAD-BEARING EXTERIOR WALL SYSTEM

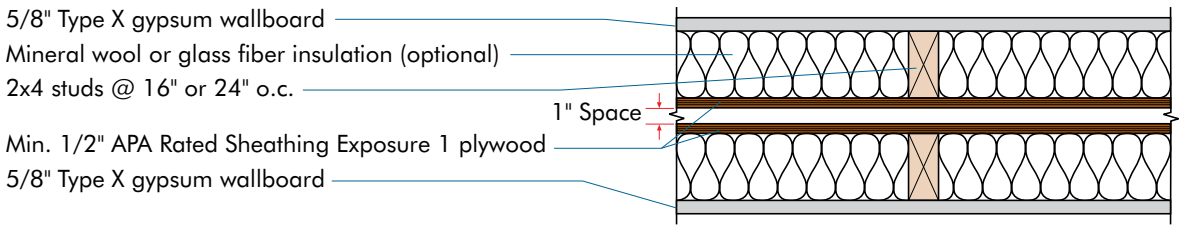
Based on U.L. Design Nos. U326, U330 (shown) and U335 (shown) in Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.





2H – LOAD-BEARING INTERIOR (CHASE) WALL SYSTEM

Based on U.L. Design Nos. U339 and U341 (shown) in Underwriters Laboratories Inc. (U.L.) Fire Resistance Directory.



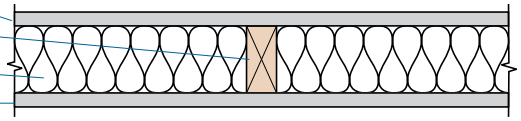
Continued on next page

FIGURE 2 (Continued)

ONE-HOUR COMBUSTIBLE LOAD-BEARING WALL ASSEMBLIES

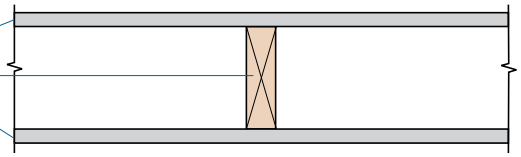
2I – LOAD-BEARING INTERIOR WALL SYSTEM

5/8" Type X gypsum wallboard
2x4 studs @ 16" o.c.
3-1/2" mineral wool
5/8" Type X gypsum wallboard



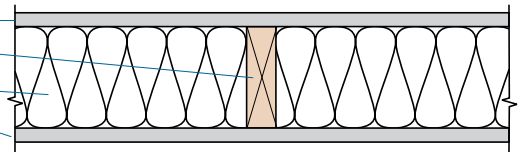
2J – LOAD-BEARING INTERIOR WALL SYSTEM

5/8" Type X gypsum wallboard
2x6 studs @ 16" o.c.
5/8" Type X gypsum wallboard



2K – LOAD-BEARING INTERIOR WALL SYSTEM

5/8" Type X gypsum wallboard
2x6 studs @ 16" o.c.
5-1/2" mineral wool
5/8" Type X gypsum wallboard



a. Wall systems exposed to fire on both exterior and interior faces, except where indicated by "Fire Side" (tested from interior face only).

b. For a two-hour load-bearing exterior wall of similar construction, see GA File No. WP 8415 (requires two layers of 5/8" Type X gypsum sheathing on exterior side of wall and two layers of 5/8" Type X gypsum wallboard on interior side).

c. See APA *Engineered Wood Construction Guide* (Form E30) for installation recommendations when stucco exterior finish is used. Building paper is required where stucco is applied over structural wood panel sheathing (check local building code and applicator for specific requirements).

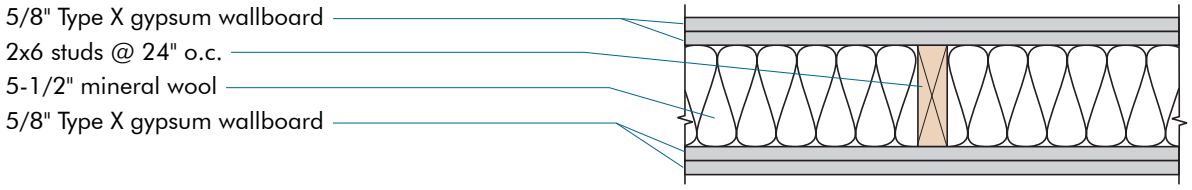
d. Footnote (*l*) of Table 721.1(2) in the 2021 IBC permits installation of wood structural panel sheathing directly over studs, beneath fire protective membrane, for added racking resistance or shear wall applications, in certain generic, nonproprietary fire-rated wall assemblies.

e. For proprietary names, see latest *U.L. Fire Resistance Directory*, www.ul.com

f. Min. 5/16-inch APA Rated Sheathing Exposure 1 plywood, with building paper and APA Rated Siding Exterior or other exterior finish, or min. 3/8-inch APA Rated Siding Exterior directly over studs, may be used in accordance with Table 722.6.2(3) of the 2021 IBC.

FIGURE 3

TWO-HOUR LOAD-BEARING INTERIOR WALL SYSTEM



Interior Walls and Partitions. Generally accepted building code regulations place a flame spread limit of 200 (Class C) on materials used for interior surfaces (in areas other than certain exitways and corridors, as noted earlier). Wood structural panel ratings generally are well within the range of acceptable materials.

For interior areas requiring lower flame spread ratings, fire-retardant-treated plywood paneling is acceptable. Such panels qualifying for the U.L. label are capable of a Class A rating, and are accepted by codes. Proprietary fire retardant paints when properly applied may also be used to reduce the flame spread rating to Class A or B and are often recognized by building officials. In single-family residential use, Class C is usually acceptable. Softwood plywood paneling is well within the acceptable range and has been used for interior as well as exterior walls where plywood's strength and rigidity help the unit withstand horizontal loads.

As for thermal resistance in fires, because of its superior insulating qualities, wood structural panels may be expected to develop a finish rating (based on time to develop an average temperature rise of 250°F or an individual temperature rise to 350°F on the back of the panel) of approximately 20 or more minutes per inch of thickness when exposed to the standard ASTM E119 or UL 263 time-temperature curve. Pressure treatment of plywood with fire-retardant chemicals does not materially affect the finish resistance, though coating with fire-retardant paints may be somewhat more effective.

Floor and Roof Systems

Code-accepted roof and floor systems that provide maximum strength and economy include numerous constructions with wood structural panels over a variety of support systems. Complete information on APA panel sheathing in general, and roof and floor systems, may be found in *APA's Engineered Wood Construction Guide,* Form E30.

Protected Roof-Ceiling and Floor-Ceiling Systems. There are numerous fire-rated, specially designed assemblies combining wood structural panels with protective materials, suitable especially for commercial and public buildings. They include one-hour-rated and two-hour-rated protected wood-frame floor-ceiling systems.

Many floor-ceiling (or roof-ceiling) systems are listed in the *U.L. Fire Resistance Directory* and are accepted as rated constructions by building codes. Examples are shown in Figures 4.1, 4.2 and 4.3 using solid-sawn lumber joists, while Figures 5.1 through 5.9 and Figure 6 are applicable to prefabricated wood I-joists. Other proprietary floor-ceiling or roof-ceiling systems also are recognized in evaluation reports issued to individual manufacturers or trade associations.

In these assemblies, materials such as gypsum wallboard, plaster and acoustical tile provide primary fire protection. The panel floor or roof acts to prevent flame passage and temperature rise, as well as to reinforce joists against collapse under load after the effectiveness of the ceiling has been lost.

Based on comparative tests, APA OSB may be used in plywood floor-ceiling (or roof-ceiling) systems without jeopardizing fire-resistance ratings. In double-layer wood systems (i.e., Figures 4.1 and 4.2), 7/16-inch APA Rated OSB Sheathing 24/16 may be used in lieu of 15/32-inch plywood subfloor. Other substitutions are based on equivalent panel thickness. The substitution of 1-1/8-inch APA RATED STURD-I-FLOOR 48 oc for the combination of subfloor, paper and underlayment is often allowed. Check with the local building official.

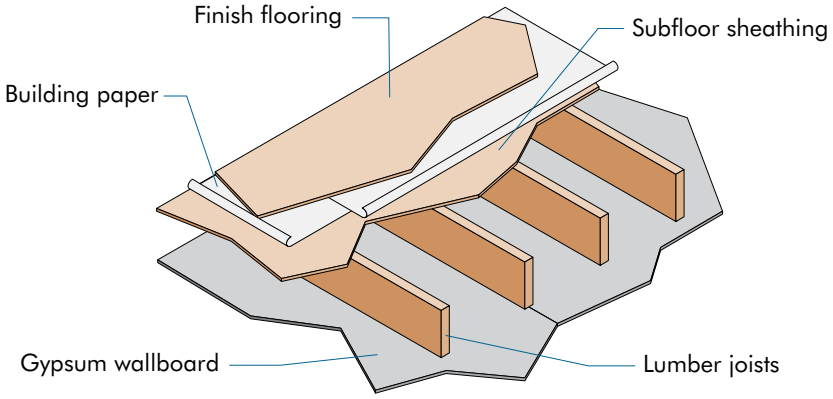
Roof Coverings. The fire resistance ratings of finish roofing materials are listed as Class A, B, or C in descending order of fire protection afforded. Their use is prescribed in the IBC. The standard test for measuring the fire characteristics of roof coverings is ASTM E108 or UL 790. Untreated APA Rated Sheathing panels are recognized as a roof deck substrate for rated roof coverings. For individual requirements, see the U.L. *Roofing Materials and Systems Directory [23],* Category TGFU for built-up or single ply roofing membranes or spray-applied foam insulation and roof coating systems, or Category TFWZ for roof covering materials such as shingles, shakes, cement tile and metal roofing panels.

Fire Protection of Floors

Starting with the 2009 IBC and International Residential Code (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 IRC added the minimum requirements on the fire protection of floors when constructed with floor assemblies that are not required elsewhere in the IRC to be fire-resistance-rated except for wood floor assemblies using dimension lumber or structural composite lumber (SCL) equal to or greater than 2 x 10 in dimension or other approved floor assemblies demonstrating equivalent fire performance. Since then, APA has developed several fire protection methods equivalent to 2x10 lumber or SCL joists for wood floors that are constructed with prefabricated wood I-joists. See *APA System Report SR-405* [1] for available options.

FIGURE 4.1

ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES WITH LUMBER JOISTS



A. BASIC ASSEMBLIES

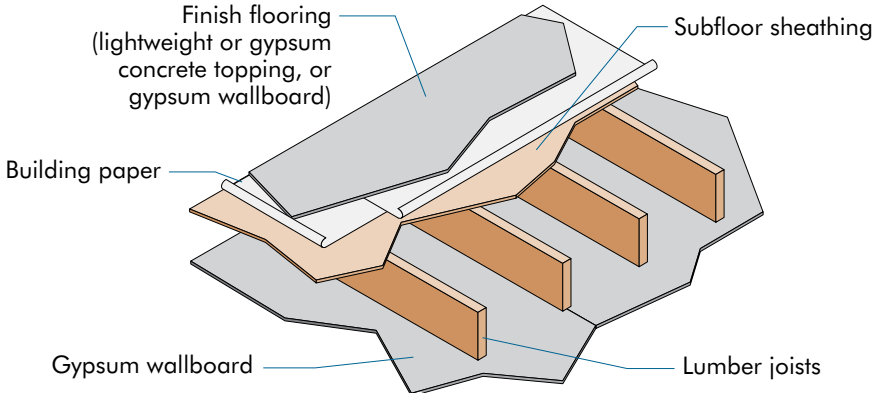
1. Floor sheathing:
   a. Subfloor of 1-inch (25-mm) nominal boarding, a layer of asbestos paper weighing not less than 14 pounds per 100 square feet (6.7 N/m^2) and a layer of 1-inch (25-mm) T&G finish flooring, or
   b. Subfloor of 1-inch nominal T&G boarding or 15/32-inch (12-mm) wood structural panels with exterior glue and a layer of 1-inch (25-mm) nominal T&G finished flooring or 19/32-inch (15-mm) wood structural panel finish flooring or a layer of Type 1 Grade M-1 particleboard not less than 5/8-inch (16-mm) thick.
2. Structural members: Wood joist: Min. nominal 2×10 dimension lumber, spaced 16 inches (406 mm) on center.
3. Ceiling: One layer of 1/2-inch (12.5-mm) Type X gypsum wallboard nailed to joists with 5d cooler or wallboard nails at 6 inches (152 mm) on center. End joints of wallboard centered on joists.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 13-1.4
2. U.L. Design Nos. L003 (System No.1), L006, L201, L202, L206 (System No.1), L209, L210, L211 (2 hrs.), L212, L501 (System No.1), L502 (System No.1), L503 (System No.1), L505 (2 hrs., Systems No.1 and No.17), L511 (2 hrs., System No.3), L512 (System No.1), L514 (Systems No.1 and No.17), L519 (System No.1), L522 (System No.1), L525 (System No.1), L526 (System No.1), L535 (System No.1), L537 (System No.1)

FIGURE 4.2

ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES WITH LUMBER JOISTS



A. BASIC ASSEMBLIES

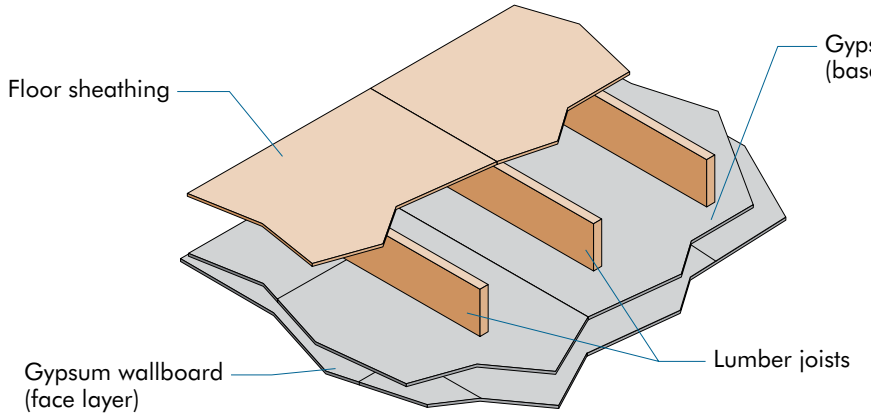
1. Floor sheathing:
   a. Subfloor: 1-inch nominal T&G boarding or 15/32-inch (12-mm) wood structural panels with exterior glue.
   b. Finish flooring: Floor topping mixture bearing the UL Classification Marking as to Fire Resistance.
2. Structural members: Min. nominal 2×10 dimension lumber.
3. Ceiling: One layer of 1/2-inch (12.5-mm) Type X gypsum wallboard nailed to joists with 5d cooler or wallboard nails at 6 inches (152 mm) on center. End joints of wallboard centered on joists.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SIMILAR ASSEMBLIES

1. U.L. Design Nos. L003, L006, L201, L202, L206, L209, L210, L211 (2 hrs.), L212, L501, L502, L503, L505 (2 hrs.), L507, L511 (2 hrs.), L512, L514, L515, L516, L519, L522, L523, L525, L526, L533, L536 (2 hrs.), L537, L541 (2 hrs.), L545

FIGURE 4.3

ONE-HOUR COMBUSTIBLE FLOOR-CEILING AND ROOF-CEILING ASSEMBLIES WITH LUMBER JOISTS



A. BASIC ASSEMBLIES

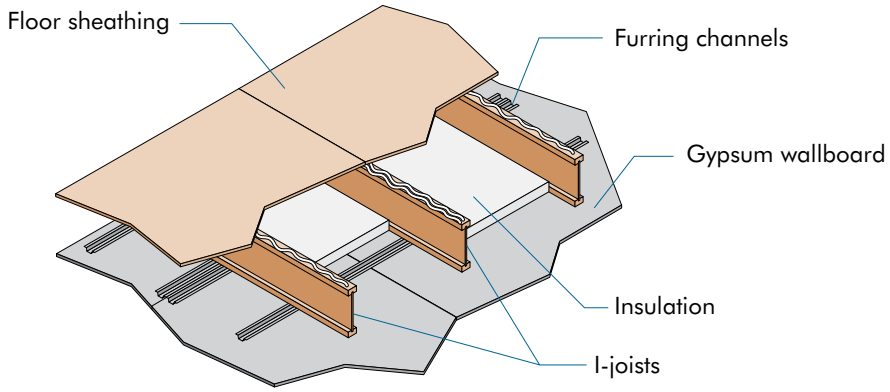
1. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
2. Structural members:
   Wood joist: nominal 2×10 dimension lumber, spaced 24 inches (610 mm) on center (U.L. Design No. L508: 4×10's spaced at 48 inches on center; U.L. Design No. 540: 2×8's spaced at 16 inches on center).
3. Ceiling: Two layers of 5/8-inch (16-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension parallel to joists. Attach to the joists using 1-1/4-inch (32-mm) Type S or Type W drywall screws at 24 inches (610 mm) on center.
   b. Face layer: Install with long dimension parallel to joists. Attach to the joists through the base layer using 1-7/8-inch (48-mm) Type S or Type W drywall screws spaced at 12 inches (305 mm) on center at joints and intermediate joist. Face layer Type G drywall screws placed 2 inches (51 mm) back on either side of face layer end joints, 12 inches (305 mm) on center.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 21-1.1

FIGURE 5.1

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. A construction adhesive must be applied to the top of the joists prior to placing sheathing. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Min. 1-1/2-inch (38-mm) mineral wool insulation batts (min. 2.5 pcf). Installed adjacent to the bottom flange of the I-joist and supported by the furring channels. Ends of batts shall be centered over furring channels.
4. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 5.25 inches^2 (3,387 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Furring channels: Min. 0.026-inch (0.66-mm) hat shaped galvanized steel channels attached perpendicular to the bottom flange of the I-joist with 1-5/8-inch (41-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center, are doubled at each wallboard end joint, and extend to the next joist beyond each joint.
6. Ceiling: One layer of 5/8-inch (16-mm) Type C gypsum wallboard. Installed with long dimension perpendicular to furring channels and fastened with min. 1-1/8-inch (29-mm) Type S drywall screws spaced at 12 inches (305 mm) on center on intermediate joists and 8 inches (203 mm) on center at end joints, and 3/4 inch (19 mm) from wallboard edges and ends. The end joints of the wallboard must be staggered.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	48 (51)	42 (43)	48 (51)	61 (63)	63 (65)	50 (52)	63 (65)	65 (67)
16"/16" o.c.	44 (46)	37 (39)	44 (46)	60 (61)	56 (57)	46 (47)	56 (57)	58 (59)

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values established by engineering analysis based on 1.5-inch (38-mm) thick mineral wool batt insulation. Values in parentheses are based on 3.5-inch (89-mm) thick mineral wool batt insulation.

c. STC and IIC values for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

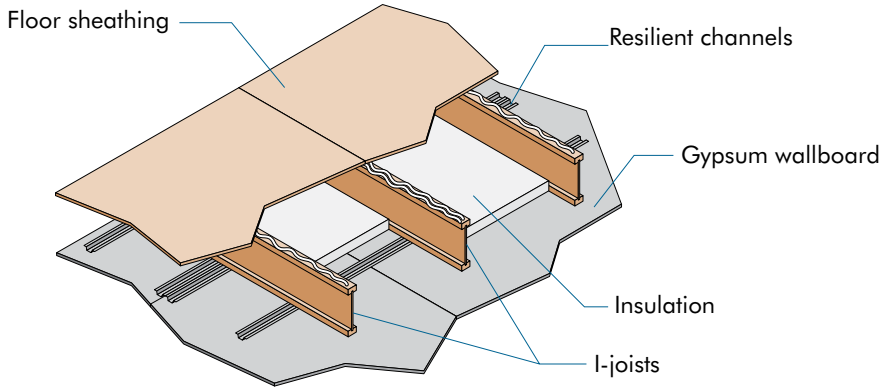
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 24-1.1 and DCA 3 WIJ-1.1.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.2

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. A construction adhesive must be applied to the top of the joists prior to placing sheathing. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Min. 1-1/2-inch (38-mm) mineral wool insulation batts (min. 2.5 pcf). Installed adjacent to the bottom flange of the I-joist and supported by the resilient channels. The ends of the batts shall be centered over resilient channels.
4. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 5.25 inches^2 (3,387 mm^2). Min. web thickness of 7/16 inch (11 mm).
5. Resilient channels: Min. 0.019-inch (0.5-mm) galvanized resilient channels. Attached perpendicular to the bottom flange of the I-joist with 1-5/8-inch (41-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center, are doubled at each wallboard end joint and extend to the next joist beyond each joint.
6. Ceiling: One layer of 5/8-inch (16-mm) Type C gypsum wallboard. Installed with long dimension perpendicular to resilient channels and fastened with min. 1-inch (25-mm) Type S drywall screws spaced at 12 inches (305 mm) on center on intermediate joists and 8 inches (203 mm) on center at end joints, and 3/4 inch (19 mm) from wallboard edges and ends. The end joints of the wallboard must be staggered.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	48 (51)	42 (43)	48 (51)	61 (63)	63 (65)	50 (52)	63 (65)	65 (67)
16"/16" o.c.	44 (46)	37 (39)	44 (46)	60 (61)	56 (57)	46 (47)	56 (57)	58 (59)

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values established by engineering analysis based on 1.5-inch (38-mm) thick mineral wool batt insulation. Values in parentheses are based on 3.5-inch (89-mm) thick mineral wool batt insulation.

c. STC and IIC values for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

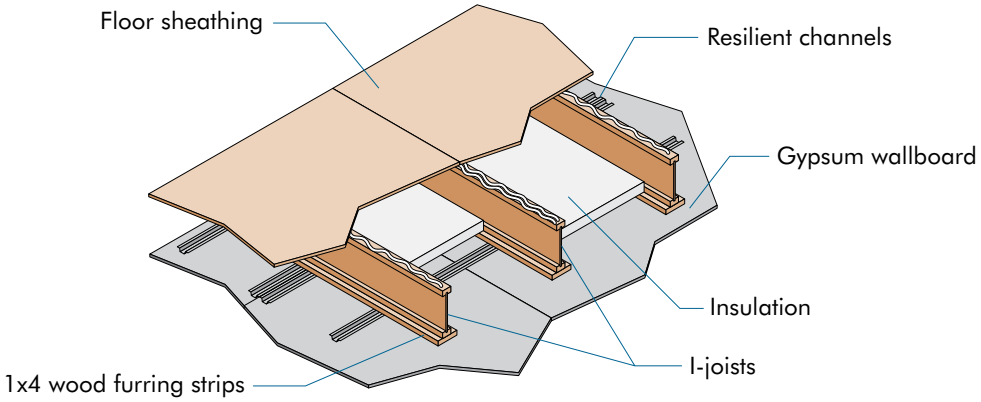
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 25-1.1 and DCA 3 WIJ-1.2.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.3

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Min. 2-inch (51-mm) mineral wool insulation batts (min. 3.5 pcf). Installed adjacent to the bottom flange of the I-joist and supported by 1x4 wood furring strip spacer. The ends of the batts shall be centered over resilient channels.
4. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-5/16 inches (33 mm) and each flange area of at least 2.25 inches^2 (1,452 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Wood furring strip spacers: Min. nominal 1 inch (25 mm) x 4 inches (102 mm) attached with 1-1/2-inch (38-mm) long drywall screws at 24 inches (610 mm) on center along the bottom of the bottom flange of each I-joist.
6. Resilient channels: Min. 0.019-inch (0.5-mm) galvanized resilient channels (1/2-inch or 13-mm deep single leg). Attached perpendicular to the wood furring strip and bottom flange of the I-joist with 1-7/8 inch (48-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center, are doubled at each wallboard end joint and extend to the next joist beyond each joint.
7. Ceiling: One layer of 5/8-inch (16-mm) Type C gypsum wallboard. Installed with long dimension perpendicular to resilient channels and fastened with min. 1-1/8-inch (29-mm) Type S drywall screws spaced at 7 inches (178 mm) on center, and 3/4 inch (19 mm) from wallboard edges and ends. The end joints of the wallboard must be staggered.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	50 (51)	43 (43)	52	66	63 (65)	51 (52)	63 (65)	67 (67)
16"/16" o.c.	45 (46)	38 (39)	45 (46)	60 (61)	57 (57)	46 (47)	57 (57)	59 (59)

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values established by engineering analysis based on 1.5-inch (38-mm) thick mineral wool batt insulation. Values in parentheses are based on 3.5-inch (89-mm) thick mineral wool batt insulation.

c. STC and IIC values for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

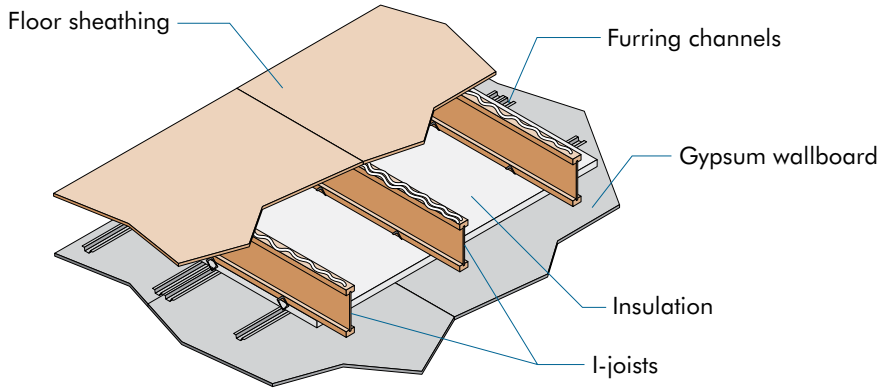
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 23-1.1 and DCA 3 WIJ-1.3.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.4

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Min. 1-inch (25-mm) mineral wool insulation batts (min. 6 pcf) with width equal to on-center spacing of the I-joists. Installed below the bottom flange of the I-joist and on top of furring channels with sides butted against support clips. The ends of the batts shall be centered over furring channels with batts tightly butted at all joints.
4. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 3.45 inches^2 (2,226 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Furring channels: Min. 0.019-inch (0.5-mm) hat shaped galvanized steel channels attached perpendicular to the bottom flange of the I-joist with Simpson Type CSC support clips at each intersection with the I-joists. Clips nailed to the side of bottom flange with one 1-1/2-inch (38-mm) long No. 11 gauge nail. Channels are spaced a max. of 24 inches (610 mm) on center, are doubled at each wallboard end joint and extend to the next joist beyond each joint. At channel splices, adjacent pieces overlapped a minimum of 6 inches (152 mm) and tied with a double strand of No. 18 gauge galvanized steel wire at each end of the overlap. A row of furring channel located on each side of wallboard end joints and spaced 2-1/4 inches (57 mm) from the end joint (4-1/2 inches or 114 mm on center).
6. Ceiling: One layer of 1/2-inch (13-mm) Type C gypsum wallboard. Installed with long dimension perpendicular to furring channels and fastened with min. 1-inch (25-mm) Type S drywall screws spaced at 12 inches (305 mm) on center on intermediate joists, 6 inches (152 mm) on center at end joints and 3/4 inch (19 mm) from wallboard edges and ends. The end joints of the wallboard must be staggered and the furring channels must extend a min. of 6 inches (152 mm) beyond each end of the joint.
   a. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/24" o.c.	--	--	46	68	51	47	50	73

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values are based on tests of assemblies with 5/8-inch (15.9-mm) thick gypsum boards.

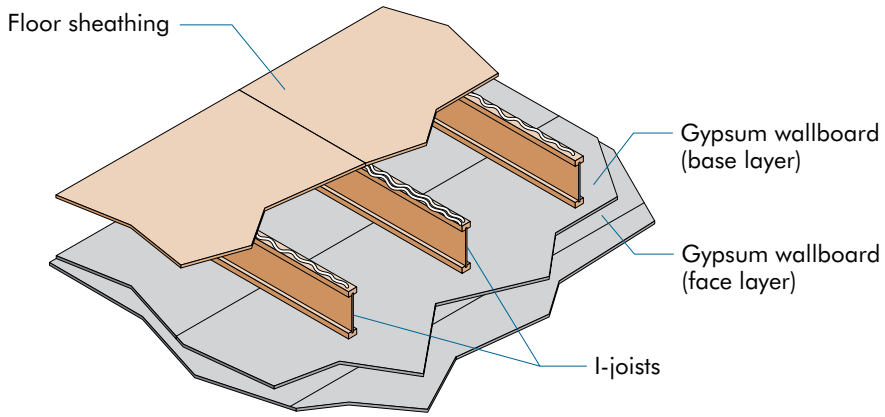
C. SIMILAR ASSEMBLIES

1. DCA 3 WIJ-1.4.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.5

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 2.25 inches^2 (1,452 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
4. Ceiling: Two layers of 1/2-inch (13-mm) Type C gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists using 1-inch (25-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be centered on the bottom flange of the joist and must be staggered.
   b. Face layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists through the base layer using 1-5/8-inch (41-mm) Type S drywall screws spaced at 12 inches (305 mm) on center on intermediate joists and 8 inches (203 mm) on center at end joints. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. The end joints must be centered on the bottom flange of the joists and offset a min. of 48 inches (1,219 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 8 inches (203 mm) on center with a 4-inch (102-mm) stagger, placed 6 inches (152 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24" o.c.	--	--	--	--	--	--	49	55

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values are based on tests of assemblies with 5/8-inch (15.9-mm) thick gypsum boards.

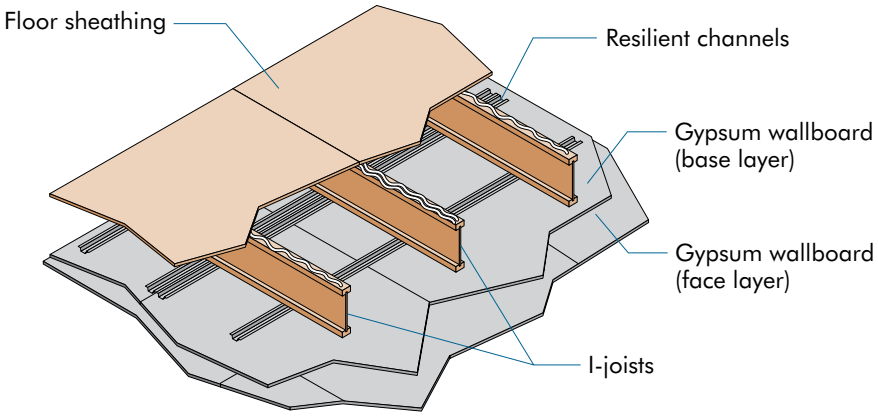
C. SIMILAR ASSEMBLIES

1. DCA 3 WIJ-1.5.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.6

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*†



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Structural members: Min. 9-1/2 inches (241 mm) deep I-joists. Max. 24 inch (610 mm) on center spacing. Min. flange thickness of 1-5/16 inches (33 mm) and each flange area of at least 1.95 inches^2 (1,258 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
4. Resilient channels†: Min. 0.019-inch (0.5-mm) galvanized resilient channels. Attached perpendicular to the bottom flange of the I-joist with 1-1/4-inch (32-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center (24 inches or 610 mm when I-joists are spaced a max. of 16 inches or 406 mm on center), are doubled at each base layer wallboard end joint and extend to the next joist beyond each joint.
5. Ceiling: Two layers of 1/2-inch (13-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels using 1-1/4 inch (32-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be staggered.
   b. Face layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels through the base layer using 1-5/8-inch (41-mm) Type S drywall screws spaced at 12 inches (305 mm) on center. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 8 inches (203 mm) on center placed 1-1/2 inches (38 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	46	44	46	61	58	47 (51)	58	67
16"/24" o.c.	47	43	47	64	60	49 (52)	60	67

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values established by engineering analysis. Values in parentheses are based on laminate wood flooring over a 0.08-in. (2-mm) closed-cell foam underlay, in lieu of cushioned vinyl flooring.

c. STC and IIC values for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

C. SIMILAR ASSEMBLIES

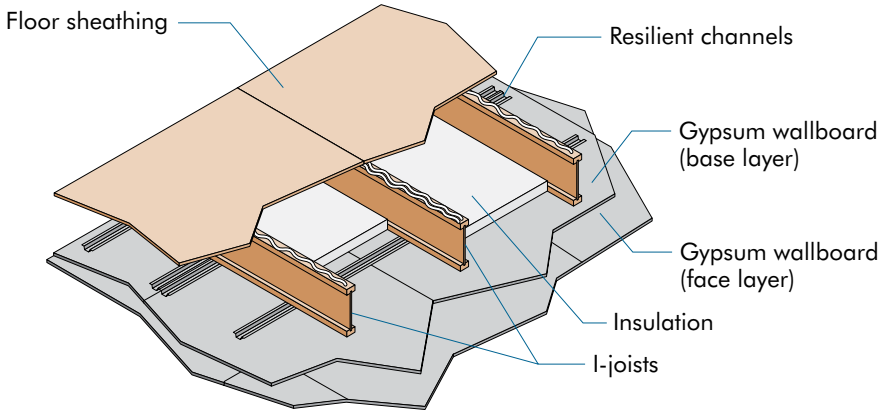
1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 27-1.1, and DCA 3 WIJ-1.6.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

† Direct attachment of gypsum wallboard in lieu of attachment to resilient channels is typically deemed acceptable. When gypsum wallboard is directly attached to the I-joists, the wallboard shall be installed with the long dimension perpendicular to the I-joists and sound rating for assembly in Figure 5.5 shall be used.

FIGURE 5.7

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Glass fiber insulation. Installed between I-joists and supported by resilient channels.
4. Structural members: Min. 9-1/2 inches (241 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 2.25 inches^2 (1,452 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Resilient channels: Min. 0.019-inch (0.5-mm) galvanized resilient channels. Attached perpendicular to the bottom flange of the I-joist with 1-1/4 inch (32-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center (24 inches or 610 mm when I-joists are spaced a max. of 16 inches or 406 mm on center), are doubled at each base layer wallboard end joint and extend to the next joist beyond each joint.
6. Ceiling: Two layers of 1/2-inch (13-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels using 1-1/4 inch (32-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be staggered.
   b. Face layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels through the base layer using 1-5/8-inch (41-mm) Type S drywall screws spaced at 12 inches (305 mm) on center. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 8 inches (203 mm) on center placed 1-1/2 inches (38 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	56	51	56	69	64	53	64	71
16"/24" o.c.	55	48 (51)	55	67	64	54	64	67

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values established by engineering analysis based on 3.5-inch (89-mm) thick glass fiber insulation. Values in parentheses are based on laminate wood flooring over a 0.08-inch (2-mm) closed-cell foam underlay, in lieu of cushioned vinyl flooring.

c. STC and IIC values for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

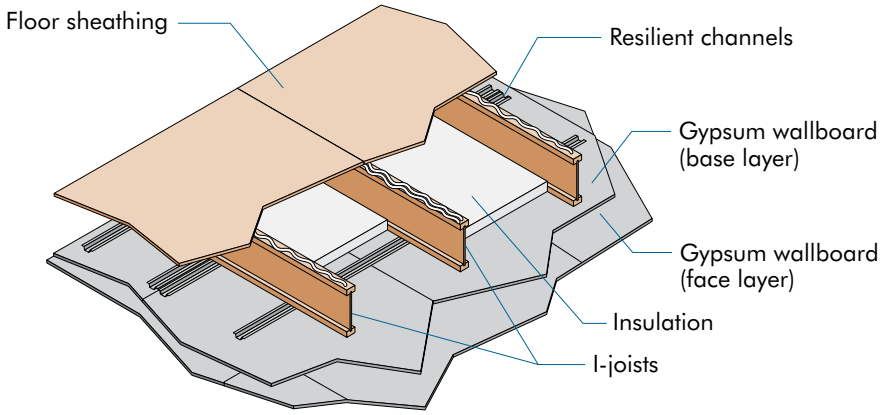
C. SIMILAR ASSEMBLIES

1. 2015/2018/2021 IBC Table 721.1(3) Item 30-1.1 and DCA 3 WIJ-1.7.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.7a

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Glass fiber insulation. Installed between I-joists and supported by resilient channels.
4. Structural members: Min. 9-1/2 inches (241 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/8 inches (29 mm) and each flange area of at least 1.95 inches^2 (1,258 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Resilient channels: Min. 0.019-inch (0.5-mm) galvanized resilient channels. Attached perpendicular to the bottom flange of the I-joist with 1-1/4 inch (32-mm) Type S drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center (24 inches or 610 mm when I-joists are spaced a max. of 16 inches or 406 mm on center), are doubled at each base layer wallboard end joint and extend to the next joist beyond each joint.
6. Ceiling: Two layers of 5/8-inch (16-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels using 1-1/4 inch (32-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be staggered.
   b. Face layer: Install with long dimension perpendicular to resilient channels. Attach to the resilient channels through the base layer using 1-7/8 inch (48-mm) Type S drywall screws spaced at 12 inches (305 mm) on center. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 8 inches (203 mm) on center placed 1-1/2 inches (38 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing[c]	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	56	--	56	--	64	--	64	--
16"/24" o.c.	55	--	55	--	64	--	64	--

a. Sound ratings are conservative estimates from Figure 5.7.

b. STC and IIC values established by engineering analysis based on 3.5-inch (89-mm) thick glass fiber insulation.

c. STC for 16-inch (406-mm) on center joist spacing are applicable to 19.2-inch (488-mm) on center joist spacing.

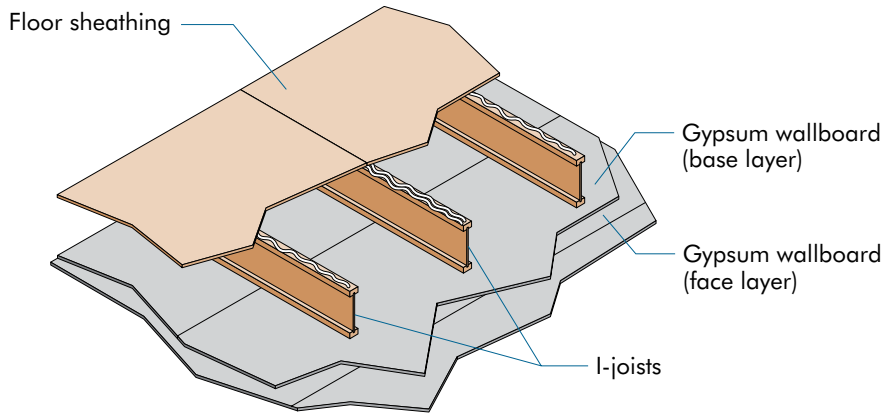
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 21-1.1.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.8

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 2.25 inches^2 (1,452 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
4. Ceiling: Two layers of 1/2-inch (13-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists using 1-5/8-inch (41-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be centered on the bottom flange of the joist and must be staggered the equivalent of two joist spacings with those of adjacent sheets.
   b. Face layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists through the base layer using 2-inch (51-mm) Type S drywall screws spaced at 12 inches (305 mm) on center on intermediate joists and 8 inches (203 mm) on center at end joints. Face layer end joints must not occur on the same joist as base layer end joints. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 8 inches (203 mm) on center placed 6 inches (152 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING

Information not available.

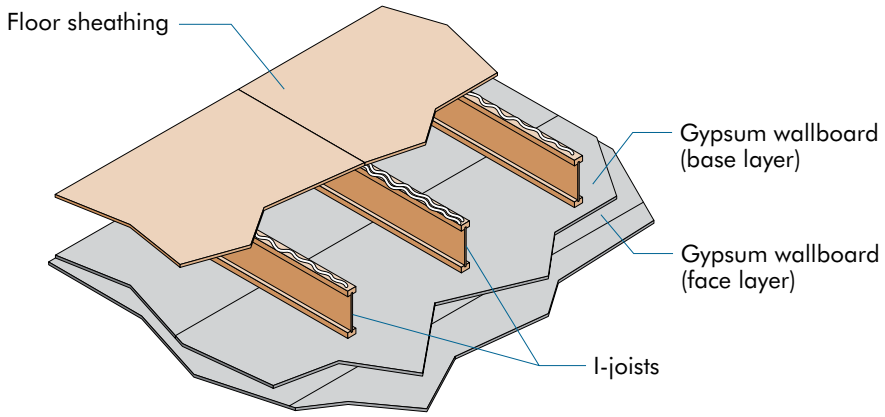
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 26-1.1.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.8a

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 19/32-inch (15-mm) T&G wood structural panel for joist spacing of 19.2 inches (488 mm) or less, or 23/32-inch (18-mm) T&G wood structural panel for joist spacing greater than 19.2 inches (488 mm). The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Structural members: I-joists with max. 24 inches (610 mm) on center spacing.
4. Ceiling: Two layers of 5/8-inch (16-mm) Type X gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists using 1-1/4 inch (32-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be centered on the bottom flange of the joist and must be staggered the equivalent of two joist spacings with those of adjacent sheets.
   b. Face layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists through the base layer using 1-7/8 inch (48-mm) Type S drywall screws spaced at 12 inches (305 mm) on center. Face layer end joints must not occur on the same joist as base layer end joints. The longitudinal joints of this layer must be offset 24 inches (610 mm) from those of the base layer. Additionally, face layer end joints are attached to the base layer with 1-1/2-inch (38-mm) Type G drywall screws at 12 inches (305 mm) on center placed 2 inches (51 mm) either side of the joint.
   c. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING

Information not available.

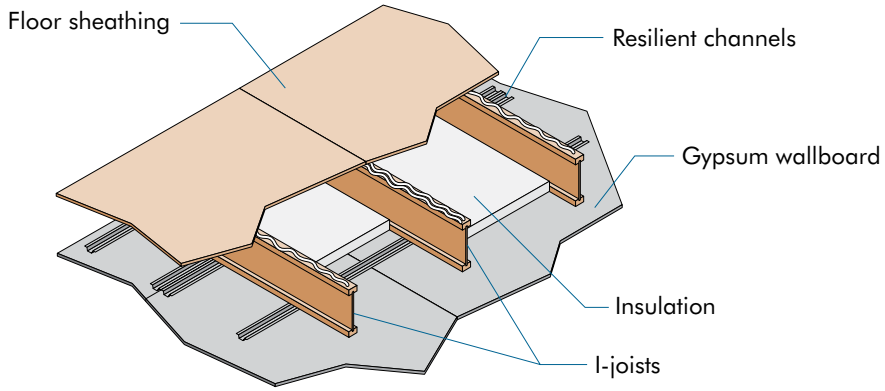
C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 21-1.1.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 5.9

ONE-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. A construction adhesive must be applied to the top of the joists prior to placing sheathing. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: Min. 3-1/2-inch (89-mm) fiber glass insulation (R13). Installed adjacent to the bottom flange of the I-joist and supported by the resilient channels.
4. Structural members: Min. 9-1/2-inch (241-mm) Deep I-Joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 3.75 inches^2 (2,419 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Resilient channels: Min. 0.019-inch (0.5-mm) galvanized resilient channels. Attached perpendicular to the bottom flange of the I-joist with 1-1/4-inch (32-mm) Type W drywall screws. Channels are spaced a max. of 16 inches (406 mm) on center, are doubled at each wallboard end joint and extend to the next joist beyond each joint.
6. Ceiling: One layer of 3/4-inch (19-mm) Type X gypsum wallboard with a minimum weight of 3.0 lbf/ft^2 (14.6 kg/m^2) in compliance with ASTM C1396. Installed with long dimension perpendicular to resilient channels and fastened with min. 1-1/8-inch (29-mm) Type S drywall screws spaced at 8 inches (203 mm) on center, 1 inch (25 mm) from wallboard edges and 1-1/2 inches (38 mm) from wallboard ends. The end joints of the wallboard must be staggered.
   a. Finish: The face joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a]

Components	STC	IIC
Base Assembly with cushioned vinyl	52	44
Base Assembly with carpet andpadding	52	64
Base Assembly with cushioned vinyl, gypsum concrete	64	53
Base Assembly with carpet and padding, gypsum concrete	64	68

a. Sound ratings determined from engineering analysis using AWC Technical Report 15, Calculation of Sound Transmission Parameters for Wood-Frame Assemblies in accordance with Section 1206.2 of the 2021/2018 IBC.

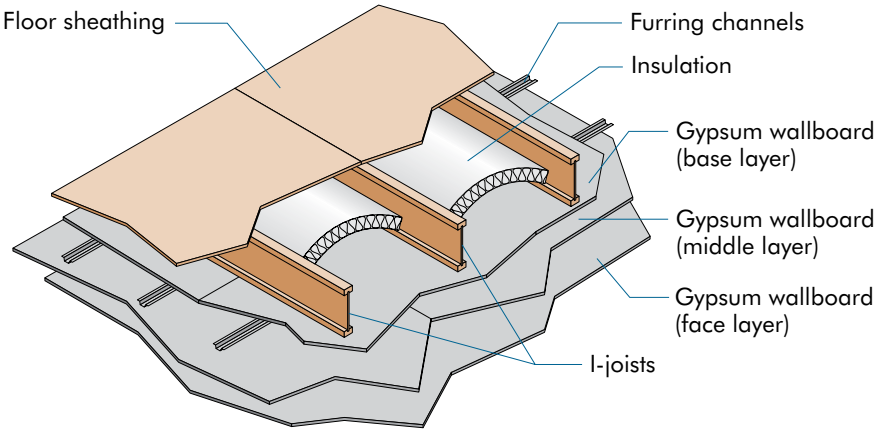
C. SIMILAR ASSEMBLIES

1. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

FIGURE 6

TWO-HOUR COMBUSTIBLE FLOOR-CEILING ASSEMBLIES WITH I-JOISTS*



A. BASIC ASSEMBLIES

1. Floor topping (optional): Varies (reference sound ratings if applicable).
2. Floor sheathing: Min. 23/32-inch (18-mm) T&G wood structural panel. The sheets shall be installed with their long edge perpendicular to the joists with end joints centered over the top flange of joists. Floor sheathing must be installed per code requirements.
3. Insulation: 3-1/2-inch (89-mm) unfaced glass fiber insulation. Friction fitted between I-joists and supported by stay wires spaced 12 inches (305 mm) on center along the top of the I-joist bottom flange.
4. Structural members: Min. 9-1/4 inches (235 mm) deep I-joists. Max. 24 inches (610 mm) on center spacing. Min. flange thickness of 1-1/2 inches (38 mm) and each flange area of at least 2.25 inches^2 (1,452 mm^2). Min. web thickness of 3/8 inch (9.5 mm).
5. Furring channels: Min. 0.0179-inch (0.45-mm) hat shaped galvanized steel channels attached perpendicular to the bottom flange of the I-joist with 1-5/8-inch (41-mm) Type S drywall screws penetrating through the wallboard base layer into each I-joist flange. Channels are spaced a max. of 16 inches (406 mm) on center, are doubled at each base layer wallboard end joint and extend to the next joist beyond each joint.
6. Ceiling: Three layers of 5/8-inch (16-mm) Type C gypsum wallboard.
   a. Base layer: Install with long dimension perpendicular to joist length. Attach to the bottom flange of the joists using 1-5/8-inch (41-mm) Type S drywall screws at 12 inches (305 mm) on center. The end joints of the wallboard must be centered on the bottom flange of the I-joist and must be staggered.
   b. Middle layer: Attached to furring channels using 1-inch (25-mm) Type S drywall screws at 12 inches (305 mm) on center with the long dimension perpendicular to furring channels. End joints must be staggered from end joints of adjacent sheets and end joints on the face layer.
   c. Face layer: Attached to furring channels through the middle layer using 1-5/8-inch (41-mm) Type S drywall screws spaced at 8 inches (203 mm) on center with long dimension perpendicular to furring channel. End joints must be staggered from end joints of adjacent sheets and staggered from end joints on the middle layer. Edge joints (long dimension) must be offset 24 inches (610 mm) from those of the middle layer.
   d. Finish: The face layer joints must be covered with tape and coated with joint compound. Screw heads must also be covered with joint compound.

B. SOUND RATING[a,b]

	Without Gypsum Concrete				With 1-in. (25-mm) Gypsum Concrete			
	Cushioned Vinyl		Carpet & Pad		Cushioned Vinyl		Carpet & Pad	
Joist/RC Spacing	STC	IIC	STC	IIC	STC	IIC	STC	IIC
24"/16" o.c.	-	-	49	54	58	45	58	64

a. Sound ratings from the American Wood Council publication Design for Code Acceptance (DCA) 3, available from www.awc.org.

b. STC and IIC values are based on engineering analysis performed by David L. Adams Associates, Inc.

C. SIMILAR ASSEMBLIES

1. 2012/2015/2018/2021 IBC Table 721.1(3) Item 28-1.1 and DCA 3 WIJ-2.1.
2. Assemblies that meet the fire-resistance rating in accordance with NBC Table 9.10.3.1.-B or the calculation method specified in NBC Appendix D-2.3.

** This assembly may also be used in a fire-rated roof/ceiling assembly, but only when constructed exactly as described.*

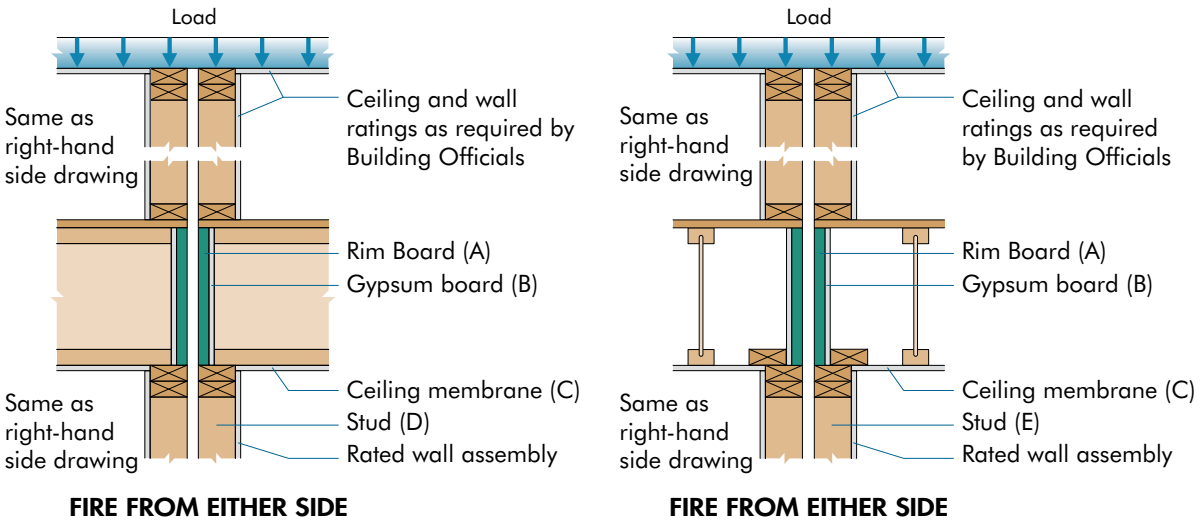
APA Rim Board Assemblies (One- and Two-Hour)

See *APA Data File: Rim Board in Fire Rated Assemblies*, Form D350, available at www.apawood.org, for typical assemblies, such as that shown in Figure 7 below.

FIGURE 7

FIRE RESISTANCE RATED RIM BOARD ASSEMBLY RB3

This fire resistance design is listed in accordance with ASTM E119 and CAN/ULC S101.



DOUBLE WALL CONFIGURATION WITH LOAD TRANSFER BASE ASSEMBLY

Rim Board Thickness, in.	Rim Board Protection	Ceiling Membrane Req. for 1-hr	Ceiling Membrane Req. for 2-hr	Min. Stud Size	Min. Stud Size
A	B	C	C	D	E
1	Unprotected	1/2" Type X	90-min Fire-rated Assembly	2x4	2x4
	(1) 1/2" Type X	No Ceiling Required	1-hour Fire-rated Assembly	2x4	2x4
	(1) 5/8" Type X	No Ceiling Required	45-min Fire-rated Assembly	2x4	2x4
	(2) 1/2" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
	(2) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
1-1/8	Unprotected	1/2" Type X	90-min Fire-rated Assembly	2x4	2x4
	(1) 1/2" Type X	No Ceiling Required	1-hour Fire-rated Assembly	2x4	2x4
	(1) 5/8" Type X	No Ceiling Required	5/8" Type X	2x4	2x4
	(2) 1/2" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
	(2) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
1-1/4	Unprotected	1/2" Regular	90-min Fire-rated Assembly	2x4	2x4
	(1) 1/2" Type X	No Ceiling Required	45-min Fire-rated Assembly	2x4	2x4
	(1) 5/8" Type X	No Ceiling Required	5/8" Regular	2x6	2x4
	(2) 1/2" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
	(2) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
1-1/2	Unprotected	No Ceiling Required	1-hour Fire-rated Assembly	2x4	2x4
	(1) 1/2" Type X	No Ceiling Required	5/8" Type X	2x6	2x4
	(1) 5/8" Type X	No Ceiling Required	1/2" Regular	2x6	2x4
	(2) 1/2" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
	(2) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x6
1-3/4	Unprotected	No Ceiling Required	1-hour Fire-rated Assembly	2x4	2x4
	(1) 1/2" Type X	No Ceiling Required	1/2" Type X	2x6	2x4
	(1) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x4
	(2) 1/2" Type X	No Ceiling Required	No Ceiling Required	2x6	2x6
	(2) 5/8" Type X	No Ceiling Required	No Ceiling Required	2x6	2x6

1. Rim assembly for fire from either side of wall. "With load transfer" assumes load transfers to the adjacent rim board if the fire exposed rim board fails.
2. Gypsum wallboard shown on the ceiling is to protect the rim board only. It does not necessarily cause the floor assembly to be rated.
3. Attach 1-layer Type X (1/2 or 5/8-inch) gypsum wallboard to rim board with 1-1/2-inch Type W drywall screws spaced 12 inches o.c.
4. Attach 2-layer Type X (1/2 or 5/8-inch) gypsum wallboards to rim board with 2-inch Type W drywall screws spaced 12 inches o.c.
5. Provide min. 1-3/4-inch bearing for I-joist.
6. Type C may be substituted for Type X, and Type X may be substituted for regular gypsum wallboard of the same thickness.
7. Rim Board and gypsum wallboard thicknesses are shown as minimums. Thicker Rim Board and gypsum wallboard may be substituted.
8. When 2-layer gypsum wallboards are used, I-joist end nails shall be 16d box (0.135 inch x 3-1/2 inches) nails.
9. Rim Board shall be sized for vertical and lateral loads.
10. Stud size may be reduced if the gypsum protection is discontinuous, provided that other requirements in the code are satisfied.

Structural Glued Laminated Timber (Glulam)

A structural member's fire resistance is measured by the time it can support its design load during a fire. An exposed beam or column sized for a minimum one-hour fire resistance will support its full design load for at least one hour during standard fire test conditions which simulate an actual fire. As with all other structural framing, final specifications of members designed to have one-hour fire resistance should be carefully checked by a professional engineer or architect to assure compliance with all local building codes.

For further information, see *APA Technical Note: Calculating Fire Resistance of Glulam Beams and Columns*, Form Y245.

Beams. Charring of glulam surfaces during a fire places a premium on cross-sectional area. Charring weakens a glulam cross section slowly because of the self-insulating character of the char. Glulam beams with a minimum width of 5-1/8 inches (nominal 6 inches) can be adapted to a one-hour fire rating in accordance with procedures recognized by the IBC.

For 6-3/4-inch and 8-3/4-inch widths, there is a minimum depth at and above which all members with these widths can be adapted at 100% of the allowable design load for a one-hour fire rating. The minimum depth increases when the design calls for the beam to be exposed on four rather than three sides. See Table 5.

TABLE 5

MINIMUM DEPTH AT WHICH GLULAM BEAMS CAN BE ADAPTED FOR ONE-HOUR FIRE RATINGS

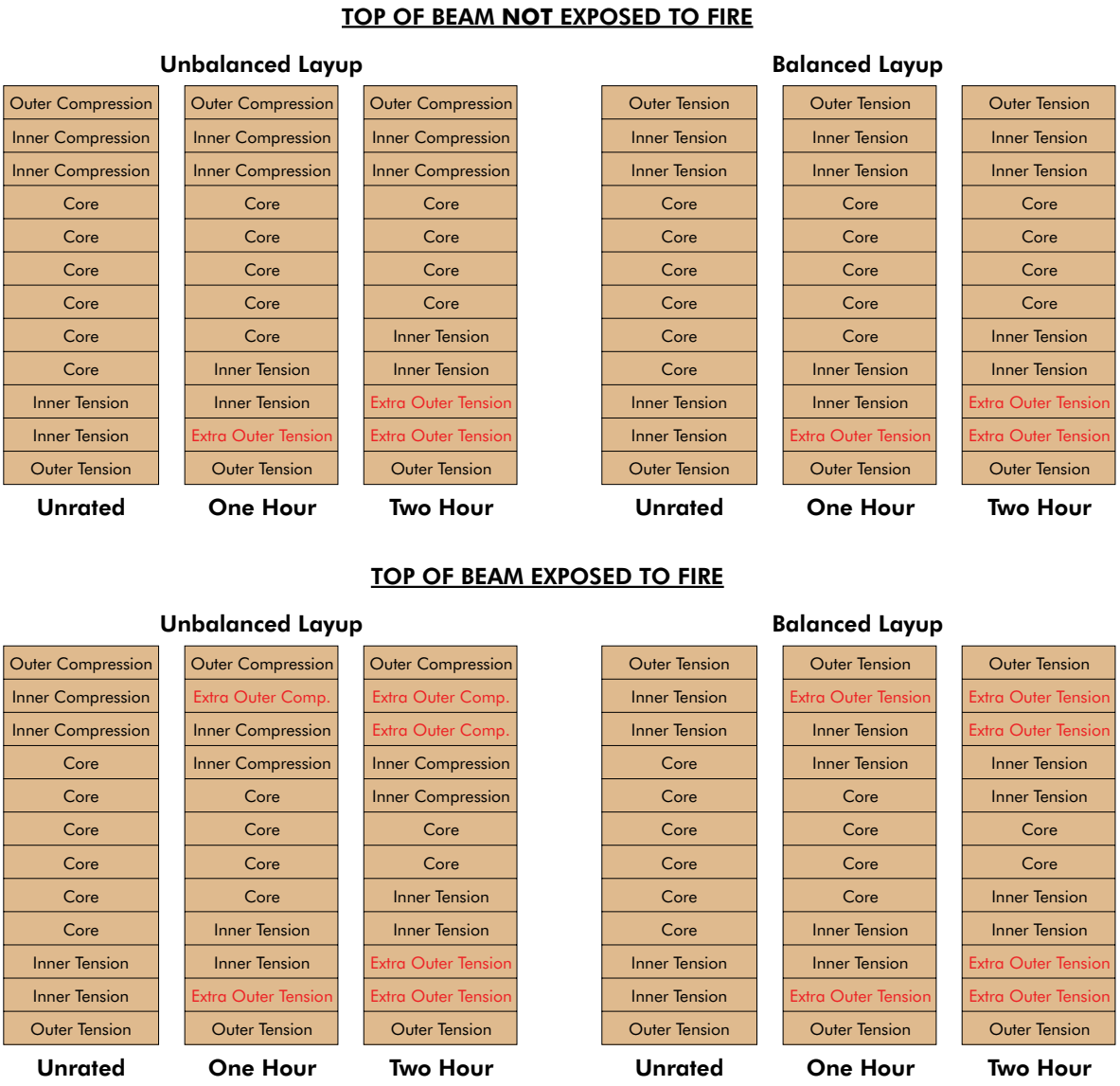
Beam Width (in.)	Depth 3 Side Exposed (in.)	Depth 4 Side Exposed (in.)
5-1/8[a]	12	22-1/2
6-3/4	13-1/2	27
8-3/4	7-1/2	13-1/2

a. When 5-1/8-inch wide glulam is used for one-hour fire-rated beams, load capacity is reduced to 50% of the allowable design load for depths shown in this table.

Tension laminations of glulam beams are always positioned as the outermost laminations of the beam subjected to maximum tension stresses, and in a fire, the outermost fibers in a wood member are the first to be damaged. For this reason, when a rating is required for a glulam beam, the designer should specify additional tension lamination(s) in place of a core lamination (see Figure 8) and the glulam should be marked "Fire-rated one-hour" or "Fire-rated 2 hours" by the manufacturer. For a balanced beam layup, additional tension lamination(s) should be added to both outer zones unless the top of the beam is not exposed to fire, in which case the additional tension lamination(s) is required only on the bottom of the beam. Additional tension lamination(s) are not required for columns and arches.

FIGURE 8

TYPICAL GLULAM BEAM LAYUPS FOR UNRATED AND FIRE-RATED GLULAM



Columns. Columns are often produced with a single grade of laminations throughout and therefore need no special layup to qualify for a one-hour fire rating. For glulam beams having 8-3/4-inch and 10-3/4-inch widths, columns meeting the minimum size standard satisfy the one-hour fire rating requirement at 100% of the allowable design load.

However, column length plays a significant role in determining minimum size for one-hour ratings. The column size needed for a one-hour fire rating is determined by calculating the ℓ/d and then using the appropriate minimum dimensions in Table 6.

ℓ = column length in inches

d = column least dimension in inches

If ℓ/d is less than or equal to 11, the minimum required size is smaller than when ℓ/d is greater than 11.

TABLE 6

MINIMUM DEPTH AT WHICH GLULAM COLUMNS QUALIFY FOR ONE-HOUR RATING FOR GIVEN ℓ/D

ℓ/d Criteria	Column Width (in.)	Depth 3 Side Exposed (in.)	Depth 4 Side Exposed (in.)
ℓ/d>11	10-3/4	10-1/2	13-1/2
ℓ/d≤11	6-3/4[a]	10-1/2	10-1/2
	8-3/4	9	12
	10-3/4	7-1/2	10-1/2

a. Glulam with a nominal width of 6-3/4 inches can be used for one-hour fire-rated columns, but load capacity is reduced to 50% of the allowable design load for depths shown in this table.

Metal Connectors for Glulam. In structures using one-hour fire-rated glulam, all supporting metal connectors and fasteners must be protected to achieve a one-hour fire rating. A 1-1/2-inch covering of wood, 5/8-inch Type X gypsum wallboard or any coating approved for a one-hour rating provides the needed protection.

How Building Areas Can Be Increased

The IBC places limitations on the height and area of a building according to its compliance with certain established criteria, which are based on code concerned with health and safety of the occupants. These criteria include occupancies, types of construction and location within fire zones.

Because light-frame construction is usually the best choice from the standpoint of cost and simplicity, yet is accorded the lowest basic allowable areas, it is to the designer's advantage to find ways to secure area increases to take advantage of the economy and versatility of wood construction.

The following suggestions should help. Refer to Tables 504.3, 504.4 and 506.2, and Chapter 5 of the 2021 IBC for the allowable building height and area limitations on different building types and occupancy classifications with and without automatic sprinkler systems. Online calculators, such as the American Wood Council's Heights and Areas Calculator (www.awc.org) might be used to determine the applicable building height and area limitations for specific design conditions.

1. **One-hour fire resistance:** The IBC allows the area of a wood-frame building to be increased when one-hour fire resistance is provided for all structural elements in the building, including beams and columns, floors, walls and roofs.

2. **Automatic sprinkler protection:** The IBC has provisions that allow building areas to be increased when an automatic sprinkler system is installed throughout the building. For example, under the IBC, a 300% increase is permitted for one-story buildings and 200% for multistory buildings. An additional benefit is the likelihood of substantially lower insurance rates with sprinklers. Sprinkler systems can be connected to a central alarm system for additional protection.

3. **Building separation:** Basic area increases are allowed if there are large open areas on two or more sides of a building. Under the IBC, a 175% increase is allowed if all sides face toward public streets.

4. **Unlimited areas:** In the IBC, provisions are made for the construction of unlimited area buildings for industrial, storage or business uses. Generally, there must be large areas of open space surrounding the building and the building must be completely sprinklered.

   The IBC permits unlimited areas in certain factory and storage buildings. The IBC also permits unlimited areas for all business, factory, mercantile and storage occupancies when the building is one story and equipped with an automatic sprinkler system.

5. **Fire walls:** The equivalent effect of area increases can be achieved by introduction of properly constructed fire walls. In effect, two contiguous buildings are erected when they are separated by a fire-rated wall or partition with all openings protected.

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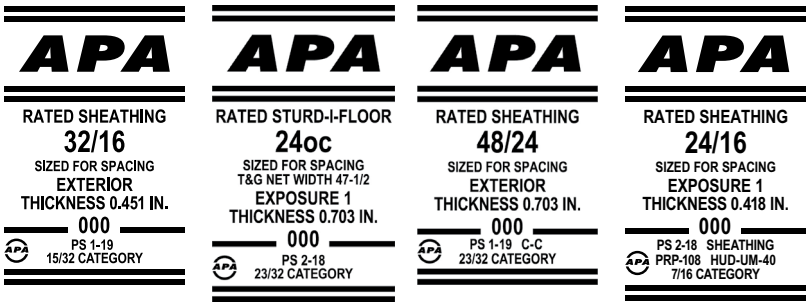

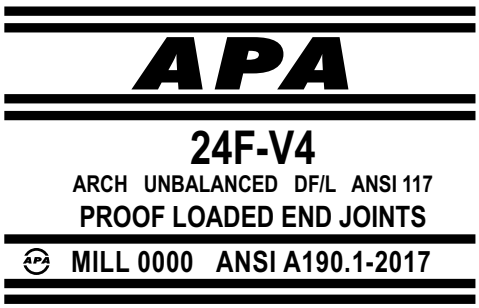

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