Development Services

From Concept to Construction

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More Contact Info (http://www.portlandoregon.gov//bds/article/519984)

APPEAL SUMMARY

Status: Decision Rendered

Appeal ID: 22003	**Project Address:** 3565 NE Columbia Blvd
Hearing Date: 10/16/19	**Appellant Name:** Ron Powell
Case No.: B-010	**Appellant Phone:** 952-426-7422
Appeal Type: Building	**Plans Examiner/Inspector:** Steven Mortensen, Corey Stanley
Project Type: commercial	**Stories:** 3 **Occupancy:** S-1, B **Construction Type:** II-B
Building/Business Name: Beyond Self Storage	**Fire Sprinklers:** Yes - Fully Sprinkled
Appeal Involves: Erection of a new structure	**LUR or Permit Application No.:** 18-175511-CO, 18-175515-CO
Plan Submitted Option: pdf [File 1] [File 2] [File 3] [File 4] [File 5]	**Proposed use:** Self Storage

APPEAL INFORMATION SHEET

Appeal item 1

Code Section	2014 OSSC 2603.5.5 with NFPA 285
Requires	This (entire) exterior wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.
Proposed Design	The Appeal is to allow exterior wall type B to be an alternative design method to comply with OSSC 2603.3.5 and NFPA 285. Exterior wall type B is 2.5” insulated metal panel system attached to a 1.5” hat channel and a 6” steel stud bearing wall. This is a non-rated exterior wall system. See attached sheet A003.
Reason for alternative	Insulated metal panels have been tested and approved for NFPA 285 as a component and only in a non-load bearing condition. This Appeal is to allow for insulated metal panels to be constructed on a steel stud bearing wall systems. Currently the only tested UL Design assembly that I am aware of that has steel stud exterior support walls is UL Design U053. See attachment. This appeal is to allow insulated metal panels to be approved for the exterior wall assemblies in the various cladding varieties shown, but not explicitly tested. See attachment for HARMATHY’S ten rules, especially noting Rule No. 1 and No. 2.

Appeal item 2

Code Section	2014 OSSC 2603.5.5 with NFPA 285
Requires	

	This (entire) exterior wall assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.
Proposed Design	The Appeal is to allow exterior wall type G to be an alternative design method to comply with OSSC 2603.3.5 and NFPA 285. Exterior wall type G is a 2.5” insulated metal panel system attached to a 1.5” hat channel and a 6” steel stud bearing wall with one layer of 5/8” type “X” gypsum board on the exterior and interior sides of the steel studs. This is a one-hour rated exterior wall system similar to UL Design U050. See attached sheet A003.
Reason for alternative	Insulated metal panels have been tested and approved for NFPA 285 as a component and only in a non-load bearing condition. This Appeal is to allow for insulated metal panels to be constructed on a steel stud bearing wall systems. Currently the only tested UL Design assembly that I am aware of that has steel stud exterior support walls is UL Design U053. See attachment. This appeal is to allow insulated metal panels to be approved for the exterior wall assemblies in the various cladding varieties shown, but not explicitly tested. See attachment for HARMATHY'S ten rules, especially noting Rule No. 1 and No. 2.

APPEAL DECISION

1. Use of alternate exterior insulated wall panel assembly with panels not tested per NFPA 285: Granted as proposed.

2. Use of alternate exterior insulated wall panel assembly with panels not tested per NFPA 285: Granted as proposed.

The Administrative Appeal Board finds that the information submitted by the appellant demonstrates that the approved modifications or alternate methods are consistent with the intent of the code; do not lessen health, safety, accessibility, life, fire safety or structural requirements; and that special conditions unique to this project make strict application of those code sections impractical.

Pursuant to City Code Chapter 24.10, you may appeal this decision to the Building Code Board of Appeal within 90 calendar days of the date this decision is published. For information on the appeals process, go to www.portlandoregon.gov/bds/appealsinfo, call (503) 823-7300 or come in to the Development Services Center.

October 14th, 2019

Mohagen Hansen
Ron Powell, AIA
1000 Twelve Oaks Center Drive, Suite 200
Wayzata, MN 55391
rpowell@mohagenhansen.com
(952) 426-7422

RE: **Beyond Self Storage**
Columbia

Dear Mr. Powell,

The design intent for the Beyond Self Storage (Columbia) project Exterior Wall sections **B, G** (below) are to be *compliant* with the Fire Propagation protocols stipulated in the **NFPA 285** standard regarding *Fire Propagation Characteristics* of Exterior Wall Assemblies Containing Components. Noting that Wall section **G** must be a 1hr (min) Fire rated system.

The Beyond Self Storage (Columbia) Project *exterior wall designs* include the following sections (**B, G**):

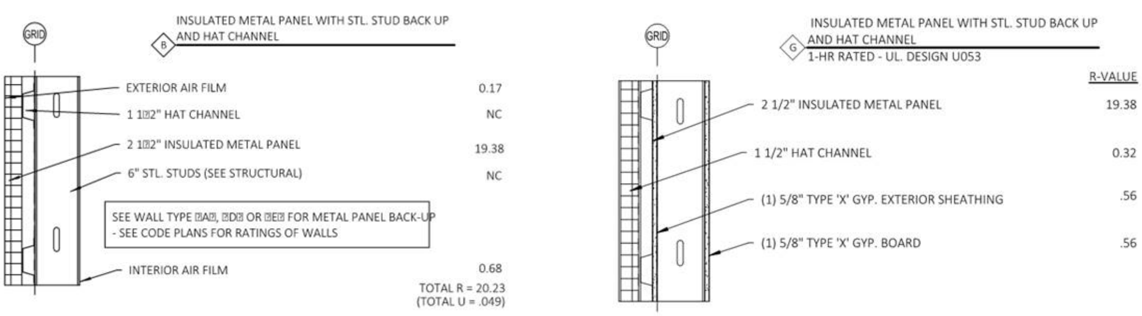


Figure 1

Note: Assembly B is not fire-rated per UL 263 – 053.

For the Wall designs included in the Project, there are (3) elements to review:

A) Wall section status pursuant to the requirements of the current NFPA 285 standard;
B) Wall assembly *variations* to the NFPA 285 standard;
C) Review of UL 263 (Design: 053).

A) **NFPA 285** has evolved in several ways over the span of its development; most notably, is the reference callout for the Test Standard itself. The NFPA 285 standard, has been referenced as follows:

pre-2019:
"***NFPA 285 Standard Test Method for Evaluation of Fire Propagation Characteristics of <u>Exterior Non-Load-Bearing Wall Assemblies</u> Containing Combustible Components***"

2019:
"***Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of <u>Exterior Wall Assemblies</u> Containing Combustible Components***"

Noting the distinctions: (pre 2019) "*Exterior Non-Load-Bearing Wall*…" to (current) "*Exterior Wall Assemblies*…", an independent determination was sought to confirm or invalidate pre 2019 NFPA 285 testing, when compared with the current NFPA standard.

The external Jensen Hughes (Fire) Report*, references in part: (*under separate cover)

"The change in the title and scope of the 2019 Edition of NFPA 285 does not change the testing requirements or applicability of the testing results to load bearing or non-load bearing wall assemblies. The introductory material in the front of the 2019 Edition of NFPA 285 states "The document has been revised to include both bearing and non-load bearing wall assemblies." This change in the document does not restrict the applicability of the test standard, rather it expands the applicability of the NFPA 285 standard from originally only non-load bearing wall assemblies to now both load bearing and non-load bearing wall assemblies. The rationale used by the NFPA Fire Test Committee in accepting this modification is that as long as the wall is built to function structurally as a load bearing wall assembly (as would be needed to pass the fire-resistance test), then testing that stronger wall assembly in the NFPA 285 test, which is a test of the surface flammability, not fire-resistance, would not compromise the ASTM E119 test results. Additionally, any exterior wall assembly previously tested as a non-load bearing wall assembly remains compliant with the current version of the standard since the construction of the test wall is not specified in the NFPA 285 test standard, which is consistent with the fire-resistance standards such as ASTM E119 and UL 263 not specifying the construction of the test wall..

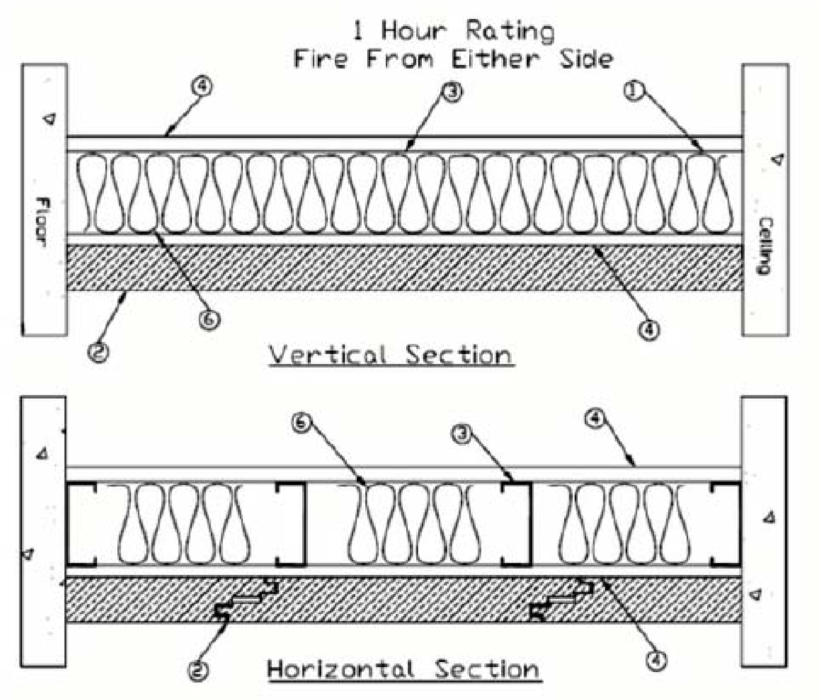
In summary, any exterior wall assembly previously tested in accordance with NFPA 285 remains compliant with the new standard as the change in the standard was intended to expand the applicability and does not technically change how any portions of the test are conducted."

In summing up the Jensen Hughes (external) report regarding the updated NFPA 285 standard:

1. Any exterior wall previously tested under NFPA 285, remains compliant under the current standard;
2. Surface flammability characteristics of a non-load-bearing-wall will not be compromised when used as part of a properly designed load-bearing wall;
3. The Metl-Span CF Panel is certified under the current NFPA 285 standard.

B) NFPA 285 Variations: As referenced in the Jensen Hughes report, properly designed wall assemblies which are based upon NFPA certified elements, but include (non-flammable, non-combustible) additional elements, will in fact not reduce the fire related performance as related to the initial rated assembly.

C) In review of fire ratings when considering the **UL 263** design standard, **Design 053*** provides methods and procedures by which to achieve 1hr, 2hr or 3hr fire ratings (as published); noting that the fire ratings achieved are directly related to the gypsum being attached to the wall assembly. Wall assemblies must be properly designed for all applicable loads (separately); noting also that *sub-girts are optional*. For example: (*under separate cover)



Considering the UL 263/U053 design for an exterior wall condition, as previously referenced in the Jensen Hughes report:

"The construction requirements for a wall assembly to function as a fire-resistance rated load bearing wall assembly have been established and are described in each wall design such as contained in the UL Fire Resistance Directory. Typically, the minimum framing member type, gauge or size is specified, the minimum spacing and bracing requirements listed, and additional construction requirements such the number of top and bottom plates for wood framed assemblies are specified. The construction requirements for load bearing walls are much more onerous than that for non-load bearing walls because in addition to providing fire-resistance, maintaining the structural load requires a much stronger wall framing construction component to the wall assembly. "

The findings hereby referenced above, state *minimum design requirements* for a wall assembly rating; for example, an *interior* wall assembly configuration has an assigned UL fire rating, then, the *exterior* load-bearing wall for an equivalent assembly, (with a much stouter load-bearing design) will have at least the same UL Fire Rating.

All referenced documents are provided under separate cover.

If you have any questions or need further assistance – please feel free to contact me directly.

Regards,

Craig W. Storch, P.E.
MetlSpan – Director of Engineering
AL, AZ, FL, GA, ID, IN, MI, NCEES, OR, UT, WA, WY
File: _BEYOND SELF STORAGE - NFPA 285 V2R1 COLUMBIA .DOCX

JENSEN HUGHES
Advancing the Science of Safety

June 26, 2019

Mr. Christopher Smith
CENTRIA
1005 Beaver Grade Road
Moon Township, PA 15108

RE: Implications of Changes to NFPA 285 Standard, 2019 Edition
Project No. 1AJP00213.000

Dear Mr. Smith:

The NFPA Fire Test Committee, of which both authors are active committee members, recently approved changes to the 2012 Edition of NFPA 285 to expand the usage and applicability of the document for evaluating the fire performance of exterior walls containing combustible materials. One of the changes incorporated into the 2019 Edition of the standard was to eliminate the words "Non-Load-Bearing" from the title and the scope section.

The historical development of the test standard revolved around non-load bearing steel framed curtain wall systems installed on the exterior of buildings common in the 1980's. Exterior Insulation Finish Systems (EIFS) and Insulated Metal Panel (IMP) systems were the initial exterior wall cladding materials evaluated during the development of the test standard. At that time, these exterior curtain walls were steel framed wall assemblies, supported at each floor line, and did not carry any applied building load (non-load bearing assemblies). Over the years, laboratories did periodically perform an NFPA 285 on a load-bearing wall. In these instances, the wall was constructed as designed but an applied load was not applied to the wall.

Recent increases in building construction with the use of Type III construction has begun to incorporate load bearing exterior walls which are now containing combustible exterior insulation materials and cladding systems. In some types of construction (for example, podium construction), the exterior walls are being designed to contain combustible components requiring compliance with NFPA 285 and act as load bearing exterior walls (which would require a fire-resistance rating).

Additionally, the Scope of NFPA 285 was changed so as to encompass all Types of Construction whereas in the previous editions, the Scope addressed only Construction Types I through IV. With the expansion of the Scope to Type V, is was necessary to address load-bearing walls since many Type V buildings use exterior load-bearing walls of wood construction.

The construction requirements for a wall assembly to function as a fire-resistance rated load bearing wall assembly have been established and are described in each wall design such as contained in the UL Fire Resistance Directory. Typically, the minimum framing member type, gauge or size is specified, the minimum spacing and bracing requirements listed, and additional construction requirements such the number of top and

3610 Commerce Drive, Suite 817
Baltimore, MD 21227 USA
O: +1 410-737-8677
F: +1 410-737-8688
jensenhughes.com

bottom plates for wood framed assemblies are specified. The construction requirements for load bearing walls are much more onerous than that for non-load bearing walls because in addition to providing fire-resistance, maintaining the structural load requires a much stronger wall framing construction component to the wall assembly.

The change in the title and scope of the 2019 Edition of NFPA 285 does not change the testing requirements or applicability of the testing results to load bearing or non-load bearing wall assemblies. The introductory material in the front of the 2019 Edition of NFPA 285 states "The document has been revised to include both bearing and non-load bearing wall assemblies." This change in the document does not restrict the applicability of the test standard, rather it expands the applicability of the NFPA 285 standard from originally only non-load bearing wall assemblies to now both load bearing and non-load bearing wall assemblies. The rationale used by the NFPA Fire Test Committee in accepting this modification is that as long as the wall is built to function structurally as a load bearing wall assembly (as would be need to pass the fire-resistance test), then testing that stronger wall assembly in the NFPA 285 test, which is a test of the surface flammability, not fire-resistance, would not compromise the ASTM E119 test results. Additionally, any exterior wall assembly previously tested as a non-load bearing wall assembly remains compliant with the current version of the standard since the construction of the test wall is not specified in the NFPA 285 test standard, which is consistent with the fire-resistance standards such as ASTM E119 and UL 263 not specifying the construction of the test wall..

In summary, any exterior wall assembly previously tested in accordance with NFPA 285 remains compliant with the new standard as the change in the standard was intended to expand the applicability and does not technically change how any portions of the test are conducted.

We trust the above information will be acceptable to the local Authority Having Jurisdiction (AHJ) for your projects. Should you have any questions, please feel free to contact us at (410) 737-8677.

Sincerely,

Jensen Hughes

Arthur J. Parker, P.E.
Sr. Fire Engineer

Jesse J. Beitel
Senior Scientist/Principal

FIRE-RESISTANCE DESIGN

Assembly Usage Disclaimer

BXUV - Fire Resistance Ratings - ANSI/UL 263 Certified for United States

BXUV7 - Fire Resistance Ratings - CAN/ULC-S101 Certified for Canada

See General Information for Fire-resistance Ratings - ANSI/UL 263 Certified for United States
Design Criteria and Allowable Variances

See General Information for Fire Resistance Ratings - CAN/ULC-S101 Certified for Canada
Design Criteria and Allowable Variances

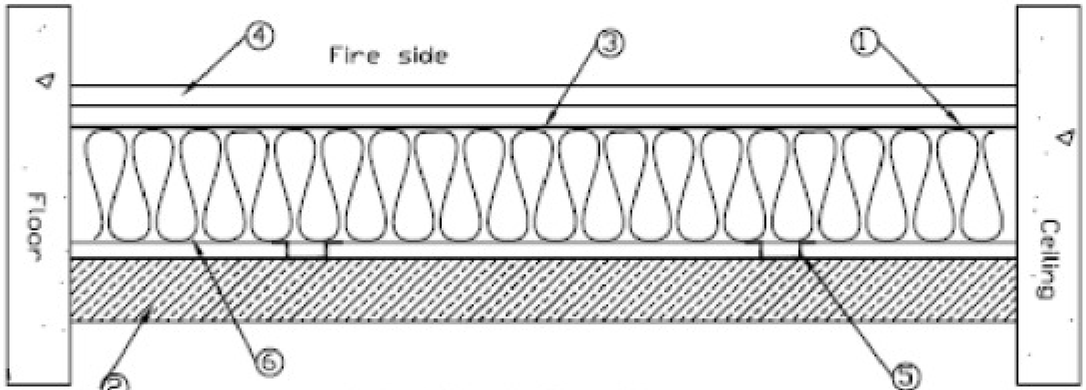
Design No. U053

November 20, 2018

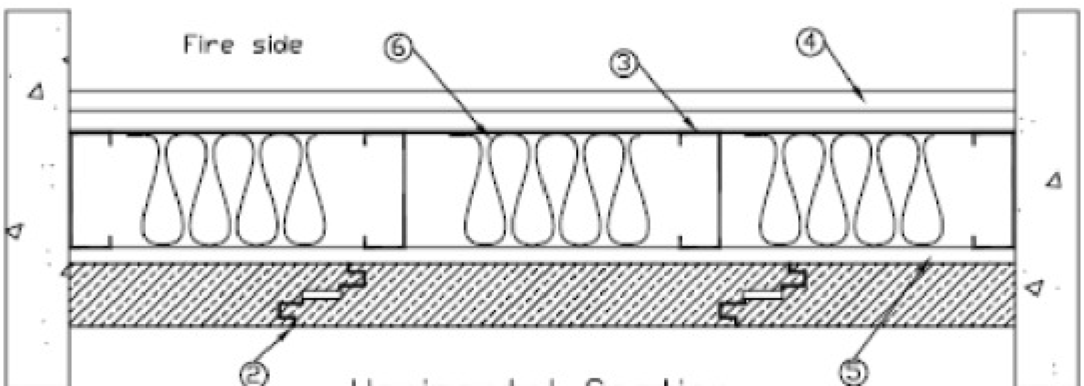
Nonbearing Wall Rating — 1, 2 or 3 Hr (See Item 4)

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

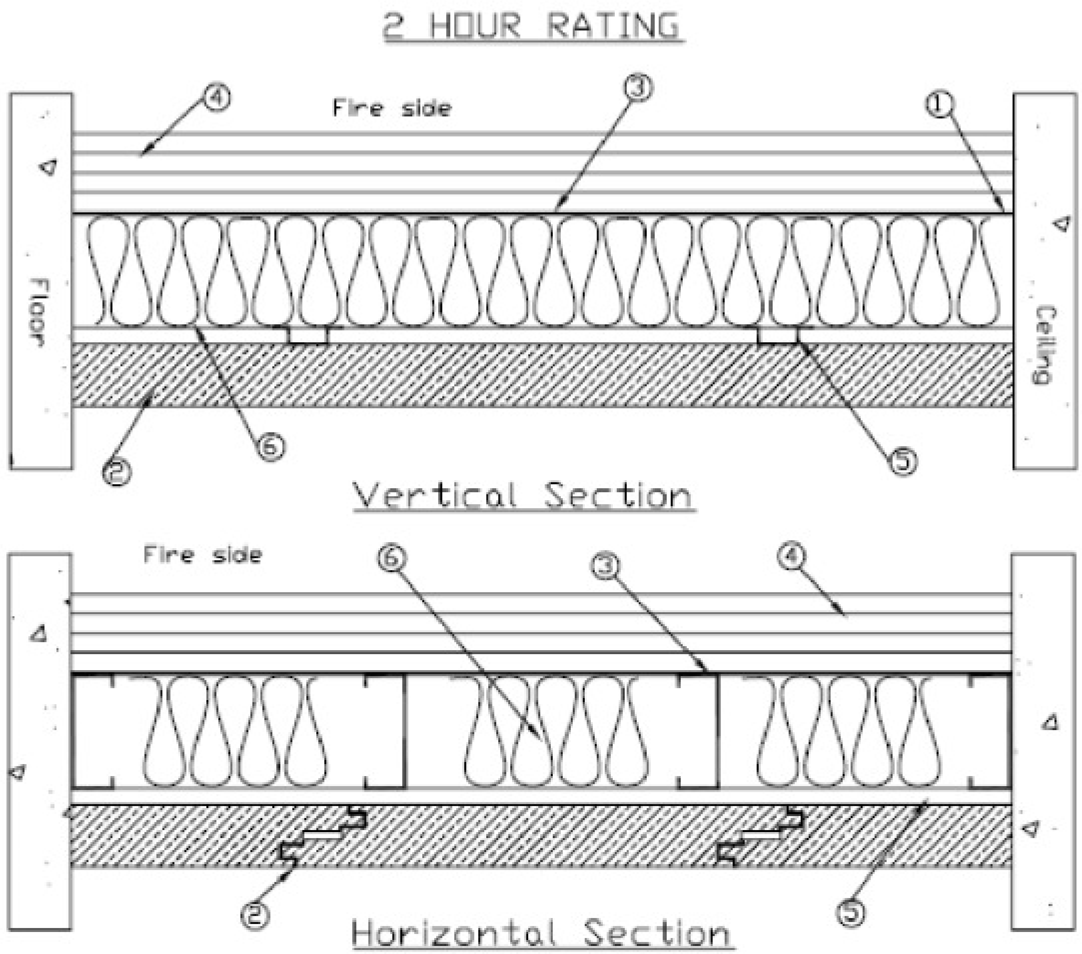
1 HOUR RATING

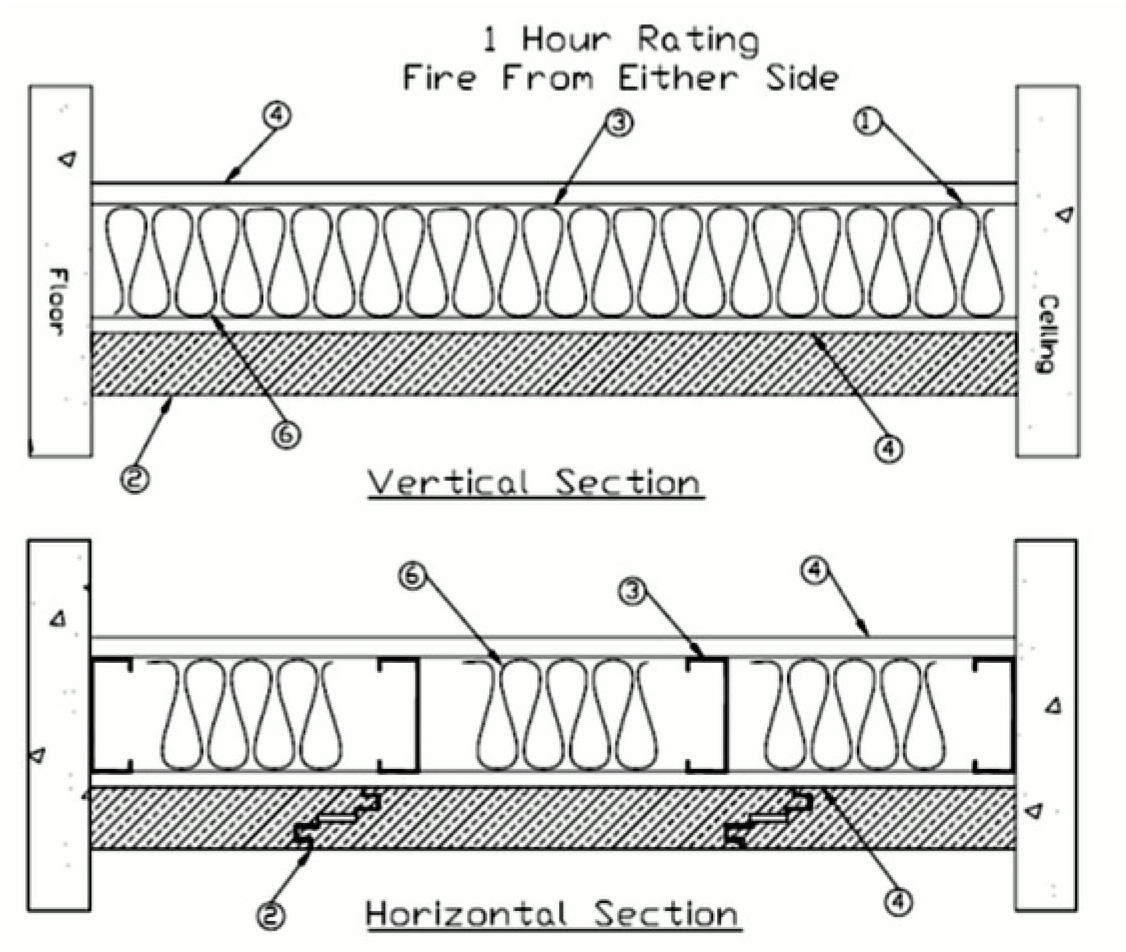


Vertical Section

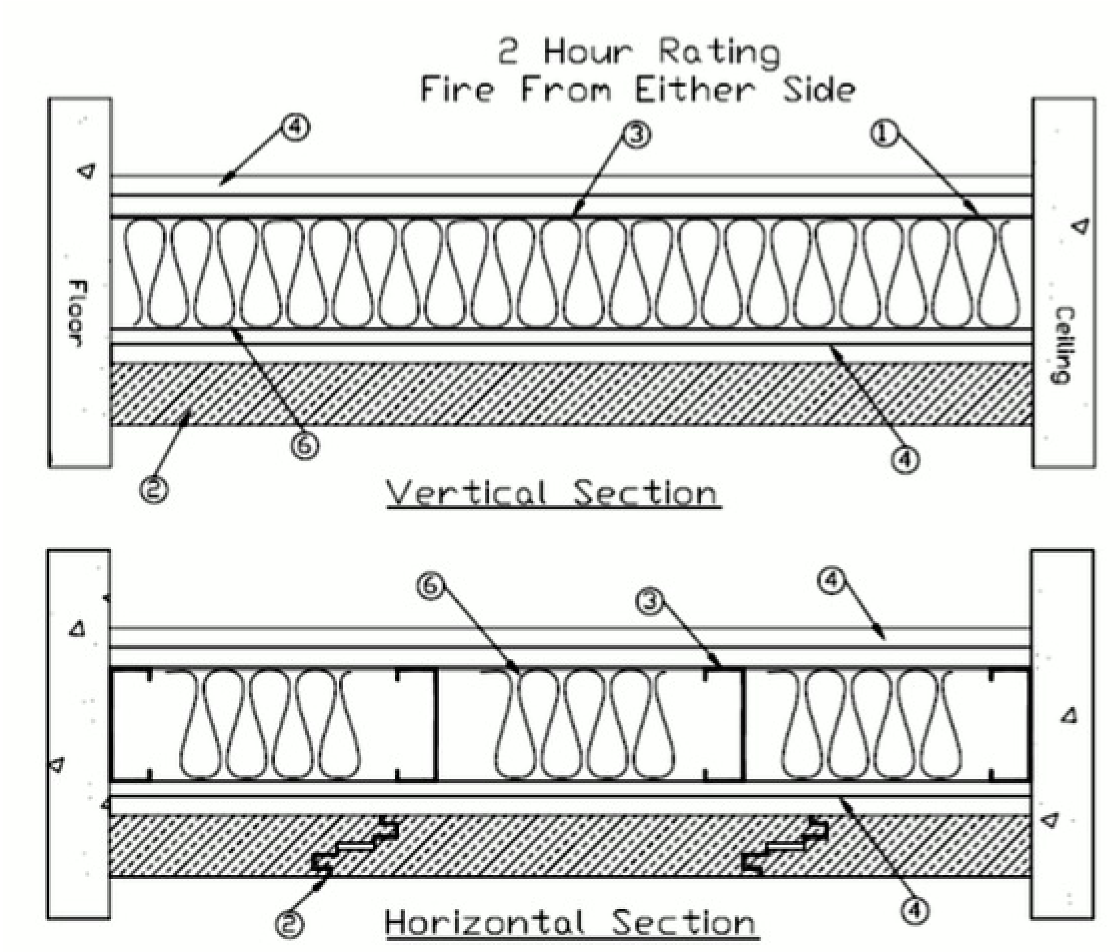


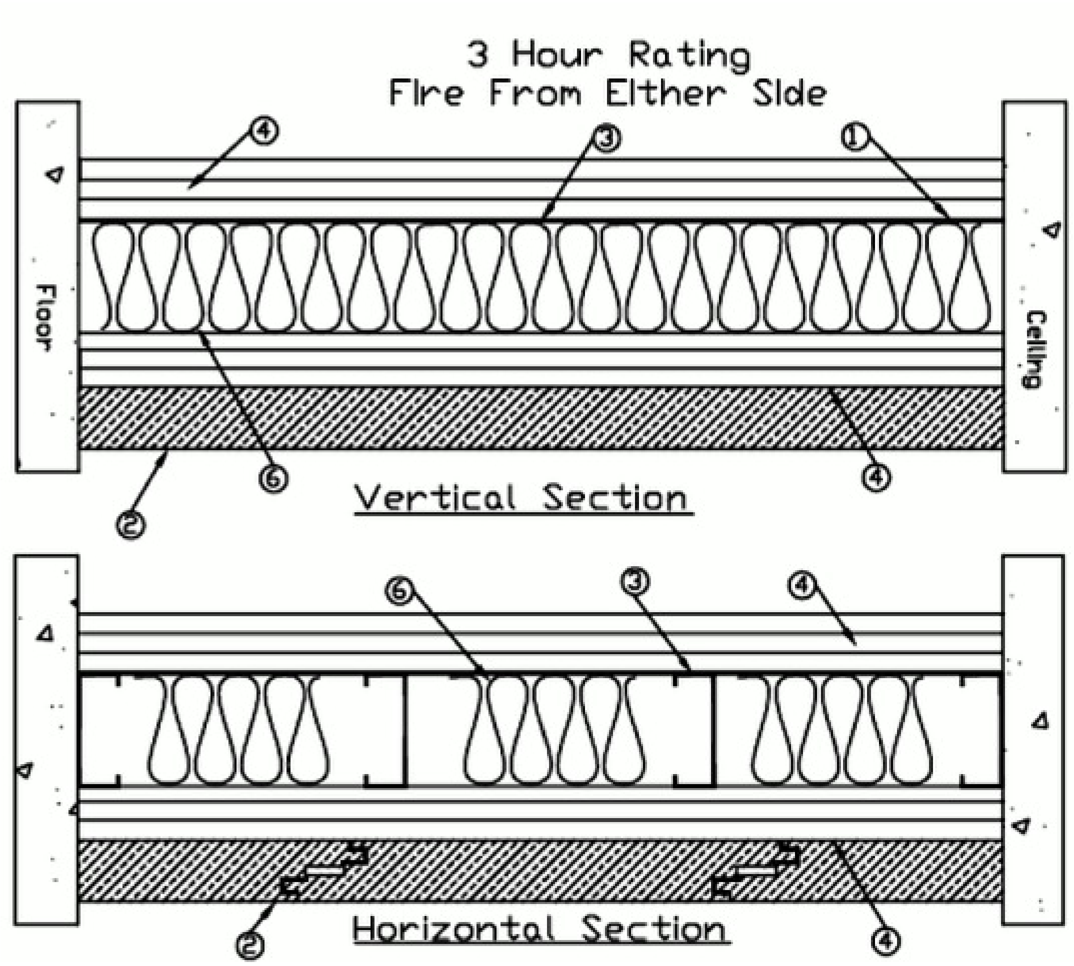
Horizontal Section


2 HOUR RATING
Fire side
4
3
1
Floor
Ceiling
6
5
2
Vertical Section
Fire side
6
3
4
2
5
Horizontal Section



1 Hour Rating
Fire From Either Side
Floor
Ceiling
Vertical Section
Horizontal Section


2 Hour Rating
Fire From Either Side
Floor
Ceiling
1
2
3
4
6
Vertical Section
Horizontal Section



1. **Floor and Ceiling Runners —** Channel-shaped runners, 3-5/8 in. wide min, fabricated from No. 25 MSG galv steel. Attached to floor and ceiling with fasteners spaced 24 in. OC, max.

2. **Building Units* —** Insulated steel panels, 12 through 42 in. wide. Attached through retainer clips to studs or support steel with No. 14 hex head self-tapping screws located at each joint in the concealed lip of the units and spaced in accordance with the structural design requirements. **KINGSPAN INSULATED PANELS INC** — Types 200, 300, 400, 900, or KS series, 2 through 6 in. thickness; CWP-V, H, 2 through 3 in. nominal thickness or Designwall 2000 or Designwall 4000, 2 and 3 in. nominal thickness.

2A. **Units, Partition Panel* —** As an alternate to Item 2 — Two metal faced panels installed in either order. Min. 2 in.(51 mm) thick urethane foam core panel overlayed with a min. nom. 4 in.(102 mm) thick (for the 1 Hour Rating) nom. 7 in.(178 mm) thick (for the 2 Hour Rating), or nom. 8 in.(203 mm) thick (for the 3 Hour Rating) mineral fiber core panel. Panels may be installed vertically or horizontally. Urethane foam core panels produced in 24(610 mm), 30(762 mm), 36(914 mm), 42(1067 mm) and

44-1/2 in.(1130 mm) widths Mineral fiber core panels produced 42 in.(1067 mm) wide. Panel lengths vary.
For the 3 hour rating, 1/8 in.(3.2 mm) diameter steel or stainless steel pop rivets shall be installed through the tongue and groove joint of the mineral wool core panel 1/4 in.(6 mm) from the panel edge and 3 ft.(915 mm) on center along the length of the joint. The rivets shall be long enough to secure the exterior face of the male edge of the tongue and groove joint (single layer of metal skin) to the exterior face of the female edge of the tongue and groove joint (double layer of metal skin). As an alternate to the rivets, min. No. 6-20 x 3/8 in.(10 mm) long carbon or stainless steel self-drilling screws may be used. The rivets or screws may be eliminated on one side of the assembly. When the rivets or screws are eliminated on one side of the assembly, the rating is limited to fire exposure on the side of the assembly with the rivets or screws only.

METL-SPAN, A DIVISION OF NCI GROUP, INC. — Type ThermalSafe (mineral fiber core) and CF (urethane foam core) Panels.

2B. **Panel Fasteners —** For use with Item 2A - Urethane foam core panels secured to steel studs (item 3) or subgirts (item 5) with concealed panel clips and min. #14 self-tapping fastener provided at each longitudinal panel edge. Mineral fiber core panels secured with min. #14 self-tapping fasteners through panel into the supports, spaced 18 in.(457 mm) OC and 3 in.(76 mm) from each joint. Screw lengths shall permit full thread engagement into the panel supports.

3. **Steel Studs —** Channel shaped, 3-5/8 in. wide min, 1-1/4 in. legs, 3/8 in. folded back returns, min 0.020 in. thick (25 gauge) galv steel spaced 24 in. OC max. Studs 3/8 in. less in lengths than assembly height.

3A. **Wood Studs —** As an alternate to Steel Studs Item 3. Non-loadbearing, nom 2 by 4 in. spaced 16 in. OC with two 2 by 4 in. top and one 2 by 4 in. bottom plates. Walls effectively fire stopped at top and bottom of wall.

4. **Gypsum Board* —** (For 1 and 2 hour ratings when exposed on interior face only) - Any 5/8 in. thick UL Classified Gypsum Board that is eligible for use in Design Nos. L501, G512 or U305. **For a 1 hour rating**, 5/8 in. thick, 4 ft wide, two layers applied vertically with joints centered over studs. Inner layer attached to studs and runners with 1 in. long, Type S screws spaced 12 in. OC. Face layer attached through inner layer into studs and runners with 1-5/8 in. long Type S screws spaced 18 in. OC. Joints to be staggered from the inner layer. **For a 2 hour rating**, 5/8 in. thick, 4 ft wide, four layers applied vertically with joints centered over studs. Base layer attached to studs and runners with 1 in. long, Type S screws spaced 12 in. OC. Second layer attached through base layer into studs and runners with

1-5/8 in. long Type S screws spaced 18 in. OC. Third layer attached through base layer into studs and runners with 2-1/4 in. long Type S screws spaced 18 in. OC. Face layer attached through base layer into studs and runners with 3 in. long Type S screws spaced 18 in. OC. Joints to be staggered 24 in. from the inner layer joint. Screws offset a min. 6 in. from layer below.
ACADIA DRYWALL SUPPLIES LTD (View Classification) — CKNX.R25370

AMERICAN GYPSUM CO (View Classification) — CKNX.R14196

BEIJING NEW BUILDING MATERIALS PUBLIC LTD CO (View Classification) — CKNX.R19374

CERTAINTEED GYPSUM INC (View Classification) — CKNX.R3660

CGC INC (View Classification) — CKNX.R19751

GEORGIA-PACIFIC GYPSUM L L C (View Classification) — CKNX.R2717

CONTINENTAL BUILDING PRODUCTS OPERATING CO, L L C (View Classification) — CKNX.R18482

LOADMASTER SYSTEMS INC (View Classification) — CKNX.R11809

NATIONAL GYPSUM CO (View Classification) — CKNX.R3501

PABCO BUILDING PRODUCTS L L C, DBA PABCO GYPSUM (View Classification) — CKNX.R7094

PANEL REY S A (View Classification) — CKNX.R21796

SIAM GYPSUM INDUSTRY (SARABURI) CO LTD (View Classification) — CKNX.R19262

GEORGIA-PACIFIC GYPSUM L L C (View Classification) — CKNX.R6937

THAI GYPSUM PRODUCTS PCL (View Classification) — CKNX.R27517

UNITED STATES GYPSUM CO (View Classification) — CKNX.R1319

USG MEXICO S A DE C V (View Classification) — CKNX.R16089

4A. **Gypsum Board* —** (For 1, 2 and 3 hour rating when exposed on either side of wall) - Any 5/8 in. thick UL Classified Gypsum Board that is eligible for use in Design Nos. L501, G512 or U305. See Item 4 for list of Companies. **For a 1 hour rating**, 5/8 in. thick, 4 ft wide, attached to steel studs and floor and ceiling track with 1 in. long, Type S steel screws spaced 8 in. OC. along edges of board and 12 in. OC in the field of the board. Joints oriented vertically and staggered on opposite sides of the assembly. **For a 2 hour rating**, 5/8 in. thick, 4 ft wide, two layers applied vertically on both sides of studs with joints centered over studs. Base layer attached to studs and runners with 1 in. long, Type S screws spaced 16 in. OC statting 8 in. from the edge of the board with an additional screw placed 1-1/4 in. from each edge of boad. Second layer attached through base layer into studs and runners with 1-5/8 in. long Type S screws spaced 16 in. OC starting 8 in. from each edge of the board with an additional screw placed 1-1/4 in. from each edge of the board. Joints to be staggered 24 in. from the inner layer joint. Screws offset a min. 6 in. from layer below. **For a 3 hour rating**, 5/8 in. thick, 4 ft wide, three layers applied vertically on both sides of studs with joints centered over. Base layer attached to studs and runners with 1 in. long, Type S screws spaced 24 in. OC. Second layer attached through base layer into studs and runners with 1-5/8 in. long Type S screws spaced 24 in. OC. Third layer attached through second and base layers into studs and runners with 2-1/4 in. long Type S screws spaced 12 in. OC. Joints to be staggered 24 in. from the inner layer joint. For all layers, an additional screw shall be placed 1-1/4 in. from the edge of the board. Screws offset a min. 6 in. from layer below.

5. **Subgirts (optional) —** Hat or Z shaped min 1/2 in. deep, min .045 in. thick (18 gauge) galv steel, attached to studs, 48 in. OC with No. 14 self-tapping screws or No. 14 self-drilling screws.

6. **Batts and Blankets* —** (Optional) — Placed in stud cavities. Any glass fiber or mineral wool batt material bearing the UL Classification Marking as for Fire Resistance, of a thickness to completely fill the stud cavity.

See **Batts and Blanket** (BZJZ) Category for names of Classified companies.

6A. **Fiber, Sprayed* —** As an alternate to Batts and Blankets (Item 6) — Spray applied cellulose material. The fiber is applied with water to completely fill the enclosed cavity in accordance with the application instructions supplied with the product with a nominal dry density of 2.7 lb/ft^3. Alternate Application Method: The fiber is applied without water or adhesive at a nominal dry density of 3.5 lb/ft^3, in accordance with the application instructions supplied with the product.
U S GREENFIBER L L C — INS735& INS745 for use with wet or dry application. INS765LD and INS770LD are to be used for dry application only.

6B. **Fiber, Sprayed* —** As an alternate to Batts and Blankets (Item 6) and Item 6A - Spray applied cellulose insulation material. The fiber is applied with water to interior surfaces in accordance with the application instructions supplied with the product. Applied to completely fill the enclosed cavity. Minimum dry density of 4.3 pounds per cubic ft.
NU-WOOL CO INC — Cellulose Insulation

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

Last Updated on 2018-11-20

Design/System/Construction/Assembly Usage Disclaimer

- Authorities Having Jurisdiction should be consulted in all cases as to the particular requirements covering the installation and use of UL Certified products, equipment, system, devices, and materials.
- Authorities Having Jurisdiction should be consulted before construction.
- Fire resistance assemblies and products are developed by the design submitter and have been investigated by UL for compliance with applicable requirements. The published information cannot always address every construction nuance encountered in the field.
- When field issues arise, it is recommended the first contact for assistance be the technical service staff provided by the product manufacturer noted for the design. Users of fire resistance assemblies are advised to consult the general Guide Information for each product category and each group of assemblies. The Guide

Information includes specifics concerning alternate materials and alternate methods of construction.
- Only products which bear UL's Mark are considered Certified.

The appearance of a company's name or product in this database does not in itself assure that products so identified have been manufactured under UL's Follow-Up Service. Only those products bearing the UL Mark should be considered to be Certified and covered under UL's Follow-Up Service. Always look for the Mark on the product.

HARMATHY'S TEN RULES

Rule 1: The "thermal"[1] *fire endurance of a construction consisting of a number of parallel layers is greater than the sum of the "thermal" fire endurances characteristic of the individual layers when exposed separately to fire.*

The minimum performance of an untested assembly can be estimated if the fire endurance of the individual components is known. Though the exact rating of the assembly cannot be stated, the endurance of the assembly is greater than the sum of the endurance of the components.

When a building assembly or component is found to be deficient, the fire endurance can be upgraded by providing a protective membrane. This membrane could be a new layer of brick, plaster, or drywall. The fire endurance of this membrane is called the "finish rating." Appendix Tables 1.5.1 and 1.5.2 contain the finish ratings for the most commonly employed materials. (See also the notes to Rule 2).

The test criteria for the finish rating is the same as for the thermal fire endurance of the total assembly: average temperature increases of 250°F (121°C) above ambient or 325°F (163°C) above ambient at any one place with the membrane being exposed to the fire. The temperature is measured at the interface of the assembly and the protective membrane.

Rule 2: The fire endurance of a construction does not decrease with the addition of further layers.

Harmathy notes that this rule is a consequence of the previous rule. Its validity follows from the fact that the additional layers increase both the resistance to heat flow and the heat capacity of the construction. This, in turn, reduces the rate of temperature rise at the unexposed surface.

This rule is not just restricted to "thermal" performance but affects the other fire test criteria: direct flame passage, cotton waste ignition, and load bearing performance. This means that certain restrictions must be imposed on the materials to be added and on the loading conditions. One restriction is that a new layer, if applied to the exposed surface, must not produce additional thermal stresses in the construction, i.e., its thermal expansion characteristics must be similar to those of the adjacent layer. Each new layer must also be capable of contributing enough additional strength to the assembly to sustain the added dead load. If this requirement is not fulfilled, the allowable live load must be reduced by an amount equal to the weight of the new layer. Because of these limitations, this rule should not be applied without careful consideration.

Particular care must be taken if the material added is a good thermal insulator. Properly located, the added insulation could improve the "thermal" performance of the assembly. Improperly located, the insulation could block necessary thermal transmission through the assembly, thereby subjecting the structural elements to greater temperatures for longer periods of time, and could cause premature structural failure of the supporting members.

Rule 3: The fire endurance of constructions containing continuous air gaps or cavities is greater than the fire endurance of similar constructions of the same weight, but containing no air gaps or cavities.

By providing for voids in a construction, additional resistances are produced in the path of heat flow. Numerical heat flow analyses indicate that a 10 to 15 percent increase in fire endurance can be achieved by creating an air gap at the midplane of a brick wall. Since the gross volume is also increased by the presence of voids, the air gaps and cavities have a beneficial effect on stability as well. However, constructions containing combustible materials within an air gap may be regarded as exceptions to this rule because of the possible development of burning in the gap.

There are numerous examples of this rule in the tables. For instance:

Table 1.1.4; Item W-8-M-82: Cored concrete masonry, nominal 8 inch thick wall with one unit in wall thickness and with 62 percent minimum of solid material in each unit, load bearing (80 PSI). Fire endurance: $2^1/_2$ hours.

Table 1.1.5; Item W-10-M-11: Cored concrete mansonry, nominal 10 inch thick wall with two units in wall thickness and a 2-inch (51 mm) air space, load bearing (80 PSI). The units are essentially the same as item W-8-M-82. Fire endurance: $3^1/_2$ hours.

These walls show 1 hour greater fire endurance by the addition of the 2-inch (51 mm) air space.

Rule 4: The farther an air gap or cavity is located from the exposed surface, the more beneficial is its effect on the fire endurance.

Radiation dominates the heat transfer across an air gap or cavity, and it is markedly higher where the temperature is higher.

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1. The "thermal" fire endurance is the time at which the average temperature on the unexposed side of a construction exceeds its initial value by 250° when the other side is exposed to the "standard" fire specified by ASTM Test Method E-19.

The air gap or cavity is thus a poor insulator if it is located in a region which attains high temperatures during fire exposure.

Some of the clay tile designs take advantage of these factors. The double cell design, for instance, ensures that there is a cavity near the unexposed face. Some floor/ceiling assemblies have air gaps or cavities near the top surface and these enhance their thermal performance.

Rule 5: The fire endurance of a construction cannot be increased by increasing the thickness of a completely enclosed air layer.

Harmathy notes that there is evidence that if the thickness of the air layer is larger than about $^1/_2$ inch (12.7 mm), the heat transfer through the air layer depends only on the temperature of the bounding surfaces, and is practically independent of the distance between them. This rule is not applicable if the air layer is not completely enclosed, i.e., if there is a possibility of fresh air entering the gap at an appreciable rate.

Rule 6: Layers of materials of low thermal conductivity are better utilized on that side of the construction on which fire is more likely to happen.

As in Rule 4, the reason lies in the heat transfer process, though the conductivity of the solid is much less dependent on the ambient temperature of the materials. The low thermal conductor creates a substantial temperature differential to be established across its thickness under transient heat flow conditions. This rule may not be applicable to materials undergoing physico-chemical changes accompanied by significant heat absorption or heat evolution.

Rule 7: The fire endurance of asymmetrical constructions depends on the direction of heat flow.

This rule is a consequence of Rules 4 and 6 as well as other factors. This rule is useful in determining the relative protection of corridors and stairwells from the surrounding spaces. In addition, there are often situations where a fire is more likely, or potentially more severe, from one side or the other.

Rule 8: The presence of moisture, if it does not result in explosive spalling, increases the fire endurance.

The flow of heat into an assembly is greatly hindered by the release and evaporation of the moisture found within cementitious materials such as gypsum, portland cement, or magnesium oxychloride. Harmathy has shown that the gain in fire endurance may be as high as 8 percent for each percent (by volume) of moisture in the construction. It is the moisture chemically bound within the construction material at the time of manufacture or processing that leads to increased fire endurance. There is no direct relationship between the relative humidity of the air in the pores of the material and the increase in fire endurance.

Under certain conditions there may be explosive spalling of low permeability cementitious materials such as dense concrete. In general, one can assume that extremely old concrete has developed enough minor cracking that this factor should not be significant.

Rule 9: Load-supporting elements, such as beams, girders and joists, yield higher fire endurances when subjected to fire endurance tests as parts of floor, roof, or ceiling assemblies than they would when tested separately.

One of the fire endurance test criteria is the ability of a load-supporting element to carry its design load. The element will be deemed to have failed when the load can no longer be supported.

Failure usually results for two reasons. Some materials, particularly steel and other metals, lose much of their structural strength at elevated temperatures. Physical deflection of the supporting element, due to decreased strength or thermal expansion, causes a redistribution of the load forces and stresses throughout the element. Structural failure often results because the supporting element is not designed to carry the redistributed load.

Roof, floor, and ceiling assemblies have primary (e.g., beams) and secondary (e.g., floor joists) structural members. Since the primary load-supporting elements span the largest distances, their deflection becomes significant at a stage when the strength of the secondary members (including the roof or floor surface) is hardly affected by the heat. As the secondary members follow the deflection of the primary load-supporting element, an increasingly larger portion of the load is transferred to the secondary members.

When load-supporting elements are tested separately, the imposed load is constant and equal to the design load throughout the test. By definition, no distribution of the load is possible because the element is being tested by itself. Without any other structural members to which the load could be transferred, the individual elements cannot yield a higher fire endurance than they do when tested as parts of a floor, roof or ceiling assembly.

Rule 10: The load-supporting elements (beams, girders, joists, etc.) of a floor, roof, or ceiling assembly can be replaced by such other load-supporting elements which, when tested separately, yielded fire endurances not less than that of the assembly.

This rule depends on Rule 9 for its validity. A beam or girder, if capable of yielding a certain performance when tested separately, will yield an equally good or better performance when it forms a part of a floor, roof, or ceiling assembly. It must be emphasized that the supporting element of one assembly must not be replaced by the supporting element of another assembly if the performance of this latter element is not known from a separate (beam) test. Because of the load-reducing effect of the secondary elements that results from a test performed on an assembly, the performance of the supporting element alone cannot be evaluated by simple arithmetic. This rule also indicates the advantage of performing separate fire tests on primary load-supporting elements.

ILLUSTRATION OF HARMATHY'S RULES

Harmathy provided one schematic figure which illustrated his Rules.[1] It should be useful as a quick reference to assist in applying his Rules.

EXAMPLE APPLICATION OF HARMATHY'S RULES

The following examples, based in whole or in part upon those presented in Harmathy's paper (35), show how the Rules can be applied to practical cases.

Example 1

Problem

A contractor would like to keep a partition which consists of a $3^3/_4$ inch (95 mm) thick layer of red clay brick, a $1^1/_4$ inch (32 mm) thick layer of plywood, and a $^3/_8$ inch (9.5 mm) thick layer of gypsum wallboard, at a location where 2-hour fire endurance is required. Is this assembly capable of providing a 2-hour protection?

Solution

(1) This partition does not appear in the Appendix Tables.

(2) Bricks of this thickness yield fire endurances of approximately 75 minutes (Table 1.1.2, Item W-4-M-2).

(3) The $1^1/_4$ inch (32 mm) thick plywood has a finish rating of 30 minutes.

(4) The $^3/_8$ inch (9.5 mm) gypsum wallboard has a finish rating of 10 minutes.

(5) Using the recommended values from the tables and applying Rule 1, the fire endurance (FI) of the assembly is larger than the sum of the individual layers, or

$$FI > 75 + 30 + 10 = 115 \text{ minutes}$$

Discussion

This example illustrates how the Appendix Tables can be utilized to determine the fire resistance of assemblies not explicitly listed.

Example 2

Problem

(1) A number of buildings to be rehabilitated have the same type of roof slab which is supported with different structural elements.

(2) The designer and contractor would like to determine whether or not this roof slab is capable of yielding a 2-hour fire endurance. According to a rigorous interpretation of ASTM E 119, however, only the roof assembly, including the roof slab as well as the cover and the supporting elements, can be subjected to a fire test. Therefore, a fire endurance classification cannot be issued for the slabs separately.

(3) The designer and contractor believe this slab will yield a 2-hour fire endurance even without the cover, and any beam of at least 2-hour fire endurance will provide satisfactory support. Is it possible to obtain a classification for the slab separately?

Solution

(1) The answer to the question is yes.

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(2) According to Rule 10 it is not contrary to common sense to test and classify roofs and supporting elements separately. Furthermore, according to Rule 2, if the roof slabs actually yield a 2 hour fire endurance, the endurance of an assembly, including the slabs, cannot be less than 2 hours.

(3) The recommended procedure would be to review the tables to see if the slab appears as part of any tested roof or floor/ceiling assembly. The supporting system can be regarded as separate from the slab specimen, and the fire endurance of the assembly listed in the table is at least the fire endurance of the slab. There would have to be an adjustment for the weight of the roof cover in the allowable load if the test specimen did not contain a cover.

(4) The supporting structure or element would have to have at least a 2-hour fire endurance when tested separately.

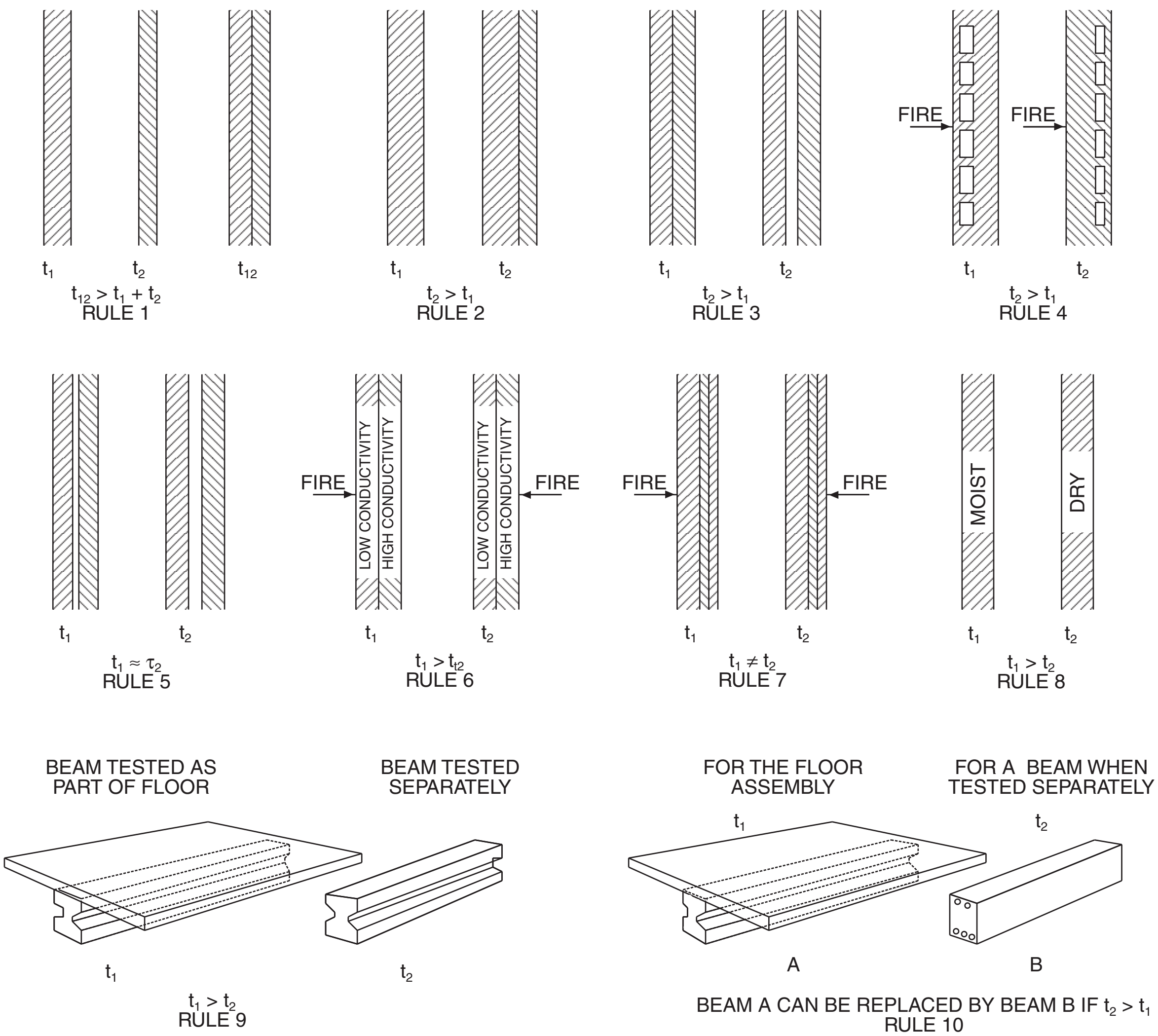
Discussion

If the tables did not include tests on assemblies which contained the slab, one procedure would be to assemble the roof slabs on any convenient supporting system (not regarded as part of the specimen) and to subject them to a load which, besides the usually required superimposed load, includes some allowances for the weight of the cover.

Example 3

Problem

A steel-joisted floor and ceiling assembly is known to have yielded a fire endurance of 1 hour and 35 minutes. At a certain location, a 2-hour endurance is required. What is the most economical way of increasing the fire endurance by at least 25 minutes?



Diagrammatic illustration of ten rules.
t = fire endurance

Solution

(1) The most effective technique would be to increase the ceiling plaster thickness. Existing coats of paint would have to be removed and the surface properly prepared before the new plaster could be applied. Other materials (e.g., gypsum wallboard) could also be considered.

(2) There may be other techniques based on other principles, but an examination of the drawings would be necessary.

Discussion

(1) The additional plaster has at least three effects:

a) The layer of plaster is increased and thus there is a gain of fire endurance (Rule 1).

b) There is a gain due to shifting the air gap farther from the exposed surface (Rule 4).

c) There is more moisture in the path of heat flow to the structural elements (Rules 7 and 8).

(2) The increase in fire endurance would be at least as large as that of the finish rating for the added thickness of plaster. The combined effects in (1) above would further increase this by a factor of 2 or more, depending upon the geometry of the assembly.

Example 4

Problem

The fire endurance of item W-10-M-l in Table 1.1.5 is 4 hours. This wall consists of two $3^3/_4$ inch (95 mm) thick layers of structural tiles separated by a 2-inch (51 mm) air gap and $^3/_4$ inch (19 mm) portland cement plaster or stucco on both sides. If the actual wall in the building is identical to item W-10-M-1 except that it has a 4-inch (102 mm) air gap, can the fire endurance be estimated at 5 hours?

Solution

The answer to the question is no for the reasons contained in Rule 5.

Example 5

Problem

In order to increase the insulating value of its precast roof slabs, a company has decided to use two layers of different concretes. The lower layer of the slabs, where the strength of the concrete is immaterial (all the tensile load is carried by the steel reinforcement), would be made with a concrete of low strength but good insulating value. The upper layer, where the concrete is supposed to carry the compressive load, would remain the original high strength, high thermal conductivity concrete. How will the fire endurance of the slabs be affected by the change?

Solution

The effect on the thermal fire endurance is beneficial:

(1) The total resistance to heat flow of the new slabs has been increased due to the replacement of a layer of high thermal conductivity by one of low conductivity.

(2) The layer of low conductivity is on the side more likely to be exposed to fire, where it is more effectively utilized according to Rule 6. The layer of low thermal conductivity also provides better protection for the steel reinforcement, thereby extending the time before reaching the temperature at which the creep of steel becomes significant.