
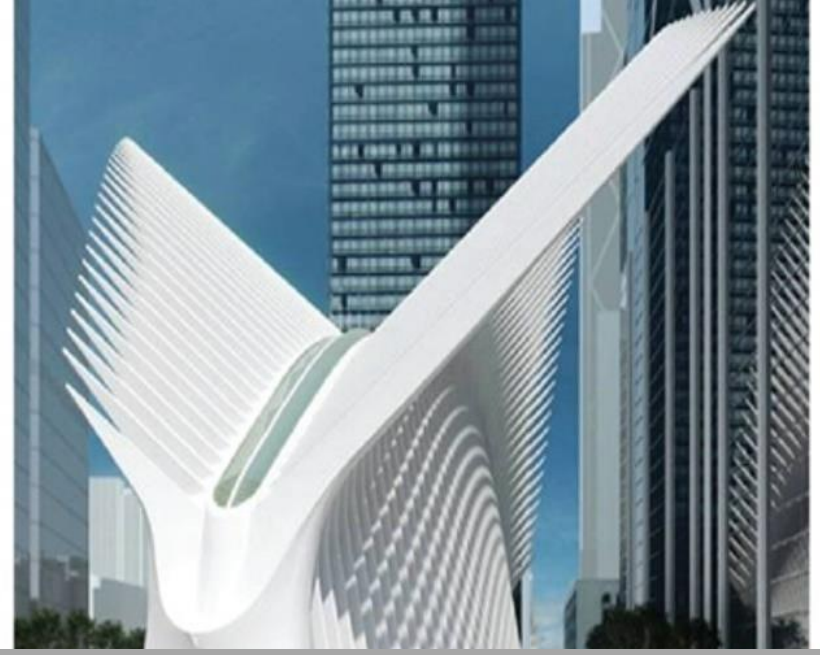


Fireproofing Structural Steel

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Fireproofing Structural Steel

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Purpose and Learning Objectives

Purpose:

Today's complex steel structures present numerous design challenges, including the challenge of fireproofing appropriately in order to ensure the safety and well-being of building occupants as well as protection of the structure itself. This course outlines the code and testing standards that inform fireproofing choices and the various passive fire protection products and methodologies that can address a comprehensive range of design challenges; insight into the proper specification of fire protection products as well as their ability to improve LEED® certification levels is also provided.

Learning Objectives:

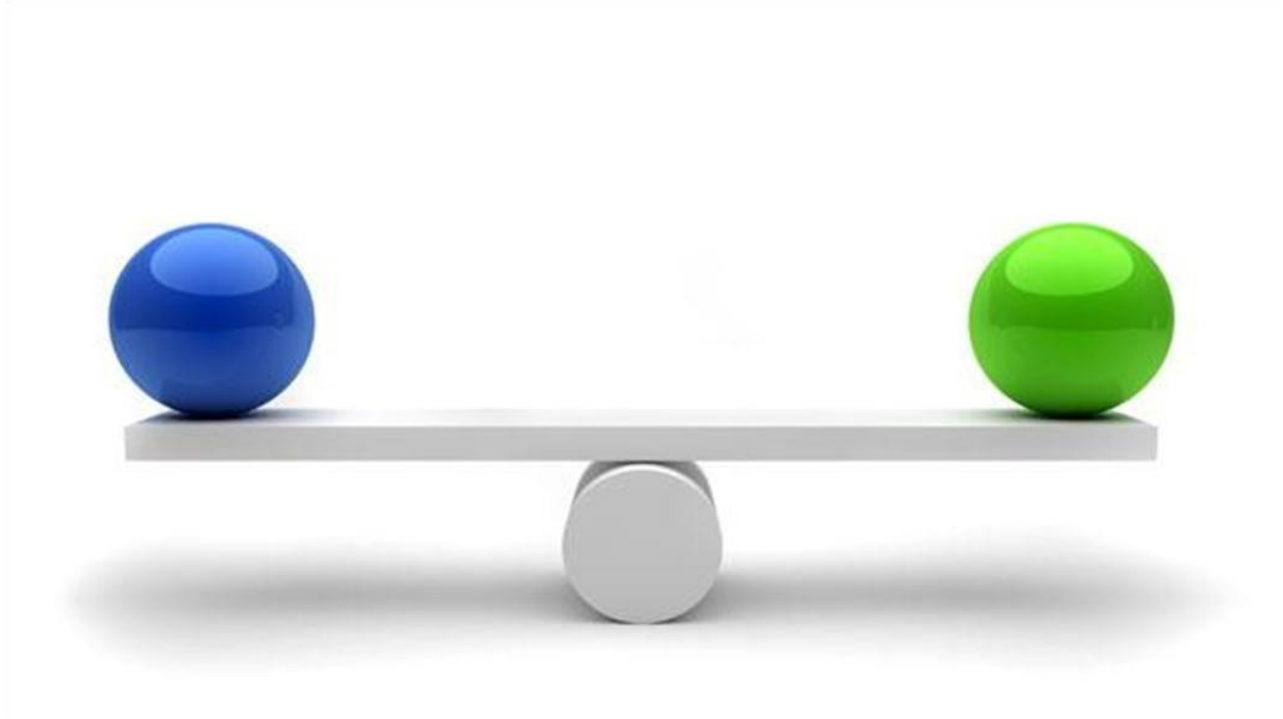
At the end of this program, participants will be able to:

- prioritize the importance and requirements of passive steel fireproofing when designing steel structures
- specify steel fireproofing solutions that meet or exceed all code requirements
- utilize innovative passive fireproofing products to overcome all design and fireproofing challenges, and
- improve building certification levels using fire protection methodologies and products.

Contents

Introduction

Introduction: Balancing Project Goals

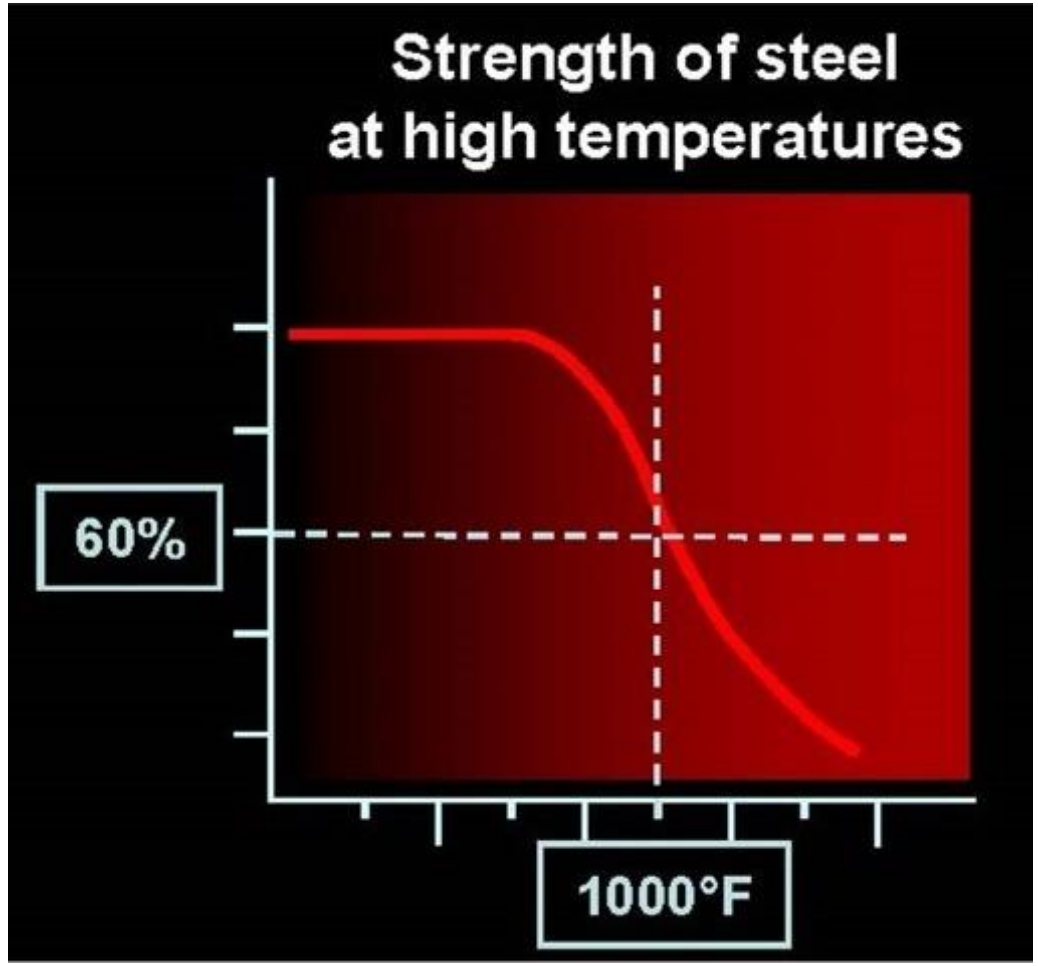


Balancing project goals demands an assessment of the requirements of the overall building design, including building code requirements and fire risks, understanding the performance characteristics and roles of various building elements and fireproofing materials, and selecting them so that they work together to address multiple issues simultaneously.

The Behavior of Steel in a Fire

Understanding how building elements behave in a fire is instrumental to selecting the appropriate fire protection measures.

This graph illustrates the loss in load-carrying capacity of structural steel when a steel temperature of 1000ºF (537ºC) is reached. This is the point at which steel will no longer support loads, and structural failure can then occur.



The Behavior of Steel in a Fire

Applied Fireproofing, Intumescent Fireproofing, and Rigid Board Fireproofing products are applied to envelop the structural steel framework of a building such that they delay the rise in temperature of the steel for a prescribed hourly rating period. These products are discussed in greater detail later in the course.

This image illustrates the effectiveness of structural steel Applied Fireproofing (protected steel) and the damaging effects of fire on steel left unprotected.

The protected steel member in the photo has retained its original shape and appears unaffected by the fire event.

The unprotected steel shows visible warping, twisting, and deflection, which is an indication that elevated steel temperatures were reached.

The Role of Passive Fireproofing

Passive fireproofing is structural steel's silent protector and serves as the main line of defense against the collapse of a building.

Contrary to active systems such as sprinklers, which rely on human or mechanical activation, passive fireproofing envelops and insulates the steel structural members (columns, beams, and decking) and works to delay the rise in steel temperature for a given period of time, during which the temperature is kept below the critical point where the steel will fail.

The Role of Passive Fireproofing



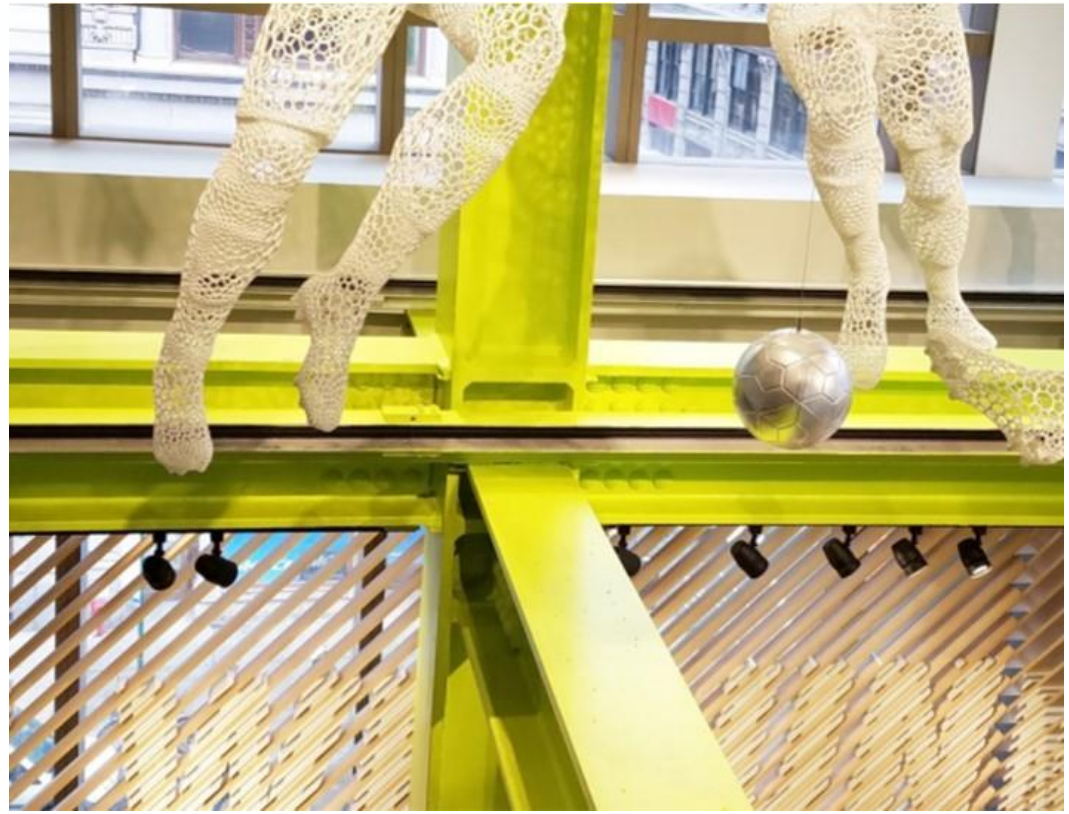

A fire in the Parque Central Complex in Caracas, Venezuela, emphasized the need for balanced fire protection and demonstrated that relying too heavily on active systems is not always the best. Active systems require constant attention. Modern office designs can produce fires that are far beyond the capacity of a light-hazard sprinkler system. This building was originally protected with Applied Fireproofing. After a very intense fire, the building remained standing, the steel members were not deformed, and the structure was then fireproofed again and reoccupied.

Overcoming Design Challenges

Many design challenges are overcome with today's fireproofing materials.

For example, an area of the building that must receive an Applied Fireproofing product may also require acoustical control/sound absorption characteristics, such as a minimum noise reduction coefficient (NRC) value. Several Applied Fireproofing products can provide a range of NRC values based on the substrate and the final applied thickness.

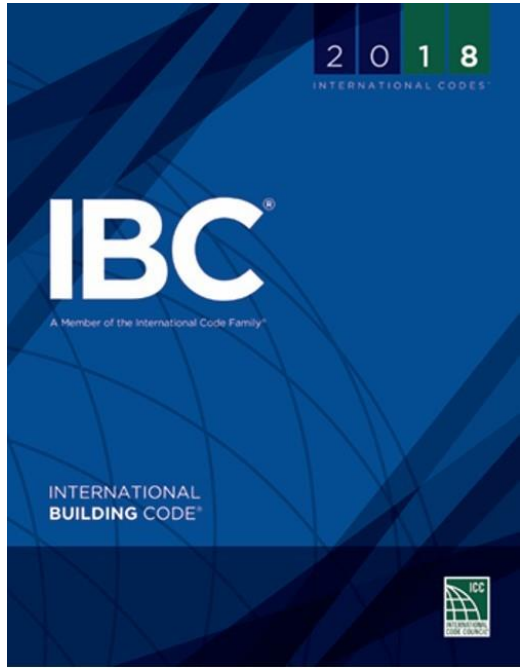
In other instances, designers may wish to expose steel columns to view, maintain their steel appearance, and protect them from impact and abrasion while giving them an hourly fire resistance rating.



Intumescent Fireproofing products (image) are ideally suited to deliver the fire rating, physical performance properties, and desired aesthetics in these circumstances.

Assessing Code Requirements

All building codes represent minimum requirements; ideally, designers should strive to exceed them.



The *International Building Code* (IBC) and other model building codes based on the IBC prescribe the fire-resistive rating requirements based on the type of construction and building elements.

IBC Chapter 5, “General Building Heights and Areas,” sets allowable building heights and areas based on the occupancy and construction type.

IBC Chapter 6, “Types of Construction,” Table 601 (next slide) sets fire resistance rating requirements for all building elements in hours based on construction type.

As an example, a Type I A structure requires a 3-hour fire resistance rating for its primary structural frame, a 2-hour fire resistance rating for its floor construction and associated secondary members, and a 1½-hour fire resistance rating for its roof construction and associated secondary members.

IBC Requirements

Table 601 (image) identifies building elements as:

- primary structural frame (see Section 202)
- bearing walls (exterior and interior)
- nonbearing walls and partitions (exterior)
- floor construction and associated secondary members (see Section 202), and
- roof construction and associated secondary members (see Section 202).

See chart:

A Type I B structure requires a 2-hour fire resistance rating for its primary structural frame, a 2-hour fire resistance rating for its floor construction and associated secondary members, and a 1-hour fire resistance rating for its roof construction and associated secondary members.

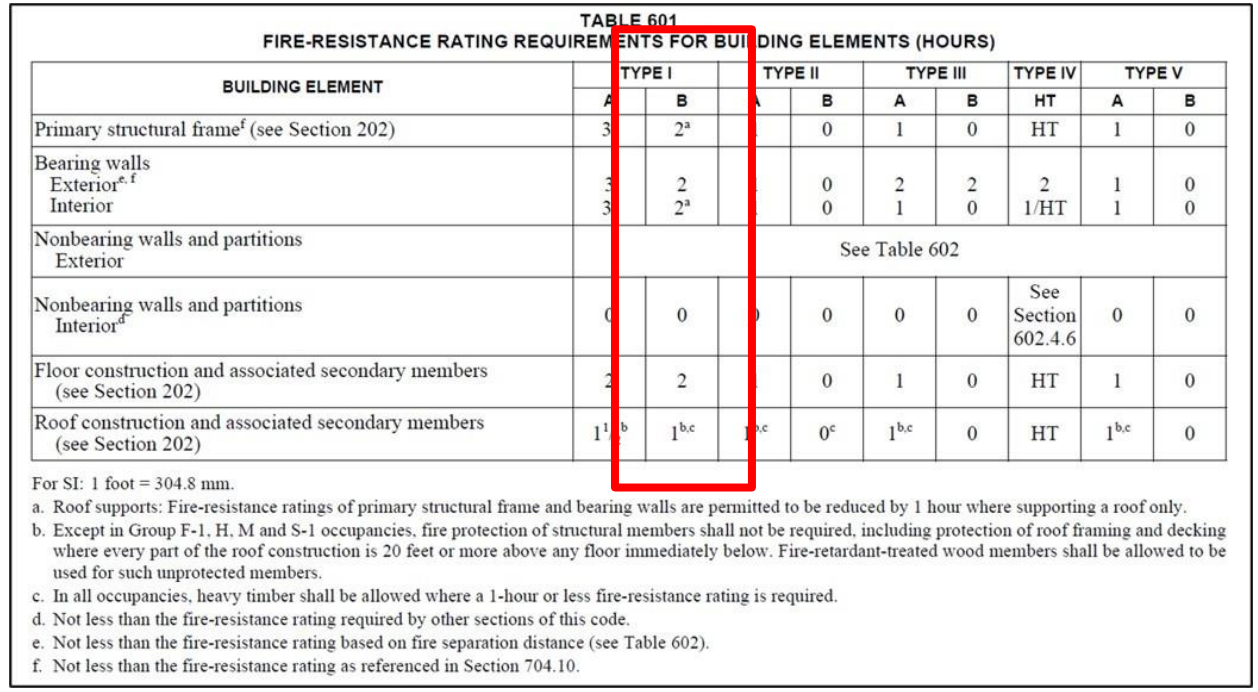


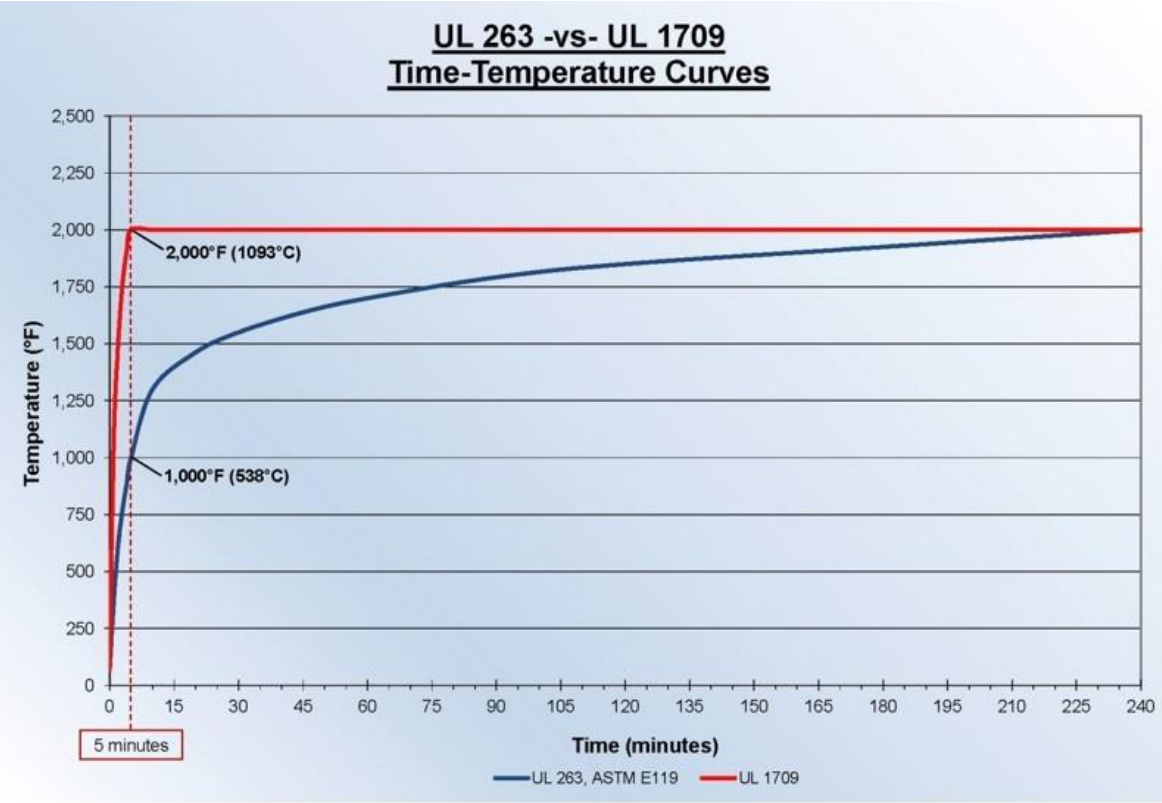
TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[f] (see Section 202)	3	2[a]		0	1	0	HT	1	0
Bearing walls Exterior[e, f] Interior	3 3	2 2[a]		0 0	2 1	2 0	2 1/HT	1 1	0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[d]	0	0		0	0	0	See Section 602.4.6	0	0
Floor construction and associated secondary members (see Section 202)	2	2		0	1	0	HT	1	0
Roof construction and associated secondary members (see Section 202)	1[1/2][b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	HT	1[b,c]	0

For SI: 1 foot = 304.8 mm.

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 shall not be required, including protection of 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. In all occupancies, heavy timber shall be allowed where a 1-hour or less fire-resistance rating is required.
d. Not less than the fire-resistance rating required by other sections of this code.
e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).
f. Not less than the fire-resistance rating as referenced in Section 704.10.

Testing Standards



* ASTM International was formerly known as the American Society for Testing Materials
**UL was formerly known as Underwriters Laboratories

The fire-resistive properties of structural steel fireproofing products are determined primarily through two test standards: ASTM E119/UL 263, “Standard Test Methods for Fire Tests of Building Construction and Materials,” and UL 1709, “Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel.”

*ASTM E119/UL 263, often referred to as a “cellulosic” fire test standard, applies to most commercial structures. In this test standard, the temperature within the test furnace reaches 1000ºF (537ºC) in 5 minutes.

**UL 1709, often referred to as a “hydrocarbon” fire test standard, applies to petrochemical and other industrial facilities where the fire event is more intense. In this test standard, the temperature within the test furnace reaches 2000ºF (1093ºC) in 5 minutes.

ANSI/UL 263: Commercial Structures Testing

From left to right the images show:

1. the full-scale test furnace; gas jets deliver the fuel into the furnace so that the heat is generated to match the time-temperature curve of ASTM E119/UL 263 and UL 1709 (previous slide)
2. a partially constructed test assembly on the furnace lid; the assembly to be tested is a roof assembly consisting of steel decking with built-up insulation supported by wide-flange steel beams and steel bar joists
3. the completed construction of the roof assembly; the assembly is now ready to receive the application of the fireproofing product to be tested
4. the hydraulic jacks used to load the assembly, a requirement of the ASTM E119/UL 263 fire test standard; note the deflection that is occurring as the fire test progresses, and
5. the inside view of the furnace while the fire test is progressing.

Industry-Recognized Fire Testing

When specifying an Applied Fireproofing product, it is important to verify that the material been tested by well-known authorities, such as UL, and is tested in compliance with the ASTM E119 standard.

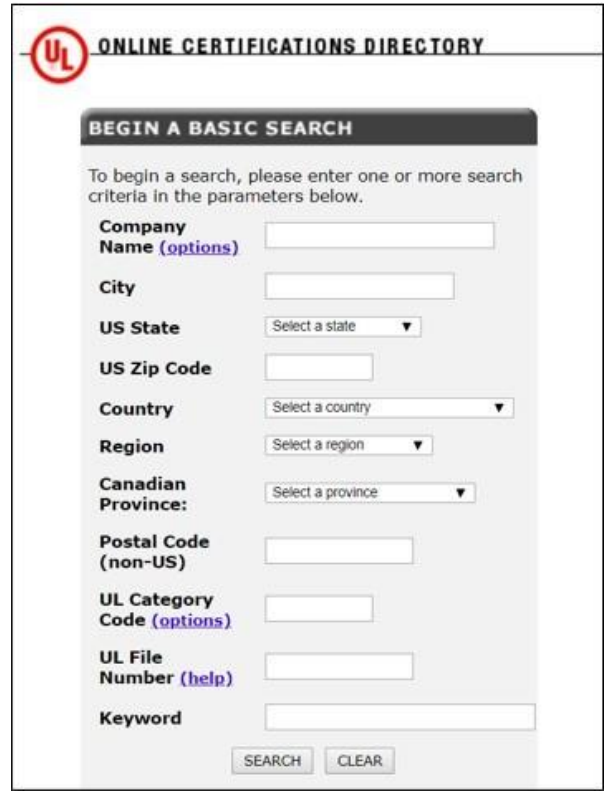
This table specifies the limiting temperatures established in ASTM E119/UL 263. The steel columns, beams, and floor and roof assemblies must not exceed the limiting temperatures for the duration of the fire test. When the limiting temperatures are exceeded, the time at which this occurs is recorded and becomes the fire rating in hours.

ASTM E119 specifies limiting temperatures for structural steel members and decking. Average and individual temperatures for beams, columns, and decking are listed above. The limiting temperatures in red are the unexposed surface temperatures measured on the top side (unexposed side) of the assembly.

ASSEMBLY	LIMITING TEMPERATURE (F)
BEAMS	Average Temp 1100° Individual Temp 1300°
COLUMNS	Average Temp 1000° Individual Temp 1200°
DECKING	Average Temp 1100° Individual Temp 325° Average Temp. 250°+ Ambient

UL Fire Resistance Directory

Successful UL tests are listed in the UL Online Certifications Directory (formerly the UL Fire Resistance Directory, Volume 1). The listing includes the manufacturer and their product(s). There are hundreds of designs for beam, column, floor, and roof assemblies, etc.



A typical UL design will contain the UL design number, the hourly fire resistance rating(s) (restrained and unrestrained ratings), an illustration of the construction assembly tested, verbiage indicating all the components that the assembly is composed of, and the manufacturer's product(s).

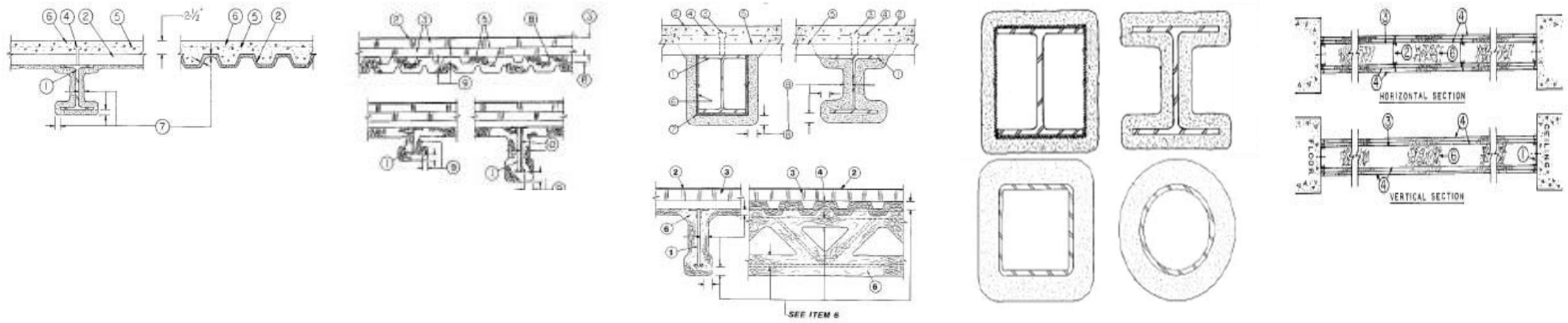
All manufacturers and their products that are listed in the UL Online Certifications Directory are subject to the UL follow-up service. Through this service, UL performs unannounced audits at manufacturers' production facilities to ensure that each product's formulation is being made with the approved ingredients and manufacturing processes that were used for the product originally tested by UL.

This service is essentially a "product formulation guarantee" validating that the material manufactured and supplied to projects is the same as the material tested by UL.

UL Fire Resistance Directory

Volume 1, Hourly Ratings for:

Floor Assemblies	Roof Assemblies	Beam/Joist	Columns	Walls
D, G, J, & E	P	N & S	X, Y, & XR	U



All fireproofing types that meet the requirements outlined in ASTM E119 are listed in the UL Online Certifications Directory. Each construction assembly is designated by a letter as shown in the chart above. The various assemblies containing all fireproofing types are shown above along with their corresponding diagrams.

UL Fire Resistance Directory

A UL design designation consists of a letter, as per the previous slide, and a number.

The number indicates the type of fireproofing used in the tested construction assembly.

The 300 series UL designs are specific to Rigid Board Fireproofing, 600 series to Intumescent Fireproofing, 700 and 800 series to Applied Fireproofing, and 900 series to all fireproofing types. (SFRM is sprayed fire-resistive material.)

The alphanumeric designation results in a UL design: e.g., D902, P719, or Y615.

Volume 1, Design Identification System

NUMBER SERIES	FIREPROOFING TYPE
300	Rigid Board
600	Intumescent
700	SFRMs
800	SFRMs
900	All Types

UL Design Selection

There are two basic categories of floor/ceiling assemblies using steel decking topped with lightweight concrete or normal-weight concrete. These are referred to as “unprotected” and “protected” assemblies.

Unprotected assemblies, as shown here (UL Design D902), do not require the application of fireproofing to the underside of the steel decking due to sufficient concrete topping.

Only the supporting structural steel members of this assembly receive the application of fireproofing.

Unprotected Assembly

Design No. D902

May 20, 2016

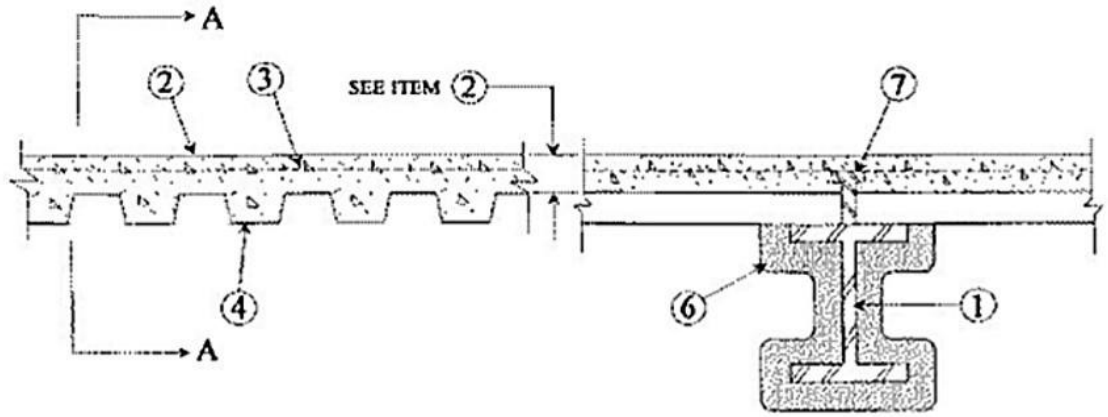
Restrained Assembly Ratings — 1, 1-1/2, 2 and 3 Hr.

Unrestrained Assembly Ratings — 0, 1, 1-1/2, 2 or 3 Hr. (See Items 4 & 6)

Unrestrained Beam Ratings — 1, 1-1/2, 2 and 3 Hr.

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BXUV or BXUV7

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



SECTION A-A

UL Design Selection

Protected assemblies, as shown in this illustration (UL Design D832) do require the application of fireproofing to the underside of the steel decking due to insufficient concrete topping.

The supporting structural steel members and underside of the steel decking both receive the application of fireproofing.

Protected Assembly

Design No. D832

December 03, 2015

Restrained Assembly Ratings — 1, 1-1/2, 2 and 3 Hr.

(See items 4, 6A and 7)

Unrestrained Assembly Ratings — 1, 1-1/2 , 2 and 3 Hr.

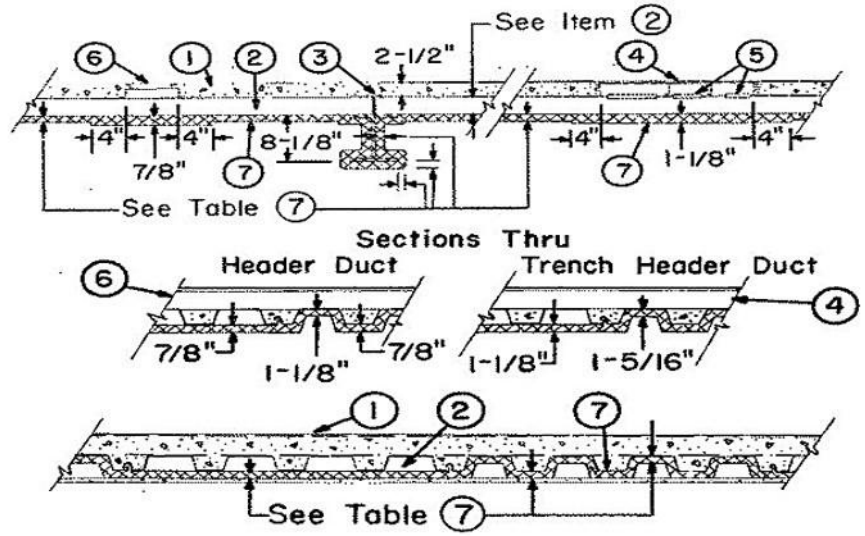
(See Items 4 and 7)

Unrestrained Beam Ratings — 1, 1-1/2 , 2 and 3 Hr.

(See Items 4 and 7)

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BXUV or BXUV7

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



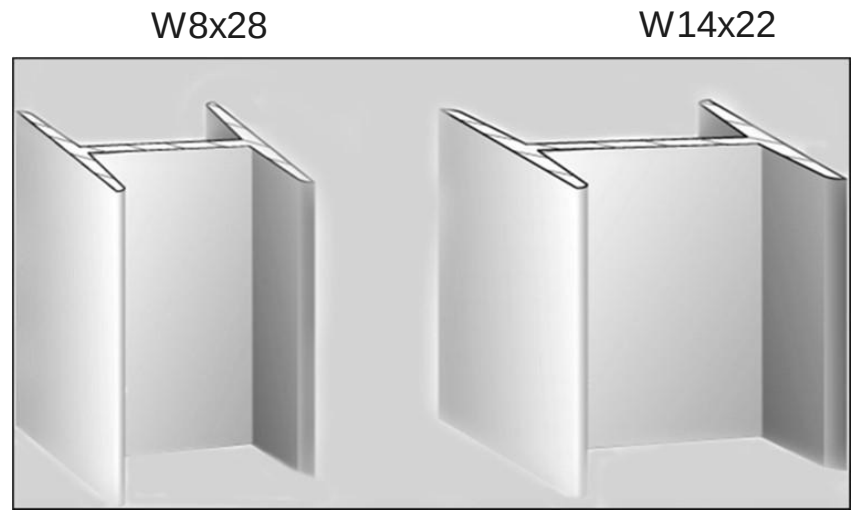
Thermal Massivity

Thermal massivity is determined by calculating the W/D* ratio for solid members and the A/P* ratio for hollow steel sections (HSS).

The W/D ratio is calculated by dividing the weight per linear foot of the member by the heated perimeter (the surface of the member exposed to fire).

Since the W8x28 column is more thermally massive—i.e., possesses the larger W/D value in comparison to the W14x22 column—the W8x28 column takes longer to reach the limiting temperature and therefore requires less fireproofing to achieve the same hourly rating as the W14x22 column.

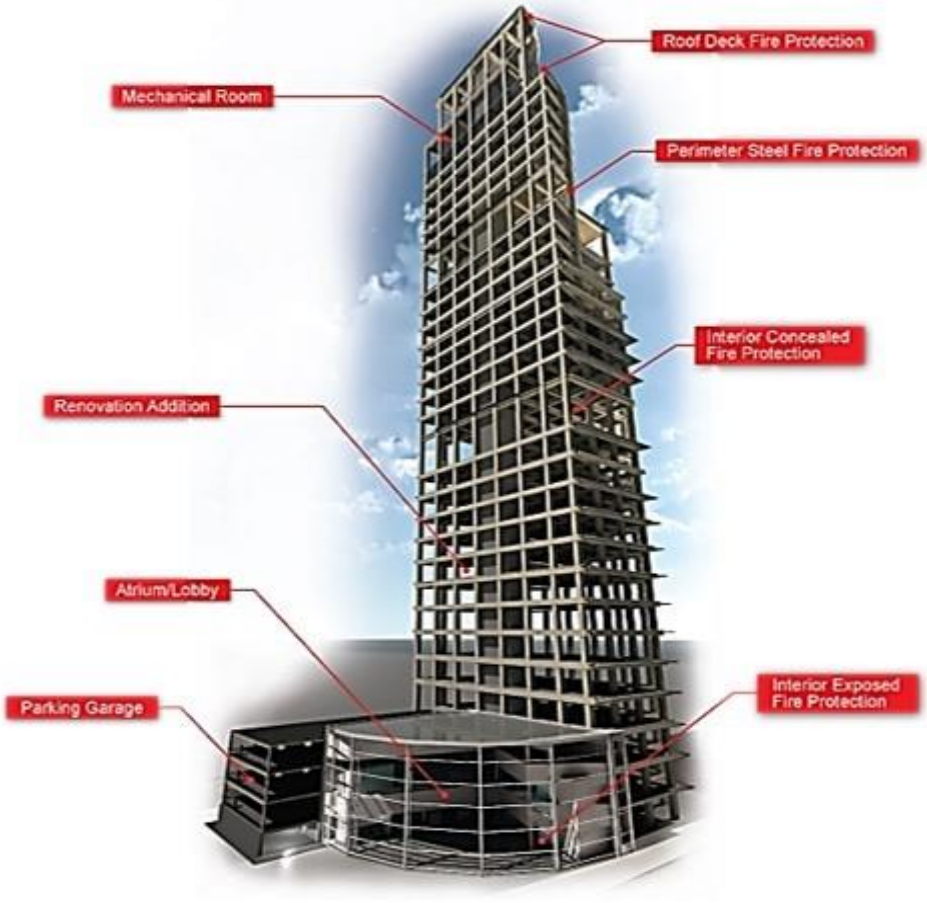
The image illustrates that although the W14x22 column is visually larger, the W8x28 column has a larger W/D and is therefore more “thermally massive.”



***For imperial sizes:**
W = Weight of steel section (lb/ft)
D = Heated perimeter of steel section in inches
***For imperial shapes:**
A = Cross sectional area of steel section (in^2)
P = Heated perimeter of steel section in inches
For metric sizes:
M = Mass of steel section (kg/m)
D = Heated perimeter of steel section in meters (m)

Design Challenges and Fireproofing Solutions

Design Challenges



Every fireproofing project comes with certain design challenges. The various types of fireproofing can often address other design issues and project requirements above and beyond the fire resistance ratings they provide.

The various locations noted on the sample building in the image illustrate the “design based on exposure needs” concept.

Each of the areas noted has additional needs, such as increased resistance to impact and abrasion, optimal aesthetics, and acoustical absorption, beyond just fireproofing.

Fireproofing Options

There are three basic fireproofing types. From left to right, they are spray-applied fire-resistive material (SFRM or Applied Fireproofing), intumescent fire-resistive material (IFRM or Intumescent Fireproofing), and rigid board fire-resistive material (RBFRM or Rigid Board Fireproofing).

These products are sprayed, troweled, or fastened directly to the steel depending on the type of material chosen either during the initial construction phase or as a retrofit project. They serve a variety of functions related to both fire and physical performance.

SFRMs

SFRMs (Applied Fireproofing) offer the widest range of hourly ratings for the widest variety of construction assemblies and are the most commonly used products in commercial structures.

They are classified into three density categories: commercial, medium, and high density.

They are chosen by fire resistance, SFRM exposure needs, and in-place physical performance properties.

They are typically composed of a gypsum or cement binder coupled with an aggregate.

SFRM Densities

Commercial-density SFRMs range from 15 to 19 lb/ft^3 (240 to 309 kg/m^3). They are primarily used in concealed applications, e.g., behind suspended ceilings, gypsum wallboard ceilings, or enclosures, and are formulated with a gypsum or cement binder.

TYPE	DENSITY	APPLICATION	BINDER
Commercial	15-19 pcf	Concealed	Gypsum Cement
Medium	22-25 pcf	Indirect Semi Exposed	Gypsum Cement
High	40-50 pcf	Exterior Exposed	Cement

Medium-density SFRMs range from 22 to 25 lb/ft^3 (352 to 400 kg/m^3) and are primarily used in semiexposed applications and where they may be subject to higher levels of physical abuse. Cement-based medium-density SFRMs are well suited for conditioned and unconditioned spaces. Gypsum-based medium-density SFRMs are well suited for interior conditioned spaces that may be subject to higher levels of physical abuse.

High-density SFRMs range from 40 to 50 lb/ft^3 (640 to 800 kg/m^3) and are primarily used in fully exposed interior and exterior applications where the highest levels of abrasion resistance and hardness are necessary. All are formulated with a cement binder, making them well suited for unconditioned spaces.

SFRM Physical Performance Requirements

Physical Property	ASTM Standard	Commercial Density	Medium Density	High Density
Surface Burning Characteristics	ASTM E84	Flame Spread: ≤ 10 Smoke Dev.: 0	Flame Spread: ≤ 10 Smoke Dev.: 0	Flame Spread: ≤ 10 Smoke Dev.: 0
Density	ASTM E605	≥15 pcf	≥ 22 pcf	≥ 40 pcf
Cohesion/Adhesion (Bond Strength)	ASTM E736	Minimum 150 psf	Minimum 430 psf	Minimum 1,000 psf
Deflection	ASTM E759	No cracking,spalling or delamination	No cracking,spalling or delamination	No cracking, spalling or delamination
Bond Impact	ASTM E760	No cracking, spalling or delamination	No cracking,spalling or delamination	No cracking,spalling or delamination
Compressive Strength	ASTM E761	Minimum 1,440 psf	Minimum 14,400 psf	Minimum 43,200 psf
Air Erosion	ASTM E859	Max. 0.025g/ft.²	Max. 0.025g/ft.²	Max. 0.025g/ft.²
Corrosion	ASTM E937	Does not contribute	Does not contribute	Does not contribute

See next slide for an explanation of this chart.

SFRM Physical Performance Requirements

The chart on the previous slide outlines the physical requirements of SFRMs based on the AIA (American Institute of Architects) MasterSpec®.

AIA MasterSpec sets forth minimum physical performance requirements for each SFRM density category.

Specifying the AIA MasterSpec minimum physical performance requirements for each density category provides the basis against which all SFRMs can be measured.

Note that as the density of the SFRMs increases, so do the minimum physical performance values relating to bond strength, compressive strength, etc.

Most of the ASTM Standards listed in the previous chart are specific to SFRMs.

SFRM Application (Wet Mix)

There are two types of SFRMs: wet mix (image) and dry mix (next slide).

Each type provides the equivalent fire resistance ratings when compared to the other. The main differences are the formulations and methods of application.

Wet-mix SFRMs are formulated with either a gypsum binder (commercial- and medium-density SFRMs) or a cement binder (medium- and high-density SFRMs) and an aggregate. The product is mixed with water to form a slurry, which is then pumped through a plastering-type pump and hoses to a nozzle, where high-pressure air is introduced to atomize the slurry for application to the steel substrates.

SFRM Application (Dry Mix)

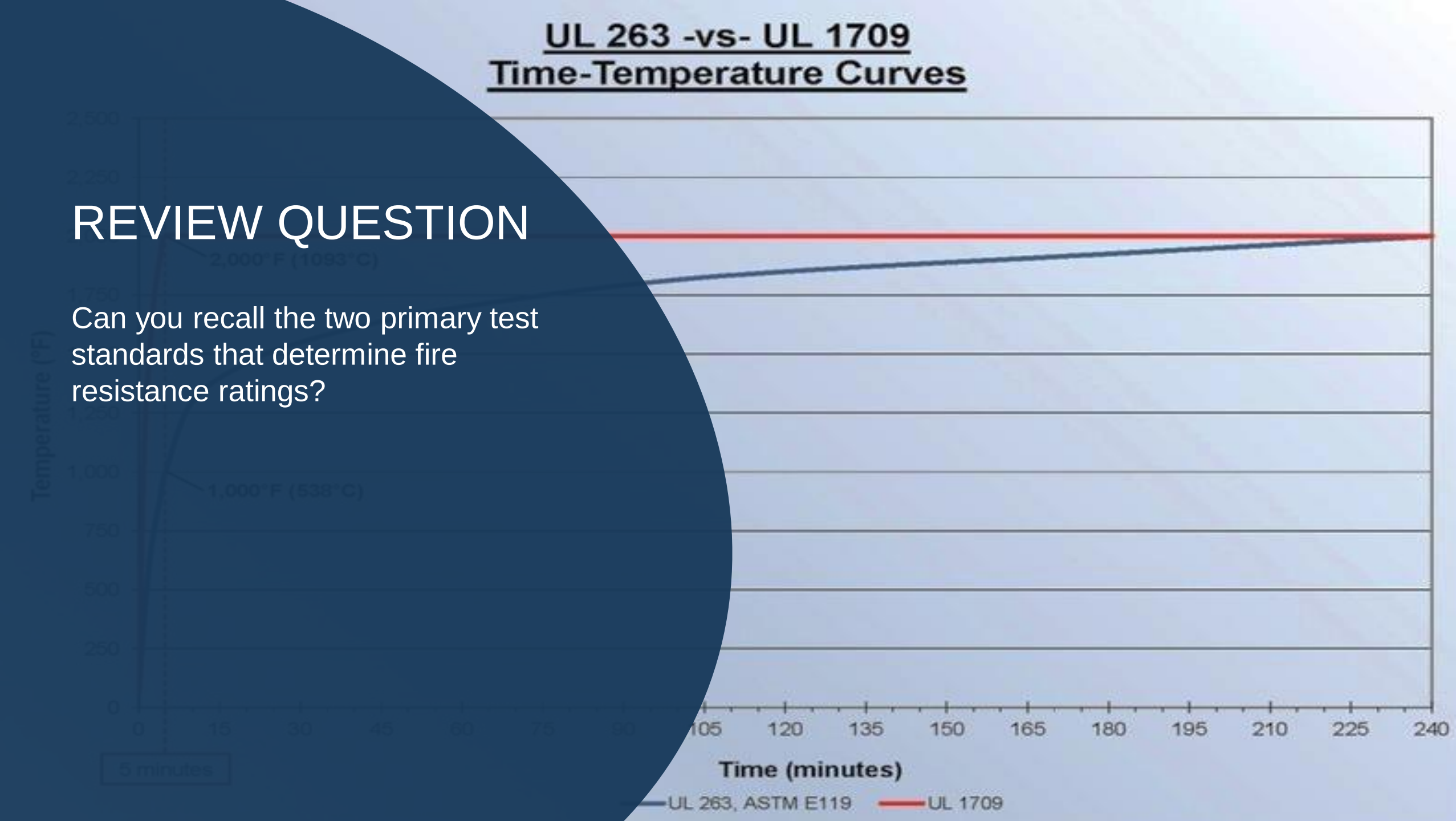
Dry-mix SFRMs (image) are formulated with a cement binder and an aggregate and are available in commercial- and medium-density options.

The product is pumped in a dry state through a pneumatic-type pump and hoses to the nozzle, where atomized water is introduced. The atomized water mixes with the product to hydrate the cement binders, forming a durable, fire-resistant, and weather-resistant fireproofing material.

Dry-mix SFRMs are inorganic in nature and are UL Classified as “investigated for exterior use,” meaning they are able to withstand exterior weathering elements throughout the construction phase.

REVIEW QUESTION

Can you recall the two primary test standards that determine fire resistance ratings?

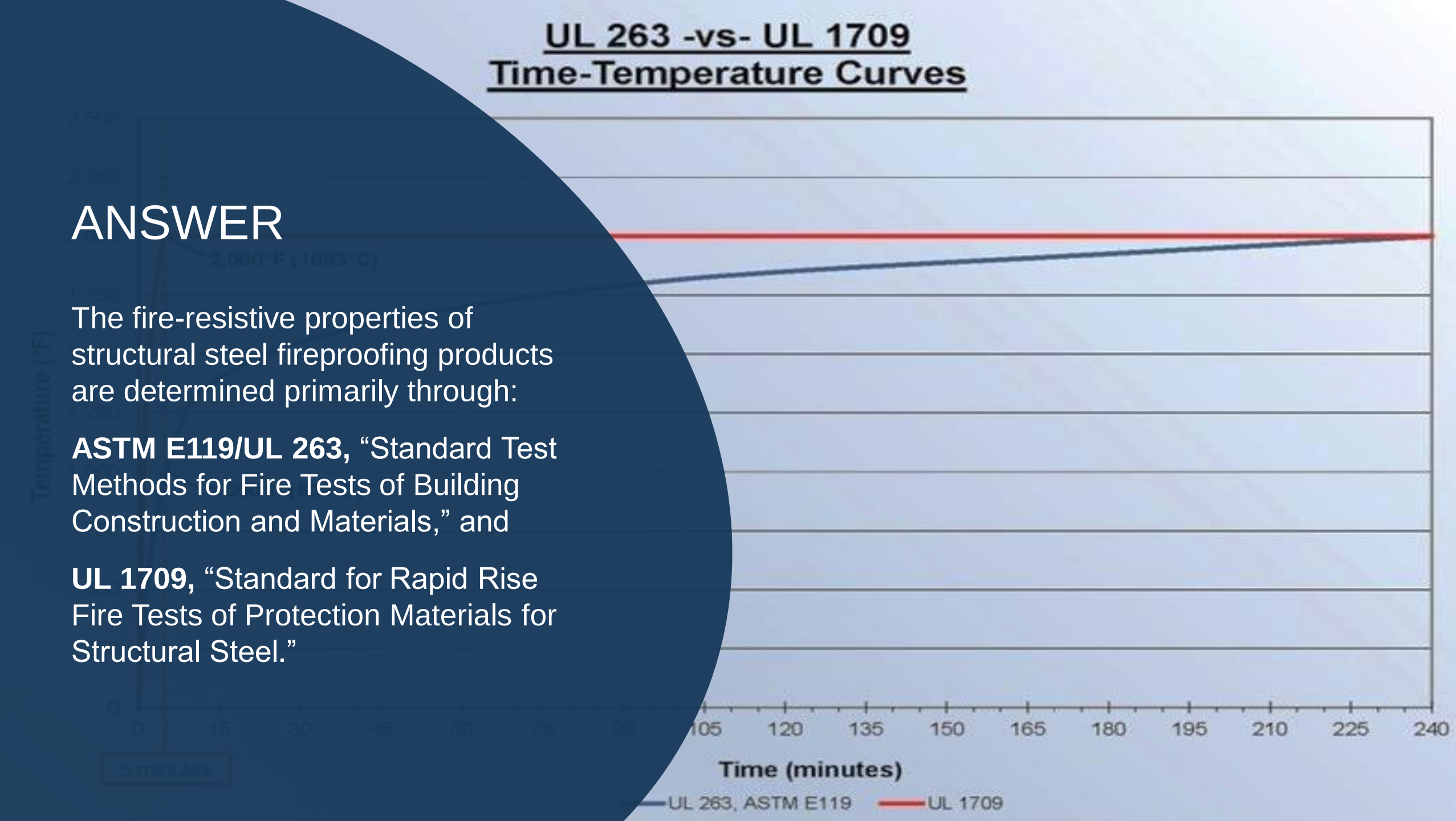


ANSWER

The fire-resistive properties of structural steel fireproofing products are determined primarily through:

ASTM E119/UL 263, “Standard Test Methods for Fire Tests of Building Construction and Materials,” and

UL 1709, “Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel.”



Design Challenge: Interior Structures

Commercial-/Medium-Density SFRMs

Commercial-density SFRMs are most typically utilized in concealed applications where they are hidden from view by a drop-ceiling or gypsum wallboard covering. They can, however, be left exposed to view provided impact, abrasion, and similar forces will not occur. Gypsum or cement-based fireproofing is appropriate for conditioned spaces; cement-based fireproofing is recommended for unconditioned spaces.

Note that the high-rise building requirements for fireproofing in the current IBC Section 403.2.4 require that a fireproofing product deliver minimum bond strength performance values based on a building's height. Further information is provided later in the course.

Design Challenge: Parking Garages

Fireproofing applied in parking garages will see greater impact and abuse; these areas are best served by specifying high-density fireproofing or a combination of medium density on beams and high density on columns.

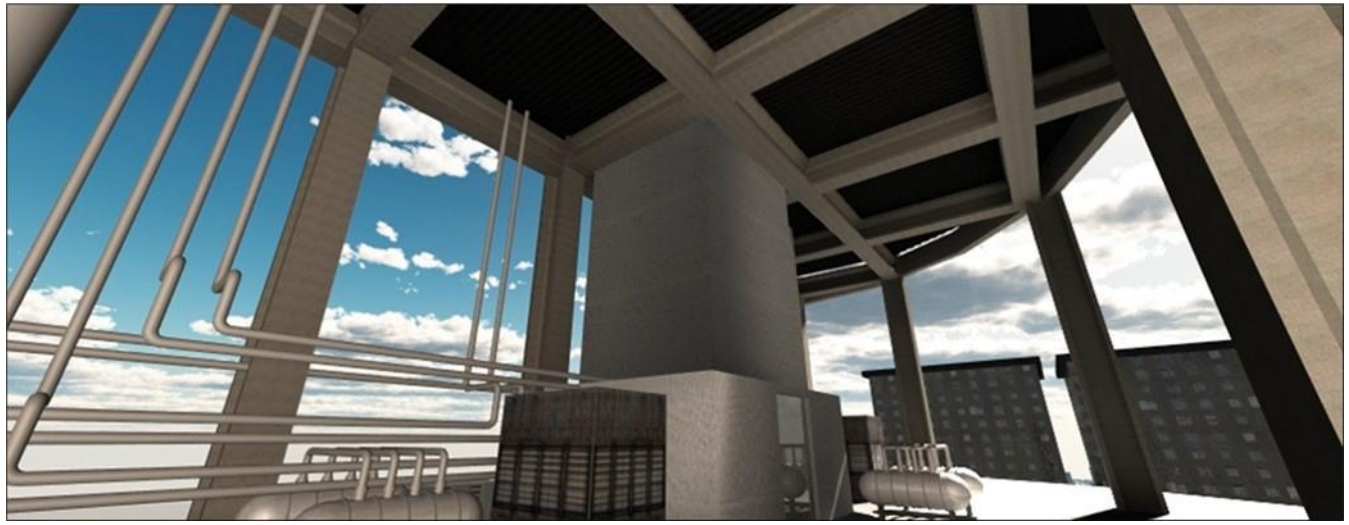
Since parking garages are often unconditioned spaces where temperature and humidity variations will exist over the design life of the structure, the use of cement-based SFRMs is recommended.

Intumescent Coatings
Medium-Density SFRMs
High-Density SFRMs

Design Challenge: Mechanical Rooms

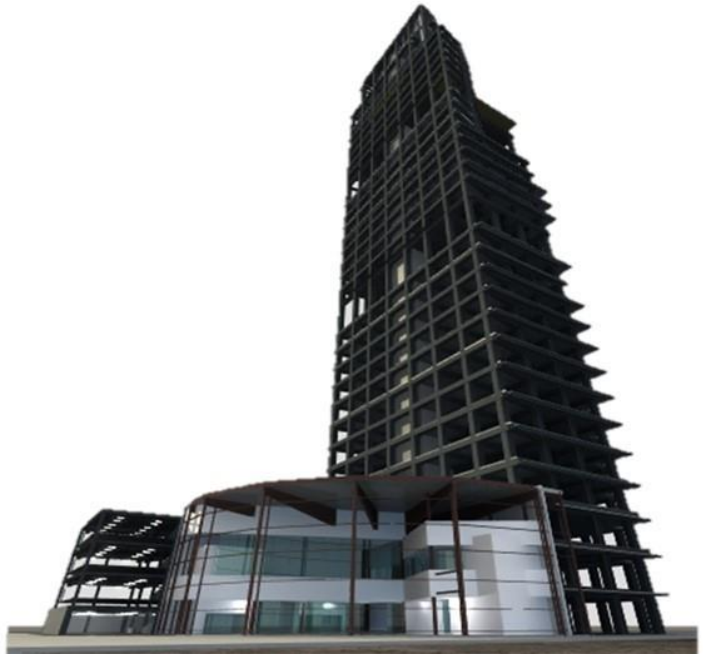
Mechanical rooms have exposed steel subject to moderate foot traffic and abuse whenever the mechanical units are being serviced.

These areas are best served by specifying medium- or high-density cement-based fireproofing products.



Medium-Density SFRMs
High-Density SFRMs
Rigid Board Intumescent Coatings

Design Challenge: High-Rise Construction



IBC Requirements:

Up to 420 ft:

- 430 psf (20.6 kPa) minimum bond strength

Over 420 ft:

- 1000 psf (47.9 kPa) minimum bond strength

Regardless of a building's height, the entire structure must be protected throughout with the appropriate fireproofing that at least satisfies the minimum bond strength requirement.

This does not mean that only one Applied Fireproofing product has to be used. There are many products that can meet the requirement of 430 psf required for this height.

For example, for a building up to 420 ft (128 m) in height, one product can be specified for interior locations that are concealed from view, another for mechanical rooms where fireproofing is exposed to view, and another in the parking garage area, where an unconditioned environment exists and the fireproofing will be subject to a high degree of impact and abrasion forces. This approach is acceptable when all the products meet the minimum bond strength requirement of 430 psf.

IBC High-Rise Requirements

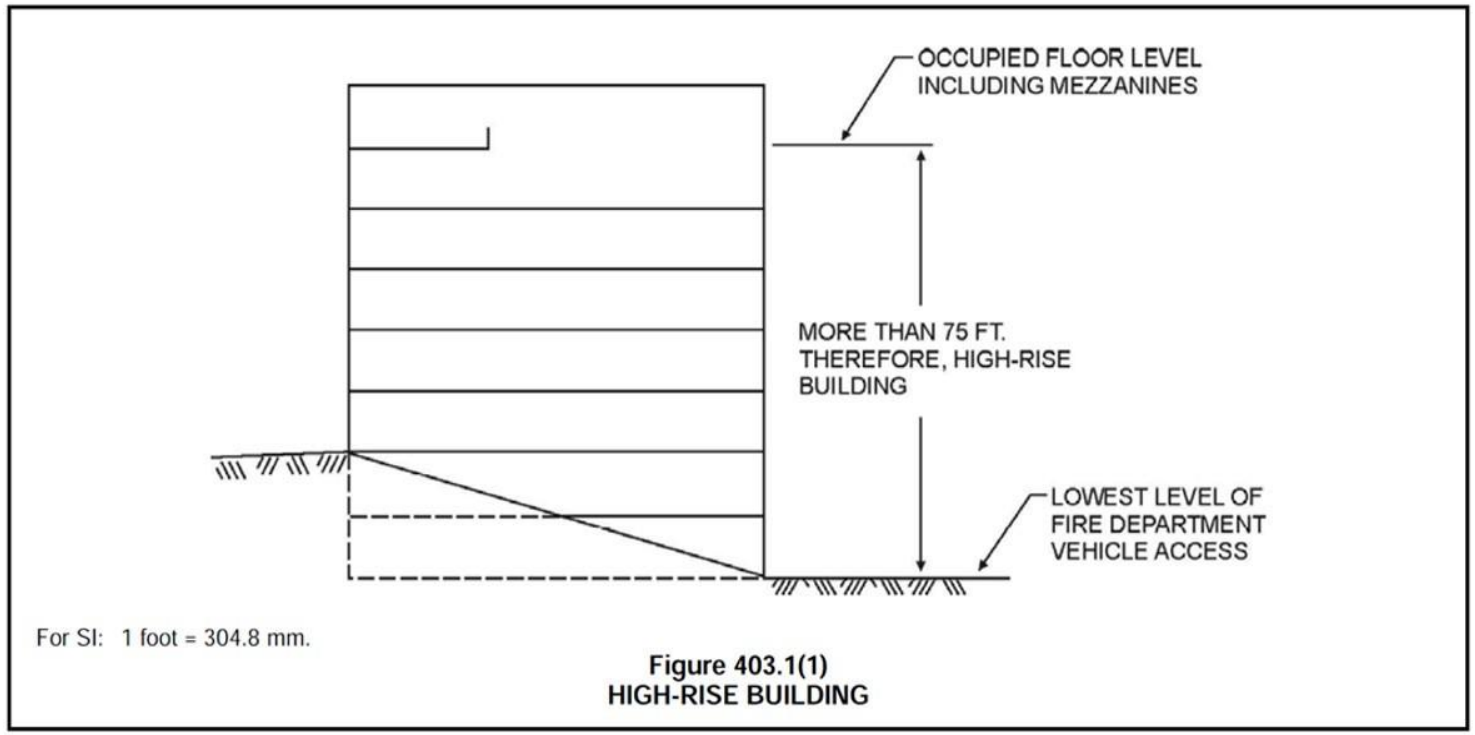
Table 403.2.4.
MINIMUM BOND STRENGTH

HEIGHT OF BUILDING*	SFRM MINIMUM BOND STRENGTH
Up to 420 ft (128 m)	430 psf (20.6 kPa)
Over 420 ft	1000 psf (47.9 kPa)

* Above the lowest height of fire department access. See next slide.

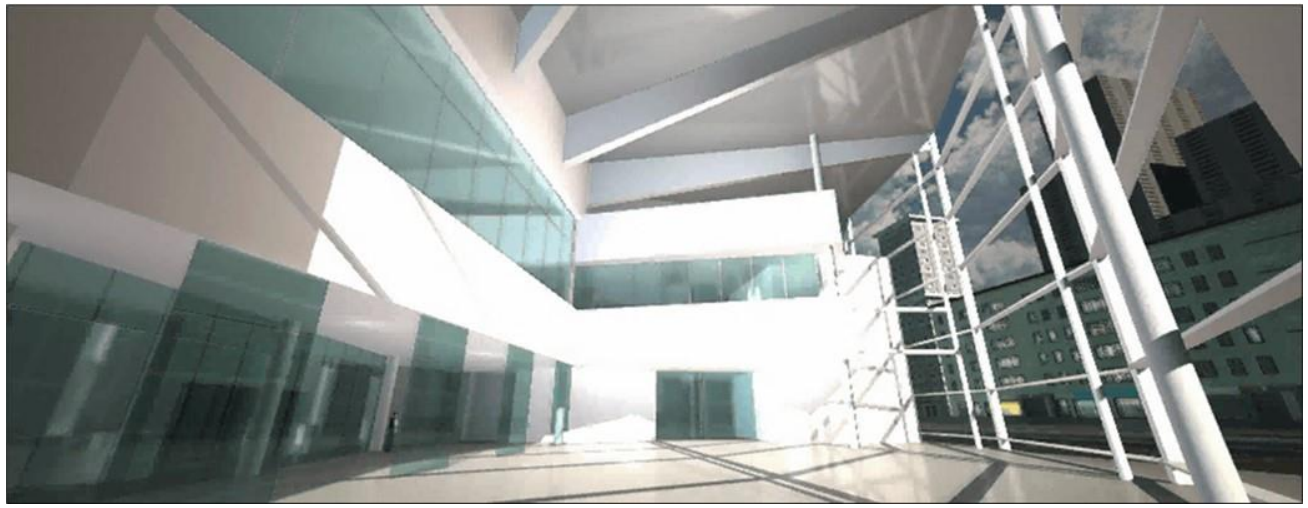
The addition of high-rise building requirements to the IBC for fireproofing has led to a much broader, and potentially more complex, offering of fireproofing products to satisfy these requirements.

IBC High-Rise Requirements



This diagram indicates how building height is measured per IBC Section 403 from the lowest level of fire department vehicle access to the highest occupied floor, including mezzanines.

Design Challenge: Atriums and Lobbies

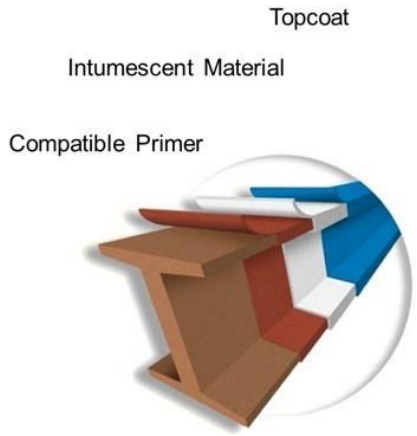


Intumescent Coatings

Architects often wish to maintain the natural beauty of exposed steel while maintaining the required fire rating of the structural steel. Steel that makes up a building's lobby is often exposed to view and will experience heavy foot traffic, impact forces, and abrasion forces over its design life.

Intumescent coatings meet all these challenges: they achieve the necessary fireproofing standards, maintain the look of the steel, and resist damaging forces.

Intumescent Coatings



Intumescent coatings are thin-film coatings composed of resins and additives that expand when exposed to a fire and form an insulating char. Intumescent Fireproofing systems are generally composed of a:

1. compatible primer
2. intumescent material, and
3. optional or required topcoat (depending on the environment in which the system is installed).

There are three types of intumescent products: water based, solvent based, and epoxy based.

Intumescent Coatings

Intumescent Fireproofing products provide the hourly fire resistance rating required by building codes while also maintaining the natural visual aesthetic of exposed structural steel beams and columns.

Intumescent Fireproofing products are also extremely resistant to abrasion and impact forces that exposed structural steel columns and beams are likely to experience. Their surface hardness and abrasion resistance make them ideally suited for exposed applications.

The resulting aesthetic upon completing the Intumescent Fireproofing application is influenced by the required dry film thicknesses (DFT) based on the hourly fire resistance rating. The lower the DFT, the greater the likelihood is of achieving a smoother finish. Water-based Intumescent Fireproofing products generally require lower DFTs compared to solvent-based IFRMs and significantly lower DFTs when compared to epoxy-based IFRMs.

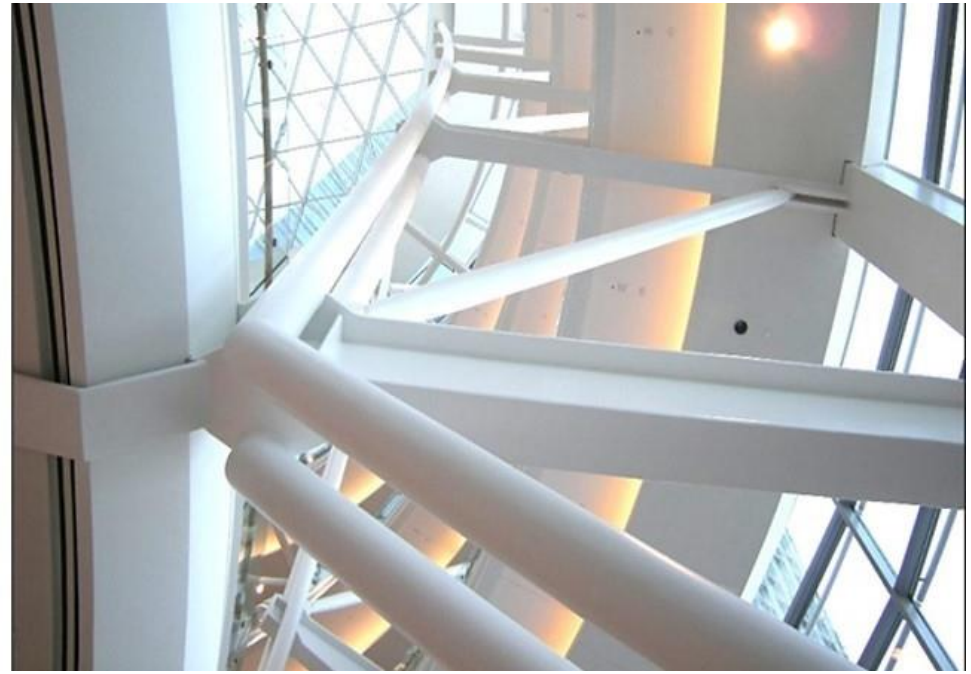
Intumescent Coatings

Water-based intumescent coatings are the most thermally efficient, technologically advanced of the three types.

Some water-based Intumescent Fireproofing products have zero VOCs (volatile organic compounds) and do not negatively impact the interior building environment or its occupants.

Cost influencers include:

- thermal efficiencies, i.e., DFT required to achieve the hourly rating(s)
- percentage of solids by volume (%SBV), and
- application efficiencies.

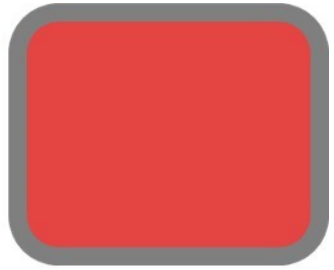


Cost Comparison

HSS 8″x8″x¼″

A/P = 0.24
327 mils (2 hr)

HSS 8″x8″x⅜″

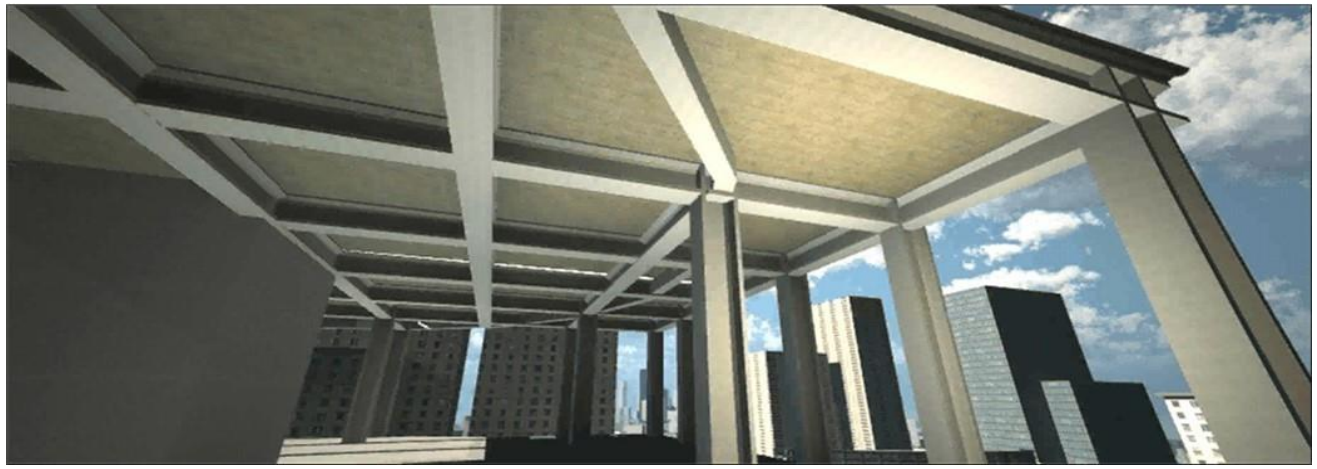


A/P = 0.24
218 mils (2 hr)

This comparison illustrates the concept of “sizing up the steel.” By increasing the wall thickness of the HSS 8″x8″x¼″ column to a ⅜″ (9.5 mm) wall thickness, the required DFT is reduced from 327 mils to 218 mils, representing a 33% reduction in the required DFT. Depending on the Intumescent Fireproofing scope of work on any given project, this “sizing up the steel” comparison may be advantageous to perform. Leading manufacturers can assist with performing this comparison, which can lower costs and enhance aesthetics.

Please remember the **test password APPLIED**. You will be required to enter it in order to proceed with the online test.

Design Challenge: Roof Decks



Rigid Board Fireproofing

Roof decks are subject to deflection forces caused by roof traffic during initial construction or reroofing, which can compromise the bond of the sprayed fireproofing to the deck substrates.

The mechanical attachment of Rigid Board Fireproofing ensures long-term bonding to the substrate even in the event of reroofing.

Rigid Board Fireproofing is the “ultimate problem solver”; it can be installed regardless of substrate condition, ambient and substrate temperatures, or ongoing roof construction and is suitable for seismic-prone areas.

Rigid Board Fireproofing

Rigid Board Fireproofing comes as prefabricated, pressed, mineral wool boards with a predetermined thickness; boards are mechanically attached to the steel. It is available as foil faced and unfaced. The materials are unaffected by environmental conditions during application and are used to address sequencing issues resulting from roof construction and related traffic. This type of fireproofing can be applied without waiting for the roofing to be complete.

Because the board is mechanically fastened to the substrate, it is unaffected by roof traffic during and after application. More recently, architects are specifying this material in retrofit projects, where the space is presently occupied and the introduction of water is not feasible, or where long-term building owners will experience a reroof in the future.

In addition, Rigid Board Fireproofing offers exceptional thermal value and acoustical benefits.

Rigid Board Fireproofing

Mechanical attachment ensures the bond to the substrate is maintained despite deck deflection caused by roof traffic or reroofing, and it overcomes sequencing matters associated with spray-applied fireproofing such as freezing temperatures.

Rigid Board Fireproofing is ideal for retrofit projects; it can be installed regardless of substrate condition, and it introduces no water into the enclosed built environment.

Rigid Board Fireproofing is a solutions-oriented passive fireproofing technology.

Rigid Board Fireproofing

Rigid Board Fireproofing can be installed at virtually any stage of a project, particularly where sequencing challenges exist. As an example, the application of Applied Fireproofing is scheduled to begin prior to the completion of the roof's construction. Since Rigid Board Fireproofing is mechanically attached to the underside of the roof decking and even supporting structural members, it is unaffected by ongoing roof traffic and, as a result, eliminates any delay in job progress.

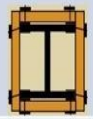
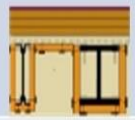
Another example is a fireproofing application that is required in a finished, occupied building. Since no water is needed during application, waste is minimal, and there is very little disruption to the interior built environment. Rigid Board Fireproofing is a viable solution.

Rigid Board Fireproofing

The project shown above is the Apple Campus 2 located in Cupertino, California. Roof deck “pods” were preconstructed at ground level, the rigid board was mechanically fastened to the underside of the roof decking, and Applied Fireproofing was installed to the supporting wide-flange beams. The preconstructed “pods” were then craned/hoisted into place.

Rigid Board Fireproofing

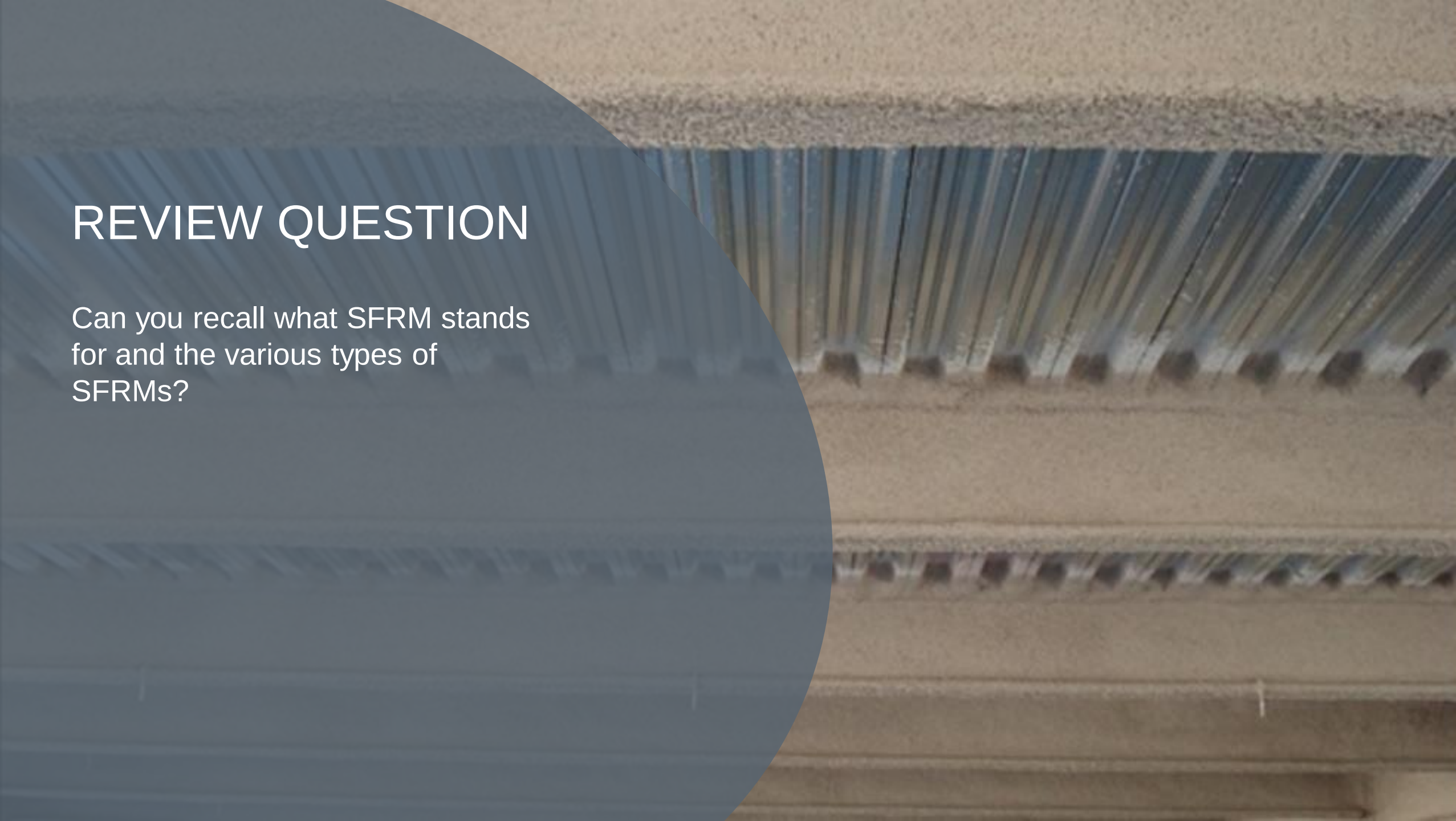
DENSITY	THICKNESS	STD DIMENSIONS	ADDED BENEFITS*
9 pcf	1" – 4.5"	2' X 4'	Insulation Acoustic

COLUMNS	BEAMS	FLOORS	ROOF ASSEMBLY
			
1-4 hr.	1-4 hr.	1-3 hr.	1-2 hr.

Rigid Board Fireproofing products range in density from 9 to 11 lb./ft^3 (144 to 176 kg/m^3) and are premanufactured in varying thicknesses to address the various hourly fire resistance rating requirements.

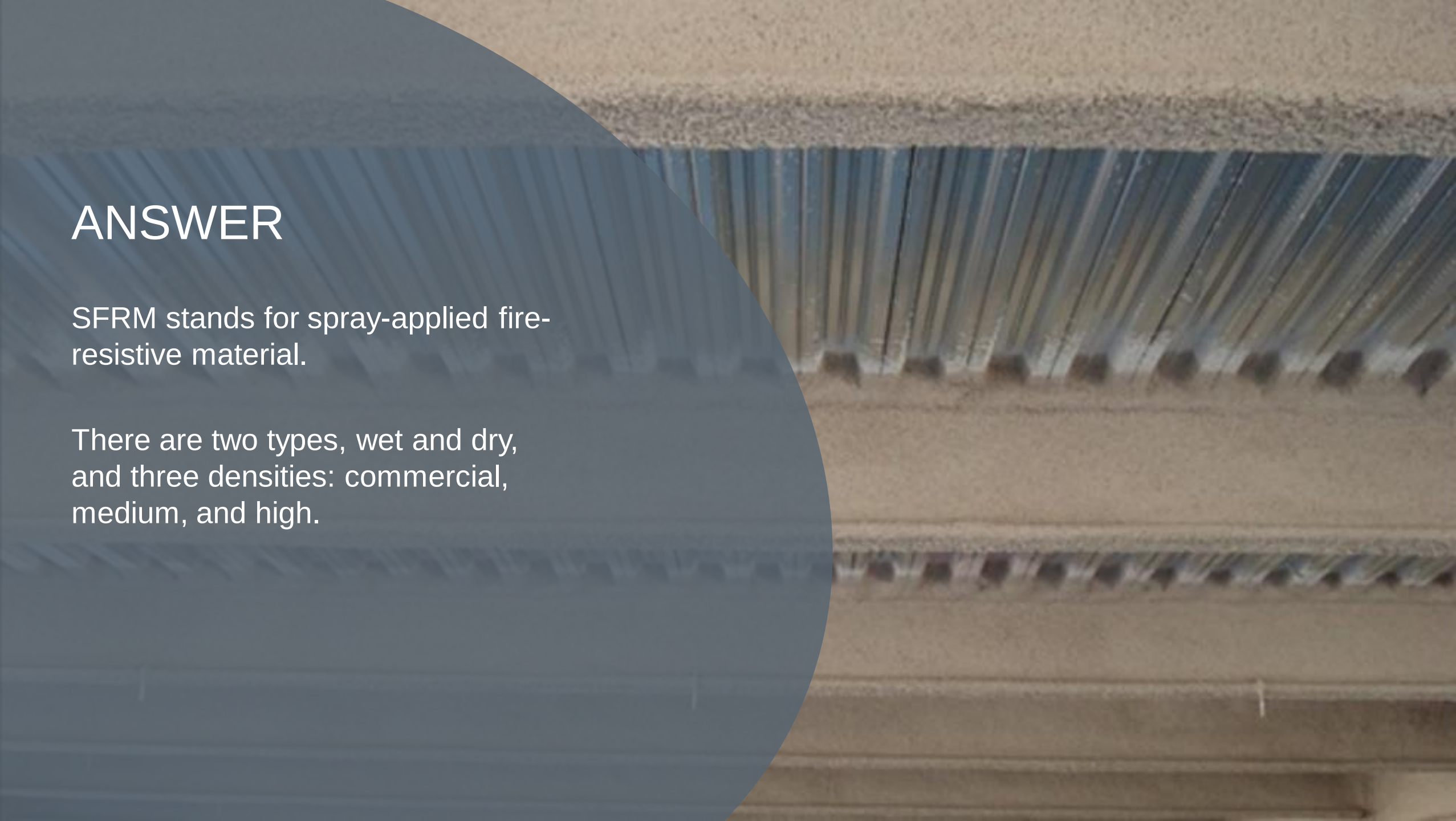
In addition to their fireproofing capabilities, Rigid Board Fireproofing products also provide additional thermal benefits in the form of an R-value of 4.2/in (RSI 0.73/25 mm). Further, they provide an acoustical benefit up to an NRC value of 1.00.

Mechanical attachment to structural steel beams and columns is in the form of friction-fit clips or weld pins with locking washers or is fastened using noggings. Mechanical attachment to steel decking uses self-tapping screws with washers or weld pins with locking washers.



REVIEW QUESTION

Can you recall what SFRM stands for and the various types of SFRMs?



ANSWER

SFRM stands for spray-applied fire-resistive material.

There are two types, wet and dry, and three densities: commercial, medium, and high.

REVIEW QUESTION

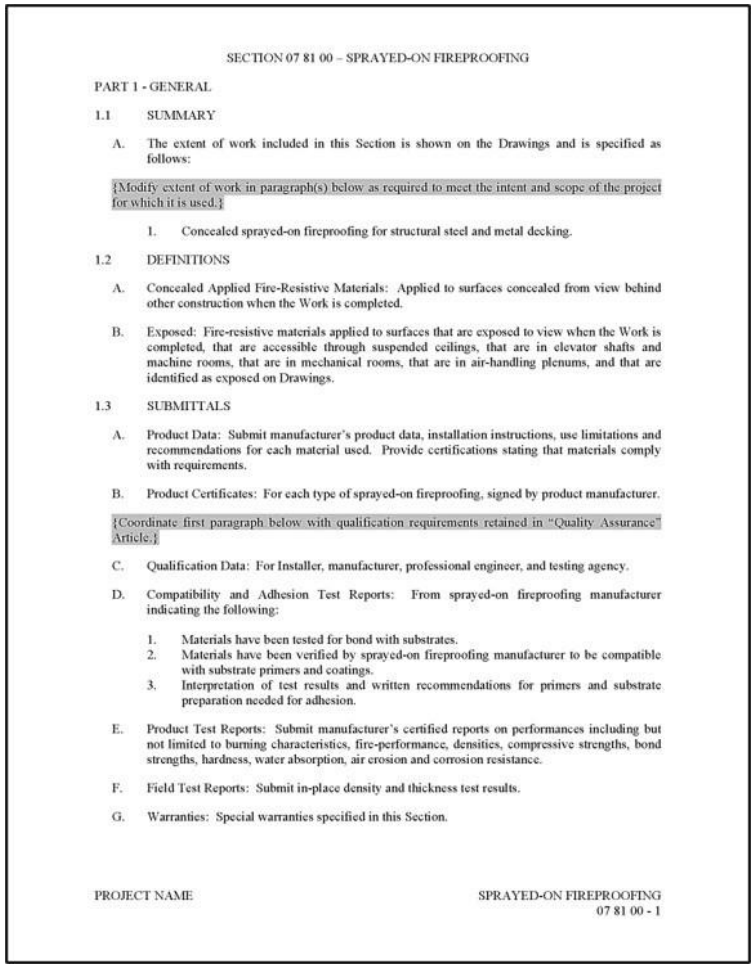
What are the bond strengths required for Applied Fireproofing for buildings up to 420 ft in height and above 420 ft in height?

ANSWER

Buildings up to 420 ft in height require a bond strength of 430 psf; over 420 ft, they require 1000 psf.

Specifications and Contributions to LEED Certification

Specifications and LEED® Contributions



SECTION 07 81 00 – SPRAYED-ON FIREPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. The extent of work included in this Section is shown on the Drawings and is specified as follows:

{Modify extent of work in paragraph(s) below as required to meet the intent and scope of the project for which it is used.}

1. Concealed sprayed-on fireproofing for structural steel and metal decking.

1.2 DEFINITIONS

A. Concealed Applied Fire-Resistive Materials: Applied to surfaces concealed from view behind other construction when the Work is completed.

B. Exposed: Fire-resistive materials applied to surfaces that are exposed to view when the Work is completed, that are accessible through suspended ceilings, that are in elevator shafts and machine rooms, that are in mechanical rooms, that are in air-handling plenums, and that are identified as exposed on Drawings.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations for each material used. Provide certifications stating that materials comply with requirements.

B. Product Certificates: For each type of sprayed-on fireproofing, signed by product manufacturer.

{Coordinate first paragraph below with qualification requirements retained in "Quality Assurance" Article.}

C. Qualification Data: For Installer, manufacturer, professional engineer, and testing agency.

D. Compatibility and Adhesion Test Reports: From sprayed-on fireproofing manufacturer indicating the following:

1. Materials have been tested for bond with substrates.
2. Materials have been verified by sprayed-on fireproofing manufacturer to be compatible with substrate primers and coatings.
3. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

E. Product Test Reports: Submit manufacturer's certified reports on performances including but not limited to burning characteristics, fire-performance, densities, compressive strengths, bond strengths, hardness, water absorption, air erosion and corrosion resistance.

F. Field Test Reports: Submit in-place density and thickness test results.

G. Warranties: Special warranties specified in this Section.

PROJECT NAME SPRAYED-ON FIREPROOFING
07 81 00 - 1

This part of the course briefly reviews those sections of the specification where Applied Fireproofing, Intumescent Fireproofing, and Rigid Board Fireproofing should be described.

In addition, it provides appropriate specification verbiage that will ensure that properly tested life- and structure-saving fireproofing products are used in each context.

Further, it highlights the potential impact that fireproofing products can have on LEED certification and adds transparency information that may be available for the various types of fireproofing products.

Specification Types

MasterSpec/SpecLink

Division 7 – Thermal and Moisture Protection
Section 078100 – Applied Fireproofing
Section 078123 – Intumescent Fireproofing
Section 078200 – Board Fireproofing

UFGS: United Facilities Guide Specifications

This is a joint venture product of:

- US Army Corps of Engineers (USACE)
- Naval Facilities Engineering Systems Command (NAVFAC)
- Air Force Civil Engineer Center (AFCESA)
- National Aeronautics and Space Administration (NASA)

The most most widely used publication that assists in specification writing is MasterSpec, the product selection tool that provides the design professional unbiased, objective information on building products, written by professional architects and engineers and vetted by AIA-sponsored architectural and engineering review committees.

The U.S. Government also has specifications (UFGS) that are performance-based and do not list manufacturers and their products by name but describe what they should do.

Manufacturers of fireproofing products also offer their own guide specifications and will provide guidance on developing specific project specifications.

Specification Requirements

These are a few of the specification “must haves”:

- Specify only UL Classified Applied Fireproofing, Intumescent Fireproofing, and Rigid Board Fireproofing. Ensure the product is listed in the UL Online Certifications Directory.

- All fireproofing products should be tested in accordance with ASTM E119/UL 263 at an accredited, independent laboratory; it is important to ensure that there were no modifications to the fire test(s) carried out at the independent testing agency. Specifying UL Listed fireproofing products ensures that the code-mandated fire test standards have been adhered to.

- Products should be recognized by a third-party agency and have a valid Evaluation Service Report from that entity. As an example, UL issues Evaluation Service Reports for fireproofing products, indicating they comply with model building code requirements.

- It is important to specify the industry standard minimum performance values, not arbitrary values set forth by specific manufacturers. Using manufacturer-specific values may limit the submission of viable, properly tested fireproofing products for code-mandated fire resistance ratings.

Specification Requirements

Performance Characteristic	Industry Standard Performance Value	Arbitrary Performance Value
Cohesion/Adhesion	430 lb/sq ft	600 lbs./sq. ft.
Compressive Strength	1440 lb/sq ft	4,464 lbs./sq. ft.

The example provided in the table is based on a commercial-density, high-strength Applied Fireproofing for high-rise buildings up to 420 ft in height where the IBC requires a minimum bond strength of 430 psf.

Be aware that specifying artificially high values or manufacturer-specific performance values may exclude products that are viable solutions for fireproofing. The proper values to specify are those listed in the “Industry Standard Performance Value” column in the table above, which are commensurate with AIA MasterSpec.

Contributions to LEED v4

The construction industry continues to see upward trends regarding environmentally conscious building practices and transparency. As a result, achieving LEED (or other building certifications such as WELL Building Standard®, BREEAM, and Green Globes®) status for buildings continues to become more prevalent.

While specific products are not credited directly, they can contribute to overall performance. Passive fireproofing may contribute in several categories, including:

Energy and Atmosphere (EA)

- **Prerequisite: Minimum Energy Performance**
- **Credit: Optimize Energy Performance**

Applied Fireproofing and Rigid Board Fireproofing both add NRC and thermal resistance (R) values. These values allow for the reduction of the amount of energy needed for climate control and reduce the need for additional materials required for soundproofing and insulation within the building envelope.

Contributions to LEED v4

Materials and Resources (MR)

- **Prerequisite: Construction and Demolition Waste Management Planning**
- **Credit: Building Life-Cycle Impact Reduction**
- **Credit: Building Product Disclosure and Optimization – Sourcing of Raw Materials**
- **Credit: Building Product Disclosure and Optimization – Material Ingredients**

Indoor Environmental Quality

- **Credit: Low-Emitting Materials**

Manufacturers publish guidance documents that provide information identifying which credits are available for their products. In addition to VOC testing in accordance with EPA Method 24, manufacturers test their products to meet the emission requirements set forth by California Department of Public Health (CDPH) Standard Method v1.2.

Fireproofing manufacturers also publish transparency documents such as Declare labels, health product declarations (HPDs), and environmental product declarations (EPDs).

Summary

Summary

Steel construction projects are becoming increasingly complex; along with this complexity, there are a number of emerging design challenges for the fireproofing methodologies that can both keep buildings safe and make projects aesthetically pleasing.

In addition, there is an increasing number of building code requirements related to minimum standards for fireproofing and several testing procedures that can determine the performance of various products and thus their compliance to such code requirements.

The steel fireproofing industry, in response, has developed a much broader, and potentially more complex, offering of fireproofing products to satisfy these requirements. These products can address every fireproofing requirement as well as add further benefits for acoustic and thermal control and abrasion resistance.

Fireproofing products fall into three broad categories of Applied Fireproofing, Intumescent Fireproofing, and Rigid Board Fireproofing, all of which can be applied to the envelope. There are variations as to application methodologies within each category. They also come in a range of densities and formulations, and the designer should become familiar with the purpose for, and performance and benefits of, each one.

Summary

By selecting the correct product and application method, the designer can safely fireproof parking garages, atriums, and lobbies even when the steel structure is to remain exposed; interior structures even after they have been occupied; and mechanical rooms, roof decks, and every situation in high-rise projects.

By selecting fireproofing products that also address acoustics, aesthetics, and thermal performance, the designer can help reduce project costs and improve project rankings with green building standards such as LEED and WELL.

Conclusion

If you desire AIA/CES, state licensing, or CE credits for another organization, please click on the button to commence your online test. A score of 80% or better will allow you to print your Certificate of Completion; you may also go to your AEC Daily Transcript to see your completed courses and certificates.

For additional knowledge and postseminar assistance, click on the Ask an Expert link.

If you have colleagues who might benefit from this seminar, please let them know. Feel free to revisit the AEC Daily website to download additional programs.

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