



# SPEAKING IN CODE

The Low Down on Testing and Special Inspection Topics

January 25, 2022

## Sprayed FIRE-Resistant Materials (SFRM) and the Code ...A Heated Discussion

Sprayed fire-resistant material (SFRM) is used to delay or even prevent the weakening of steel and concrete spalling in structures that are exposed to high temperatures that occur during a fire. SFRM thermally insulates the structural elements to keep them below the temperature that causes failure. Often referred to as “spray-applied fireproofing,” SFRM is a passive fire protection material directly applied to structural building members. They are predominantly cementitious or mineral-fiber-based, with fire-resistive qualities and physical characteristics varying widely between the respective types.

The two basic types of fireproofing used in construction: SFRM and Thin-Film Intumescent Fire-Resistive Materials (TFIFRM) can both be applied to steel components such as columns, joists, beams, and decking. These fireproofing materials encapsulate or coat the structural steel components to protect them from fire damage. Within the SFRM category, there are two types: 1) sprayed mineral fiber SFRM and 2) sprayed cementitious SFRM. The sprayed cementitious SFRM contains binders of cement/gypsum of 50%-80% by weight. When mixed with water, create a slurry suitable for pumping and spraying. The high binder content and wet mixing ensure a strong, durable, and homogeneous coating. The sprayed mineral fiber SFRM contains rock-wool fibers created from spinning molten iron slag at high temperatures. These fibers are also mixed with a cement binder of 20%-30% by weight. This dry mix is air conveyed and mixed with water at the application nozzle. The mineral fiber spray is less costly than the sprayed cementitious SFRM, but it does not adhere to steel and dislodges more easily.



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## SPECIAL INSPECTIONS

While project fire protection specifications may be vague and inadequate, the International Building Code (IBC) is not. In most jurisdictions throughout the United States, the IBC code represents the MINIMUM building code requirements and is the law of the land.

IBC Chapter 17, Section 1705.14 stipulates most of the code required special inspections for SFRM applied to floor, roof, and wall assemblies and structural members. The special inspections and tests set forth by IBC must be based on inspections, tests and samples from specific floor, roof, wall assemblies, and structural members. Some of the special inspections mandated in IBC Chapter 17 in order to observe code compliance and fire-resistance rating are 1) Condition of substrates 2) Thickness of application 3) Density 4) Bond strength, adhesion/cohesion and 5) Condition of finished SFRM application after complete drying and curing. The final inspection set forth in item 5 is to make certain that the SFRM does not exhibit cracks, voids, spalls, delamination, or any exposure to the substrate.

The test methodology for SFRM thickness testing, bond strength, density, etc. is stipulated by IBC in ASTM E 605, "*Thickness and Density of SFRM*" and ASTM E 736, "*Cohesion and Adhesion of SFRM*." It is important to note that while ASTM E 605 requires a certain test frequency, IBC requires that the tests be done more frequently than ASTM E 605, and the IBC criteria takes precedence over the ASTM (reference standard) criteria. SFRM sampling and testing frequency should be done in accordance with IBC criteria. ASTM E 605 and ASTM E 736 are IBC reference standards (listed in Chapter 35 of the IBC Code). When a standard is incorporated into the (IBC) code as a reference standard, it becomes an enforceable part of the code. When a jurisdiction or state adopts the IBC code as its minimum building requirements, it adopts all of the applicable reference standards as well. All of the testing and inspection requirements required on SFRM by Chapter 17 of IBC and the reference standard requirements (ASTM E 605 and E 736) become MINIMUM special inspection requirements of the (IBC) CODE.



The IBC code lists three specific physical properties (included in special inspections) that should be provided on SFRM in Chapter 17 and they are:

1. Thickness of application
2. Density in pounds per cubic foot
3. Bond strength (adhesion/cohesion)

Of these three properties, only bond strength has requirements, specifically, outlined by the IBC CODE. In the case of application thickness and density, the CODE states that these properties must meet the requirements of the approved Underwriter's Laboratories (UL) fire resistance design. These properties require special inspections as required in IBC Chapter 17. The CODE requires that one thickness test be performed for every 1,000 square feet of rated floor or roof assembly, and for 25% of the individually rated beams and columns. One thickness test consists of averaging several thickness measurements taken in a prescribed pattern (stipulated by UL) and this process results in a lot more testing than was done prior to the issuance of IBC 2009 and after the 9-11 collapse investigations and reports by the National Institute of Standards and Technology (NIST).

## SPECIAL INSPECTIONS (cont'd)

IBC Section 1705.14.6 stipulates that the cohesive/adhesive bond strength of the cured SFRM shall be not less than 150 pounds psf. As a point of interest, cohesive bond strength failures are failures within the SFRM and adhesive failures are failures between the SFRM and substrate. The adhesion of the SFRM is critical to its performance because this is the key factor in minimizing the chances of the SFRM becoming dislodged from the substrate. This 150 psf criteria is only applicable to low-rise structures. IBC, Chapter 4, section 403.2.4 provides more stringent bond strength requirements for high-rise structures. The CODE moved away from the single value (150 psf) for all buildings and implemented new minimum bond strength values based on the building's height several code cycles ago. The current high-rise minimum bond strength values for SFRM are located in IBC Chapter 4, Table 403.2.4.

**IBC Table 403.2.4 Modified**

Minimum Bond Strength	
HEIGHT OF BUILDING <sup>(a)</sup>	SFRM MINIMUM BOND STRENGTH <sup>(b)</sup>
0 to 74 Feet	150 psf
Greater than 74 Feet, Up to 420 Feet	430 psf
Greater than 420 Feet	1,000 psf

- a) Above the lowest level of fire department vehicle access
- b) The minimum bond strength requirement for the SFRM must be installed throughout the building

This revised bond strength criteria adopted by the (IBC) CODE has had no impact on any other physical property criteria for the SFRM in a specification. For example, the new code verbiage has no impact on density requirements. The selection of density criteria by the designer is an independent decision of the required minimum bond strength as dictated by the IBC code in IBC chapters 4 and 17; the density of the SFRM is generally dependent upon the **UL design** designation.

Ambient temperatures during the SFRM application and curing process is very important and receives a lot more attention during special inspections than it (perhaps) used to. Most manufacturers' recommendations require a minimum substrate and ambient temperature of 40 degrees F prior to, during, and 24 hours after SFRM application. The temperatures at which SFRM is installed and cured are critical to the long-term fire and physical performance characteristics.

Several specific IBC code changes were adopted directly because of NIST recommendations after the 9-11 collapse investigations and report findings and some of them are as follows:

1. An additional exit stairway for buildings more than 420 feet in height.
2. A minimum of one fire service access elevator for buildings more than 120 feet in height.
3. Increased bond strength for fireproofing (nearly 3 times greater for buildings 75 to 420 feet in height and seven times greater for buildings more than 420 feet in height).
4. Field installation requirements for fireproofing to ensure that:
  - Installation complies with manufacturer's instructions
  - Substrates (surfaces being fireproofed) are clean and free of any condition that prevents adhesion is maintained for primed, painted, or encapsulated steel surfaces
  - Testing is conducted to demonstrate that required adhesion is maintained for primed, painted, or encapsulated steel surfaces
  - Finished condition of the installed fireproofing, upon complete drying and curing, does not exhibit cracks, voids, spalls, delaminations, or any exposure of the substrate



## SPECIAL INSPECTIONS (cont'd)

5. Special field inspections of SFRM to ensure that the as-installed thickness, density, and bond strength meet specified requirements and that a bonding agent is applied when the bond strength is less than required due to the effect of a primed, painted, or encapsulated steel surface. The inspections are to be performed after the rough installation of mechanical, electrical, plumbing, sprinkler, and ceiling systems.
6. Increasing by one hour the fire-resistance rating of structural components and assemblies in building 420 feet and higher.
7. Explicit adoption of the "structural frame" approach to fire resistance ratings that requires ALL members of the primary structural frame to have the higher fire resistance rating commonly required for columns. The primary structural frame includes the columns, other structural members including the girders, beams, trusses, and spandrels having direct connections to the columns and bracing members designed to carry gravity loads.
8. Luminous markings delineating the exit path (including vertical exit enclosures and passageways) in buildings more than 75 feet in height to facilitate rapid egress and full building evacuation.

When it comes to code-required special inspections related to SFRM, don't limit your review to IBC chapter 17. IBC Chapter 7, Section 704.13 includes verbiage that is intended to increase the durability of SFRM. Section 704.13.3.2 addresses instances when SFRM can be applied over primers, paints, or encapsulate. Extra bond strength tests are required and there are limitations on the sizes of structural members that can utilize the bond strength field tests (ASTM E736). Sections 704.13.1 and 704.13.2 require that the application of SFRM be done in accordance with the terms and conditions of the listing and the manufacturer's instructions. The manufacturer's installation instructions, thereby, become CODE.



***Can You  
Believe it?***

***But Wait, We Have a Lot More to Say!***

*For a complete picture of the Code and how it relates to Special Inspections, F&R would love to provide a virtual (for the time being) AIA accredited Lunch & Learn presentation to the professionals at your firm.*

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### *Troubles Deciphering the Code?*

**Call the Experts at F&R!**

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