Caveat

The testing and inspection procedures described herein for Sprayed Fire-Resistive Materials are provided solely as guides for field inspection. Their use is purely voluntary. The described procedures do not in any way determine the suitability or appropriateness of any application. The application of the procedures, or compliance with the procedures, shall not constitute any warranty, expressed or implied, of the performance characteristics of any sprayed fire-resistive material for any purpose. The standards, guidelines and assemblies referred to in the procedures are for reference only, and shall not constitute a recommendation for the use of any such standard, guideline or assembly.

The list of suppliers of test equipment found in Appendix C is provided for informational purposes only and has been compiled from all known, available information. The listing is solely in alphabetical order, made at no charge and does not constitute an endorsement or warranty, expressed or implied, of the suitability or appropriateness of any products manufactured by these firms for the intended testing purpose; nor does this listing purport to be all inclusive of the manufacturers of adhesive products available, which may be evaluated for this purpose. Manufacturers of adhesive products are encouraged to contact The Association of the Wall and Ceiling Industries—International for listing, at no charge, in subsequent printings of this manual.

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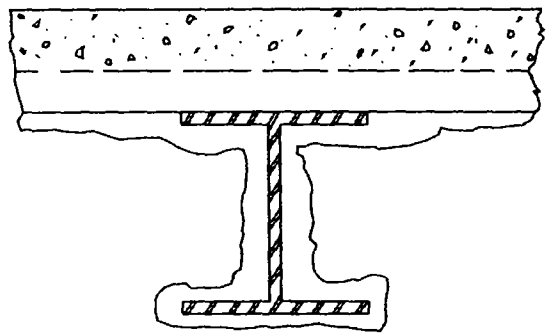
TECHNICAL MANUAL 12-A

Third Edition

Standard Practice for the Testing and Inspection



of Field Applied Sprayed Fire-Resistive Materials; an Annotated Guide

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And the similar contributions of those individuals before them who brought order to the testing and inspection of spray applied fire-resistive materials through the development and publication of the earlier version of this publication.

Foreword

The predecessor to this document, Inspection Procedure for Field Applied Sprayed Fire Protection Materials, first published in 1975 and last revised in 1990, provided invaluable guidance to building owners, architects, code officials, testing agencies, inspectors, contractors and others, by providing standard methods and practices for the field inspection of sprayed fire-resistive materials.

Developed by the Spray Fire-Resistive Materials Committee of The Association of the Wall and Ceiling Industries—International, the procedure was the first to provide information critical to establishing consistent field testing practices. Subsequently, several standards for laboratory testing and field inspection of these materials were published. Most notable were standards developed by the American Society of Testing and Materials (ASTM) Subcommittee E6.21. These standards are designated ASTM E605, "Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Materials Applied to Structural Members," and ASTM E736, "Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members." The ASTM standards were developed within a consensus process and represent a continual evolvement of physical and analytical methods for the measurement of thickness, density and bond strength.

Additional standards and guidelines were provided by the Uniform Building Code (UBC) in UBC Standard No. 7-6, "Thickness, Density and Cohesion/Adhesion Determination for Spray-Applied Fireproofing," and by Underwriters Laboratories Inc (UL) and Underwriters Laboratories of Canada's (ULC) adoption of tolerance criteria for sprayed fire-resistive material thicknesses. These thickness tolerances have been adopted by all three United States model code jurisdictions. UL and ULC thickness tolerance and fire-resistance-rating design-criteria are published in the UL Fire Resistance Directory and in the ULC List of Equipment and Materials, Volume 2 Building Construction.

As of the end of 1995, all three United States model code jurisdictions have adopted inspection requirements for SFRM that include testing for thickness, density and cohesion/adhesion. These requirements are applicable to all projects using SFRM.

These new standards and acceptance criteria, along with the evolution of knowledge gained through additional testing, engineering research and practical field experience, have brought about the need to update the procedure. Concomitantly, information from these standards and acceptance criteria that may be useful to personnel involved in the testing of sprayed fire-resistive

materials have been annotated and cross-referenced with the updated procedure to produce this standard practice.

It is the responsibility of the concerned parties utilizing this standard practice to review and comply with the contract specifications, applicable building code and the latest issue of the standards cited therein, in determining the acceptability of spray applied fire-resistive material.

This standard practice attempts to provide consistency in field testing methods and interpretation of the results. The goal, as always, is to promote a higher level of quality and performance of sprayed fire-resistive materials, and to facilitate the accurate, timely and cost-effective inspection thereof.

Contents

Section Description

Standard Practice for the Testing and Inspection of Field Applied Sprayed Fire-Resistive Materials; an Annotated Guide

1. Scope

1.1 Purpose. The purpose of this standard practice is to provide field inspection procedures for the testing of sprayed fire-resistive materials (SFRM) applied to structural members and assemblies.

1.2 Description. This standard practice provides methods by which a qualified testing agency can determine whether the application of the SFRM is in accordance with the requirements of the tested fire-rated assemblies referenced in applicable standards and previously submitted for specific project approval. Testing methods for obtaining physical characteristics of applied SFRM are detailed in Sections 5, 6 and 7.

1.2.1 Limitation. This standard practice shall not be used to establish levels of performance.

1.2.2 Acceptance. The requirements of the contract specifications and applicable building code shall govern the acceptability of applied SFRM.

2. General Information

2.1 Standards. This standard practice shall be applicable for the testing of SFRM applied to structural members and assemblies as evaluated in accordance with standards recognized by the applicable building code. These standards include American Society for Testing and Materials E119, National Fire Protection Association NFPA 251, Underwriters Laboratories Inc. ANSI/UL 263, and Underwriters Laboratories of Canada ULC-S101-M.

2.2 SFRM Classification. This standard practice shall be applicable for the testing of SFRM identified as either "sprayed fiber" or "cementitious mixtures" bearing the UL or ULC label, as appropriate.

Note: Cementitious mixtures typically consist of one or more binders, aggregates or fibers that are mixed with water to form a slurry and conveyed through a hose to a nozzle where compressed air is typically used to disperse the material into a spray pattern. Spray fiber materials typically consist of one or more

binders, fibers or aggregates that are conveyed by low-pressure air through a hose to a nozzle where the material is mixed with atomized water and sprayed. Spraying and application instructions are printed on each bag of SFRM.

2.3 Application Requirements. The SFRM application requirements shall be based on testing conducted by a recognized agency, in accordance with accepted standards, for an hourly fire-resistance rating of a structural member or assembly. The requirements detailed in the published reports include, but shall not be limited to, the minimum thickness and dry density of the applied SFRM, method of application, substrate surface condition (including paints, primers and encapsulants), the use of bonding adhesives, sealants (overcoats), reinforcing or other materials, and the need to seal the void at the intersection of fluted decks and beams. These published requirements shall be met on the jobsite.

2.3.1 Manufacturer's Instruction. The manufacturer's published instructions for the application of specific SFRM shall be followed. These instructions include, but are not limited to, substrate temperatures and surface conditions, and SFRM handling, storage, mixing, conveyance, method of application, curing and ventilation.

2.4 Testing Requirement. SFRM shall be tested, as required by the applicable building code and/or regulatory agency, when applied to structural members and assemblies including, but not limited to, beams, joists, columns, metal decking, floor systems, wall assemblies, trusses, roof assemblies and other related structural components.

3. Substrate Conditions

3.1 Inspection. Substrate conditions shall be inspected and deemed acceptable by the SFRM applicator and/or a representative of the manufacturer prior to the application of the SFRM.

3.2 Surface Conditions. Substrates to receive SFRM shall be free of dirt, oil, grease, release agents, loose scale or paint, primers, paints and encapsulants other than those fire tested and classified by a recognized testing agency, and any other condition that may prevent adequate adhesion. Surface conditions not in compliance with the cited fire-resistance-rating design-criteria or the SFRM manufacturer's specifications shall be reported to the general contractor, and the owner or owner's representative, for correction. The acceptability of primed, painted or encapsulated steel shall be determined by consulting the design criteria cited for the fire-rated assembly.

3.2.1 Primers, Paints and Encapsulants. Unless specifically prohibited in the fire-resistance-rating design-criteria, SFRM shall be permitted to be applied to primed, painted or encapsulated wide flange steel shapes, in assemblies published in UL's Fire Resistance Directory, provided

A. The beam flange width does not exceed 12 in. (300 mm).
B. The column flange width does not exceed 16 in. (400 mm).
C. The beam or column web depth does not exceed 16 in. (400 mm).
D. Bond tests conducted in accordance with ASTM E736 indicate a minimum average bond strength of 80 percent and a minimum individual bond strength of 50 percent, when compared to the bond strength of the SFRM as applied to clean uncoated 1/8-in. (3-mm) thick steel plate. The average and minimum bond strength values shall be determined based on a minimum of five bond tests conducted in accordance with ASTM E736.

3.2.1.1 Primer, Paint and Encapsulant Bond Tests. Bond tests to qualify a primer, paint or encapsulant per item 3.2.1.D shall be conducted only when the fire-resistive coating is applied to a primed, painted or encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistive material has not been measured. An acceptable bonding agent approved by the SFRM manufacturer is allowed to be applied to a primed, painted or encapsulated surface to obtain the minimum required bond strength where the bond strengths are found to be below minimum acceptable values.

As an alternative to the bond test conducted on control samples applied to an uncoated steel plate, the following method is acceptable for use on unknown coatings in existing structures: Sections of painted steel shall be coated with a bonding agent compatible with the sprayed material being used on the project. The treated and untreated substrates shall be coated with SFRM, cured and subjected to five bond tests each, in accordance with ASTM E736. If the failure mode of the sections treated with the bonding agent is 100 percent cohesive in nature, it shall be acceptable to use this bond test value as the control bond strength. The value obtained on the untreated painted section shall be compared to the control value using the minimum 80 percent average, 50 percent individual bond-strength acceptance-criteria.

If condition 3.2.1.D is not met, it shall be acceptable to provide a mechanical bond by wrapping the structural member with expanded metal lath having a weight of not less than 1.7 lbs per yd^2 (1.0 k/m^2).

If any of the conditions specified in 3.2.1.A, 3.2.1.B or 3.2.1.C are not met, a mechanical break shall be provided. A mechanical break shall be provided by mechanically fastening one or more minimum 1.7 lbs per yd^2 (1.0 k/m^2) metal lath strips to the flange or web either by weld, screw or powder-actuated fasteners, on maximum 12 in. (300 mm) centers, on each longitudinal edge of the strip, so that the clear spans do not exceed the limits established in conditions 3.2.1.A, 3.2.1.B or 3.2.1.C as appropriate. No less than 25 percent of the width of the oversize flange or web element shall be covered by the metal lath. No strip of metal lath shall be less than 3-1/2 in. (89 mm) wide.

As an alternative to metal lath, the mechanical break shall be provided by the use of minimum No. 12-gauge steel studs with minimum No. 28-gauge galvanized steel disks if such a system is described in a specific design (usually bottomless trench in an electrified floor design) for the SFRM being applied. The studs shall be welded to the oversize element in rows such that the maximum clear span conforms to conditions 3.2.1.A, 3.2.1.B or 3.2.1.C as appropriate. The spacing of studs along each row shall not exceed 24 in. (600 mm) and a minimum one stud per 256 in^2 (1,652 cm^2) shall be provided.

Where metal lath strips or steel studs and disks are used, an acceptable bond strength as described in item 3.2.1.D shall be required. A bonding agent applied to the painted surface is an acceptable method of obtaining the required minimum bond strength where bond strength to a painted surface is found to be below minimum acceptable values.

3.2.2 Temperature. A minimum ambient and substrate temperature of 40°F (4.4°C) shall be maintained during and for a minimum of 24 hours after the application of the SFRM, unless otherwise recommended by the SFRM manufacturer.

3.2.3 Ventilation. Should natural ventilation not be sufficient, forced ventilation shall be introduced for curing. The SFRM manufacturer shall be consulted for specific recommendations.

4. Inspection Procedure

4.1 Physical and Visual Tests. The following types of physical and visual tests are required by the fire-resistance-rating design-criteria, contract specifications or applicable building code:

A. Condition of substrates.
B. Thickness of application.
C. Density in pounds per cubic foot (kgs per m^3).
D. Bond strength-adhesion/cohesion (psf or kPA).
E. Condition of finished application.
F. Inspection of patching work.

4.2 Acceptance. The agency named in Section 4.3 shall be guided by the instructions as specified in Sections 5, 6 and 7 of this practice in determining the compliance of the SFRM application to the project specifications. See Section 1.2.2.

4.3 Inspection Firm. The testing of SFRM shall be conducted by an accredited independent inspector and/or testing laboratory and/or agency acceptable to the owner or his representative and the SFRM applicator.

4.3.1 Qualifications. Personnel testing SFRM shall be familiar with the application and use of these products, shall be thoroughly trained in the test methods and shall be experienced in conducting field or laboratory testing procedures.

4.3.2. Testing Experience. Personnel responsible for the execution of field inspection procedures and test reports shall have a minimum of three years of testing experience.

4.4 Procedure. The procedures discussed in Sections 4.4.1 through 4.4.6 shall be established at a preconstruction meeting attended by representatives of the owner, general contractor, SFRM applicator and the testing agency and/or laboratory. Applicable construction records, reports and information as described herein shall be furnished by the responsible party.

4.4.1 Design Criteria. The owner or his representative (architect or engineer) and SFRM applicator shall make available to the testing agency and/or laboratory a complete description of the structural members and assemblies requiring SFRM. The description shall have sufficient details, including UL, ULC or applicable testing agency fire-resistance-rating design-information, for the purpose of conducting the field-inspection procedures.

4.4.1.1 Design Number. The UL or ULC fire-resistance-rating design-number, and date of issue of the appropriate UL or ULC publication shall be deemed to be adequate information for reference in contracts, specifications, drawings, submittals and reports. A copy of the published fire-resistance designs from other acceptable testing agencies shall be furnished.

4.4.1.2 Adjustment Formula. Where a formula is used to adjust SFRM thickness applied to columns, beams or trusses, a complete protection thickness schedule shall be provided.

4.4.2 Fire-Resistive Material. The SFRM applicator shall make available to the owner, general contractor and testing agency and/or laboratory the name of the manufacturer and a product description of the SFRM that will be applied. The testing agency and/or laboratory shall determine that the containers of SFRM to be applied are properly labeled by the manufacturer, and con-

firm that the SFRM is the material listed in the fire-resistance-rating design-criteria of the assembly to be protected.

4.4.2.1 Container Labels. The SFRM container labels shall include the manufacturer and product name. The container shall bear the UL, ULC or other recognized agency marking, which includes fire-resistance rating-information and (optional) the surface-burning characteristics of the product.

4.4.3 Schedule. Dates and schedules shall be mutually agreed upon for the application and testing of SFRM, the rendering and receipt of appropriate test reports and construction records, the repair of cited deficiencies and final acceptance of the SFRM application.

4.4.4 Access. Testing agency and/or laboratory personnel shall be permitted to enter the premises to observe the progress and application of the SFRM, review the applicable construction records and perform their functions.

4.4.4.1 Inspection Conduct. The conduct of field inspection procedures shall not interfere with the application of SFRM. Testing agency and/or laboratory personnel shall not occupy scaffolding from which spraying operations are being conducted, nor shall they attempt to supervise or in any other manner attempt to direct the activities of SFRM applicator employees during the handling, mixing, conveyance or application of SFRM.

4.4.5 Conduct of Testing. The independent testing agency and/or laboratory shall perform the specified tests in accordance with the methods described in Section 5 as soon after the application of SFRM as practical. The SFRM applicator shall be immediately advised of any deficiencies.

4.4.5.1. Noting Deficiencies. The observed deficiency shall be noted on the permanent test records similar to those found in Appendix A. In standard industry practice, the testing agency physically marks the area on the structural component where the test results indicate that the minimum design criteria has not been met.

4.4.6 Test Reports. A written report shall promptly be submitted to the owner or his representative (architect or engineer), general contractor and SFRM applicator within one week after each floor or 10,000 ft² (930 m²) is tested, and at such time as the tested area is still readily available for correction of any deficiencies. The delivery of test reports shall be performed in a timely manner to ensure that project construction schedules are met and that the SFRM applicator has an adequate opportunity to repair all deficiencies prior to the work of other trades (e.g., installation of ductwork, electrical and mechanical equipment, etc.) that would impair proper application. See Sections 5.4.7 and 5.5.7.

5. Method of Tests

5.1 Random Sampling. The tests described in this section shall be based on random samplings of specific structural members, or roof or floor deck, agreed upon by the owner, his representative or the testing agency.

5.2 Test Apparatus. The following apparatus shall be used to determine the thickness and density of the SFRM:

A. *Steel Rule.* Steel rule, tape or other measuring device graduated in at least 1/16-in. or 1-mm increments.
B. *Thickness Gauge.* A thickness gauge as approved by the building authority having jurisdiction. See Figure 1 (page 10) for illustration.
C. *Scales.* Scales of sufficient capacity and sensitivity to weigh the test specimens to an accuracy of at least 0.1 g.
D. *Template.* A rectangular template of known length and width, having a minimum area of 48 in² (30,967 mm²); the template shall be a minimum of 3 in. (76 mm) on one side.
E. *Knife.* A knife or other suitable instrument capable of cutting completely through the SFRM to the substrate.
F. *Drying Oven.* A drying oven or other device capable of maintaining temperature and humidity conditions during the specimen curing cycle in accordance with the SFRM manufacturer's requirements.
G. *Lead Shot.* Six 600 g bottles of lead shot size #8.*
H. *Graduated cylinders.* One 100 cc and one 250 cc graduated cylinder.
I. *Funnel.* One polypropylene funnel (top I.D. 150 mm; bottom I.D. 28 mm).
J. *Cylinder.* One cylinder approximately 3 in. I.D. and 4 in. tall (a 400 ml smooth wall beaker will suffice).
K. *Straightedge.* One 6 in. (150 mm) or greater stiff straightedge to be used as a screed.
L. *Pan.* One shallow, flat pan (approximately 6 in. (150 mm) in diameter).

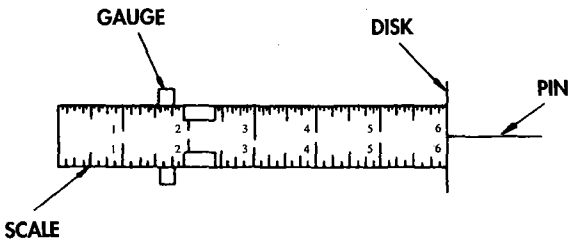
5.3 Thickness Determination. Thickness of applied SFRM shall be determined by an appropriate thickness gauge approved by the building authority having jurisdiction, or as shown in Figure 1 (page 10), and reported in accordance with Section 5.4.7.

Description: The gauge shall consist of a disk fixed to a measuring rule with a needle probe attached to a sliding clip indicator. The disk shall be a minimum of 7/8-in. (22 mm) and a maximum of 1-1/8-in. (29 mm) in diameter. The needle probe shall be able to extend to penetrate the SFRM until the point reaches the substrate. The thickness shall be read in 1/16-in. or 1-mm

* Ottawa silica sand and unexpanded polystyrene bead (designation "C bead") may also be used in lieu of lead shot.

increments as shown by the position of the sliding clip indicator against the measuring rule.

Figure 1: Illustration of Gauge



When the thickness gauge shown in Figure 1 is used, the following procedure shall be employed:

A. During the thickness measurement procedure, the gauge shall be positioned perpendicular to the substrate so that the disk contacts the SFRM surface. Adequate pressure shall be exerted (1) for the needle probe to penetrate the SFRM and make contact with the substrate and (2) for the disk to register the average plane of the surface of the SFRM. The gauge shall then be withdrawn to read the thickness in 1/16-in. or 1-mm increments as shown by the position of the sliding clip indicator against the measuring rule.

B. If there are excessive irregularities in the surface texture at a point of thickness measurement, the thickness gauge shall be repositioned to the closest location representative of a more uniform surface. See Section 6.1.

5.3.1 Testing Hardened or Cured Material. Where medium- and high-density SFRMs are too hard to test for thickness using a standard procedure, it is recommended that thicknesses shall be checked immediately after application and before curing.

The applicator shall adjust the thickness of the freshly applied SFRM to yield thickness after cure, in accordance with the SFRM manufacturer's recommendations.

Where the product is cured and too hard to insert the thickness gauge, small-diameter holes just large enough to accommodate the thickness-gauge pin shall be drilled perpendicular to the surface of the SFRM being measured. The thickness gauge shall then be inserted into these holes and thickness determined using the standard procedure. Holes shall be closed off immediately following the test using the same SFRM.

When metal lath is used in conjunction with bar joists, care shall be taken to ensure that the needle probe contacts the substrate (bar joist).

5.3.2 Thickness Criteria. The required thickness of SFRM shall be detailed in the UL, ULC or applicable testing agency fire-resistance design or report for the fire-resistance rating of the structural member or assembly. See Section 4.4.1.

5.3.3 Thickness Measurement. One series of measurements shall be taken on the deck, columns and beams in an area to be inspected, unless more frequent measurements are required by the project specifications or applicable building code. See Section 5.3.4 for testing frequency. Thickness measurements shall be taken when the SFRM has stabilized and be recorded on permanent records similar to the illustrations in Appendix A. Thickness measurements shall be averaged in accordance with Section 5.3.3.5 and reported in accordance with Sections 5.4.7.F and 5.5.7.F.

5.3.3.1 Timing. Thickness measurements shall be taken after the SFRM has stabilized. Contact the SFRM manufacturer for recommendations.

Note: The physical characteristics of freshly applied SFRM vary. During the initial set, some SFRMs expand while others shrink.

5.3.3.2 Thickness Maximum. For the purpose of averaging measurements, individual measured thicknesses that exceed the thickness specified in a fire-resistance-rating design-criteria by 1/4 in. (6 mm) or more shall be recorded as the thickness specified in the design plus 1/4 in. (6 mm).

5.3.3.3 Thickness Minimum. No individual measurement shall be more than 1/4 in. (6 mm) less, or more than 25 percent less, than the thickness specified in the fire-resistance-rating design-criteria. For thicknesses 1 in. (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus 1/4 in. (6 mm). For thicknesses less than 1 in. (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent.

5.3.3.4 Failure. If an individual thickness measurement, or the average calculated measurement, of a structural member or roof or floor deck in the randomly selected area or bay does not meet the design criteria for thickness average or minimum individual thickness, then only that specific member or bay shall fail. The remaining structural members or decks, in other areas or bays on the building elevation (floor), shall not be deemed to have failed solely because the tested component has failed.

If a structural member or roof or floor deck fails to meet the design criteria for thickness average or minimum individual thickness, it shall be corrected and retested, and another similar component in another randomly selected area on the same elevation (floor) shall also be tested.

5.3.3.5 Thickness Measurement Averaging. A single average measurement shall be calculated from each series of individual measurements of the structural members or roof or floor decks tested. The calculated average thickness shall be equal to or greater than the thickness specified in the fire-resistance design-criteria. Where a reduced thickness of SFRM on flange tips is specified in fire-resistance design-criteria, the thickness of SFRM applied on the flange tips shall be averaged separately. The single average measurement calculated shall be reported as required in Sections 5.4.7.F and 5.5.7.F. Thickness maximum and minimum tolerances as detailed in Sections 5.3.3.2 and 5.3.3.3 shall apply only to individual measurements. Acceptability of applied SFRM thickness shall not be determined by applying these tolerances to the thickness measurement average.

5.3.4 Testing Frequency. Thickness measurements shall be made on structural elements on a random basis in at least one bay per floor, or for each 10,000 ft² (930 m²) of floor area, whichever provides the greatest number of tests, but not to exceed one test per 10,000 ft² (Example: 14,000 ft² would require two tests.). Thickness measurements shall be conducted on each of the following structural elements present in each randomly selected bay: one area of metal deck or concrete slab; one column; one primary beam and one secondary beam; one joist; and one truss.

5.3.4.1 Building Codes. Where the applicable building codes govern testing frequency, the applicable building code shall be consulted for exact requirements.

5.3.4.2 Test for Floor (Deck) Sections. A series of thickness measurements shall be conducted in a specific pattern as detailed herein. The result shall be recorded as a single average measurement. See Section 5.3.3.5; Appendix A-1; Section 5.4.7.F.

A. *Flat Decks.* In the preselected area, lay out a 12-in. (300-mm) square and take a minimum of four measurements, symmetrically.
B. *Fluted Decks.* In the preselected area, lay out a 12-in. (300-mm) square and take four random, symmetrical measurements within the square, including one each of the following: valley, crest and sides and report as an average.

5.3.4.2.1 Test Report. The test report shall clearly state the locations of thickness measurements and the individual values measured at each point. In certain fire-resistance-rating design-criteria, the required thicknesses of SFRM applied to the crest sides and valley of fluted deck vary and, if so, shall be averaged apart. Consult the referenced design criteria.

5.3.4.2.2 Void Inspection. It shall be determined that the voids created by the intersection of the fluted deck and the beam have been filled with SFRM unless they are not required to be filled by the fire-resistance-rating design-criteria. Where the referenced design allows the bridging or plugging of voids (in lieu of completely filling the voids), the applicable building code shall be consulted to determine acceptability. Any observed deficiencies shall be immediately reported to the SFRM applicator for correction. Applications initially found to be deficient shall be corrected and reinspected.

5.3.4.3 Test for Beams, Joists, Trusses and Columns. A series of thickness measurements shall be conducted in a specific pattern as detailed herein. Certain UL and ULC fire-resistance-rating design-criteria for beams and columns allow for a reduced thickness of SFRM on flange tips when a greater thickness of SFRM is applied to the contour of the beam, truss or column. These reduced flange tip thicknesses shall be averaged apart from other sections of the beam, truss or column. Where a single thickness is required, the result shall be recorded as a single average measurement. See Sections 5.3.3.5 and 5.4.7.F; Appendix A-2 for beams, A-3 for joists and trusses, A-4 for columns.

A. *Beams.* Thickness measurements shall be made at nine locations around the beam at each end of a 12-in. (300-mm) length.
B. *Joists and Trusses.* Thickness measurements shall be made at seven locations around the joist or truss at each end of a 12-in. (300-mm) length.

   Certain UL and ULC fire-resistance-rating design-criteria list the optional use of glass fiber mesh and/or metal lath attached to one side of a bar joist to facilitate the application of SFRM. When fiber mesh is utilized, the SFRM shall be sprayed only to the required thickness, following the contour of both sides of the bar joist; the glass fiber mesh between the vertical members shall not be required to be sprayed. When metal lath is utilized, the SFRM shall be sprayed to the required thickness, following the contour on both sides of the bar joist; the metal lath between the vertical members shall also be fully covered with SFRM but with no minimum thickness. Where use of glass fiber mesh and/or metal lath results in a protection thickness reduction in the applicable UL or ULC fire-resistance design, the SFRM thickness shall be applied to the entire joist, including all metal lath and/or glass fiber mesh, at the full design thickness specified, i.e. "sprayed solid."
C. *W-Shape Columns.* Thickness measurements shall be made at 12 locations around the column at each end of a 12-in. (300-mm) length.
D. *Tube and Pipe Columns.* Thickness measurements shall be made at a minimum of four locations around the column at each end of a 12-in. (300-mm) length.

5.3.5 Thickness Correction. Thickness shall be corrected by applying additional SFRM at any location where the calculated average thickness of the material is less than that required by the design; or where an individual measured thickness is more than 1/4-in. (6 mm) less, or for thicknesses less than 1 in., more than 25 percent less, than the specified thickness required by the design.

5.4 Density Determination. Density of applied SFRM shall be determined and reported in accordance with Section 5.4.7.

5.4.1 Density Criteria. The minimum dry density at which the SFRM shall be applied to building elements shall be specified in the individual fire-resistance-rating criteria or as otherwise required by the specification or SFRM manufacturer and as furnished by the owner or his representative (architect or engineer).

A thickness to density correction formula is contained in certain UL and ULC fire-resistance-rating criteria. The appropriate publication or the SFRM manufacturer shall be consulted for specific information. See Sections 4.4.1 and 5.4.6.

5.4.2 Testing Frequency. The density of the applied SFRM shall be determined by conducting tests on specimens on each floor, or in each 10,000 ft² (930 m²), whichever provides the greatest number of tests, but not to exceed one test per 10,000 ft². (Example: 14,000 ft² would require two tests.) Density shall be determined by conducting tests on specimens from each of the following elements: a flat portion of the deck; a beam, either the bottom of the beam lower flange or the beam web; and a column, either the column web or the outside of one of the column flanges. Alternate elements shall be tested so that each element listed is equally tested. See Section 5.3.4 for building code requirements.

5.4.3 Specimen Preparation. Density measurements shall be accomplished by selecting, measuring and preparing specimens in accordance with either of the two methods described herein.

5.4.4 Measurement Method

5.4.4.1 Length and Width. The specimen to be tested shall be marked off by scoring the in-place SFRM on the building element using a suitable template of known length and width. The specimen area shall be not less than 48 in² (30,967 mm²); where possible, no dimension shall be less than 3 in. (76 mm).

5.4.4.2 Thickness. Thickness shall be determined within the area of the specimen by the procedure described in Section 5.3. A minimum of 12 thickness measurements shall be made in a symmetrical pattern prior to removal of the SFRM from the substrate. The average value of these 12 measurements shall be deemed the thickness of the specimen.

5.4.4.3 Removal. The specimen shall be removed from the substrate by cutting with a knife or other suitable device along the perimeter of the scored SFRM and through to the substrate. The knife shall be positioned perpendicular to the substrate during the sampling procedure to ensure that the edges of the specimen are square. The specimen shall be carefully removed without loss of material.

5.4.4.4 Drying. The specimen shall be conditioned by force drying at a temperature of 109° ±10°F (43° ±6°C), and relative humidity not greater than 60 percent, until constant weight is obtained. See Section 5.2.F and 5.4.4.5.

5.4.4.4.1 Microwave Ovens Used in Curing. Where SFRM manufacturers permit the use of microwave ovens or other devices for the curing of SFRM, the SFRM manufacturer shall be consulted for specific recommendations.

5.4.4.5 Weight. The constant weight shall be defined as successive readings taken at eight-hour intervals differing by less than 1 percent, as determined on a suitable scale or weighing device in appropriate U.S. or metric units. See Section 5.2.C.

5.4.4.6 Density Calculation. Density shall be calculated in accordance with one of the following formulae:

A. $D = W / l \times w \times t$
   Where: D = density, lb/ft³ (or kg/m³),
   W = weight of the dried material, lb (or kg),
   l = length of the specimen, ft (or m),
   w = width of the specimen, ft (or m), and
   t = average thickness of the specimen, ft (or m).

B. $D = W \times 1728 / l \times w \times t$
   Where: D = density, lb/ft³ (or kg/m³),
   W = weight of dry material in lbs,
   l = length of specimen in inches,
   w = width of specimen in inches, and
   t = average specimen thickness in inches.

C. $D = W \times 12/t$
   Where: D = density, lb/ft³ (or kg/m³),
   W = weight of dry material in pounds, and
   t = average specimen thickness in inches.

5.4.5 Displacement Method. This method is recommended when the SFRM specimen is difficult to remove from the substrate, such as when medium- or high-density or cured SFRM are installed.

5.4.5.1 Test Procedure. The sample shall be cut to a size to fit inside the test cylinder, leaving at least 1/4 in. (6 mm) of space between the sample and the cylinder on all sides. The sample shall be dried in an oven at a temperature of 109° ±10°F (43° ±6°C) and relative humidity not greater than 60 percent. Dry-

ness shall be determined by a moisture-probe meter or by having the sample reach a constant weight in accordance with Section 5.4.4.5. Once dry, the sample shall be weighed to the nearest 0.1 g.

5.4.5.2 Volume Determination. With the shallow pan placed under the test cylinder, all of the lead shot shall be poured through the funnel into the test cylinder in a loose-fill manner. No tapping or shaking of the cylinder shall take place. The lead shot shall completely fill the cylinder and overflow the cylinder slightly, allowing the excess lead shot to fall into the shallow pan. The straightedge shall be placed on and perpendicular to the top rim of the test cylinder. In an even, back-and-forth manner, the straightedge shall be drawn across the top rim of the cylinder to screed off the excess lead shot until the lead shot in the cylinder is flush with the top rim of the cylinder. All the excess lead shot that has fallen into the shallow pan shall be taken out of the pan and set aside. The cylinder now contains all of the lead shot needed for testing.

The lead shot from the cylinder shall be emptied into another container. A small amount of lead shot shall be poured from the container back into the cylinder in a quantity sufficient to cover the bottom of the cylinder. The sample to be tested shall be placed onto the bed of lead shot in the center of the test cylinder. Using the funnel, and with the shallow pan under the cylinder to collect the overflow of lead shot, all of the remaining lead shot shall be loose-poured back into the cylinder. The lead shot shall be screeded with the straightedge in the same manner as described previously. No shaking or tapping of the cylinder shall take place, and the lead shot in the cylinder shall be level with the top rim of the cylinder. All the lead shot screeded off the top of the cylinder shall be allowed to fall into the shallow pan.

To determine the volume of the sample, the lead shot shall be poured from the shallow pan into the graduated cylinder. The size of the graduated cylinder shall depend on the size of the sample being tested. The graduated cylinder shall not be shaken or tapped, and the volume of lead shot shall be read in cubic centimeters. The volume of the sample shall be equal to the volume of lead shot in the graduated cylinder.

5.4.5.3. Density Calculation. The density of the specimen shall be determined using the following method. It is suggested that the reported density be the average of three measurements:

$D = W \times 62.43 / V$

Where: D = density in lb/ft,
W = weight of sample in grams,
V = volume of sample in cubic centimeters.

5.4.6. Density Correction. Where density measurements fail to meet the fire-resistance-rating design-criteria, the owner's representative (architect or engineer) shall determine remedial procedures.

5.4.6.1 Thickness Correction Formula. Certain UL and ULC designs allow in-place SFRM density corrections by using a specific thickness correction formula for densities below the listed minimum average and/or individual density requirement. The appropriate publication or the SFRM manufacturer shall be consulted for requirements of the specific design being tested.

5.4.7 Test Report: Thickness and Density. The completed test report shall contain all appropriate information, including the following:

A. Project name and location.
B. Date of test and report.
C. Exact location on project where test was conducted or specimen was removed.
D. Identification of the SFRM (product name, manufacturer and other pertinent information).
E. Description of specimen:
   (1) Size of test specimen.
   (2) Any modification made to the SFRM specimen tested to obtain the reported values shall be noted.
   (3) Description of any deviations from the test method.
F. *Thickness.* The overall average, and the maximum and minimum thicknesses recorded in the measurement of the tested structural members and assemblies (reduced flange tip thickness shall be averaged separately), expressed in inches (or millimeters). A copy of the permanent records, similar to Appendix A, shall be attached to this report.
G. *Density.* The average, minimum and maximum density values of the test specimens, expressed in pounds per cubic foot (or kilograms per cubic meter).
H. *Appendices.* All data not specifically required by this section but useful for a better understanding of the test report.

5.5 Bond-Strength Determination. Cohesion/adhesion (bond-strength) determination shall be conducted as part of the field testing of SFRM as required by contract specifications, the applicable building code or where jobsite conditions dictate. Bond-strength determination is an acceptable method for determining the suitability of a questionable substrate (surface condition) scheduled to receive SFRM or if prior evaluation has not been conducted. See Section 3.2.1.1. An accurate determination of bond strength shall be accomplished only after the in-place SFRM has cured. The SFRM manufacturer shall be contacted for recommendations.

Note: The test method described in this section has a maximum theoretical bond strength measurement capacity of 1,146 psf when using the preferred 3 1/4 in. diameter cap and a 66 lb force capacity fish hook scale. Project specifications for bond strength of some SFRM can significantly exceed this value. An alternate test method for determining bond strengths of these SFRM is described in Appendix B.

5.5.1 Waiver. Where jobsite conditions make testing difficult or impossible, the building code authority having jurisdiction shall be authorized to allow modified or alternative test procedures as provided under the "Alternate Means of Evaluation" section of the appropriate building code.

5.5.2 Bond-Strength Criteria. In-place SFRM shall be subjected to an increasing force (either uniform or step-wise) at the rate of 11 lb (5 kg) per minute applied perpendicular to the surface via a spring scale or series of weights until failure occurs, the required bond strength is attained or the capacity of the scale is reached. Bond strength measurements of applied SFRM shall be noted in the test report. See Sections 3.2.1.D and 5.5.5.

5.5.3 Testing Frequency. The test shall be conducted on completely cured material from areas adjacent to test sections where thickness and density determinations have been made. One test shall be conducted for beams, and one test for decks for each 10,000 ft² (930 m²) of floor area, with a minimum of two tests per floor. No bond-strength testing shall be conducted until the SFRM is completely cured. Where necessary, ventilation shall be provided so that curing is expedited. The SFRM manufacturer shall be contacted for specific recommendations.

5.5.4 Test Apparatus. The following equipment shall be used to conduct density testing:

A. A metal or rigid plastic bottle cap, 3-1/4 in. (83 mm) in diameter and approximately 1/2 in. (12 mm) deep with a hook attached at the center point. Reference Figure 2 (page 19) for an example. Caps are available from laboratory supply houses or bottle suppliers.
B. A two-component adhesive system of urethane resin to form a rigid foam or other acceptable adhesive. Reference Appendix C for sources of two-component urethane resin systems.
C. Weighing scale, spring type (fish hook), capacity of 25 to 66 lbs (12 to 30 kg), with an accuracy within 1/4 lb (0.1 kg).
D. A 12-in. (300-mm) square template.

5.5.5 Methodology. Specimens of SFRM shall be secured and tested in the following manner:

A. A 12-in. (300-mm) square area shall be selected at the predetermined location. Where an area of this size is not available, the specimen shall be no less than 4 in. x 12 in. (100 mm x 300 mm).
B. A quantity of adhesive sufficient to fill the cap (with the hook attached) shall be applied. The adhesive manufacturer's published mixing directions shall be followed.
C. The cap shall be immediately placed against the SFRM, in the center of the area to be tested. The cap shall be held in place until the adhesive has set sufficiently to become self supporting. Excess adhesive shall be removed from around the cap before testing.
D. After the adhesive becomes hard, force perpendicular to the surface shall be applied slowly to the hook at a uniform rate and with deliberate care until failure occurs or the capacity of the scale is reached. The weight in pounds (or kilograms) at the time of cohesive/adhesive failure shall be noted.

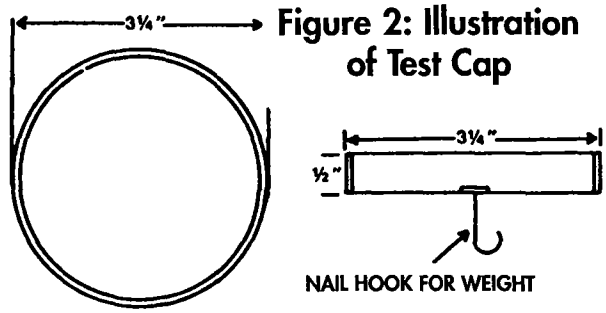


Figure 2: Illustration of Test Cap

5.5.5.1 Nondestructive Testing. Where nondestructive testing is conducted, the spring scale shall be replaced with fixed weight. A series of incremental weights, beginning with a maximum of 2 lbs (0.9072 kg), shall be suspended slowly and carefully from the hook, perpendicular to the surface, until the SFRM manufacturer's published product specifications, the applicable building code requirement or the project specifications criteria for bond strength (psf) have been met. SFRM applications meeting the requirement are to be deemed as having passed and shall be so noted in the test report. SFRM applications that do not meet the manufacturer's product specifications or the project specifications criteria are to be deemed to have failed and also shall be noted in the report. Consult the applicable building code and construction specifications for acceptability of nondestructive testing procedures.

Note: The ASTM Standard E736 requirement that an increasing force (either uniform or step-wise) be exerted at the rate of approximately 11 lbs (5 kg) per minute until failure occurs or the capacity of the scale is reached is not to be construed to mean that applied SFRM must sustain a total of 11 lbs (5 kg) of weight for a period of one (1) minute to meet minimum bond strength requirements. The ASTM requirement specifies that an increasing

force (i.e., foot-pounds, applied incrementally) be exerted at an 11 lbs (5 kg) per-minute rate of application (from the moment the test begins until the end of one minute) perpendicular to the surface until failure occurs or the capacity of the scale is reached. To apply the force, a spring scale may be attached to the hook on the test cap and slowly drawn at a uniform rate perpendicular to the surface; or the spring scale can be replaced with an incremental series of fixed weights.

To calculate the approximate weight that must be sustained prior to failure of the applied SFRM to meet bond strength requirements, insert the manufacturer's product specification or the project specification criteria for the cohesive/adhesive force (psf) and an accurate measurement of the area of the test cap (ft^2) into the formula in Section 5.5.6. The weight sustained by specific SFRM in successfully meeting bond-strength requirements varies. Contact the SFRM manufacturer for information.

Project specifications or applicable building-code provisions require that applied SFRM attain a minimum specified bond strength. For example, building construction specifications for US General Services Administration projects require that applied SFRM have a minimum bond strength of 150 lbs per ft^2 (150 lbs/ft^2), and the UBC requires that SFRM applied to steel have a minimum bond strength of 20 times the weight of the in-place SFRM (but not less than 150 psf) when tested in accordance with ASTM E736. Consult the construction specifications and applicable building code for specific requirements.

5.5.6 Calculation. The cohesive/adhesive force shall be calculated as follows:

$CA = F/A$

Where: CA= cohesive/adhesive force, psf (kPa),
F= recorded force, lbs-force (lbf or Newtons [N]), and
A= area of the metal or plastic cap, ft^2 (m^2).

Note: The cap specified in Section 5.5.3.A has an area of 0.0576 ft^2 (5.36 x 10^{-3} m^2).

5.5.7 Test Report: Bond Strength. The completed test report shall contain all applicable information as required in Section 5.4.7 with the addition of the following:

A. Force, pounds-force (or newtons).
B. Calculated cohesive/adhesive force, pounds-force per square foot (kilo-pascals).
C. Cohesive/adhesive force as detailed in manufacturer's published product specification.
D. Description of the type of failure.
   (1) Cohesive failure, if separation occurred within the SFRM.
   (2) Adhesive failure, if separation occurred at the interface of the substrate and the SFRM.

E. Approximate area of material involved in the failure, if it extends beyond the perimeter of the test cap.
F. Thickness of SFRM, inches (or millimeters).
G. Density of the SFRM, pound/cubic foot (or kilogram/cubic meter).

5.5.8 Bond-Strength Correction. Where bond-strength measurements have failed to meet the specified criteria, the owner's representative (architect or engineer) shall determine remedial procedures. The correction method shall not adversely affect building-code compliance or compliance with the project specification.

5.5.8.1 Bonding Agents. Certain UL and ULC fire-resistance rating desig- criteria allow the use of classified bonding agents or mechanical attachments on primed, painted or encapsulated surfaces to obtain the minimum required bond strength where the bond strengths are found to be below minimum acceptable values. The use of classified bonding agents shall be limited to columns, beams, joists and galvanized, UL- or ULC-classified primed/painted floor and roof deck units. See Section 3.2.1. The appropriate UL or ULC publication shall be consulted for the specific design criteria. The SFRM manufacturer shall be consulted for specific recommendations.

6. Condition of Finished Application

6.1 Visual Inspection. SFRM applied to structural members or assemblies shall not, upon complete drying or curing, exhibit deep or wide cracks, voids, spalls, delamination or any exposure of the substrate. The surface appearance of spray-applied SFRM can be described as a rough texture when compared to the smoother surface of trowel-applied SFRM. Minor surface irregularities of spray-applied SFRM are inherent with spray application and shall be deemed acceptable.

6.2 Correction of Deficiencies. Defects noted during the visual inspection shall be repaired with the same SFRM as applied to the fire-rated structural member or assembly so that the fire rating is maintained and specified performance requirements are met.

7. Patching

7.1 Patching. When SFRM has been removed for any purpose, it shall be replaced.

7.2 Patching Material. All areas to be repaired shall be resprayed, or patched by troweling, with the same SFRM as used for the original application or with the manufacturer's recommended patching material.

Appendices

Appendix A—Permanent Test Report Records and Illustrations

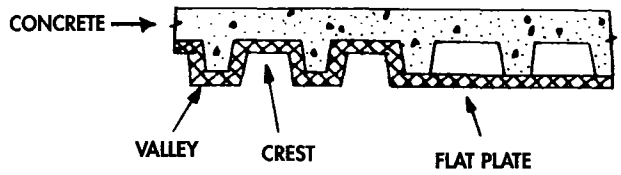
A.1 Thickness of SFRM on Floor (Deck) Section

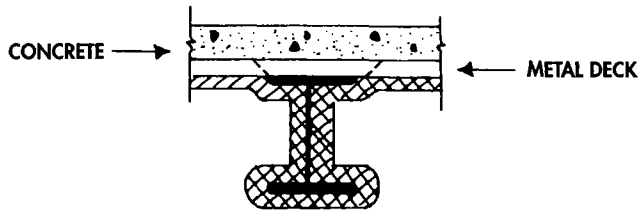
Lay out a 12 in. x 12 in. (300 mm x 300 mm) square and take 4 random symmetrical measurements on each of the following: (1) valley, (2) crest and (3) sides, for a total of 12 measurements.

LOCATION	CREST	SIDES
TOTAL		
AVERAGE		

Date_____

Inspector_____



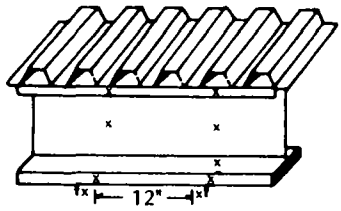


VALLEY	FLAT PLATE		

Average Required _____

Average Recorded _____

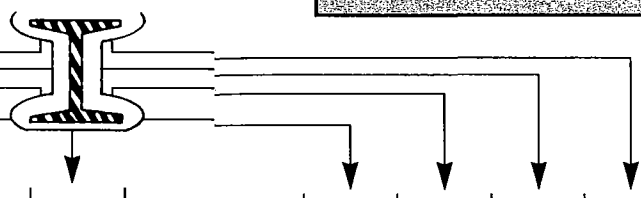
A.2 Thickness of SFRM on Beam



Take 9 measurements at each end of 12-in. length

FLUTES:
- ☐ Plugged?
- ☐ Filled?
- ☐ Open?

Comments _____



LOCATION	1	2	3	4*	5	6*	7	8	9	TOTAL	AVERAGE

Note: *Average the Flange Tip measurements separately where reduced thicknesses are applied under W/D formula.

TOTAL ☐ + ☐

AVERAGE ☐ + ☐ = ☐ → AVERAGE* ☐

Beam:

Average Required _____

Average Recorded _____

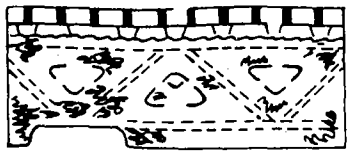
Flange Tip (W/D):

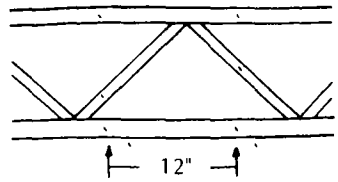
Average Required _____

Average Recorded _____

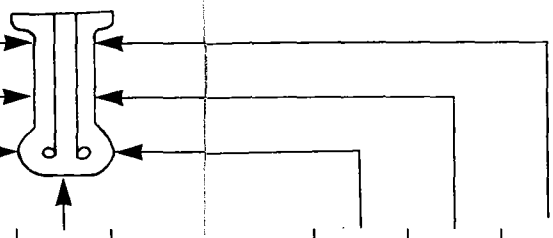
Date _____ Inspector _____

A.3 Thickness of SFRM on Joists and Trusses





Take 7 measurements from around joist or truss at each end of 12-in. length.



LOCATION	1	2	3	4	5	6	7	TOTAL	AVERAGE

Date_____

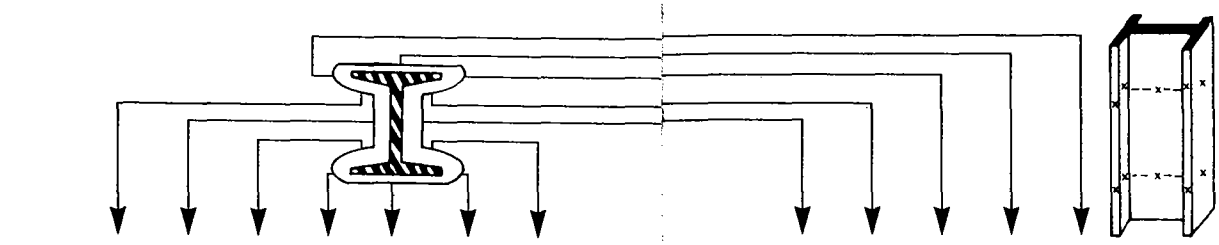
Inspector_____

Thickness Required _____

Thickness Recorded _____

A.4.1 Thickness of SFRM on W-Shape Columns

Take 12 measurements at each end of 12-in. length.



LOCATION	1	2	3	4*	5	6*	7	8	9	10*	11	12*	TOTAL	AVERA
TOTAL														
AVERAGE					+		+				+		=	AVERAGE*

Note: *Average the Flange Tip measurements separately where reduced thicknesses are applied under W/D formula.

Date_____

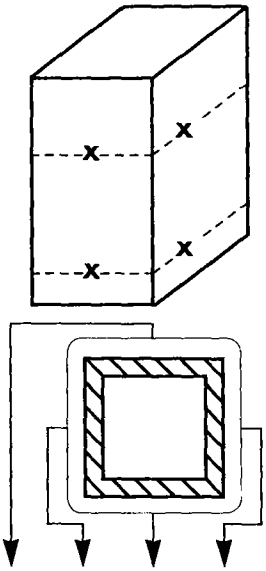
Inspector_____

Column:
Average Required _____
Average Recorded _____

Flange Tip (W/D):
Average Required _____
Average Recorded _____

A.4.2 Thickness of SFRM on Tube & Pipe Columns

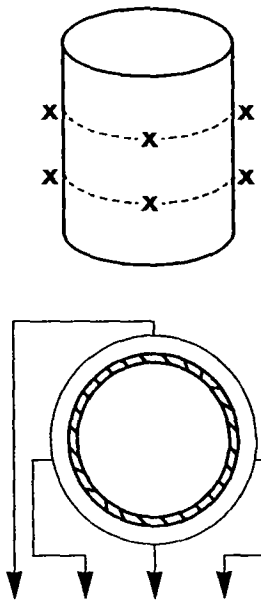
Take a minimum of 4 measurements at each end of 12-in. length.



LOCATION	1	2	3	4	TOTAL	AVERAGE

Date_____

Inspector_____



LOCATION	1	2	3	4	TOTAL	AVERAGE

Average Required _____

Average Recorded _____

Appendix B–Alternate Method for Bond Strength (Cohesion/Adhesion) of SFRM Exceeding 1,146 PSF

Note: This test method is recommended for products that have bond strengths exceeding 1,146 psf.

B.1 Laboratory Method.

B.1.1. Required Apparatus.

B.1.1.1. Wooden disk 1 3/8 in. (34 mm) diameter, 1 in. (25 mm) thick with 1/4 in. (6 mm) eye bolt screwed perpendicularly into center of disk.

B.1.1.2. Two-component epoxy adhesive with a minimum 4,000 psi strength. (also known as two-ton epoxy).

B.1.1.3. Standard hydraulic tensile machine.

B.1.1.4. Load cell with 1,000 lb. (453 kg) capacity.

B.1.1.5. Drill press.

B.1.1.6. Fostner bit, 36 mm.

B.1.2. Sample Preparation.

B.1.2.1. Material to be tested shall be applied to a 11.5 in. (292 mm) by 12.5 in. (318 mm) by 1/4 in. (6 mm) steel plate.

B.1.2.2. Material shall be applied according to the manufacturer's directions to the steel substrate in a thickness not less than 3/4 in. (19 mm).

B.1.2.3. Material shall be screeded to a smooth and level surface and allowed to set and cure as recommended by the manufacturer. To avoid inconsistent results, all material shall be dry. Material containing cement shall be cured for a minimum of 28 days.

B.1.2.4. Fully cured and dried sample shall be placed in a drill press in a perfectly level position.

B.1.2.5. Following attachment of the Fostner bit to the drill press, a hole shall be drilled in the center of the sample. The hole shall be deep enough to establish a smooth even surface for the adhering of the wooden disk, but in no instance shall the hole be less than 1/4 in. (6 mm) deep.

B.1.2.6. The sample shall be inspected for loose dust, dirt or any loose material that will impair the adhesive quality of the epoxy.

B.1.3 Test Procedure.

B.1.3.1. Using the epoxy, the wooden disk shall be adhered into the hole. The epoxy shall be allowed to fully set and cure.

B.1.3.2. After the epoxy has fully cured, the test sample shall be suspended face down in the top jaw of the tensile machine.

B.1.3.3. The eye screw that is attached to the wooden disk shall be attached to the lower jaw of the tensile machine so that the lower jaw of the machine is perpendicular to the test sample.

Note: Failure to properly align the test material in the machine may result in shearing of the test sample and produce results that are not indicative of the material's true bond strength.

B.1.3.4. Tensile machine shall be set to a crosshead speed of 0.05 in./min. Machine shall be started and continued until sample failure.

B.1.3.5. Peak load at material failure shall be recorded.

B.1.4 Calculations.

B.1.4.1. Cohesion/adhesion (bond) strength shall be calculated as

$CA = F/A$

Where:

CA = cohesive/adhesive strength (lb/ft^2),

F = recorded force (lb),

A = area of wood disk (ft^2).

B.1.5 Report.

B.1.5.1. Material manufacturer name, product name, material density, material thickness tested and cohesion/adhesion (bond) test strength results shall be reported.

B.2 Field Procedure.

Note: WARNING! This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

B.2.1 Required Apparatus.

B.2.1.1. Wooden disk 1 3/8 in. (34 mm) diameter, 1 in. (25 mm) thick with 1/4 in. (6 mm) eye bolt screwed perpendicularly into center of disk.

B.2.1.2. Two-component epoxy adhesive with a minimum 4,000 psi strength (also known as two-ton epoxy).

B.2.1.3. Portable load cell with 1,000 lb (453 kg) capacity.

B.2.1.4. Drill.

B.2.1.5. Fostner bit, 36 mm.

B.2.1.6. Level.

B.2.2 Sample Preparation.

B.2.2.1. Material shall be applied according to the manufacturer's directions to the substrate in a thickness not less than 3/4 in. (19 mm). This procedure shall not be used for testing of material thicknesses less than 3/4 in. (19 mm).

B.2.2.2. Material shall be allowed to set and cure as recommended by the manufacturer. To avoid inconsistent results, all material shall be dry. Material containing cement shall be cured for a minimum of 28 days.

B.2.2.3. Following attachment of the Fostner bit to the drill, a hole shall be drilled in the center of the sample. The hole shall be deep enough to establish a smooth, even surface for the adhering of the wooden disk, but in no instance shall the hole be less than 1/4 in. (6 mm) deep.

B.2.2.4. The sample shall be inspected for loose dust, dirt or any loose material that will impair the adhesive quality of the epoxy.

B.2.3 Test Procedure.

B.2.3.1. Using the epoxy, the wooden disk shall be adhered into the hole. The epoxy shall be allowed to fully set and cure.

B.2.3.2. The eye screw that is attached to the wooden disk shall be attached to the load cell using an "S" hook. The test shall be positioned so that the "pull" is perpendicular to the sample.

Note: Failure to properly align the test material may result in shearing of the test sample and produce results that are not indicative of the material's true bond strength.

B.2.3.3. The load cell shall be pulled using a steady, perpendicular force at a maximum rate of 50 lbs/min.

B.2.3.4. Peak load at material failure shall be recorded.

B.2.4 Calculations.

B.2.4.1. Cohesion/adhesion (bond) strength shall be calculated as:

$CA = F/A$

Where:

CA = cohesive/adhesive strength (lb./ft²),

F = recorded force (lb),

A = area of wood disk (ft²).

B.2.5 Report.

B.2.5.1. Material manufacturer name, product name, material density, material thickness tested and cohesion/adhesion (bond) test strength results shall be reported.

Appendix C–Resource Materials and Test Apparatus

Resource Materials.

The following standards, building-code provisions and reference documents were utilized in the development of this standard practice:

Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members, E 605-93, American Society for Testing and Materials, West Conshohocken, PA.

Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials (SFRM) Applied to Structural Members, E 736-92, American Society for Testing and Materials, West Conshohocken, PA.

Standard Practice for Application of Sprayed Fire-Resistive Materials (SFRMs), E 1513-93, American Society for Testing and Materials, West Conshohocken, PA.

Fire Resistance Directory, 1996 issue, Underwriters Laboratories Inc., Northbrook, IL.

List of Equipment and Materials, Volume 11, Building Construction, 1996 edition, Underwriters Laboratories of Canada, Scarborough, Ontario.

Thickness, Density, and Cohesion/Adhesion Determination for Spray-Applied Fireproofing, Uniform Building Code Standard No. 7-6, 1995 edition, International Conference of Building Officials, Whittier, CA.

Inspection of Spray-Applied Fire Resistant Materials, Section 1709 Standard Building Code, 1988 edition, Southern Building Code Congress International, Inc., Birmingham, AL.

MASTERSPEC, Section 07250, Sprayed-On Fireproofing, 1992, American Institute of Architects, Washington, D.C.

Design Selection Utilizing Sprayed Fire Protection, 1993 edition, The Association of the Wall and Ceiling Industries—International, Falls Church, VA.

Test Apparatus.

Two-component urethane resin adhesives for use in adhering test caps to SFRM during bond-strength testing are available from various sources of supply, including those listed below. Contact the adhesive manufacturer to determine product suitability.

Brim Products Co., Inc.
6531 S.W. 20th Court
Plantation, FL 33317
(954) 584-1150

C & R Products Co.
Div. of Clothier & Rose.Inc.
1000 E. Del Amo Blvd.
Carson, CA 90746
(310) 537-2800

Fomo Products, Inc.
2775 Barber Road
P.O. Box 1078
Norton, OH 44203
(330) 753-4585

Insta-Foam Products, Inc.
1500 Cedarwood Drive
Joliet, IL 60435
(815) 741-6800

Clayton Corp./Convenience Products, Inc.
866 Horan Drive
Fenton, MO 63026
(314) 349-5333

Mine Safety Appliance Co.
Walden Road
Cranberry Township, PA 16066
(412) 967-3000

Ohio Sealants, Inc.
7405 Production Drive
Mentor, OH 44060
(216) 951-5678

Red Devil, Inc.
2400 Vauxhall Road
Union, NJ 07063
(908) 688-6900

Approved thickness measuring gauges and devices are available from various sources of supply, including

The Association of the Wall and Ceiling Industries—International
307 E. Annandale Road, Suite 200
Falls Church, VA 22042
Phone (703) 534-8300
Fax (703) 534-8307

Bottle screw caps are available from various sources of supply, including those listed below. Contact supplier to determine availability of cap that complies with requirements outlined herein.

Andler Bottle Co.
376 Third St.
Everett, MA 02149
(617) 387-5700

Thomas Scientific Co.
99 High Hill Road
Swedesboro, NJ 08085
(609) 467-2000

Appendix D–Conversion Factors

Conversion Factors. The following conversion factors shall be used when calculating density in accordance with the formulae referred to in this document:

1 pound (lb) = 0.4536 kilogram (kg)
1 kilogram (kg) = 2.204 lb
1 ounce (oz) = 28.359 grams (g)
1 gram (g) = 0.035 ounce (oz)
1 inch (in) = 0.0254 meter (m)
1 meter (m) = 39.37 inches (in.)
1 inch (in.) = 25.4 millimeters (mm)
1 millimeter (mm) = 0.04 inch (in)
1 cubic meter (m^3) = 35.3 cubic feet (ft^3)
1 cubic foot (ft^3) = 0.028 cubic meters (m^3)
1 cubic inch (in^3) = 16.387 cubic centimeters (cm^3)
1 cubic meter (m^3) = 61023 cubic inches (in^3)