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FiberTite® FM Approval

FM Global (Factory Mutual Insurance/FM) business roots extend back to 1835 with the founding of the Manufacturer's Mutual Fire Insurance Company. The company was formed by Zachariah Allen in conjunction with other Rhode Island textile mill owners in an effort to pool their resources for the purpose of reducing property loss. At the time, property loss prevention was an aberrant concept. So much so that efforts targeted at reducing risk and/or property loss weren't recognized by insurance companies as deserving of discounted rates. FM has progressed from a large conglomerate of individual insurance companies into today's ownership group.

FM's research, testing and subsequent standards in the prevention of property loss due to fire and wind have promulgated modern precepts for the design and installation of single ply roofing systems.

Although FM approvals are generally associated with wind uplift testing and performance, their 4470 Standard for Class 1 Roof Covers is much broader in scope. The complete FM approval process includes examination of a product's fire resistance, (above and below the deck) wind uplift resistance, simulated hail resistance, water leakage resistance, corrosion of metal parts and other small scale physical property testing when deemed appropriate.

Wind and Wind Uplift

Wind can be classified as being fluid in it's movement. When an object interrupts the air flow, a turbulence is created very similar to the effect of an object placed in a stream of flowing water. As a current of air strikes the side of a building or structure, it is deflected upward, condensing the air stream as it moves up the vertical plane of the building and mixes with the uninterrupted air flow above the horizontal plane of the building. This upward movement increases the velocity of the air current along the windward side of the building and the mixing of the air streams create localized areas of low pressure, or suction above the roof assembly. This negative velocity pressure (in lbs per sq. ft) is proportionate to, and can be determined by the wind velocity (in miles per hr). In other words, the higher the velocity, the greater the negative pressure.

The negative pressure functions like a magnet toward the building's interior pressure. An atmospheric area of high pressure will attempt to equalize itself by moving toward areas of lower pressure. Consequently, the turbulence along or above the building causes the air within the building (area of higher pressure) to push upward as it tries to equalize with the air above the roof assembly (area of low pressure). Hence, we have the term "wind uplift".

The publication of the American National Standards Institute's ANSI A58.1 Standard in 1972, provided designers the ability to mathematically estimate the uplift forces for buildings and other structures. The approach outlined in the ANSI Standard was embraced by FM and incorporated into Factory Mutual Engineering Corp.'s 1974 publication of Loss Prevention Data Sheet 1-7 "Wind Forces on Buildings and Other Structures". LPD 1-7 provided a series of tables that incorporated pre-determined velocity pressures into a matrix according to the building environment, height and design wind speed.

The matrix was included in LPD 1-28S "Wind Uplift Pressures on Roofs" and divided into three wind zones. Zone 1 included velocity pressures from zero to 30 psf. and Zone 2 for velocity pressures from 31 to 45 psf. In Zone 3, where pressures exceed 45 psf, special precautions were recommended. These "Wind Zones" were partitioned in accordance with I-60 and I-90 test criteria.

Wind and Wind Uplift (continued)

The I-60 (now 1-60) was derived from a mathematical evaluation of an 88 mph wind at an elevation of about 33 ft above ground. This scenario would generate a negative velocity pressure of approximately 20 psf. To this, Factory Mutual adds a shape or "turbulence" factor for low slope roofs of 1.5 times the velocity pressure. (20 psf x 1.5 = 30 psf) Hence, 30 psf is the velocity pressure for the roof area. To this pressure, a standard construction safety factor of 2 is assigned for a total value of 60 psf. This became the minimum pressure which a roof assembly must withstand in order for it to be classified for 1-60 construction.

The same formula was used to establish I-90 (now 1-90) but began with a 110 mph wind, corresponding to a velocity pressure of 30 psf. (30 psf x 1.5 x 2 = 90) Hence, 90 psf became the minimum pressure a roof system must withstand in order for it to be classified for 1-90 construction.

FMRC testing for and the evaluation of roofing systems for wind resistance began in 1954. The test procedure involved installing a sample roof assembly into a 5 ft. x 9 ft. x 2 in. static air chamber. The perimeter of the assembly was clamped to the chamber and incremental air pressure was forced beneath the roof assembly until failure. Roof systems were classified as either I-60 or I-90 according to their ability to withstand 15 pound incremental increases in pressure, beginning at 30 psf, for one minute each, up to and including the passing pressures of either 60 or 90 psf.

The terms 1-60 and 1-90 do not really represent any particular wind speed by themselves nor should they be used arbitrarily. The applicability of their individual reference has to be viewed in relation to a building's environment which includes building location, building height, permeability and a given design wind velocity.

FM I-60 and I-90 were the prevailing design standards for single ply roofing for almost 20 years. Then at 5:AM on August 24, 1992 South Florida experienced a significant wind event. The damage associated with Hurricane Andrew prompted FM to revise the test criteria for evaluating the wind resistance and approval of roofing systems.

Although the incremental pressurization of the roof system outlined in the original 4470 test criteria remained the same, the size of the test frame was increased from 5' x 9' to 12' x 24'. The larger test frame alleviated the contributory effects that the perimeter clamping devices may have had on the test results within the smaller test frame. The larger test frame also accommodates testing for wider row spacing and more accurately stresses the diaphragm of the decking.

In addition to modifications of the test criteria, the uplift pressures now contained within the tables in LPD 1-28 are not partinioned. FM currely lists approvals from 1-60 to 1-900. Now, the astute designer can either determine the numerical uplift pressures using the mathematical model presented in the ANSI Standard (now incorporated into the American Society of Civil Engineers ASCE 7 Standard) or use the FM Tables, apply a safety factory of 2 and select a roofing system that's tested within the limits of the quotient. In the case of a 32 psf velocity pressure, (32 x 2 = -64 psf) an appropriate roof assembly would only need to have meet the 75 psf test threshold.

FM is no longer publishing the Approval Guide. Approved assemblies are found in the FM "RoofNav" data base. The data base came online in 2005 and with, industry frustration. However, after ten years we are getting used to using it and the requirement for RoofNav numbers to support design requirements is ubiquitous.

Uplift Forces

Uplift forces on low sloped roofs will vary across three principle areas of segmentation. A negative force coefficient is given to each of these areas to determine the design velocity pressure for each individual area. The three areas are the field (-1), perimeter (-2) and corner (-3). Approved roof assemblies are evaluated for exposure to wind forces in the interior (field) of the roof only. Therefore, uplift pressures enumerated in the FM tables are only applicable to the field of the roof.

Uplift pressures are considerably higher in the corners and along the roof perimeter and these areas will require design enhancement. FM defines the width of roof corners and perimeter as being either 10% of the building's lesser plan dimension (width) or 40% of the eave height which ever is less subject to a minimum of 4 ft.

Enhancement to the securement of all components of the roof assembly are required in the perimeter and corners of the roof. Historically it was not necessary to calculate the increased pressures in the perimeter and corner. The negative pressure coefficients of -1, -2, and -3 had been accounted for in the following recommendation.

For mechanically attached insulation, the fastener density in the perimeter of the roof is to be increased fifty percent (50%) over the approved density of the fasteners in the field of the roof and the corners require a 70% increase in fastener density.

Uplift Forces (continued)

However, this is no longer the case for design requirments greater than 45psf. In January of 2006, FM updated Loss Prevention Sheet 1-29 to include a new set of requirements for adhered roofing systems that requires “tested” assemblies for compliance with the engineered requirements for perimeter and corner approvals. All the FM Loss Prevention Data Sheets are available online through the RoofNav portal.

Mechanically attached membranes also require enhancement but the increase in fastener density is not to be accomplished by increasing the number of fasteners along the laps. Instead, FM requires a reduction in the distance between the rows of fasteners. For the perimeter areas, the distance between the row is to be less than or equal to 60% of the approved field spacing. The distance between the rows of fasteners in the corners is to be reduced to 40% of the field approval.

It would not be feasible to manufacture a two third (2/3) roll or 60% wide roll, so half width rolls or half sheets are used to fill the designated perimeter area. When perimeter “half” sheets are incorporated into the design of the roof system along the perimeter, the fastener density is actually increased by one hundred percent (100%) while maintaining the same fastener spacing for the field membrane along the laps.

Further explaination regarding perimeter and corner enhancement for mechanically fastened roof systems is also available in FM LPD 1-29.

Fire and Combustibility

A focus on the combustibility of roofing systems in general was prompted by the catastrophic loss of life and property in the 1953 fire at the GM transmission plant in Livonia, Michigan. An equipment fire within the building created intense heat on the underside of the metal deck. The heat caused the bituminous vapor barrier that was applied directly to the steel deck to melt and vaporize. The volatile gases entered the building and ignited. The roof system continued to feed the fire until the 30 acres of roof collapsed.

In order to gain a better understanding of the factors that contributed to the GM fire, FM constructed a 20 ft. x 100 ft. building, dubbed the “White House”. The building allowed FM to duplicate the conditions at the GM plant and literally burn it down over and over, reducing the combustibility of the assembly until a successful combination of materials and methods were found that slowed the spread of the fire to six feet in thirty minutes.

Data from the White House testing was correlated toward the development of a significantly smaller scale and economically feasible lab test that would measure heat release and fuel contribution of roofing materials.

Measurements of heat release and fuel contribution rates for materials are now determined in the FMRC Construction Materials Calorimeter. Class 1 Insulated Roof Deck Construction “those not requiring automatic sprinkler systems in and of themselves” must meet maximum fuel contribution rates less than or equal to a 285 Btu/ft^2/min. average measured over the thirty minute test duration.

Exterior fire resistance is evaluated according to ASTM E108 test criteria. This testing includes spread of flame, intermittent flame and burning brand which mirrors Underwriters Laboratories UL 790 testing. Ratings are classified as Class 1 (A) or 1 (B) according to the following definitions:

> Class A tests are applicable to roof coverings that are effective against severe test exposure, afford a high degree of fire protection to the roof deck; do not slip from position and do not present a flying brand hazard.
>
> Class B tests are applicable to roof coverings that are effective against moderate test exposure, afford a moderate degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard.

Factory Mutual Research Corp. also offers a Class 1C rating similar to UL, but it too has little relevance in the design and specification of single ply roofing.

Hail Resistance

FMRC is currently classifying a roofing system’s hail resistance as either Class I-SH (Severe Hail Damage Resistant) or Class I-MH (Moderate Hail Damage Resistant).

Class I-SH testing begins with a 2 in. plastic tube, suspended from a tripod 17 ft. 9½ in. above the roof sample. Two samples each measuring 2 ft. x 4 ft and one artificially weathered sample measuring 12 in. x 24 in. are evaluated. An 1¾ in. steel ball weighing 0.79 lb. is dropped through the tube onto the sample. This is repeated ten times for each sample on various areas of the samples. The impact energy from the steel ball is approximately 14 ft lb (19 J) over the impact area.

Hail Resistance (continued)

Class I-MH testing is similar but utilizes a 2 in. steel ball weighing 1.625 lb dropped from a height of 5 ft. The impact energy from this test is reduced to 8 ft lb (10.8 J) over the impact area.

Test results must not show any signs of cracking, splitting, separation or rupture when examined under a 10X magnification.

FM Follow Up

In addition to product testing, the manufacturer is also evaluated through an examination of the manufacturing facilities which includes an audit of the manufacturing process and quality control procedures. These audits are intended to insure consistency within the process and formulations between products tested and those actually being produced. Products conforming to all the requirements of the 4470 Standard are qualified as Class 1 roof coverings. Class 1 roof coverings are those which do not present a significant fire hazard, will withstand wind uplift forces and hail stones when installed according to approval requirements.

Once a product has been approved or classified, it must bear the FMRC Approval Mark. The mark not only identifies an approved product but it also confirms that it is manufactured under periodic FM Facilities and Procedures Audits.

Seaman Corporation FiberTite® RoofNav® Guide

RoofNav® from FM Approvals provides access to the most up-to-date FM Approved roofing products and assemblies. The FiberTite RoofNav Guide is a reference provided by Seaman Corporation as an overview of *FiberTite-specific* information from FM Approvals, including lists of common FiberTite assemblies and their corresponding RoofNav numbers. This Guide is general in nature, intending to provide the user information pertaining to common roof system assemblies incorporating FiberTite roof membrane, and therefore should be viewed and used as a partial list from among the thousands of listings available on the FM Global RoofNav website.

Click Here to view Seaman Corporation FiberTite RoofNav Guide, including lists of common assemblies and corresponding RoofNav numbers.

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