Providing compete construction specifications documentation, systems and performance descriptions, and risk and quality advisory services.

ABSTRACT:
FM Global Data Sheet 1-28 helps calculate the wind uplift load. FM Global Property Loss Prevention Data Sheet 1-29 provides a simple, prescriptive method for the installation of base sheets, insulation, and system membranes.

FILING:
UniFormat™
B3010 Roofing

MasterFormat™
07 50 00 Membrane Roofing

KEYWORDS:
Wind uplift, wind loads, FM Ratings, Factory Mutual, FM Global.

STANDARDS:
FM 1-28 - Design wind Loads
FM 1-29 - Roof Deck Securement and Above-Deck Roof Components
FM 1-49 - Perimeter Flashing

FM Global Wind Uplift Ratings

By David Stutzman, AIA, CSI, CCS, SCIP, LEED AP

Factory Mutual

The first thing that should be explained about Factory Mutual (FM Global) is that they are not a governing code body, they are an insurance company. All testing is conducted by, and their standards written by, their own in-house engineers. Factory Mutual does not have any control over buildings they do not insure, even though many design professionals use the FM on-line calculator (www.roofnav.com) to determine wind uplift calculations. FM Global Loss Prevention Data Sheets 1-28, 1-29 and 1-49 are the most commonly referenced data sheets when designing a roof system.
Before calculating a wind uplift pressure and specifying a roof system, certain types of data about the building must be known. Overall height of the building, terrain surrounding the building, type of roof deck that will be installed, whether or not the building is considered a "special use facility" (hospitals, assisted living buildings, etc.) and the height of parallel walls are all taken into consideration.
As stated above the type of roof deck to be installed is critical to the type of roof system to be specified. The following is a list of FM approved roof decks:
1.) Steel, 22 gauge and heavier.
2.) Structural concrete, minimum 2,500 psi.
3.) Wood, minimum 3/4 inch thick fire rated plywood or minimum 2 inch thick dimensional lumber.
4.) Cementitious wood fiberboard.
5.) Lightweight insulating concrete.
6.) Fiberglass reinforced plastic.

Wind Uplift

Wind uplift is defined as a force that occurs when air pressure below the roof assembly is greater than the air pressure above the roof system. As air flows over the roof the pressure directly above roof decreases and at the same time the air pressure inside the building increases in an attempt to equalize the pressure differential.
Many design professionals assume wind classification ratings such as 1-60, 1-75, or 1-90 represents wind speed. This is not true. For instance, the 1-90 rating represents a Class 1 interior fire classification and the 90 represents 45 pounds per square foot of actual field of roof wind uplift pressure. Wind uplift pressures often vary at different locations of the roof. The most vulnerable roof areas are the corners and the perimeter. The field area of the roof is less susceptible to uplift damage.
"Importance Factor" and "Safety Factor" also play a role in roof design. The Importance Factor was originated to increase the designed seismic forces to provide additional seismic resistance where required. In time, the Importance Factor eventually made it's way into snow and wind load designs as well. FM Global recommends a minimum Importance Factor of 1.15 for all roof designs.
The Safety Factor is defined as "The ratio of the maximum stress or load which something can withstand to the stress or load that it was designed to withstand under normal operation." FM Global recommends a minimum Safety Factor of 2.0 for all roof designs unless the roof is to be installed on a "special use facility",

where a Safety Factor of 3.0 should be specified.

Testing

For mechanically attached single-ply roof systems a test assembly is constructed consisting of a 5 x 9 foot frame with 22 gauge steel roof deck attached to purlins. Insulation is then mechanically attached to the steel deck followed by single-ply membrane mechanically attached over the insulation into the steel deck. The test frame is clamped to a pressure vessel that is then pressurized to 15 lbs. psf and held at that level for one minute. If the roofing system remains undamaged for the one minute then the pressure is raised to 30 psf for one minute. The process in repeated in 15 lb. increments until any component in the system fails. When the failure occurs the test is stopped and the approval rating is established at the level PRECEEDING the failure, for example, if the failure occurs at 105 psf then the approval level will be set at 90 psf. Fully adhered single ply systems and built-up systems are tested in the same manner but only on a 5 x 9 foot test frame, and only to approvals of up to I-90. For ratings greater than 1-90 the system must be tested on a 12 x 24 foot test frame, probably at considerable additional cost to the roofing system manufacturer.

Miscellaneous

1-90 is considered the default standard for roofing systems that are not located on a coastal or high wind area, but project location must also be considered before specifying a roof system. A roof in the State of Wisconsin may be designed to the 1-60 or 1-75 uplift requirements to cut down on the cost of the materials required for the installation of the roof but since Wisconsin will have more hail storms than other areas of the country hail must be taken into consideration when specifying a roof system.

Prior to 2006, after the appropriate rating had been determined for the field of the roof, FM called for an increase of 50% more fasteners at the perimeter, and 75% more in the corners. The latest FM Revision requires that the perimeter and corners have separate ratings based on the field rating. In the case of FM 1-90, the system must meet FM 1-150 at the perimeter and FM 1-225 in the corners. This type of rating is not generally achievable with mechanically attached insulation, especially on steel decks. In some instances, enhancements to the structural deck are required to meet these ratings. In the case of the higher ratings for the field of the roof, such as FM1-150, compliance may not be possible regardless of the system type or number of fasteners used.

Examples of differing rating requirements per the FM revision are:

Field of Roof- FM 1-90
- Perimeter Requirement FM 1-150
- Corner Requirement FM 1-225

Field of Roof- FM1-120
- Perimeter Requirement FM 1-195
- Corner Requirement FM 1-295

Field of Roof- FM1-135
- Perimeter Requirement FM 1-225
- Corner Requirement FM 1-330

Field of Roof- FM1-150
- Perimeter Requirement FM 1-255
- Corner Requirement FM 1-360

Conclusion

FM Ratings for roof construction are an example of "outside forces" other than Mother Nature exerting strong influence on building design. In this case the findings and requirements of insurers actually drive the design requirements of roof systems. Regardless of whether or not this can be considered a desirable condition, it is a fact of life. Achieving the required FM ratings for the area and exposure is essential to the building owner's best interest, enabling the owner to properly insure his property.

Roofing manufacturers have systems that meet various FM ratings. It is very important for the designer to review the manufacturer's recommended system against the design, to make certain that the manufacturer specifically includes every design feature. For example, the manufacturer's description of the recommended roofing system may describe a maximum thickness of rigid insulation. The designer must check such provisions against his or her design to ensure that all aspects of the design are within the limits of the system. Any outstanding items can usually be addressed in a technical letter from the manufacturer. Careful design and careful review of recommended systems will result in a sound roof system.

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