WIND TESTING

Understanding Factory Mutual Wind Testing and Ratings

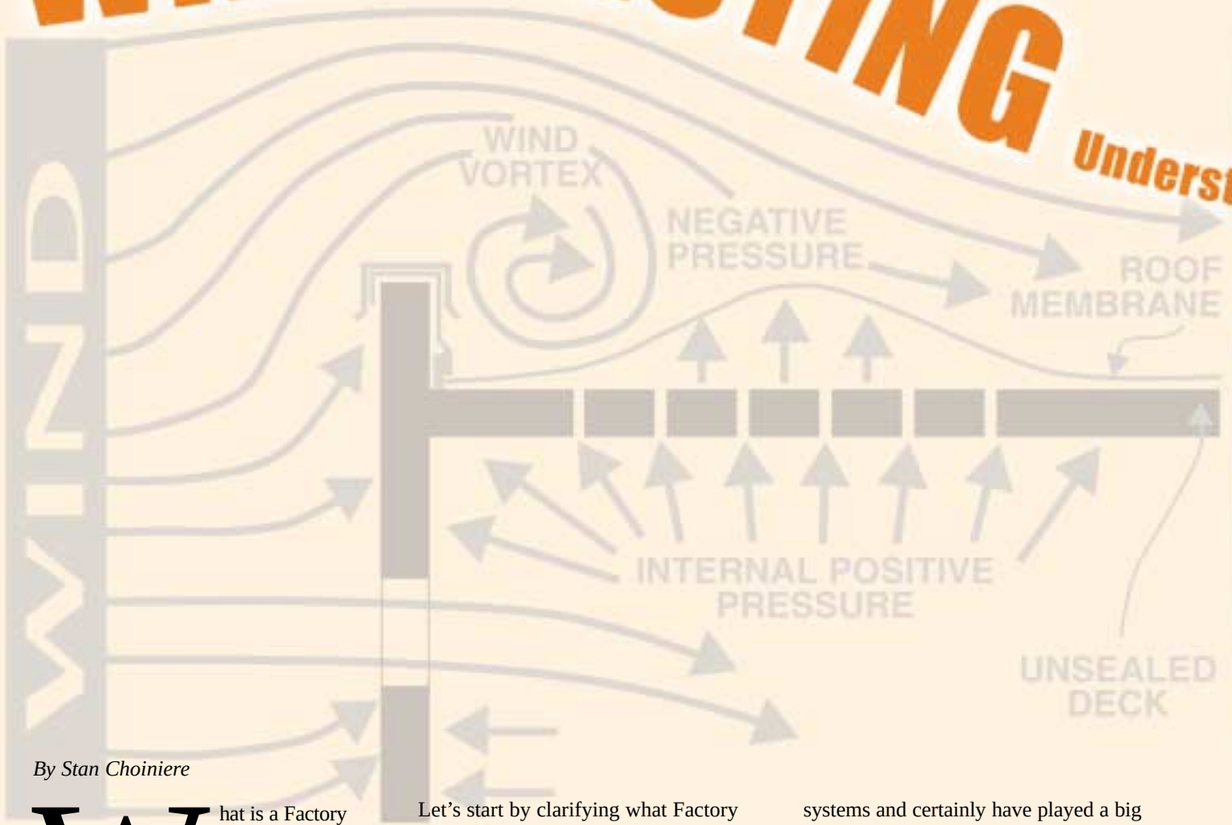

Photo appears courtesy of RCI

Membrane billowing between points or lines of attachment.

By Stan Choiniere

What is a Factory Mutual wind test and what do the various wind uplift ratings mean? This question is frequently asked, but seldom answered correctly.

Before we can answer the question, however, we must first define wind uplift. Roof damage caused by wind occurs when the air pressure below the roofing assembly is greater than the air pressure above the building's roof. As wind flows over the building, the pressure directly above the surface of the roof decreases. At the same time, internal air pressure increases in an attempt to equalize this pressure differential, resulting in an upward force of air from below the roofing system. This force is referred to as wind uplift.

Let's start by clarifying what Factory Mutual is and their role in commercial flat roofing. Factory Mutual, as we deal with them, is the research and testing arm of a group of insurance companies who insure various types of commercial and industrial buildings for property loss. Factory Mutual has a huge inventory of buildings under their coverage. Based on their experiences over many years, Factory Mutual has developed many test standards and industry protocols on various insurance-related topics. While this article is focused on wind testing, Factory Mutual also tests roofing systems for fire resistance, hail resistance and weather resistance as well as other physical properties.

Factory Mutual requirements have driven the evolution of many types of roofing systems and certainly have played a big role in the development of the high performance fastening systems we use today.

However, Factory Mutual is not a building code body, nor do they have any control over properties that are not in their inventory of insured buildings.

Regardless, Factory Mutual standards are required by many roofing specifications because designers don't always understand Factory Mutual's role or the wind ratings.

The most common mistake that people make is the belief that Factory Mutual windstorm classification ratings such as 1-60, 1-90 or 1-120 correlate to 60, 90 or 120 mph respectively of wind speed. They don't. The ratings apply to uplift pressures in pounds per square foot, not wind speeds. Furthermore, the roofing designer or specifier assumes that if there is a design wind speed requirement of 80 mph, that the roof system must have an 1-90 rating, which is not always true, at least not for the reason they think.

The second most common mistake a designer or specifier makes is that wind speed is the only factor used in the equation to determine which Factory Mutual level system is needed. For Factory Mutual, geographic location plays a significant role in system level selection.

Consider the example below of how Factory Mutual windstorm classification ratings are used correctly in roofing design.

The first step is to verify that the building in question is indeed insured by a Factory Mutual company. Once that has been confirmed, a variety of data must be gathered about the building and the geography, such as:

- The building's overall height.
- The terrain surrounding the structure.
- The type of roof deck on the building.
- Whether or not the existing deck meets Factory Mutual minimum standards.
- Whether or not the building is a "special use" facility such as an airplane hangar, a hospital or a facility with many large dock doors, etc.
- Whether or not the building has parallel walls, and if it does, their height.

These and other factors are used in conjunction with Factory Mutual Data Sheet 1-28 to establish the uplift forces on the specific building. The wind loads will vary in the corners, perimeter and field of the roof. While Data Sheet 1-28 will help to determine the specific "size" of the corner and perimeter zones, Data Sheet 1-29 will explain how to properly fasten the roof system in these high risk areas.

Let's assume that the calculations for our building require a roof that can withstand 23 pounds per square foot of uplift force in the field of the roof. Because Factory Mutual requires a 2:1 safety factor, roofs with uplift forces of 30 lbs./sq. ft. are the maximum for 1-60 ratings, and 45 lbs./sq. ft. are the maximum for 1-90 ratings etc. In this scenario, our building which is

What to Expect

Below are some of the topics that you should discuss with your roofing contractor. Having these discussions early in the process could save you considerable time when your project comes to fruition:

- Is the building FM insured? If the building is FM insured, make sure the system that your contractor recommends meets the proper windstorm classification.
- Does the recommended system meet all local building code requirements in addition to the Factory Mutual requirements?
- Understand that roofing manufacturers' warranties do not acknowledge or imply compliance with Factory Mutual approvals or building codes.
- Make sure you know what type of deck the facility has and that the building meets Factory Mutual requirements.
- If a Factory Mutual rated system is required, ask your contractor to discuss the options with the membrane manufacturer. In many instances, manufacturers have approval ratings that the contractor may not be aware of, which could save you lots of money in terms of labor costs.

designed with 23 lbs./sq. ft. of uplift would require an FM 1-60 system design, and follow the requirements of Data Sheet 1-28 for corner and perimeter enhancements.

As was stated earlier, Factory Mutual approvals are specified carte blanche by many designers on buildings that are not Factory Mutual insured. The assumption is that such systems are safe and can reduce the designer/specifier's liability. However, in many instances these non-Factory Mutual insured buildings do not meet Factory Mutual's minimum requirement for roof decks, etc., yet the designer still calls for an approved system. A perfect example of this occurs frequently on the West Coast where half-inch plywood is commonly used for roof deck construction. Half-inch plywood does not meet Factory Mutual requirements regardless of the roof cover type.

If a building is Factory Mutual insured and has a non-conforming deck type — such as half-inch plywood — Factory Mutual will work with the building owner/designer to find an acceptable roof cover for that project. In general, Factory Mutual approved decks include:

- Steel — 22 gauge and heavier.
- Structural concrete — minimum 2,500 psi.
- Wood — three-quarter-inch minimum fire resistant plywood, or minimum two-inch thick fire resistant dimensional lumber.
- Cementitious wood-fiber — such as Tectum.
- Fiber reinforced cement (i.e. precast).
- Lightweight insulating concrete.
- Fiberglass reinforced plastic.

In 1986, Hurricane Hugo ripped through the Carolinas leaving miles of devastation in its wake. Then, in 1992, Hurricane Andrew pounded South Florida like few storms ever before. The ripple effect of these hurricanes forever changed the face of the commercial roofing industry. As a legacy to these storms, roofing manufacturers continue working to develop roofing systems which will economically meet new, more stringent, Factory Mutual wind uplift standards, enhanced windstorm classifications, and Dade County test protocols.

The specific test that pertains to wind uplift utilizes a test apparatus designed by Factory Mutual over 20 years ago and modified in the early 1990s, after Hurricane Andrew.

For a roofing system to qualify for Factory Mutual approval, it must be tested at Factory Mutual. The testing is conducted to Factory Mutual standards and it must be conducted in the Factory Mutual testing laboratory. The specific test that pertains to wind uplift utilizes a test apparatus designed by Factory Mutual over 20 years ago and modified in the early 1990s, after Hurricane Andrew. For mechanically attached single-ply roofing systems, the test involves building a roof assembly on a test frame that measures 12-feet x 24-feet. The test frame has a 22 gauge steel roof deck attached to purlins. Insulation (any type) is then fastened to the steel deck and the single-ply membrane is fastened over the insulation to the steel deck. The test frame is clamped to a pressure vessel that is pressurized to 15 pounds per square foot (psf) and held at that level for one minute. Assuming that the roofing system remains undamaged at the end of the first minute, the pressure is increased to 30 psf and held for another one minute period. This process is repeated in 15 lb. increments until any

Factory Mutual windstorm classification ratings are determined using a test frame that measures 12-ft. x 24-ft., like the one shown above.

The ratings apply to uplift pressures in pounds per square foot, not wind speeds.

component of the system fails. As soon as a failure occurs the test is stopped and the approval for that assembly is established at the level preceding failure. For example, if the pressure level was at 105 psf when the failure occurred, the approval level would be set at the preceding level or 90 psf, giving the assembly a 1-90 rating. Failure can be any number of events such as de-lamination of the roof seam, membrane tear, screw pullout, etc.

While the test is conducted on a steel deck, extension of these approvals to other approved decks is common based upon favorable comparative testing of the appropriate fasteners for the respective deck types.

For fully adhered single-ply systems as well as for BUR systems, the testing is conducted the same way with the only difference being the size of the test frame. For these systems the test frame is 5-feet x 9-feet. However, as an added twist, Factory Mutual only grants approvals of up to 1-90 for assemblies tested on the 5 x 9-foot frame. Any ratings higher than 90 psf for these systems must be earned on a 12-foot x 24-foot test frame.

It is important for building owners and designers alike to understand that Factory Mutual ratings do not correlate to miles per hour of wind speed, and that understanding FM testing procedures and windstorm classification ratings will help avoid the many potential problems associated with wind uplift, one of the most common enemies to any commercial roofing system. ▲

About the Author

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