Fundamentals of wind design

by **Mark S. Graham**

Although the primary function of roof assemblies is to provide watertight protection of buildings' interiors, roof assemblies' abilities to resist wind also are critical functions.

Fundamentals

The fundamental concept of wind design as it applies to roof assemblies is that the design wind loads that will occur on a building's roof assembly should be less than or equal to the wind-resistance (uplift-resistance) capacity of the roof assembly. This is mathematically depicted as $w_l \leq w_r$ where w_l = design wind load and w_r = wind resistance, which typically is measured in pounds per square foot (kPa).

In the event actual wind loads exceed a roof assembly's actual resistance capacity, failure (blow off) of the roof assembly is possible. Therefore, it is important a building's design wind loads and roof assembly's wind resistance accurately be determined.

Wind loads

Design wind loads are mathematical predictions of anticipated maximum wind loads that apply to a specific building (taking into account configuration, height and size) and location.

Specific procedures for determining design wind loads typically are described in building codes. For example, in the *2003 International Building Code* (IBC), permissible design wind-load determination procedures are provided in Chapter 16—Structural Design. IBC Section 1609—Wind Loads provides prescriptive procedures for determining a building's design wind loads. For determining design wind loads, IBC also allows the use of ASCE 7, "Minimum Design Loads for Buildings and Other Structures," and, in certain instances, SBCCI STD 10, "Standard for Hurricane Resistant Residential Construction." For more information about ASCE 7, see "Detailing ASCE 7's changes," page 26.

FM Global's Property Loss Prevention Data Sheet 1-28 (FM 1-28), "Design Wind Loads," provides an additional means of determining design wind loads for roof assemblies. The current edition of FM 1-28, published in January 2002, is said to be based on ASCE 7, but it is not specifically included as a permissible reference in model building codes.

Resistance

Many low-slope roof assemblies are laboratory-tested to determine their wind-resistance properties.

FM Approvals standards FM 4450, "Approval Standard for Class 1 Insulated Steel Deck Roofs," and FM 4470, "Approval Standard for Class 1 Roof Covers," are two recognized laboratory test methods for determining the wind-uplift resistances of roof assemblies. FM 4450 and FM 4470 are the basis of FM's 1-60, 1-90, 1-120, etc., approvals.

Underwriters Laboratories (UL) Inc.'s standards UL 580, "Test for Uplift Resistance of Roof Assemblies," and UL 1897, "Uplift Tests for Roof Covering Systems," provide additional recognized methods for determining uplift resistance. These test methods are the basis for UL's Class 15, Class 30, Class 60, etc., ratings.

Closing thoughts

Proper evaluation of design wind loads and resistance is an important consideration for roof assembly design.

Determining roof assemblies' design wind loads should be conducted by roof assembly designers. If a designer does not feel comfortable performing the necessary analysis, I encourage him to retain a structural engineer or consultant experienced in wind design. Determining design wind loads is beyond the practical expertise of many roofing contractors.

Determination of roof assemblies' resistance capacities also should be conducted by roof assembly designers. Information regarding wind-resistance approval listings are provided in FM's *Approval Guide* and UL's *Roofing Materials and Systems Directory*. Additional information also may be available from roof system manufacturers.

When comparing uplift resistances using FM and UL approval ratings, it is important designers realize FM's approvals already include an appropriate safety factor but UL's uplift-resistance ratings generally do not. When using UL's uplift-resistance ratings, I recommend designers incorporate appropriate safety factors.

For roof assemblies where mechanical attachment of rigid board insulation is necessary to achieve an FM or UL approval listing, roof assembly designers should graphically depict the fastener pattern for the specific approval listing used on their drawings or project specifications. Determining fastener patterns should not be left to roofing contractors because they may not be aware of the specific roof assembly approval listing used in a project's design.

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