From: metalmag September 2009 | Posted on: September 10, 2009

Winds of Change

Methods for Verifying Wind Resistance Continue to Evolve

By: Scott Florida

A metal roof system's ability to withstand wind forces is critical in determining how well it can serve its primary function of protecting interior contents. Even minimal wind damage to a roof can dramatically increase property losses due to the accompanying water-related damage.

While current test methods for commercial roof coverings rely upon air pressure in a closed system (for uplift) rather than wind, procedures have continued to evolve and incorporate the latest research findings. Local building codes and product certifications also can help as building designers sort through the often complex process of designing an effective metal roof system.

Wind Damage

During a windstorm, the force of the wind pushes against the outside of building and is passed from the roof to the exterior walls and finally to the foundation. Buildings can be damaged or destroyed when the energy is not properly transferred to the ground. Building occupants can be injured and flying debris can cause secondary damage.

Danger from wind events is a serious issue. The Silver Spring, Md.-based National Weather Service summarizes fatalities, injuries, and damages caused by severe weather. There were 70 wind-related deaths in 2008, more than doubling the 2007 total of 34 and well above the 10-year average of 47 victims. For comparison, the National Weather Service tracks 10-year averages for other severe weather events such as heat (170), floods (74) and lightning (44). According to climate data compiled by the Londonderry, N.H.-based Tree Care Industry Association, there were 407 deaths caused by wind related tree failures in the U.S. during 1995-2007, an average of 31 per year.

A study published in the *Journal of Business Valuation and Economic Loss Analysis* titled "Analysis of Wind-Induced Economic Losses Resulting from Roof Damage to a Metal Building," by Apoorv Dabral and Bradley T. Ewing, showed that metal roofs are highly susceptible to hurricane wind damage.

Damage to the roof is extremely significant in the estimation of losses. Even small damage can be a significant contributor to the total damage of a structure because of the entrance of rain into the building. The study also highlighted the cost effectiveness of mitigation. According to statistics from the National Weather Service, thunderstorm wind events alone caused more than $1.2 billion worth of property damages in 2008.

Codes and Standards

In the early 1970s, there was increasing interest among building designers to incorporate wind loads into model building codes. The problem, however, was that existing standards from the Washington, D.C.-based American National Standards Institute were based on testing high-rise buildings. Low-rise buildings, frequently constructed of metal, reacted differently to wind based on boundary layer flow and the action of turbulence. The Cleveland-based Metal Building Manufacturers Association was instrumental in sponsoring wind-load research aimed at settling differences among standards.

During the 1980s, the Standard Building Code adopted these low-rise building standards, and in the 1990s, the American Society of Civil Engineers, Reston, Va., incorporated the standards in its standard, ASCE 7, "Minimum Design Loads for Buildings and Other Structures." The new International Building Code, which combines the regionally focused National Building Code, Standard Building Code and Uniform Building Code, recognizes the ASCE wind-design loads.

Building codes generally require metal roofs to resist design wind-load pressures without any damage to roof systems. The 2000 IBC, for example, is very explicit in requiring that metal-roofed buildings adequately address wind uplift. The code addresses issues of roof design and product testing.

Designing for Wind

Many factors influence the magnitude of wind velocity across a roof deck and the resulting uplift pressures. Wind gusts for the building location, the shape of the roof deck, edge configuration and the surrounding structures all influence a roof's wind resistance. Spacing and physical properties of supporting structural members such as gauge, yield strength and grade influence design and can affect fastener attachments.

Furthermore, wind resistance is influenced by secondary supports, such as beams, purlins and joists, as well as their connections to main structural members and construction details along edges and near openings like skylights and chimneys.

Luckily, building designers have several resources available when designing roof systems. The Rosemont, Ill.-based National Roofing Contractors Association, in cooperation with the Lawrence, Kan.-based Midwest Roofing Contractors Association and Braintree, Mass.-based North/East Roofing Contractors Association, offer an online wind-load calculator called Roof Wind Designer. The calculator, available at www.roofwinddesigner.com, provides roofing professionals a means of accurately determining roof systems' design wind loads for common building types.

The Metal Building Manufacturers Association publishes the *Metal Roofing Systems Design Manual*, a resource for architects, manufacturers, engineers, specifiers, builders and other professionals involved in the metal roofing industry. The manual includes systems components, details, substrates, specifications and standards, as well as information about retrofit, common industry practices, design, installation, energy and fire protection.

In cases where the structural standing seam roof system is supplied as an item separate from the building's structural system, the MBMA also offers its "Metal Roofing System Guide Specification" for use. The specification is available for free download from the association's Web site, www.mbma.com.

Testing for Wind Resistance

There are several recognized laboratory test methods for determining the wind-uplift resistances of roof assemblies. Norwood, Mass.-based FM Approvals—a third-party certification firm tied to the insurance industry—certifies against standards FM 4450, "Approval Standard for Class 1 Insulated Steel Deck Roofs," and FM 4470, "Approval Standard for Class 1 Roof Covers." Another standard setting body is the Camas, Wash.-based Underwriter's Laboratories and its standard UL 580, "Tests for Uplift Resistance of Roof Assemblies" and UL 1897, "Uplift Tests for Roof Covering Systems." A manufacturer meeting these standards obtains certification marks such as FM's 1-60, 1-90, 1-120, etc., or UL Class 15, Class 30, Class 60, etc., ratings. The designations refer to pressure tests; a UL-15 mark means the products withstood nominal static uplift pressure of 15 pounds (6.8 kg) per square foot.

The UL 580 test method subjects a 10- by 10-foot (3- by 3-m) test sample to various static and oscillating air pressures to predict performance under uplift loads imposed on roof decks. The test examines the comparative resistance of roof assemblies to positive and negative pressures and evaluates the roof deck, as well as its attachment to supports and roof covering materials.

When designing a roof system over open framing or structural members, building codes require testing results established by the West Conshohocken, Pa.-based ASTM International. The ASTM E1592 protocol requires tests be performed on a 12- by 24-foot (3.7- by 7.3-m) apparatus where a specific standing seam metal product is installed for testing. The test specimen then is pressurized to simulate the effects of negative wind pressure on a rooftop.

The MBMA initiated tests against the ASTM E1592 standard in the 1980s to better predict the actual performance of metal roofing against high wind uplift forces. Using a grid of 34 electromagnets, the tests simulated a dynamic wind event patterned after winds recorded in 1992 during Hurricane Andrew.

Results indicated that the E1592 uniform pressure test was a conservative estimate of real wind uplift. The findings later were incorporated in to the Washington-based American Iron and Steel Institute's metal roof specifications.

Understanding how wind interacts with a building is the first step in designing a long-term roof solution. Different material choices can influence how different zones on the roof behave under different circumstances.

Although the interlocking or active fastening of most metal roof panels allows them to pass severe wind and uplift tests, working with a knowledgeable roofing expert is the best choice when designing roof systems.

Scott Florida *writes about metal and architecture from Oakland, Calif.*

Related Articles

- Codes and Standards
- Why Cool Metal Roofs?
- Metal Roof Maintenance Matters
- Metal Roofs Ideal for Rainwater Capture
- Minimizing Condensation on Metal Coil

All Related Articles

Related Topics

- Roofing