Tests help reduce wind damage

by Bob LaCosse

Year in and year out, roofs are damaged by windstorms, gales, squalls, hurricanes and tornadoes. These wind forces cause roof components to separate and blow off. They can also blow aggregate off the roof, causing further damage by breaking glass in neighboring structures and injuring bystanders.

Repairing this damage can be expensive. In Houston, just one storm, Hurricane Alicia, caused millions of dollars worth of damage when it blew aggregate from downtown roofs through the glass curtain walls of nearby buildings. Some estimate that windstorms are costing building owners, the roofing industry and especially the insurance companies almost $1 billion each year.

Looking for answers

The threat of heavy losses has prompted code groups, the insurance industry, building material manufacturers and roofing contractors to search for the causes of wind-uplift failures. They have found that many of these failures are caused by the increased use of flexible thinner gauge steel decks with stiffer grooves and narrower top flanges. These decks are being used to span longer distances with less securement at the ends and no fastening at the sidelaps, creating flange dishing and providing an inadequate flat contact surface to receive adhesive and insulation. In addition, these thin-gauge decks deflect excessively under traffic loads, which causes the adhesive bond to fail. As a result, steel roof decks experience wind blowoffs more frequently and on a larger scale, the research has indicated.

Strip mopping, another recently adopted roofing procedure, has also increased the incidence of blowoffs. Factory Mutual (FM) established the practice of strip mopping to reduce the amount of bitumen applied directly to the metal deck. FM had found that excessive bitumen on the deck presented a fire hazard. Strip-mopped roofs were not adequately wind-resistant, however. Because of this, FM now requires the first layer of insulation to be mechanically fastened to a steel deck rather than strip mopped.

Evaluating the systems

Research has also led to test procedures that subject roofing materials to various simulated wind conditions. By testing roof components under controlled conditions, researchers hope to be able to predict a roof's performance during an actual windstorm. Some groups, such as FM and Underwriters Laboratories (UL), have developed laboratory and field test procedures that determine if roof assemblies comply with insurers' wind-resistance requirements.

UL's laboratory test uses an apparatus that consists of three primary units. The middle unit holds the deck specimen, to which a 10-foot-by-10-foot section of the roof to be tested has been attached. Below the test specimen is a unit that is capable of building up a positive pressure on the underside of the deck. This unit is designed to allow researchers to view the interior activity of the deck. Above the roof sample is another unit in which negative pressure is created. It, too, has viewing ports. This equipment is designed to simulate wind pressure from within a structure as well as the oscillating wind pressures that can occur on a roof's surface.

Roofs tested in UL's apparatus are rated according to the amount of pressure they can withstand. For example, to receive a 90-pound uplift classification, a test roof must pass the requirements of the 30- and 60-pound ratings and withstand loadings equal to 0.6 times the wind velocity pressure on the underside and 0.7 times the wind velocity pressure on the topside. UL also subjects test roofs to oscillating conditions where the negative pressure on the top surface is regulated according to the roof classification being tested.

The complete UL test cycle lasts 1 hour and 20 minutes and is precisely controlled. To pass the test, an assembly must remain intact during the full duration of the test period. More complete details of this test may be found in the document UL580 under the title "Tests for Wind-Uplift Resistance of Roof Assemblies."

FM's laboratory test evaluates only steel decks. The test apparatus consists of a 5-foot-by-9-foot roof deck specimen with the roofing and insulation in place. The test sample is clamped to a unit that creates positive pressure on the underside of the roof assembly.

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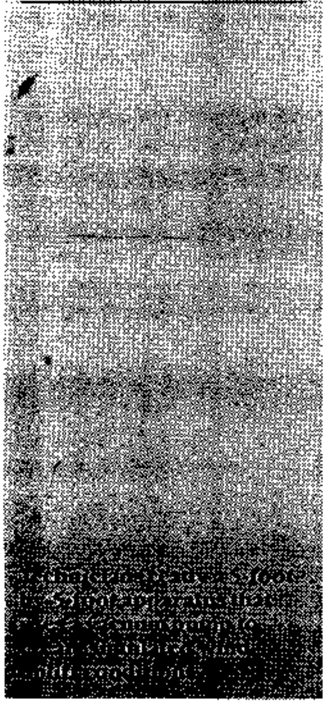

To meet the requirements for FM Class 1 construction, a roof system must show no evidence of roof bond separation between any of its layers, nor any delamination of the roof insulation while it is subjected to various pressures for the lengths of time listed in the chart below.

Pressure (Pounds per Square Foot)	Time (Minutes)
30	0:00 to 1:00
45	1:00 to 2:00
60	2:00 to 3:00
75	3:00 to 4:00

Further details of this test and FM's requirements for Class 1 construction may be found in FM loss prevention data sheets *1-7 on Wind Forces on Buildings and Other Structures* and *1-28 on Insulated Steel Deck.*

FM also recognizes two field wind-uplift test procedures to determine if a built-up roofing assembly attached to a steel deck has adequate wind resistance. One field procedure uses a 5-foot-by-5-foot test apparatus that creates a controlled negative pressure on the roof surface by means of a chamber fitted with a pressure measuring device and a vacuum pump. The American Society for Testing and Materials' designated method for field testing uplift resistance, known as E907, uses equipment comparable to FM's negative pressure apparatus.

FM's other procedure is a destructive test that requires cutting through the roof components. A scale is attached to this test cut to measure the amount of force required to pull the sample loose from the deck. This pull test is not valid with mechanical fasteners and is not recommended by FM when the roof slope exceeds 1¼ inch per foot. FM has published complete details of these tests in its loss prevention data sheet *1-52 on Field Uplift Tests.*

More information on wind-uplift testing and requirements is available from the American National Standards Institute (ANSI). ANSI's standard A58.1 for minimum design loads in buildings and other structures contains wind-uplift design data for roof assemblies built in various locations across the United States. The ANSI A58.1 requirements, which form the basis for the model national building code groups' wind-load provisions, are incorporated in the FM wind-uplift design procedure.

Ballasted roofs being tested, too

The test procedures already mentioned are primarily for built-up roofing assemblies and adhered systems. There are some efforts being made to develop design criteria for ballasted roofing systems as well. Two recently released documents are being considered as possible standards. The first document was developed by the Single Ply Roofing Institute. Its *Wind Design Guide for Ballasted Single-Ply Roofing Systems* was submitted to the International Conference of Building Officials for inclusion in the Uniform Building Code. The second document, released by the Rubber Manufacturers Association, is presently being balloted and considered as an ANSI standard.

Anyone with questions regarding wind-uplift problems or the test procedures may call NRCA's Technical Services Department for help and information.