ENGINEERING REPORT

TOPIC: Hurricane Design Louvers

Report No. ERHDL-998 **SEPTEMBER 1998** **By James Livingston**

Background

Many coastal areas are confronted with the devastating effects of hurricanes and other severe weather systems every year. The Atlantic basin alone averages 9.3 tropical storms, 5.8 hurricanes and 2.2 major hurricanes annually. This area encompasses the Atlantic Ocean, Caribbean Sea and the Gulf of Mexico. According to expert hurricane forecaster William Gray, Professor of Atmospheric Science at Colorado State University, this area "is entering an era that will see many decades of increased hurricane activity which will include particularly intense hurricanes[1]." There are indications that this prediction may prove to be accurate considering that 1995 through 1997 was the most active three year period of severe weather in this region in the last 120 years. During that period, the Atlantic basin endured 39 named storms, 23 hurricanes (12 were classified as intense hurricanes with winds of 111 mph (185 kph) or more) and 107 hurricane days.

The South Florida Building Code (SFBC) implies that products to be installed on the exterior of buildings must be designed to withstand the severe conditions produced by hurricanes. However, the widespread failure of various building products discovered in the aftermath of Hurricane Andrew in 1992 identified a need for stronger enforcement of the Code. Recognizing that standardized testing and product control could assist enforcement, the Miami-Dade County Florida Building Code Compliance Office (BCCO) developed a series of test protocols that subject products to the rigors of hurricane wind and rain conditions.

Miami-Dade County, Florida Tests

The test protocols developed by the Miami-Dade County BCCO are designed to evaluate exterior products such as louvers, roofing systems, wall systems, windows and doors. Manufacturers conduct these tests on their products at approved independent test labs. Upon successful completion of the tests, a submittal package consisting of test reports, calculations and drawings is compiled and submitted to the BCCO for review. If the results are satisfactory, the product will be granted approval for use in Miami-Dade County for three years in applications similar to the test conditions.

Louver Testing

To gain Miami-Dade County approval, louvers may be required to pass as many as four different tests depending upon their application. These tests are referred to as PA's, or Protocol and Application Standards. They are defined in Volume 2 of the Miami-Dade County Protocols, which is comprised of test methods originally developed for roofing components and roofing system assemblies (Volume 1 consists of Application Standards and field test procedures). There are four tests that may be conducted on louvers; three are structural in nature and one measures wind driven rain penetration resistance. There are two criteria that determine which tests are required. The first is whether the room or structure that the louver is installed in is designed to be "wet" or "dry." Wet rooms are designed to drain water that may penetrate and house items that are water resistant. Dry rooms are not designed to drain water penetration and/or contain non-water resistant items. This criteria determines whether the louver must prevent water penetration into the room. The second criteria is if the room is designed to be an "open" structure that can handle high pressure created by hurricane wind, or a "closed" structure which can not handle high pressure. This

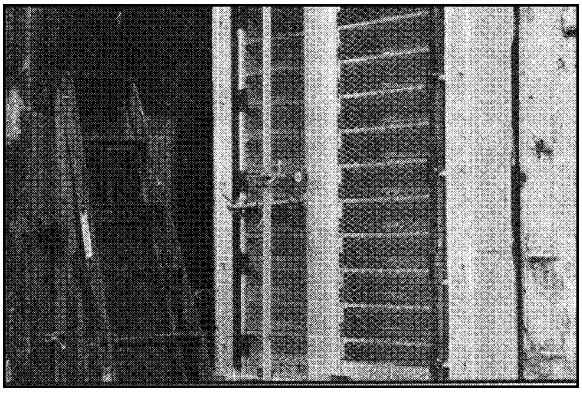
determines whether the louver must stop wind gusts from entering and pressurizing the structure. This is very important because if the building envelope is compromised, high internal pressurization can build inside the room forcing the walls outward and the roof upward. In severe storms, this can lead to the destruction of the entire building. An important fact to remember is that a manufacturer can gain approval for specific applications without conducting all four tests. This means that a louver may have Miami-Dade County approval, but only for certain applications. For example, if a louver passes the structural tests only, it will be approved for use only in wet areas as described above.

If the room that the louver is installed in is designed to be dry, the BCCO requires that the PA-100(A) Wind Driven Rain Penetration Test be performed. This test subjects the louver to high velocity winds and heavy simulated rainfall. Using a wind generator and water jets that inject the equivalent of 8.8" (224 mm) per hour rainfall into the airstream, 15 minute tests are run at wind velocities of 35, 70, 90 mph (58, 117, 150 kph). The final 110 mph (184 kph) test is performed for 5 minutes. The louver must allow no water penetration at 35 and 70 mph, and only .05% penetration of the water applied at 90 and 110 mph. In quantitative terms, the amount of allowable water penetration during the 15 minute period at 90 mph is 42.6 milliliters or .72 oz. During the 5 minute interval at 110 mph, 14.2 milliliters or .24 oz. of water is allowed. No airflow is being pulled through the louver during the test.

If the louver is installed in a room that can drain water and houses water-resistant items, the wind driven rain test is not required. Instead, the PA-202 Uniform Static Air Pressure Test must be performed. In this procedure, the louver is installed in a chamber and uniform static air pressure is applied in positive and negative directions. Several pressure levels are applied in increasing magnitude until a load equal to 1.5 times the design windload is attained. Pressures are sustained for 30 seconds. Open stationary blade louvers are covered with a plastic film before installation in the chamber to enable pressurization. The deflection of blades, frames and supports is measured during the test and the amount of recovery is checked afterwards. The anchorage system is also monitored for failure throughout the test.

If the room the louver is installed in is considered an open structure designed to withstand the high wind pressures created in a hurricane, no additional tests are required. However, if the room is considered a closed structure that cannot withstand the pressure or if it houses equipment that cannot handle the pressure, the BCCO code requires the louver assembly be tested to both the PA-201 Large Missile Impact Test and the PA-203 Cyclic Wind Pressure Test.

The PA-201 Large Missile Impact Test simulates wind-driven debris that is often present in hurricanes. In the test, the louver assembly is impacted with a 2" x 4"(51 x 102) board weighing 9 pounds (4 kg) and traveling at approximately 34 mph (57 kph). The board is projected toward the louver by air pressure. At least three separate impacts are conducted and the louver must prevent the boards from both penetrating or creating a significant opening in the assembly.



ELF6375DXD in PA-202 test.

After the Missile test, the PA-203 Cyclic Wind Pressure test is conducted. By simulating the forces applied to a louver by repeated severe wind gusts, this test exposes possible weaknesses in the assembly created by the missile impacts. In the test, the louver assembly is installed in a chamber similar to the Uniform Pressure test. However, in this test the pressures are applied for only a few seconds and repeated several hundred times. Pressure is increased until 1.3 times the design windload is achieved. As in the PA-202 procedure, the deflection of the components and the anchorage system are examined.

The 200 series Protocols are considered in the Code as Building Envelope Component tests and together they indicate the ability of the louver assembly to maintain the integrity of the building envelope during severe hurricane conditions.

An open stationary blade louver alone is not suitable for closed structure applications as it cannot completely prevent room pressurization, nor will HVAC systems or air handling units typically withstand hurricane wind pressures. One way to fortify a stationary louver for these tests is to install a damper behind it and test it with the blades closed. Since the design loads for the Miami-Dade County structural tests can exceed 148 psf

(7.08 kPa), or 28" w.g. (6.97 kPa) of static pressure, many normal commercial outside air control dampers will not suffice. Dampers for these applications must have either airfoil blades or be industrial grade construction to handle the high pressure. Combination louver/damper units are excellent to use for outside air intake on air handling units.

Ruskin's Miami-Dade County Louvers

Ruskin is the first manufacturer to gain Miami-Dade County approval for louvers with the ELF6375DXD Louver and ELF6375DXD/CD102 Louver/Control Damper combination. The Miami-Dade County, Florida Notice of Acceptance Number for these products is 97-10023.04. The ELF6375DXD louver is a modified version of the ELF6375DX designed to comply with the South Florida Code. This louver was tested in the PA-202 Static Air Pressure Test and has been approved for use in wet, open structures with wind loads up to ±138 psf (6.6 kPa). Maximum louver size is 47 1/2" x 71 1/2" (1207 x 1816). The ELF6375-DXD/CD102 combination louver/ damper assembly features an industrial control damper mounted behind the louver in a common sleeve. This assembly was tested in all the 200 series tests and has been approved for use in wet, closed structures with wind loads up to ±148 psf (7.08 kPa). Maximum size for the combination unit is 156" x 96" (3962 x 2438).

In addition to the approved models, Ruskin has also submitted the EME6625D Louver and the EME6625D/CD50 Louver/Control Damper combination to the BCCO for approval. The EME6625D alone has been tested in all four tests (including the water penetration test) and is submitted for use in dry, open structures at windloads up to +160 psf (7.66 kPa) and -140 psf (6.7 kPa). The EME/CD50 combination unit was also tested in all four tests and has been submitted for approval for use in dry, closed structures at windloads up to +160 psf (7.66 kPa) and -140 psf (6.7 kPa). Maximum size for the EME with and without damper will be 144" x 96" (3658 x 2438).

Specification Summary

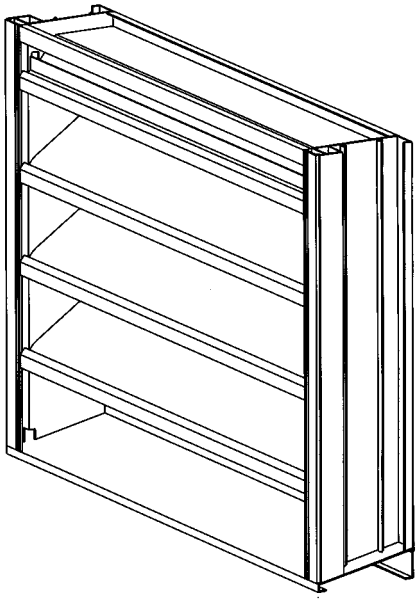
Specification writers desiring to include Miami-Dade County approval in their louver specs should reference the Miami-Dade County BCCO code in section 1.3 of their specs, and designers must determine the proper product for the application. Of course, any project in Miami-Dade County, Florida must incorporate approved products. It is also a good idea to specify the same louver design criteria for projects in other Florida locations, as well as any areas along the coast of the Gulf of Mexico. The Atlantic seaboard is another region that is prone to hurricanes and severe weather. Lastly, while certainly not as frequently, the Pacific coast can sustain hurricanes and related weather. Using Miami-Dade County design louvers in these regions provides an additional safeguard against damage if a hurricane strikes.

Footnotes:

1. Colorado State University Press Release. Dated June 5, 1998. William Gray, Professor of Atmospheric Science.

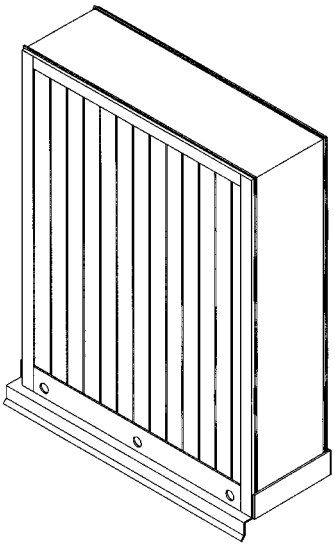
STRUCTURAL TEST DATA

MODEL	SIZE	TEST LOAD	PA201 & PA203	PA202	Miami-Dade Approval
ELF6375DXD	47 1/2" X 71 1/2" (1207 X 1816)	+138 PSF (6.6 kPa) -138 PSF (6.6 kPa)	No	Yes	Yes
ELF6375DXD/CD102	156" X 96" (3962 X 2438)	+148 PSF (7.08 kPa) -148 PSF (7.08 kPa)	Yes	Yes	Yes
EME6625D	144" X 96" (3658 X 2438)	+160 PSF (7.66 kPa) -140 PSF (6.7 kPa)	Yes	Yes	Pending
EME6625D/CD50	144" X 96" (3658 X 2438)	+160 PSF (7.66 kPa) -140 PSF (6.7 kPa)	Yes	Yes	Pending



ELF6375DXD

Overall depth of units 24" (610) or less in width is 6½"(165). Units over 24" (610) in width incorporate rear-mounted blade supports that increase the overall depth to as much as 12" (305) depending on louver height. Addition of CD102 control dampers may increase overall depth to as much as 34" (864).



EME6625D

Overall depth is 6½" (165). Addition of CD50 control dampers may increase overall depth to as much as 18" (457).