THE UNIVERSITY OF FLORIDA IS SET TO "JUDGE" BUILDING ARCHITECTURAL PRODUCTS AND ENTRY SYSTEMS

Special-Lite®

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Building entry manufacturer, Special-Lite, engineers and delivers a one-of-a-kind storm simulator

Approximately $10 billion in damage occurs in the U.S. annually due to natural events, the majority from Category 3, 4 and 5 hurricanes. In 1992, Hurricane Andrew caused more than $25B in just Dade County Florida. In 2005, Hurricane Katrina caused more than $100B in total economic loss.

In 2009, Henry Upjohn, CEO of Special-Lite, Inc., a leading manufacturer of heavy duty entrance door systems, was approached by a business acquaintance that works with the insurance industry, and routinely tours post-storm environments. This professional explained that he regularly finds instances where roll-up and sectional garage doors, built to known standards and storm ratings, were consistently failing at levels below their rating. There was a need to develop better diagnostic tools to understand how building components and claddings respond to extreme wind effects.

During that initial meeting, it was suggested that Upjohn should meet Forrest Masters, Ph.D., P.E., Associate Professor of Civil & Coastal Engineering at the University of Florida (UF). The UF wind engineering program is one of the largest of its kind in the US. The group is well known for full-scale research, i.e. performing experiments in hurricanes or replicating their effects at a sufficient scale and realism to evaluate the performance of complete building systems.

Special-Lite’s engineering team understood that property damage appeared to be most significant when building entries and windows have become compromised, often resulting in catastrophic failure. The opportunity to partner with Upjohn’s company was an ideal match as Special-Lite has built its reputation on developing engineered door entry and architectural solutions that withstand the most challenging, abusive and corrosive environments.

Henry Upjohn, CEO, Special-Lite, Inc. (left) with Forrest Masters, PhD., P.E.

J. Alex Esposito, M.E., E.I.T, lab manager, Powell Family Structures and Material Lab at the simulator’s analog control panel designed by Henry Upjohn. Monitors and equipment for digital test data capture are seen in background.

Upjohn and Masters met soon after, and decided to build a testing apparatus capable of simulating wind and wind pressure associated with some of the most severe weather known on the planet. Conventional solutions were not up to the task, so they formed a diverse team encompassing civil, mechanical, manufacturing and industrial engineering to create a one-of-a-kind machine capable of simulating the damaging effects of hurricanes and other extreme wind events.

Conceptually, the system can be thought of as a means to replicate naturally-occurring wind and pressure caused by turbulence in the approach flow and the flow distortion around a building. For example, if a pressure sensor recorded high-fidelity data on the wall of a commercial building in Homestead, Florida during Hurricane Andrew, the simulator can “replay” this pressure sequence in its entirety. Ideally, the measured and artificially-applied load would be virtually indistinguishable.

To meet the challenge, Upjohn developed the original simulator concept design drawings, as well as personally supervised the simulator construction and assembly at the Powell Laboratory on the University of Florida’s campus. He, and various members of his engineering and electrical fabrication team from the Special-Lite facility in Decatur, Michigan took many trips to Gainesville, Florida over the course of 18 months during the simulator construction.

SIMULATIONS GET REAL

The new simulator (patent pending), officially referred to as the Dynamic Wind Velocity and Pressure Simulator (DWVPS) or affectionately called “The Judge”, is a unique machine that creates dynamic simulated Saffir-Simpson Scale Category 5

Sectional roll-up door installed prior to test.

Damaged sectional roll-up door after test.

pressure events that produce rapidly fluctuating positive and negative pressures on a test specimen to determine at what level failure, if any, occurs.

The simulator's primary function is to evaluate the performance of large component and cladding systems with the goal of designing better, more robust products that will endure all classes of hurricane and tornado events.

Some of the examples of use in the construction industry include testing for both sectional and roll-up garage doors, entry doors, windows, curtain walls, siding, shingles and soffits. Other exterior components affected by extreme wind loads caused by hurricane and tornado events can also be tested.

The system operates in two modes. The apparatus has a simulation range capability of 460 psf at 70,000 cfm leakage in the pressure chamber and 230+ mph in the high-speed test section.

"We can replicate wind effects on buildings expected to occur during an entire hurricane passage," Masters said. "A strong Category 5 hurricane is not a problem. We haven't run a simulation yet, but I'm confident we can also simulate loads on a low-rise building in an EF4 tornado."

The DWVPS also features a velocity simulation area which subjects smaller specimen samples (typically shingles and siding) to high speed wind flow with rapid fluctuations.

Funding for the simulator was provided primarily by Special-Lite, with support from the Florida Catastrophic Storm Risk Management Center at FSU, the Florida Building Commission, Oak Ridge National Laboratory and the University of Florida.

"The new simulator complements multiple modeling and testing apparatuses, ranging from universal testing machines, to the boundary layer wind tunnel. Its specific purpose is to apply out-of-plane loading to large-scale building components and cladding to understand how they behave under dynamic wind loading. The findings (data) are used to verify computational modeling and rational engineering analysis," Masters said.

Test data is captured on the DWVPS with load cells, strain gauges, photogrammetry and HD video. Deliverable data includes forces (reactions), strains, 3D displacement, and video of the entire test to identify time and degree of damage.

COMPLEX ENGINEERING AND CONSTRUCTION

The simulator consists of the following primary components:

- 1800 hp Caterpillar diesel engine
- 80" diameter 1750 rpm fan capable of 100,000 cfm at 80" of water columns
- Heavy-duty 60" duct work
- (4) 60" dampers to change function of air system (Butterfly Valves)
- 4-blade opposed louver to modulate air flow through the fan
- Post-tensioned, reinforced concrete pressure chamber and accompanying reaction frames
- Analog control to drive louver valve

The 20'-5" tall x 26'-6" wide x 4'-8" deep airbox is a unique component of the simulator. It is capable of housing up to a 24' wide and 18' tall test specimen. Over 100 tons of concrete and 10 tons of rebar were used to build the airbox with 16"

Strain gauges being installed on subject door prior to testing.

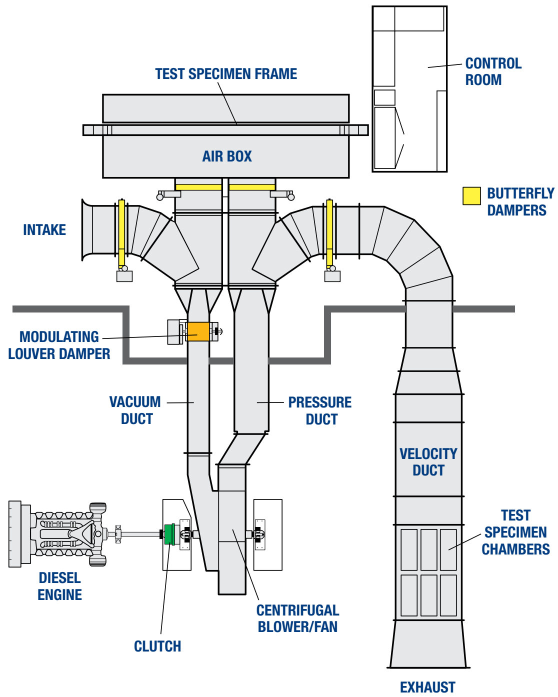
thick side walls and a 22" thick backwall to withstand the forces upward of approximately 450 lbf/ft2. The pressure exhaust bell and the vacuum inlet bells are cast permanently in the back wall of the airbox. The test specimens are mounted to the front of the airbox and can be tested in either pressure or vacuum modes.

Function through the simulator is controlled by dampers. The simulator has (4) 60" dampers, one on the inlet, one on the exhaust, one on the pressure side of the airbox and the other on the vacuum side of the airbox. Closing off the vacuum damper in the airbox and closing the exhaust damper creates a pressure build up in the airbox. Closing the inlet damper and the pressure damper in the airbox creates a vacuum in the airbox.

The modulating louver valve is the key to recreating the rapid pressure fluctuations that occur in a real hurricane. The louver valve is operated by an analog control that allows the louver to open and close very quickly to disrupt flow through the simulator causing varying pressure in the airbox and on the test specimen. Data (voltage) sent to the analog control can be actual pressure traces recorded from a model structure in a wind tunnel or a field measurement from a real building in a storm. The modulating louver valve can function anywhere between fully closed to fully open. This rapid movement in the louver will cause an interruption in the airflow, causing the test specimen attached to the airbox to react accordingly.

The design and development of the elaborate analog control system was quite complex. Henry Upjohn enlisted the help of Dr. Bob Nicholson, an analog controls engineer out of Birmingham, MI, who has more than 40 years experience of developing high-speed control systems for hydraulic and pneumatic servo applications.

Upjohn and Nicholson personally designed the elaborate control systems. All the control panels were assembled, per Upjohn's original drawings, at a facility in Michigan. The final wiring was completed by his team when the panels were installed on site.



The Dynamic Wind Velocity and Pressure Simulator (DWPVS) is a unique machine that creates simulated Siffar-Simpson Scale Category 5 pressure events.

Since its installation, the simulator has proven to be a real workhorse, performing tests on discontinuous roof cover systems such as asphalt shingles and roofing tiles, and sectional doors. Special-Lite, recognized as one of the most innovative companies in the composite building products industry, considers the machine to be a major step forward in the research and development of residential and commercial building systems intended for high-wind areas. Zoning requirements continue to be evaluated in impacted areas including the coastal regions of the southwest as well as the east coast and the midwest. The simulator will soon be made available to any company or institution for materials testing.

View video at:
https://www.youtube.com/watch?v=QRv5IeJexMo&feature=youtu.be

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