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In this issue:

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Recent Advancements in Full-Scale Simulation of Wind Pressure Effects on Full-Scale Building Components

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Damage to garage doors can cause a large breach in the building envelope, which can lead to adverse internal pressurization and wind and water ingress, and thus result in further damage to other building envelope components (e.g., blown-off of roofs). Improving the performance of garage doors under hurricane wind conditions can effectively keep the building integrity, resulting in a more robust built environment and ultimately enhancing the community resilience. However, rare research has been conducted on studying the performance of garage doors in windstorms. The objective of this research is to improve understanding of the performance of garage doors subjected to hurricane wind pressure. Full-scale experimental testing and numerical simulation are both used considering accuracy and cost.

To conduct full-scale experimental testing on building component and cladding systems, a new large-scale hurricane wind pressure simulator (Fig. 1) was designed and developed at the University of Florida. The new apparatus was designed to generate spatially uniform, time-varying pressure associated with Saffir-Simpson Hurricane Wind Scale (SSHWS) Category 5 hurricane winds while compensating for large air leakage. Five commercial sectional doors were tested under static suction using this new simulator (e.g., Fig. 2).

Two main catastrophic failure mechanisms were observed during the experimental testing: local buckling of reinforcing stiffeners and disengagement from the tracks (e.g., Fig. 3). Finite element (FE) modeling of one of the five sectional doors (Fig. 4) was per-

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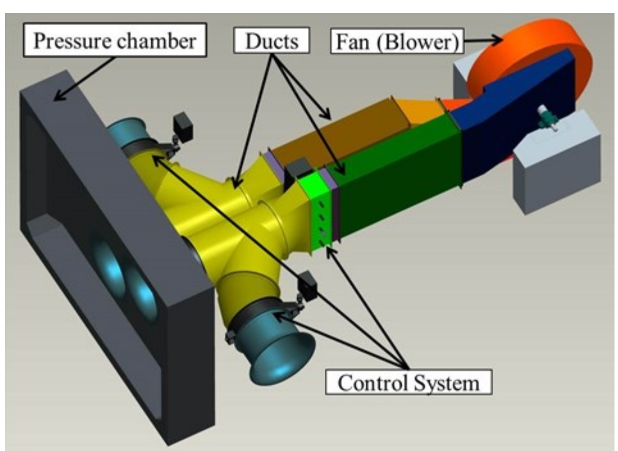

Figure 1: A 3D drawing of the new large-scale hurricane wind pressure simulator

Figure 2: Sectional door 2 mounted in the pressure chamber of the simulator

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formed in ADINA. Failure mechanism (Fig. 4) and measured displacement and strain data match well with the numerical simulation results (Fig. 5).

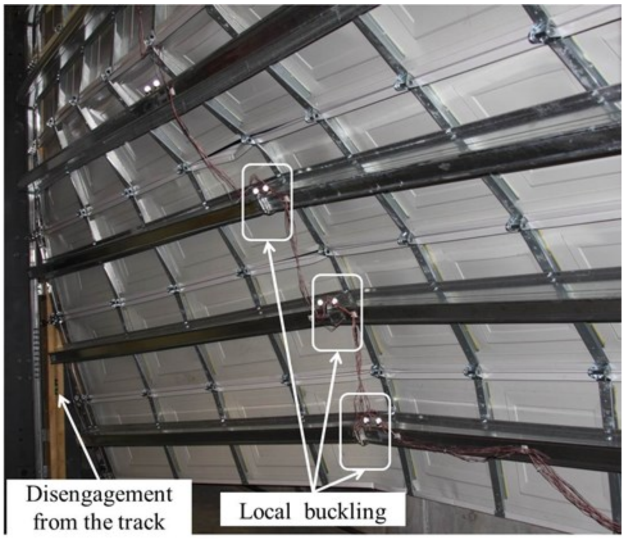

Figure 3: Catastrophic failure mechanisms of door 2 observed in experimental testing

The validated FE model can be modified and calculated under various scenarios, which can be used for performance-based design of garage doors. Future work will address the application of time varying pressure fluctuations on garage doors.

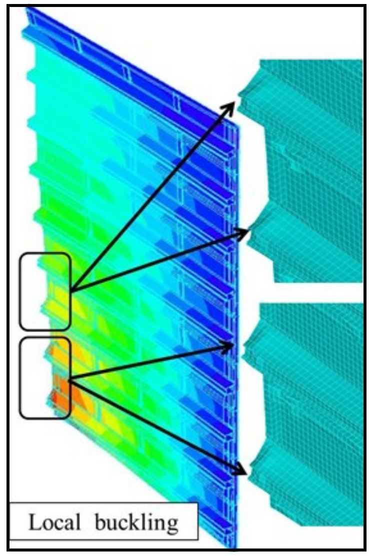

Figure 4: Finite element model of door 2 with its ultimate failure

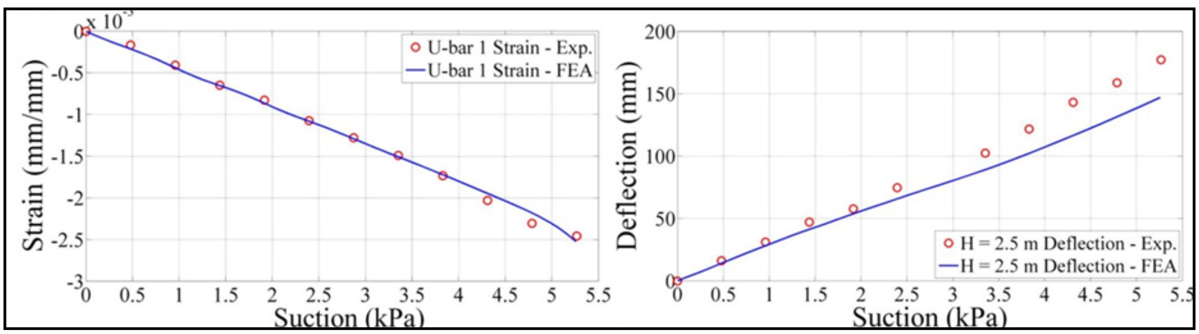

Figure 5: Examples of strain and deflection response comparisons between experimental testing and FEA

Results from Wind Load on Solar Panel Experiment

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Structural engineers seeking wind pressures for the design of a roof-mounted solar panel often refer to ASCE7 only to find that it is silent on the subject (ASCE7, 2010). ASCE7-10 is unsatisfactory for several reasons (Cochran, 2012). There is little literature available on the topic and that which exists suggests significant differences as have been reported from various studies (Stathopoulos, et al., 2012). Tilley reported on the challenges of determining wind load on solar panels, concluding there is more work to be done (Tilley, 2012). We wish to help fill a gap in the literature by collecting data on full-scale models for comparison to and verification of wind tunnel studies and/or numerical analyses. Results from a full-scale faux solar panel installation research project on a flat roof at the University of Colorado Denver in the Denver metro area are presented.

The roof on which the experiment was conducted was specifically chosen for its aerodynamic simplicity in order to emulate other buildings that have been previously modeled in wind tunnel testing and CFD analyses. The panels were located four feet from the windward edge of the roof, where relatively complex air flow was expected. The panels were constructed of plywood with vertical legs of small tube steel sections. The slope of the panel surface was 30 degrees with respect to the roof surface and the midpoint of the face of the panel was arranged so that it intersected the presumed location of the shear layer. The design of the solar panel support frame incorporated strain transducers, used to determine the resultant force acting on the surface of the panel. Wind speed and direction data was obtained via anemometers and a wind direction sensor. A technique to negate thermal effects was developed so the strain data represented was a function of the wind force alone.

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From the data obtained the resultant forces were computed and a relationship was defined between the net force values and the measured wind speeds in order to determine the values of the force coefficient, CF. A time history plotted over a 400 second time interval is provided below in Figure 1, illustrating wind and strain data which was averaged over three seconds. The force coefficients, CF, also plotted, were calculated from the post processed wind and strain data. The values of CF ranged from a minimum value of 0.1 to a maximum value of 18.7, with an average of 1.9. We note that CF values as high as 10 are reported to "often occur" on flat roofs and values up to 20 have occasionally been measured; however these values are associated with corner vortices (Holmes, 2007). The results are offered for comparison with those of other researchers. The faux solar panels developed for this experiment and presented herein are offered as a means to monitor forces due to wind on rooftop solar panels. As expected, a solar panel located near the edge of the roof will experience relatively high wind forces, thus producing higher CF values than for panel locations farther away from the roof edge.

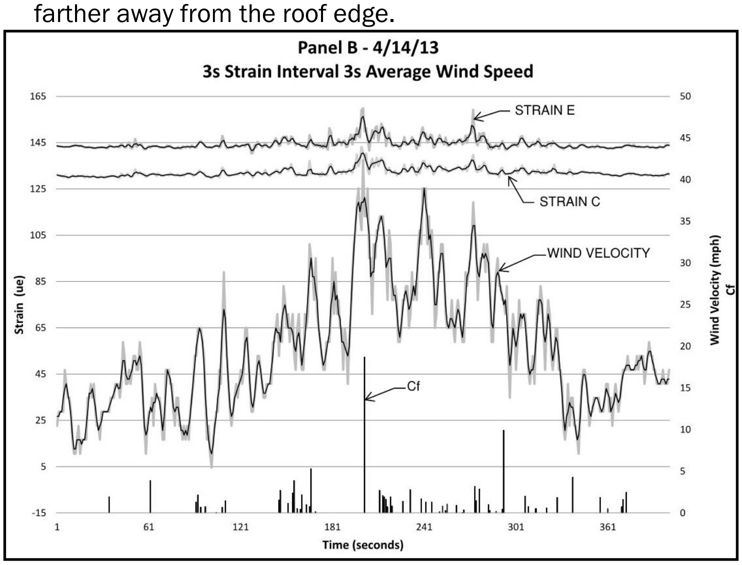

Figure 1. Wind velocity, strain records, and calculated C_F values from a selected record

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President's Corner

Greetings! On behalf of AAWE I want to wish all of you a happy and productive 2014. I would particularly like to welcome new members, as well as thank continuing members, both individual and corporate, for their support. If you have not yet renewed your membership for 2014, please take a moment to do so. It is quite easy to do on our website (aawe.org).

We hope you are enjoying our now monthly newsletter. Please feel free to distribute it to colleagues and friends who may find it of interest. Over the past number of months we have shared articles prepared by student members of AAWE and presented at the 12th Americas Conference on Wind Engineering this past June. This continues with the current issue and for the next few months. However, we are always looking for articles for the newsletter. Please do not hesitate to send articles on your research findings or interesting projects, or even ideas for special issues, to either Dr. Hector Cruzado (hcruzado@pupr.edu) or to me.

I would also like to encourage you to nominate members of AAWE for various awards. We have the AAWE Best Paper Award for papers from 2013. The deadline is at the end of February to nominate someone. Please send nominations to Dr. Anne Cope (acope@ibhs.org), who chairs our awards committee. In addition, the prestigious IAWE award nominations are also due at the end of March. There are two awards, one for researchers earlier in their careers (less than 40 years old), and the Davenport Medal for senior researchers. Please consider nominating someone who has perhaps influenced your own work.

We are interested in ways we can make AAWE more relevant to you and to enhance the implementation of our mission "to promote and disseminate technical information in the research community". If you have any questions or comments about AAWE, please do not hesitate to contact me.

With warm regards,
Greg Kopp (gakopp@uwo.ca)

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