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CALL FOR NOMINATIONS

The AAWE is requesting nominations for the position of President Elect and for three Board Members. More details on page 7.

International Association for Wind Engineering

Preliminary Report on AAWE-Sponsored Damage Survey of Christmas Day Tornado, Dallas, TX

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University of Florida

At 6:45 pm on 26 December 2015 an EF-4 tornado touched down and traveled 16 miles in a NNE direction, causing extensive damage to 1,200 houses and 13 fatalities in the towns of Garland, and Rowlett, Texas. The Garland/Rowlett tornado was part of an extensive weather system that produced a 3-day outbreak of 87 confirmed tornadoes affecting vast areas of Texas and the Mid-west. Last year, the University of Florida's WHDAG documented some of the damage in our preliminary damage report (http://bit.ly/1UfBF3m) (Roueche and Doreste 2015)(Prevatt and Roueche 2015). This report presents preliminary observations and findings of a damage survey conducted by the Wind Hazard Damage Assessment Group at UF, that was sponsored by the American Association for Wind Engineering. The report explains the objective and motivation of our survey and includes description of our data collection methodology, and preliminary conclusions.

Tornado research has grown over the past five years and has advanced our understanding of tornado-induced loads and their effects residential structures. Engineers now accept that tornado-resilient communities are feasible and indeed necessary for the future of sustainable communities, but details of the interaction are needed. Field surveys such as this one, serve to document actual performance characteristics of houses while providing an invaluable calibration data set for validating experimental models of tornadoes and numerical/analytical tools. With extensive experience in previous damage surveys, UF's WHDAG continues improving data collection and accessibility of tornado damage data.

On January 7 and 8, 2016, the UF-led team conducted a damage survey in Garland and Rowlett, TX to evaluate tornado damage to single-family residential structures, in the context of their structural characteristics and age of the buildings. The UF survey team was led by Dr. David O. Prevatt, and included PhD Candidate Mr. David B. Roueche, Masters Student Mr. Arpit Bhusar and Fulbright Scholar and UF Masters Student, Mr. Allan Gutierrez. We were assisted in our survey by several technicians and engineers from the McKinney Texas facility of Simpson- Strong Tie Inc.

Description of Housing Demographics for the Damaged Areas in the Study

The focus area was selected because it included a wide range of houses built over the last five decades. There has been rapid population growth and development of housing in the north-east Dallas area, with the population in Garland and Rowlett growing from 40,000 in 1960 to almost 300,000 persons today as shown in Figure 1 using population data from the US Census. Given this rapid growth and construction of houses, the team sought to evaluate and compare the structural performance of houses built in successive time periods and under different building codes, to ascertain whether the age of the homes influenced the level of damage sustained.

Prior to our arrival in Texas, the team used data from the Dallas Central Appraisal District (http://www.dallascad.org/) to study housing demographics of the two cities, and we identified five areas of focus for our

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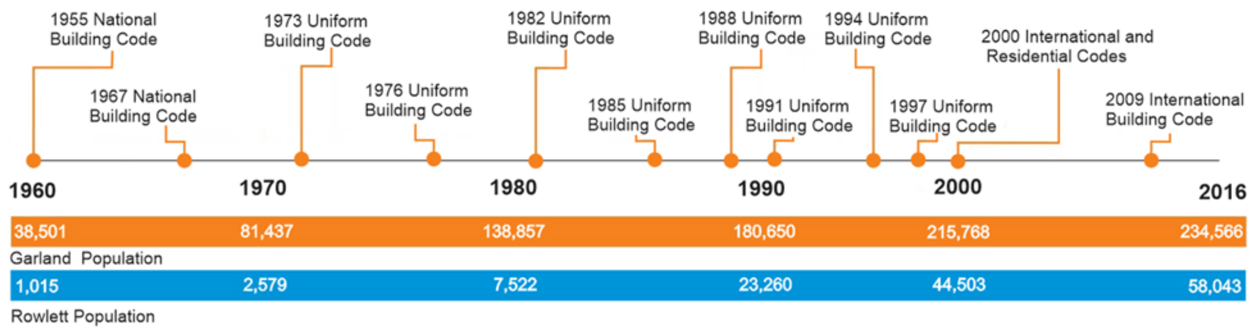

Figure 1. Population Growth and Building Code Changes in Garland, TX and Rowlett, TX (1960-2016)

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study (Regions A, B, C, D, E on Figure 2a.). The distribution of houses in one of the regions (Region A) is shown in Figure 2b.

Economically, the five regions span a wide income-range, from high income water-front properties (Region C), middle income properties (Regions A, D, E) to lower-middle income neighborhoods (Region B). The 1970s houses located in Region E were mainly single story, gable roof, ranch-style, wood-framed structures, with brick masonry exterior cladding and asphalt shingles. Houses built in the 1980s were found in all areas except Region C, and the 1990s-built houses were seen in Regions B, C, D and E.

The newest subdivisions were in Regions A and C, with the latter area (Region C) having the largest and more expensive houses that were located along an exposed waterfront of Lake Ray Hubbard. From the 1980s it appears the roof styles started to change from simple metal plate wood trusses to steeper sloped roofs having 2 in. x 6 in. wood rafters arranged into complex shapes of intersecting gable and hip roof sections. The newer subdivisions as well had a higher proportion of two-story structures.

Survey Procedure and Methods

The onsite data collection activity is a very time-critical one, in order to ensure preservation of post-tornado damage conditions before structures are demolished and removed. Thus tornado damage surveys are conducted generally in two phases; 1) rapid on-site data collection using geo-located images and field notes and 2) a longer data analysis process which includes classification of the observed damage, linking of the photographs and damage classifications to specific addresses, and sorting and archiving of the data collected. The data analysis is still in progress, and full results are to be published in a peer-reviewed journal.

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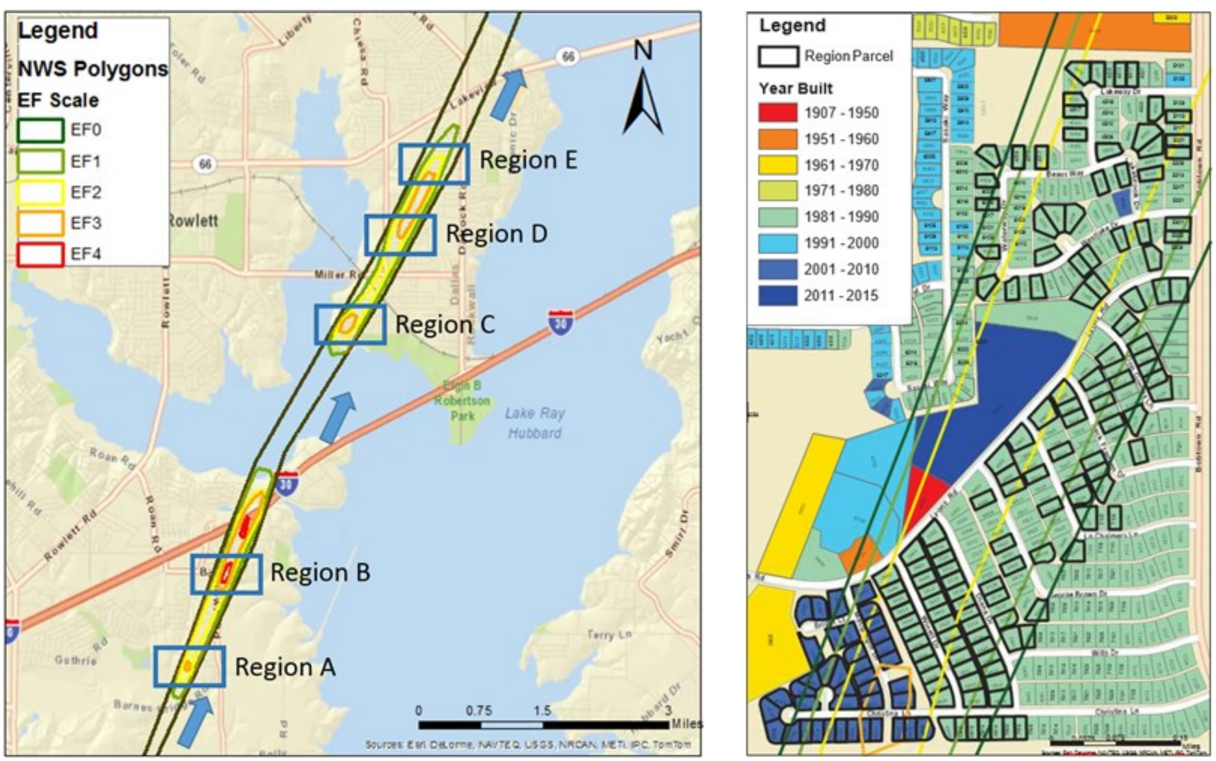

Figure 2. : (a) The Five Regions of Damage Survey and (b) Details of Region A Showing Age of Homes Extracted from Dallas Central Appraisal District (http://www.dallascad.org/)

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The data collection procedure consisted of two-person teams working sequentially along specific transects or streets, that ran approximately perpendicular to the centerline of the tornado. The teams utilized a dual-priority data collection approach in the field survey. The first priority at each home was taking photographs of all four elevations of the structure and roof for each home to capture the aggregate level of damage, as illustrated in Figure 3. The second priority was capturing additional photos and notes of specific structural component construction and damages. This typically included such details as roof sheathing and rover cover attachments, roof to wall connection details, performance of windows and doors etc., and materials and performance of the wall cover and wall framing.

The data collection process enabled the damage to be classified using the ten Degrees of Damage (DOD) for one- and two-family residences in the Enhanced Fujita (EF) Scale (McDonald and Mehta 2006). We assigned EF ratings to each house based upon the DOD. We also used the detailed photographs of all four elevations for each home to estimate the damage ratios (e.g., 8 out of 10 windows broken = 80% window damage ratio) of the primary building components.

Damage Observations

The team surveyed 718 homes in two days and collected approximately 5,000 geo-tagged photographs. The structural framing of the buildings was typical of houses built in inland areas (low design wind speed areas) away from hurricane-prone coastlines. One unique structural component observed was a structural sheathing insulation board used in nearly all houses throughout the five regions. The product which was a 1/8 in. thick cardboard-like material that also served as an insulation, that was sold and installed under several names (Thermo-Ply, Thermo-Sheath).

The observed damage varied depending upon the location relative to the center of the tornado. Near the edges of the tornado path, damage primarily consisted of building envelope and cladding failures, including damage to the exterior brick façade and asphalt roofing shingles, sheathing failure, broken windows, entry doors and failed garage doors. Near the center of the tornado path, the survey team commonly observed removal of large sections of the roof structures and complete structural collapse. When the roof structure failed, failure of large sections of the exterior wall systems was also very likely to occur. A similar association of roof to wall failures was noted in the Joplin, MO and Tuscaloosa, AL tornadoes (Prevatt et al. 2011; Roueche and Prevatt 2013). Figure 4 shows typical damage observed to houses from Region C.

The observed damage tells the story of the passage of a very powerful tornado affecting houses that were not designed for such extreme wind loads. Many roof-to-wall connections failed because of the inadequate strengths of the toe-nailed connections of rafters or truss chord to the wall top plates. Some houses actually racked sideways due to the inadequate capacity of shear wall segments

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Figure 3. Photographs of Elevations of a Damaged House (7514, Atlantic Drive Rowlett, TX) and comparison with Pre-Tornado Image (from Google StreetView)

Figure 4. Google View of Windjammer Way, Rowlett, TX identifying houses in Figure 5

Figure 5. Typical damage and DoD Ratings for eight houses on Windjammer Way, Rowlett, TX. These waterfront houses likely experienced maximum wind speeds.

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(along garage doors for example). In many houses the single-wythe brick cladding was sucked off the backing wall because the brick ties could not resist the wind loads.

Summary and Conclusions

The second (data analysis) phase of the damage survey is currently underway, and when complete the entire data set of the results will be made available online for use by other researchers. It is immediately clear that all houses, from upper income to low-middle income all suffer brittle failures at what likely is wind velocities below peak winds of this tornado. It is obvious the structural performance of houses could be substantially improved by using existing construction technologies. Further, this damage survey is an important contribution to wind engineering research as it will initiate additional research collaborations to better understand and quantify tornado damage. Initially the data is being used at UF to compare observed engineering damage ratios against actual insured losses for the buildings. Preliminary results from 37 houses in Region A are suggesting there exists a quadratic relationship between observed damage ratios for the homes and the insured losses for the houses. Of course more analysis is still needed.

In future, the WHDAG believes this and other empirically developed tornado damage data sets must be used in the validation of numerical and analytical computer models being developed to estimate and predict damage to housing from tornadoes. In addition, the damage survey dataset will also be valuable for further calibration of the experimental results from tornado simulator experiments, e.g., the Iowa State University tornado simulator and the WINDEEE Research Institute.

Acknowledgements

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Wu and Kareem Receive 2016 Alfred Noble Prize for Best Technical Paper

Teng Wu, assistant professor in the Department of Civil, Structural and Environmental Engineering at the University of Buffalo, and Ahsan Kareem, the Robert Moran Professor of Civil & Environmental Engineering & Earth Sciences at the University of Notre Dame, were selected by the Joint Prize Committee of the American Society of Civil Engineers (ASCE) to receive the 2016 Alfred Noble Prize.

Established in 1929, the award is given in honor of Alfred Noble, past president of the ASCE. It is for a technical paper of exceptional merit prepared by not more than two authors of specific engineering societies, the lead of which must be under 35 years of age.

Wu and Kareem were selected for the paper "Revisiting Convolutional Scheme in Bridge Aerodynamics: Comparison of Step and Impulse Response Functions," which appeared in the May 2014 issue of the Journal of Engineering Mechanics. The selection committee specifically called out the paper's "mathematical elegance and critical contribution to the issue of aerodynamics of bridges."

[Excerpt from: https://engineering.nd.edu/news-publications/engineering-newswire/wu-and-kareem-to-receive-2016-alfred-noble-prize-for-best-technical-paper]

News from the International Desk

In early July the Australasian Wind Engineering Society held its 18th Workshop in the wine country of the Adelaide Hills in South Australia. With about eighty attendees at the Serafino Convention Centre, in McLaren Vale, it was one of the largest workshops in years.

The organizer, Leo Noicos, very bravely tried something new for the event; a keynote talk done live from the US East Coast over the internet. We were pleased to have Charlie Thornton speak on disruptive innovation in structural engineering. This web-based keynote presentation, and the follow-up question period, was an alternative method that will almost certainly be part of future Workshops; particularly when personal attendance is not possible.

The second morning had a very thought-provoking keynote by Andrew Allsop of Arup (in person) about the myriad of issues associated with the new Hong Kong wind code.

The next AWES Workshop will be held in the Melbourne area, Victoria, in mid 2018 and is being organized by John Holmes.

Leighton Cochran
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4th American Association for Wind Engineering Workshop

The 4th American Association for Wind Engineering (4AAWE) Workshop was held in Miami, Florida, on August 14-16, 2016. The workshop was co-chaired by Ioannis Zisis of Florida international University (FIU) and Chris Letchford of Rensselaer Polytechnic Institute (RPI). The workshop is one of the official AAWE events and aims to provide the opportunity to young researchers to present their research and receive feedback from attendees. This workshop continued the success of the previous three events in Vail, Colorado (2008), Marco Island, Florida (2010) and Hyannis, MA (2012) and managed to bring the latest developments of wind engineering and its related disciplines to a broad audience, including university researchers, graduate students in civil engineering or mechanical engineering disciplines, members of national laboratories, engineering practitioners and industrial leaders in the field.

The location of the workshop was in the heart of Coconut Grove, which is the oldest continuously inhabited neighborhood of Miami. The participants of the workshop enjoyed the plenty of open-air and street side restaurants, cafes and parks. The workshop venue hotel was the Sonesta Coconut Grove which offered splendid views of the Coconut Grove municipal marina.

The workshop was well attended with a total of 67 participants visiting Miami from both North and Latin America. The 50 presentations were arranged in 7 technical ses-

Mr. Larry Griffis delivering keynote speech

sions that covered a broad area of research topics such as hurricane engineering; performance of engineered and non-engineering buildings during extreme winds; damages to building envelope produced by severe winds and rainfall penetration; wind-induced response of tall and slender structures; fatigue of structural supports for traffic signs, lighting fixtures, wind energy and wind-based harvesting

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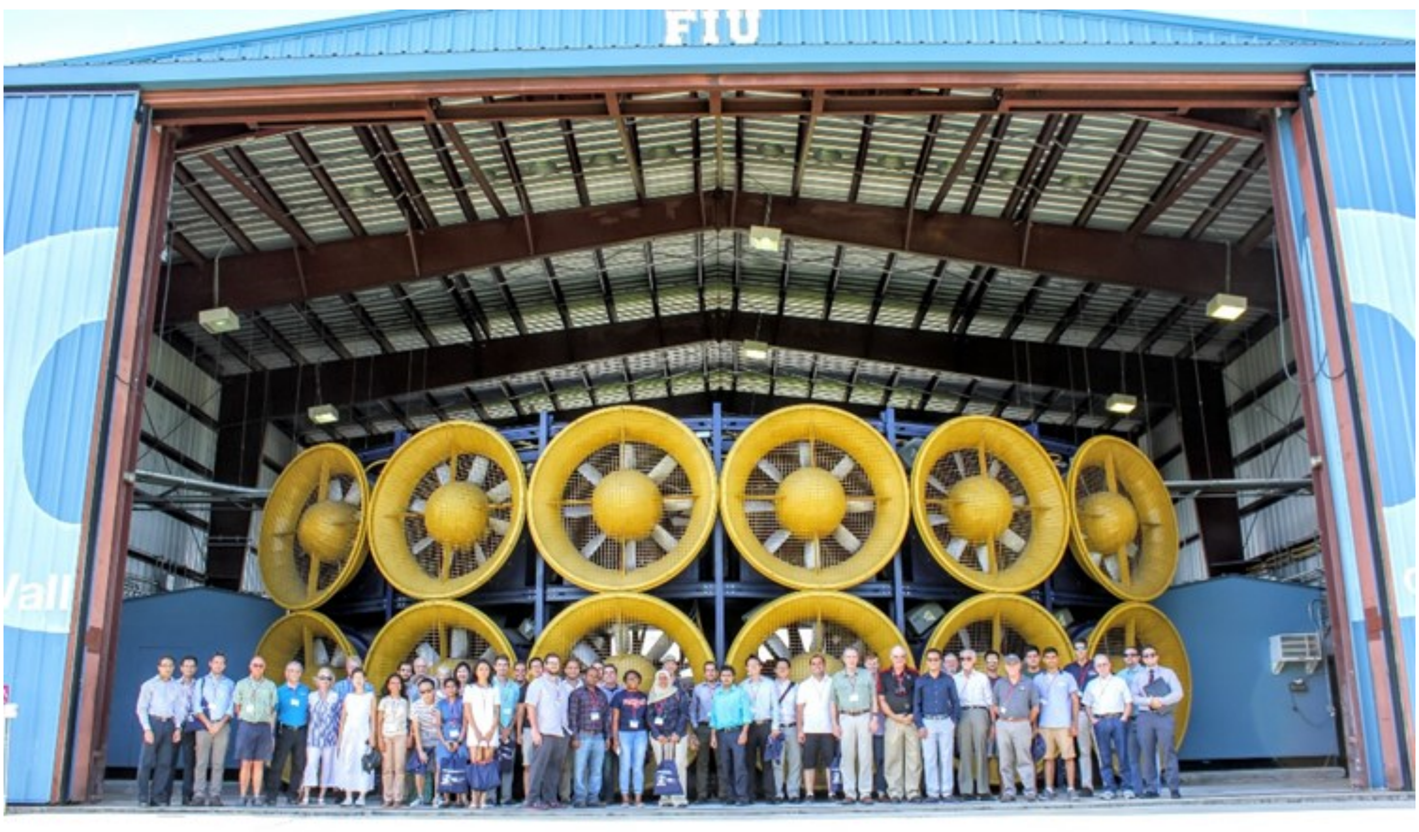

Welcome reception event at NSF-NHERI Wall of Wind Experimental Facility

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systems. Presenters had the opportunity to showcase their recent research activities and interact with the audience in a very informal setting that allowed for fruitful follow-up discussions.

The 4AAWE Workshop attendees were thrilled by the keynote speech delivered by Mr. Larry Griffis (Walter P. Moore and Associates) on Performance Based Design – Wind An Emerging Standard. Mr. Griffis provided an excellent overview of the recent advancements, current efforts and future directions on the concept of the Performance Based Design from a Wind Engineering perspective.

The 4AAWE workshop started with a welcome reception event that was held at the Wall of Wind facility at Florida International University. The participants were informed about the recent NSF Natural Hazards Engineering Research Infrastructure (NHERI) NSF program under which the Wall of Wind was designated as a National Experimental Facility. The welcome reception was concluded with a relaxed dinner and welcome remarks from the organizers and the AAWE President.

Special thanks go to the staff of the Civil and Environmental Engineering Department at FIU as well as the FIU Wind Engineering Student Association. The great success of the event would not be possible without their efforts and overall management of the workshop logistics. The 4AAWE Workshop was sponsored by AAWE, FIU Wall of Wind Experimental Facility and High Velocity Category 5 Hurricane Protection Systems.

Ioannis Zisis

Call for Nominations

The AAWE is requesting nominations for the position of President-Elect and for three Board Members (the terms of Bill Coulbourne, David Prevatt and John Schroeder are expiring).

Send nominations to Chris Letchford at letchc@rpi.edu. Nominations will be accepted until November 30, 2016.

American Association for Wind Engineering

Established in 1966

A professional organization dedicated to the advancement of the science and practice of Wind Engineering and the solution of national Wind Engineering problems through transfer of new knowledge into practice.

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