Testimony of

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INTRODUCTION

Chairman Bucshon and Chairman Massie and Honorable Subcommittee Members, my name is David Prevatt, and I am a professional engineer and Assistant Professor of Civil and Coastal Engineering at the University of Florida. The faculty of the Department of Civil and Coastal Engineering (CCE) is very active in multiple aspects of wind hazards research and the design of hazard resistant infrastructure. Our wind hazards research focuses on understanding the effects of extreme wind events (hurricanes and tornadoes) and other elements (rain, storm surge) on buildings and infrastructure in areas affected by severe winds in order to increase their resilience. Our combined expertise includes in-field measurement and characterization of hurricane winds and wind loads, evaluation of structural capacity to resist wind loads and the efficacy of retrofits.

I am also a Director of the American Association for Wind Engineering (AAWE), and a member of the American Society of Civil Engineers (ASCE). I am appearing today on behalf of the University of Florida, AAWE, and ASCE.

The American Association for Wind Engineering (AAWE) was originally established as the Wind Engineering Research Council in 1966 to promote and disseminate technical information in the research community. In 1983 the name was changed to American Association for Wind Engineering and incorporated as a nonprofit professional organization. The multi-disciplinary field of wind engineering considers problems related to wind and associated water loads and penetrations for buildings and structures, societal impact of winds, hurricane and tornado risk assessment, cost-benefit analysis, codes and standards, dispersion of urban and industrial pollution, wind energy and urban aerodynamics.

The American Society of Civil Engineers (ASCE), was founded in 1852, and is the country's oldest national civil engineering organization. It represents 140,000 civil engineers individually in private practice, government, industry, and academia who are dedicated to the advancement of the science and profession of civil engineering. ASCE is a non-profit educational and professional society organized under Part 1.501(c) (3) of the Internal Revenue Code. ASCE is an American National Standards Institute (ANSI) -approved standards developer and publisher of the Minimum Design Loads for Buildings and other Structures (ASCE-7), which is referenced in the nation's major model building codes. As part of the ASCE-7 document, engineers are provided guidance in estimating the loads resulting from wind effects on structures. Thus, ASCE is at the forefront in the development of new information for engineers regarding wind and is in a unique position to comment on the status quo and our needs for the future.

I wish to add ASCE's, AAWE's and my support for H.R. 1786 "The National Windstorm Impact Reduction Act of 2013. ASCE has a long history with the National Windstorm Impact Reduction Program (NWIRP) and worked with Congressman Randy Neugebauer on the original authorizing legislation in 2004. Since that time our members have testified on several occasions before Congressional Subcommittees in support of NWIRP. My 2008 testimony is part of my written package. While we believe it is very important to move forward to reauthorize the NWIRP, we also believe that it is important to consider the broader area of hazards mitigation and would urge the Science Committee to not only move to reauthorization of NWIRP, but to include the reauthorization of the National Earthquake Hazards Reduction Program (NEHRP) and other programs as part of boarder hazards legislation.

Individually and collectively, wind storms are among the most devastating of all natural hazards. While NWIRP was created in 2004 Public Law 108-360, absent funding, the program's potential to develop ways to mitigate the effects of extreme wind has not been realized. As the sole, unified national program designed to address efficient wind-resistant design and construction, early warning and detection, improved emergency response, and public education and awareness, a fully funded NWIRP would result in a significant reduction in losses, both human and economic.

II THE US IS LOSING ITS LEADERSHIP IN WIND ENGINEERING

The lack of coordinated and sustained support for wind engineering over four decades has severely hurt the discipline. The lack of funding has meant that research is done in piecemeal fashion on shoestring budgets, in contrast to research for the earthquake engineering community that has had the generous support of federal funds. As a result, wind engineering research tends to be locally focused and somewhat limited in scope. We are losing our competitive edge both at home and abroad. There has been attrition of wind engineering faculty, and many engineering schools do not teach wind engineering. Without funding, it has become difficult to attract the best students to the field, as fewer and fewer university faculty positions are available.

While Federally-funded research to wind engineers has averaged less than $1M/year (counting TTU, ISU, UF, Notre Dame) over the last decade, still it has helped improve our understanding of the tornado, and downburst phenomena and their damaging effects on structures. This level of support is less than 5% of the desirable level that we think is needed to address this problem. A proposed level of support of say $20M/yr over 10 years is justifiable compared to the $2 billion in losses that occurred last week in Moore, OK. The benefits of research are immense and they have long-term societal benefits.

In contrast, starting in 2002, the Network for Earthquake Engineering Simulation (NEES) has had over $70 million Federal funds invested in new experimental facilities at fifteen universities and was slated to receive an additional $40-50 million per year from 2004-2014 for research funding. Internationally, the US is also losing its stride in wind engineering. Wind tunnel testing of long-span bridges and super skyscrapers are being done overseas. China has commissioned the most sophisticated and special purpose wind tunnels and their wind research program has been heavily funded. At this rate, we may face the future possibility of having to outsource US wind engineering research.

Funding of this proposal is critical as our “state-of-the-art” research is outdated, over 40-years old, and this is reflected in our building codes and structural design of buildings that do not address tornadoes at all. Since 2000, tornadoes have caused over $19 billion in economic losses and resulted in nearly 1,200 fatalities in the U.S. I have witnessed the aftermath of the two deadliest tornadoes of 2011 (Tuscaloosa, AL and Joplin, MO) and, last week I was in Moore, OK to conduct my damage surveys following the 20 May 2013 tornado. An important observation from that damage survey (sponsored by ASCE, AAWE and the National Science Foundation), was that despite recent experiences in Moore with powerful tornadoes, (in 1999, and again in 2003), newer homes and larger homes are constructed just as inadequately as any that were built before 1999, and they fail just as catastrophically.

We visited several elementary schools that were destroyed by the 20 May tornado, and others outside the tornado’s path to examine how safe rooms or protected spaces can be included. Such details are necessary in public spaces and our schools. We were told during our visit to the Moore Medical Center, that they accommodated over 300 persons in their safe room, although there were only 30 patients and staff in the building, the majority of occupants came from the surrounding mall and neighborhoods seeking shelter just before the tornado hit.

III THREAT OF PROPERTY LOSS FROM WINDSTORMS

Property loss caused by severe wind storms is a national problem and it is increasing in magnitude. In 2011, there were 533 deaths caused by tornadoes. Lately, we have seen more frequent EF4 and EF5 tornadoes (historically less than 3% of all tornadoes historically) hitting a population center every 2-3 years (e.g. Parkersburg, IA 2008; Tuscaloosa, AL 2011; Joplin, MO 2011; Moore, OK 2013; add to this list). It is just a matter of time before a major metropolitan center will be hit. Oklahoma City barely escaped from a direct hit this time. In such a scenario the loss of life could be in thousands and property loss unimaginable. Our important cities with populations greater than 500,000, like Chicago, St. Louis, Kansas City, Dallas-Ft. Worth, Minneapolis, Des Moines, Atlanta, Washington DC are all at risk.

Our buildings and other infrastructural lifelines, such as bridges, tall buildings, airports, cell-phone towers, defense-related structures such as radars, are simply not designed to resist tornadoes of even lower intensities (EF1 to EF2: 86-135 mph), which are more common (90%). There are other types of intense winds, which are capable of causing similar destruction as most commonly occurring tornadoes.

Through considerable and sustained Federal investment, atmospheric/weather scientists and equipment have helped to increase the warning time for tornadoes and often saved lives in doing so. The bottom line is that buildings where people seek shelter and which are supposed to protect them from extreme winds often fail to do so. Whole communities are wiped out in major events, and it is no wonder that some people are afraid to shelter in their own homes when tornadoes threaten.

Many (including some engineers) hold the belief that a tornado-resilient community is an economic impossibility - our research suggests that this is not the case. However crucial information is first needed to develop an engineering model of the tornado loads and of the building's structural resistance. That said, if buildings in Moore, OK had used the latest wind-resistant construction knowledge available today, the structures would be more robust and the damage could have been reduced. We estimate the buildings destroyed by the 2013 Moore, OK tornado were designed for one-third of the loads likely imposed by that tornado. Therefore is not surprising that such extensive failures occurred. Those Moore buildings did not have common and inexpensive details, such as hurricane ties, continuous vertical load paths, continuous structural sheathing, reinforced garage doors, window protection and adequate number of anchor bolts, large washers and nuts. Buildings with these components have performed well in Florida's high-wind zones and they have suffered less economic loss in recent hurricanes as a result.

The National Science Foundation has funded research at UF to develop tornado-resiliency for residential communities and my research group is tackling the task in stages. Firstly, we are adapting technologies already deployed in coastal, hurricane-prone construction zones to upgrade construction in tornado alley buildings. Secondly, we are researching the impact of high-tech composite construction, using newer materials, adhesives and connections. The limitation to this research has been our incomplete knowledge of the magnitudes and/or how tornado forces interact with buildings. Recent research at Iowa State University and Texas Tech University is changing that, and patterns are also emerging from damage observations after tornadoes highlighting distinct differences between the tornado load patterns, and hurricane loads.

Unfortunately, reducing vulnerability to wind hazards is not just a question of developing the appropriate technical solution. Wind hazards are created by a variety of events with large uncertainties in the magnitudes and characteristics of the winds. Solving wind vulnerability problems will require coordinated work in scientific research, technology development, education, technology transfer and public outreach. Specific research needs are listed below:

- A need for a new robustness in the supporting academic infrastructure to generate improved basic supporting science and technology, to improve the availability of trained new university faculty/researchers, and trained engineers to implement improved practices and planning.
- A need to improve the techniques for assessing the economic impacts of different design decisions for both new and retrofit applications. This is an urgent need since 90% of our existing houses are over 20 years old and were built in accordance with building codes lacking engineered wind resistant provisions. If building codes are not upgraded and older structures retrofitted, the damage caused today will only increase in the future.
- A need to better understand the engineering micrometeorology of tornadoes, thunderstorm winds and downbursts and hurricanes. We need better understanding of the effects of these winds and suctions in the vortex core on structures due to their distinctly different features. Our knowledge base is to design for a boundary layer flow, while these storms have different profiles and dynamics.
- A need to better understand the potential loadings on structures through a comprehensive program of boundary layer wind tunnel testing, tornado simulation tests and validation using field observations. Pre-deployed in-field instrumentation is needed to capture the actual building loads during a tornado.
- A better understanding of how and at what level of loading existing structures fail and the application of this knowledge to new construction.
- An intense program to study various ways of identifying weaknesses in existing infrastructure and practical retrofit techniques to ameliorate these problems.
- Comprehensive testing of full scale structures to learn how to economically improve wind and hazard resistant construction and associated water penetration and damage.
- A need to quantitatively understand the surge and wave loading on coastal structures and how the coastal structures respond to loading.
- A need for technology transfer from the research to the practice and the general public, through dissemination activity, by upgrading archaic building code provisions, and by education of the building professionals.
- A need for full-scale monitoring of our taller and more flexible structures, which have been designed on the basis of scale models, but none have been tested in extreme event of a hurricane or tornado. This knowledge will help to predict the outcomes should a large urban area be impacted.

III WORKING WITH NWIRP AGENCIES

For the past 10 years, I have worked with and benefited from the support of NWIRP Agencies, including FEMA, NSF, NIST and NOAA. The support of these agencies is vital if we are to break the cycle of tornado impact, catastrophic damage and rebuilding. For example, through the NOAA Sea Grant Program, we have tested structural retrofit techniques for residential roof structures that utilize spray-on foam adhesives and insulation that simultaneously increase wind resistance, improves thermal insulation and acts as a secondary water barrier.

In 2011, the NSF supported my research team to collect perishable data after the Tuscaloosa, AL tornado. Several faculty members from different universities and their students were involved. The ASCE and the International Associations of Wind Engineering supported our damage survey of the Joplin, MO event, one month later. The reports, book and peer-reviewed papers produced from those efforts have provided new knowledge and they have facilitated the first attempt at developing a design philosophy for tornado loads. That impetus has led to ASCE Wind Load Task Subcommittee to undertake recommendations for tornado wind loads as part of the Commentary, to be included in the 2016 revision of wind loading standard.

NSF and the National Oceanic and Atmospheric Administration (NOAA) organized the "Weather-Ready Nation" series of workshops in 2012 to plan the future of our response to severe weather. Their final report included the following recommendation pertaining to the built environment:

In the area of hazard mitigation/disaster recovery, workshop participants identified the need to develop a better understanding of surface level wind and how it affects buildings. This knowledge could be used to develop more cost-effective methods of retrofitting existing structures that would enhance their wind resistance and to identify more cost-effective methods of constructing safe rooms and shelters. {There is} a need to identify ways to use regulations (e.g., building codes) and incentives (e.g., tax credits) to promote implementation of tornado-resistant retrofits, incorporation of tornado-resistant construction into new structures, and construction of safe rooms and shelters. In addition, there is a need to define community resilience, identify specific indicators for measuring it, and incorporate these indicators into the criteria for designation as Storm-Ready communities. {The workshop} also identified some activities that would achieve multiple purposes, such as establishing post-storm assessment teams."

IV. VULNERABLE BY DESIGN

Ultimately the reason we pursue this research is to be able to create protections of life and the way of life for our fellow citizens. I have seen thousands of homes damaged affecting thousands of lives, where some improvement could have mitigated their losses. Our schools remain vulnerable to damage, and safe areas must be provided. Without this research, pursued as a national priority, the engineering knowledge needed will not be produced that can change these outcomes. Our homes are vulnerable by design. By following current building codes, they have little chance of surviving a violent tornado. Over half of economic losses from tornadoes are caused by EF-3 or lower tornadoes. Further, we know that even in EF-4 or EF-5 tornadoes, the most violent forces occur only within a narrow central band of the damage swath and the majority of buildings are damaged by lower intensities (EF3 or lower).

The repeated destruction of large communities of homes by tornadoes highlights the need for acceptance of more resilient residential construction practices as the basis for viable housing in the 21st century. The engineering research community must work hand-in-hand with innovators in building construction to develop more resilient structures at an economic cost. Clearly, rebuilding after the 1999 and 2003 tornadoes to the same building codes have not served the people of Moore, Oklahoma well. Wide swaths of homes built in 2005 had the same weaknesses present as the homes destroyed in the earlier tornadoes, and they failed in similar manners. Unless we change these practices and develop structural retrofits of existing buildings, the level of damage occurring in Moore will increase and affect another community. While there are still many unknowns in windstorm designs, what is concerning is that we have not yet incorporated what we do know into our building codes.

Our communities are now calling for national leadership on the issue of wind damage to buildings. I contend that a-10-year goal of creating a tornado-resilient community is an achievable one. The research community is ready, willing and capable to undertake the challenge of producing better houses and other buildings for this nation.

There is much still to be learned regarding windstorms and in particular tornadoes, where even the wind speeds at ground level are merely estimates. We do not know what design loads should be used for tornadoes, and what is an appropriate level of performance that should be expected of our buildings during violent tornadoes. We do not completely understand how and at what level of loading existing structures fail. We do not yet know how to balance the costs and benefits of tornado-resistant designs and retrofits on a home-by-home basis. But we know that tornadoes and hurricanes are very different, and present different design challenges. We know that even at the same wind speed, building loads in a tornado are much higher than in a hurricane due to the strong vertical suction within the vortex.

VI MODEL BUILDING CODES

Responsible building is essential to improve the quality of life, assure safety and durability, and to reduce vulnerability to future hazards. Traditionally, design practice and building codes have been the responsibility of the local communities. Recent natural disasters have demonstrated a high level of interdependence between the viability of local cities and the national economy. The traditional assumption that local jurisdictions could determine the level of safety and quality to which they would build has yielded to the recognition that uniform national standards are needed to assure that the economic impact to the nation is controlled. These national standards are best delivered in a national model code that local jurisdictions should be encouraged to adopt.

The purpose of a building code is to establish minimum requirements necessary to protect and improve public health, safety and welfare in the built environment. Model building codes provide for protection from fire, structural collapse, general deterioration, as well as extreme loads related to man-made and natural hazards. They are also created to protect natural resources, owner costs and the environment through improved minimum building standards. Building codes are “living” documents, that are changed over time as more knowledge about particular loads and materials become available. The wind engineering knowledge in our building codes has not kept pace with the growth of communities in regions at risk of tornadoes. Safe and sustainable buildings are achieved through performance-based code-based design and construction practices in concert with a code administration program that ensures compliance. National model codes serve to keep construction costs down by establishing uniformity in the construction industry as well as minimizing disaster recovery costs. This uniformity permits building and materials manufacturers to do business on a larger scale - statewide, regionally, nationally, or internationally. This larger scale, in turn, creates cost savings for the end consumer. Codes also help protect real estate investments, commercial and personal, by providing a minimum level of construction quality.

Experienced volunteer professionals work together and develop model codes under a multi-step process. Most professional engineering organizations maintain code development committees that initiate code provisions based on the practice in their technical areas and these are often augmented by university-based research. Topics for code provisions are often introduced in case study reports or research papers. In time, many of these provisions are gathered together and published as design guidelines. Eventually the guidelines are transformed into standards and incorporated into the model code. ASCE, as a premiere American National Standards Institute (ANSI)-approved standards organization, develops and maintains many of the standards referenced or incorporated in the model codes. Through a thoughtful and extensive process, ASCE assures that each standard represents a broad consensus of the related professional community.

State and local legislative bodies are not obligated to adopt model building codes, and may write their own code or portions of a code. A model code does not have legal standing until it is adopted as law by a legislative body (state legislature, county board, city council, etc.). When adopted as law, owners of property within the boundaries of the adopting jurisdiction are required to comply with the referred codes. Because codes are updated regularly, existing structures are traditionally only required to meet the code that was enforced when the property was built unless the building undergoes reconstruction, rehabilitation, or alteration, or if the occupancy of the existing building changes. In that case, provisions are included in the code to require partial to full compliance depending on the extent of construction.

VII H.R. 1786 "The National Windstorm Impact Reduction Program Act of 2013"

We support reauthorization and full funding for the National Wind Storm Impact Reduction Program. We also support the transfer of leadership to the National Institute of Standards and Technology (NIST). If the program is funded and utilized to its full potential, we would see the development and transfer of new technology that will reduce losses experienced each year as a result of wind storms.

The funding should be targeted to achieve the following goals:

- Reduce economic losses from windstorms and increase the resilience and sustainability of communities.
- Develop affordable designs to provide enhanced windstorm protection.
- Improve emergency management planning.
- Develop cost-effective retrofit schemes with existing construction to improve individual and community resilience.
- Develop improved severe weather warnings with longer lead-time, fewer false alarms, and more accurate prediction of affected areas.
- Implement innovative codes and standards that provide for wind-resistant construction and programs for assuring increased compliance.
- Develop new materials and innovative design concepts and emergency response approaches to minimize electrical power loss as a result of windstorms.
- Conduct public education on wind hazards and methods for hazard reduction.
- Collect and archive wind and national infrastructure data.
- Train the next generation of technical experts and enhance the knowledge of design and construction professionals.

- Improve regional risk assessments, especially involving multiple hazards, lifeline interdependencies, and ripple effects.

VIII CONCLUSION

Windstorms are possibly the only natural disaster whose impact on humans could be mostly resolved by proper research. There are wind-engineering experts in the country (20 or so left, like endangered species) who believe that this problem can be resolved, if properly addressed. The National Earthquake Hazards Reduction Program (NEHRP) is a good example of the strong correlation between spending on research dollars at a sustained level and its impact on reducing structural damage from earthquakes.
The NIWRP needs to follow suit. This should be a coordinated effort at the national level involving universities, government agencies (national labs), building officials and industry; expect to see positive results in 5-10 years. Grand challenge problems need grand solutions.

I sincerely urge the Members of these Subcommittees to work towards bi-partisan support of this urgently needed bill, which can shift our support for wind engineering research from low to high gear, as this is an urgent national priority.

To paraphrase the words of President John Kennedy's famous 1962 "To the Moon" speech:

"Let us choose to live in tornado-resilient communities. Let us choose to develop tornado-resilient homes within a decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win".

Thank you.

END OF TESTIMONY