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The American Society of Civil Engineers (ASCE) has long recognized the need for better research into predicting and mitigating the damage from major wind events. All 50 states are vulnerable to the hazards of windstorms. In 1998, hurricanes, tornadoes and other wind related storms caused at least 186 fatalities and more than $5.5 billion in damages.

On May 3, 1999 more than 70 violent tornadoes struck from north Texas to the Northern Plains. Forty-one people died and more than 2,750 homes were damaged. In 1992, Hurricane Andrew resulted in $26.5 billion in losses and 61 fatalities, in 1989, Hurricane Hugo resulted in $7 billion in losses and 86 fatalities and in 1999, Hurricane Floyd resulted in more than $6 billion in losses and 56 deaths.

The United States currently sustains several billion dollars per year in property and economic loss due to windstorms. The Federal government's response to such events is to initiate search and rescue operations, help clear the debris and provide financial assistance for rebuilding. I am here today on behalf of the ASCE and the West-Central Wind Research Consortium. We are calling upon the Federal government to provide research funding to help reduce the significant annual toll in casualties and property damage from windstorms.

Founded in 1852, ASCE represents more than 125,000 civil engineers worldwide and is the nation's oldest engineering society. ASCE members represent the profession most responsible for the nation's built environment. Our members work in private-practice, industry, government and academia. 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.

Near-surface winds are the most variable of all meteorological elements, making the prediction and control of their impacts all the more challenging. In the United States the mean annual wind speed is 8 to 12 mph, but wind speeds of 50 mph occur frequently throughout the country, and nearly every area occasionally experiences winds of 70 mph or greater. In coastal areas of the East and Gulf coasts, tropical storms may bring wind speeds of well over 100 mph.

With the average annual damage from windstorms at more than $6 billion, the $5-10 million Federal investment in research to mitigate these impacts is woefully inadequate. In contrast, the Federal government invests nearly $100 million per year in reducing earthquake losses through the National Earthquake Hazards Reduction Program, a program which has lead to a significant reduction in the affects of earthquakes. A Federal investment in wind hazard reduction would pay similar or greater dividends in lives saved and decreased property damage.

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 random events with large uncertainties in the magnitudes and characteristics of the winds. The relevant government agencies and programs, as well as the construction industry, are fragmented. Finally, implementation requires action by owners and the public, who may not consider hazard reduction a high priority. Solving wind vulnerability problems will require coordinated work in scientific research, technology development, education, technology transfer and public outreach.

In 1993 the National Research Council published a report entitled "Wind and the Built Environment."[1] The report included the recommendations of the Panel on the Assessment of Wind Engineering Issues in the United States. The panel recommended the establishment of a national program to reduce wind vulnerability. Such a program would include wind research that draws upon the expertise of both academia and industry and addresses both structural and nonstructural mitigation methods, an outreach program to educate state and local governments on the nature of the wind risks they face, a conscious effort to improve communication with in the wind community and a commitment to international cooperation in wind-engineering.

A 1999 NRC study concurred in that recommendation and specifically urged Congress to designate "funds for a coordinated national wind-hazard reduction program that encourages partnerships between federal, state and local governments, private industry, the research community, and other interested stakeholders."[2]

As far as preventing or minimizing the impact of major wind events, the Federal government has mainly limited itself to improvements in weather prediction and public warnings. In light of the damages and loss of life that windstorms cause every year, ASCE strongly feels that the Federal government can and should do more.

To that end, ASCE has worked with Congressmen Dennis Moore of Kansas, Walter Jones of North Carolina, and others, first to help form the Congressional Wind Hazard Reduction Caucus and then to develop legislation. The Caucus was created in October of 1999 and is chaired by Mr. Moore and Mr. Jones. It has as its goal to increase Congress' awareness of the public safety and economic loss associated with major wind events and to establish and fund programs to mitigate those impacts.

On October 19, 2000, Congressmen Moore and Jones and others introduced H.R. 5499, the Windstorm Hazard Reduction Research and Technology Transfer Act." ASCE supported the development of this legislation by providing technical advice, and by helping to form the Wind Hazard Reduction Coalition. The Coalition includes professional societies, research organizations, industry groups and individual companies with knowledge and experience in dealing with the impact of high winds.

[1] National Research Council, Wind and the Built Environment (1993).
[2] National Research Council, Review of the Need for a Large-scale Test Facility for Research on the Effects of Extreme Wind on Structures, (1999).

Beginning this year, the same group that developed H.R. 5499 came together to refine and improve our legislative efforts. The draft legislation being circulated is the result of two years of collaborative effort and is designed to achieve those goals expressed by both the Congressional Wind Hazard Reduction Caucus and the Wind Hazard Reduction Coalition.

Now entitled the "Hurricane, Tornado and Related Natural Hazards Research Act," this legislation is truly a community effort. All interested groups have been involved with this from the beginning. ASCE commends Congressmen Moore, Jones and their staffs, as well as staff from the House Science Committee, for working with the community to create this consensus and, more important, technically and scientifically sound legislation.

Specifically, the legislation creates a coordinated Federal windstorm and related hazards reduction research, development and technology transfer program. The object of the program is to achieve, within 10 years, a measurable reduction in losses that would otherwise occur to life and property from wind and related disasters.

This is accomplished by the following actions:

- Coordination of Federal wind hazard reduction efforts through a multi-agency National Windstorm Hazard Reduction Program that is coordinated by the Office of Science and Technology Policy and the Federal Emergency Management Agency.

- Linkage of all aspects of the program to the goal of a major, measurable reduction in losses of life and property due to wind storms within 10 years of the date of enactment.

- A list of 11 areas where wind hazard reduction research and development with an emphasis on developing cost-effective and affordable improvements can pay big dividends.

- Establishment of a wind hazard reduction technology transfer program.

- Establishment of a National Advisory Committee for Windstorm Hazard Reduction.

- Authorization of appropriation levels that could bring the program to parity with the Federally funded earthquake research program over a three-year period.

The research program would be overseen by an **Interagency Group** of federal agencies involved in research, weather, natural disaster mitigation, housing and construction, and related standards and would give the group responsibility to develop and implement a coordinated Federal program for wind hazard reduction research, development and technology transfer.

The group is to be co-chaired by the White House Office of Science and Technology Policy and the Federal Emergency Management Agency. The program should, in part, build on current agency and private sector efforts. Major program elements are to include peer-reviewed basic and applied research. Other research will focus on ways to achieve a better understanding of impediments and disincentives to wind hazard reduction. Data collection programs will be established to achieve a better inventory of information on building components and materials and their interactions. Technology transfer components will be implemented to achieve better dissemination of wind hazard reduction technology, techniques and knowledge. The bill supports continuation of current efforts to improve technology for weather prediction and disaster response. The bill also places a priority on research to ensure proper performance of critical structures and lifelines needed during a time of disaster.

The research and development program may include basic weather research, research on materials and building technologies including retrofits, and mapping techniques. The technology transfer program is to include information collection, classification, presentation and dissemination of research results and other pertinent information to state and local officials, the private sector, and the general public and a delineation of responsibilities among these parties. The Interagency Group is to coordinate with appropriate representatives of state and local governments and the private sector in the development of a 10-year implementation plan. The plan would set out research and implementation priorities and goals, development of improved forecasting techniques, technology transfer plans, and plans for intergovernmental cooperation and coordination.

The bill would also create the National Advisory Committee for Windstorm and Related Natural Hazard Impact Reduction consisting of 21 members, appointed by the President. The members of the advisory committee will be drawn from state and local governments and the private sector with expertise in areas such as architecture, engineering, construction, finance, insurance, and research. The Committee is to review program progress and to report to the Congress annually on program status and needed improvements.

At a regional level, the West-Central Wind Research Consortium has been formed by researchers from the Colorado State University, South Dakota School of Mines and Technology, the University of Wyoming and the University of Kansas to pool our resources and expertise to address this urgent need. The focus of the Consortium will be to conduct research into wind issues in this part of the country and to help development new knowledge into wind and how it effects structures. The Consortium will work to formulate economically viable strategies to improve the safety and economic health of citizens in the member states. Improving our knowledge of wind not only can reduce damage and injury but also can help development wind as a cost effective renewal energy sources.

Minimizing the loss of life, property damage and disruption of economic activities from windstorms are primary objectives of wind engineering research. The research, engineering and scientific communities have provided some of the technical underpinnings for reducing the vulnerability of buildings and other structures to wind damage. Significant work remains to be done in this area to ensure that key vulnerabilities are identified and that technically sound, cost-effective and affordable solutions are developed and implemented.

ASCE has identified the following areas where increased research would pay significant dividends in the form of reduced loss of life and property.

Roof System Testing Procedures and Devices for Wind Resistance - No standardized testing procedures and devices exist to test roof-cladding materials for resistance to extreme winds and debris. Development of these items is a necessary prerequisite for improved roofing performance.

New Roofing Systems - Damage to roofing is perhaps the single most common result of high wind. Even small failures can allow wind and rain inside the building leading to significant interior and content damage and possible structural failure. Development of new wind-resistant roofing materials and technologies could significantly reduce wind-induced damage.

In-Residence Shelters for Hurricane Protection - In collaboration with the university research community, FEMA has conducted research and developed plans and guidelines for in-residence shelters for protection from tornadic winds. These designs provide near complete protection for occupants from even large tornadoes, but are too costly and overly conservative for use on hurricane coasts. New research is needed to find more appropriate and cost effective solutions for construction on the hurricane coasts.

Dual-Use Public Hurricane and Tornado Shelters - Schools are the most commonly used buildings for hurricane evacuation shelters, but they may not be structurally designed to provide a safe haven. Similarly, children shelter in-place while in school during tornado warnings, but these buildings are not designed with adequate protection. Research and development of design guidelines and methodologies on how best to construct schools and other public buildings for dual function as shelters from hurricanes and tornadoes are desperately needed.

Retrofit Technologies for Wind Resistance - Although it is much easier to build wind resistance into new construction, the country has an enormous investment in existing building stock. Technologies for cost-effective retrofits to improve wind resistance of these buildings should be an important focus of any new research program.

Improved Connections and Framing Systems for Light Frame Construction - Much of the structural damage which occurs in severe winds is to light frame one- and two-story construction. There has been relatively little improvement in wood and other

light framing technology in the past 20 years. New cost-effective construction techniques could significantly reduce structural damage to low-rise buildings.

Boundary Layer Meteorology for Landfalling Storms - Little is known about the structure of the wind in a hurricane and how it changes as it passes over land. Research is needed to better understand the nature of boundary layer transitions, turbulence, rainfall, and decay rates as storms move inland. The design wind speed and gust factors used in all building codes and standards (including ASCE-7) are based on a set of assumptions that hurricane winds have similar properties to winds from other events, which we know to be untrue. This research can lead to significant improvements in wind-loading related portions of our building codes and standards.

Rapid Damage Assessment using Remote Sensing for Improved Response and Recovery - The key to optimization of response and recovery operations is timely access to detailed information on the extent and intensity of damage throughout the effected areas. Very high-resolution data can be obtained from commercial satellite-based remote sensing systems, which was previously unavailable except to intelligence and defense communities. Resolutions have improved to the point where data are available on individual buildings and vehicles. Development of computerized analysis tools that automate and map damage assessment estimates will significantly assist response and rescue and recovery operations.

Conclusion

Windstorm-related costs have averaged several billion dollars per year during the last decade with a high in 1992 exceeding $25 billion, primarily as a result of Hurricane Andrew. If a severe hurricane makes landfall in Miami, New Orleans, or New York City, the damage could exceed $50 billion. Hurricanes, tornadoes, and other windstorms cause death and injury, business interruption, and unacceptably high levels of property damage in all 50 States and all U.S. territories. People continue to move to coastal areas adding to the trend toward larger disasters and increasing damage costs will continue unless an effective wind hazard reduction plan is implemented.

Currently, a number of important independent activities (e.g., FEMA's Project Impact and HUD's Project PATH) are underway to reduce the disastrous effects of windstorms. These activities will have a limited impact on reversing the trend of increasing costs unless action is taken to improve the resistance of the physical infrastructure that is now susceptible to damage by windstorms. A unified national plan of wind hazard reduction has a potential of reducing losses significantly in the next decade.

An important consideration is that improving structural performance under wind loads will have benefits in resisting other loading regimes as well. While the details of the loading may be different, a structural system that has been toughened to perform better under wind will in general perform better under earthquake or even blast loading. The

recent tragic events in New York and Washington have shown the need for structural performance under load – even those that are unforeseen.

As the recent tornadoes in the Washington, DC area demonstrated, windstorms pose a threat in many areas of the country; a threat we should not dismiss with the thought that we can not do anything about the weather. With the proper information gained from research, we still will not be able to change the weather, but we can change the way it affects peoples lives.

Thank you for the opportunity to express ASCE's views. We look forward to working with members of the Subcommittee to move this legislation forward.