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HIGHLIGHTS 1997-1998

The Wind Engineering Research Center (WERC) was established by action of the Board of Regents at Texas Tech University in September 1988. The Center’s objectives are to promote multidisciplinary research in wind engineering, to attract external funding for wind engineering research, to provide a forum for faculty and students from various disciplines to work as a team and to provide information and materials to the public through its outreach program. The Center continues to pursue these objectives with measurable success.

Highlights of wind engineering activities during 1997-98 are as follows:

• 17 funded wind engineering-related research projects were pursued during the year. Some of these projects have commitments to continue over the next few years.

• 27 faculty members representing 10 academic departments and 6 research associates are pursuing wind engineering-related research.

• 34 graduate students pursued wind engineering-related research; 6 completed M.S. degrees and 3 completed Ph.D. degrees during the year. Additionally, 30 undergraduate students are involved in various wind engineering projects.

• Research was supported by $1,322,191 in external funds ($1,207,742 in governmental grants and $114,449 in contracts from the private sector) and $314,334 in internal funding totaling over $1.6 million.

• WERC was awarded funding by the federal legislature. Funding for $3.6 million is administered through a cooperative agreement with the National Institute of Standards and Technology (NIST). A team of sixteen faculty members from the disciplines of civil and chemical engineering, architecture, atmospheric science, mathematics and economics has been assembled to pursue research and technology transfer activities in seven interrelated research thrust (RT) areas. An Information/Outreach Center has also been established under the program. This funding will extend into next fiscal year.

• 18 publications in refereed journals and 12 publications in proceedings of conferences and reports have resulted this year from research projects.

• 11 proposals were submitted for over $8 million.

• Successful deployment of mobile instrumented tower for Tropical Storm Charley in Rockport, TX and Hurricane Bonnie in Wilmington, NC. These are the first successful deployments of a mobile instrumented tower to measure ground-level properties of tropical storm winds. Deployment for Hurricane Bonnie resulted in nationwide publicity including a segment on National Public Radio.
• Damage investigation teams were dispatched following tornadoes near Birmingham, Alabama and Gainesville, Georgia; in Nashville, Tennessee and Spencer, South Dakota; and in Central Florida, especially the city of Kissimmee.

• Texas Tech University was unanimously elected to membership in the University Corporation for Atmospheric Research.

• “Tornadoes with Multiple Fatalities,” a seminar open to the community was held in the Lankford Laboratory. Moderated by Kishor Mehta, presentations were given by Ernst Kiesling, Partha Sarkar, Anna Gardner, and Russell Carter. Fifty-five people attended.

• Drs. Kiesling and Mehta gave presentations at the National Tornado Forum, organized by the Federal Emergency Management Agency (FEMA) and held in Washington, D.C. The forum was carried live for four hours on C-SPAN-2. WERC and Texas Tech University received significant publicity as a result of this symposium including segments on the CBS evening news and National Public Radio.

• Research was completed and a booklet prepared in conjunction with Greenhorne and O'Mara and FEMA presenting designs for In-residence shelters for life safety in windstorms. The booklet, “Taking Shelter from the Storm: Building a Safe Room Inside Your House,” is available from FEMA Publications as #320 by calling 1-800-480-2520.

• A short course, *Engineering for Extreme Winds*, was offered to practicing professionals in February 1998.

• An exhibit, *Winds of Destruction, Currents of Change*, continues at the Science Spectrum in Lubbock. An interactive exhibit on wind at the Lakeview Museum of Arts and Sciences, Peoria, IL, includes photographs from WERC. A house model showing an in-residence shelter is part of a nationwide museum tour organized by the Franklin Museum, Philadelphia, PA.
WIND RESEARCH 1997-1998

Figure 1. Research continued at the Wind Engineering Research Field Laboratory (WERFL). The sonic anemometer mounted on the roof of the WERFL building is used to measure 3-component wind velocity within the separation bubble.

Flow Visualization: Tuft

Wind flow visualization over the roof of the WERFL building using tufts on a grid.

Texas Tech's storm chase team investigates the factors affecting the formation of severe storms and tornadoes.
Studies of missile impact using the missile launcher (tornado cannon) formed one aspect of the research which led to the development of revised plans for building an above-ground, in-residence shelter for windstorm events. A booklet and set of plans is being published by the Federal Emergency Management Agency and made available to the public free of charge.

A house was thrown into the bottom of a ravine by a tornado which hit Birmingham, AL on April 8, 1998. The tornado destroyed over 1000 homes, killed 34 people and injured 221. Texas Tech sent a damage investigation team following the event and is currently studying the tornado’s effects with the help of aerial photographs taken a few days prior to and a few days following the event.
May 30, 1998 in Spencer, SD all but a dozen homes were destroyed or damaged.
NEW RESEARCH FACILITIES

Wind Engineering Mobile Instrumented Tower Experiment (WEMITE)

Early in 1998, Dr. Frank Marks of NOAA’s Hurricane Research Division announced an effort to mobilize researchers to gather data on landfalling hurricanes. There is a dearth of information on wind behavior in the lowest 50 ft of the high wind area surrounding the eye of the hurricane. The number of reliable anemometers in the path of any severe wind event is limited at best. Even those which do exist, often fail or inadequately record the event. From an engineering perspective this information would increase understanding of building failures and therefore lead to improved design for future construction. From a meteorological perspective the data would shed light on the influence of landfall on the structure of the storm.

The Wind Engineering Mobile Instrumented Tower Experiment (WEMITE) is a pilot program whose focus is on quickly deploying an instrumented, structurally reinforced, mobile tower in the direct path of severe wind events such as thunderstorm outflows, and landfalling hurricanes to acquire high-resolution wind speed data valuable to the wind science community. John Schroeder, Research Associate, assisted by graduate and undergraduate students in civil engineering, atmospheric science and mathematics designed, constructed, outfitted and tested the tower. The instrumentation of the tower is funded by the Idaho National Engineering and Environmental Laboratory.

The 35ft mobile tower is deployed based on forecasting information from the TTU atmospheric sciences department and several government agencies. The tower is structurally reinforced and heavily anchored (employing quick deployment methods). It is instrumented at three levels (10, 20, and 35ft.) with 3-cup and propeller anemometers. All of these wind instruments are sampled at 5 Hertz to ensure a high-resolution data set. Barometric pressure, temperature and relative humidity data is also recorded. The power supply, and data acquisition system is steel encased for protection from windborne debris and is capable of operating by itself (with no outside power supply) for at least two days.

WEMITE will provide valuable wind speed data under extreme conditions which, upon analysis, will provide comparisons for some of the current approximations employed. Once the analysis is complete, characteristics such as the vertical wind profile, turbulence intensities and integrals scales can be compared to those currently used in design codes and standards. WEMITE has already been deployed at Rockport, TX in Tropical Storm Charley and at Wilmington, NC in Hurricane Bonnie.
Wind-Tunnel Facility

Texas Tech University allocated $200,000 and the space to construct a new wind-tunnel facility for the College of Engineering. The new wind tunnel will be used for the combined research and educational needs of the College of Engineering, specifically for the Wind Engineering and Industrial Aerodynamics programs. The new wind tunnel is physically located in the high-bay area of the Mechanical Engineering laboratory. It is expected that the tunnel will be available for testing purposes starting November 1, 1998. The wind tunnel is a closed-circuit tunnel with a 57-ft long section serving as two test sections; a 6 ft wide by 4 ft high aerodynamic section (AERO) followed by a 6 ft wide by 5 ft high boundary-layer (BL) section. The maximum operational wind speeds in the tunnel is 90 mph in the boundary-layer section and 120 mph in the aerodynamic section. A schematic drawing of the closed-circuit wind tunnel is shown in Figure 2. This facility will have the state-of-the-art instrumentation for pressure, force and response measurements and data acquisition.
Figure 2. Texas Tech Wind-Tunnel Facility (Elevation View, Conceptual)

Figure 3. Wind-Tunnel facility including Aerodynamic and Boundary-layer sections.
PROMOTIONAL AND PROFESSIONAL ACTIVITIES

PUBLIC OUTREACH

Tours/Presentations for Schools/Civic Groups
Tornado Safety presentation as part of TTU Physical Plant’s Safety Standdown, presented by Dr. McDonald, 40 participants, September, 1997.
Tornado safety presentations (8 groups), Bennett Intermediate, 5th and 6th gr., presented by April MacDowell, 700 students, January 1998.
Tornadoes and tornado safety presentation (2 classes), All Saints 4th gr, presented by April MacDowell, 20 students, March 1998.
Stormy Science Saturday, Science Spectrum, tables set up by Storm Chase team, Damage Documentation team and with in-residence shelter information, 40 people, March 1998.
Tornadoes and storm chasing presentation (2 classes), Lubbock High School, presented by Anna Gardner and Todd Flanagan to the Storm Chase class, 40 students, April 1998.
Presentation for UT-Austin Civil Engineering Dept. on Wind Engineering program at Texas Tech, presented by James McDonald, April 1998.
Tour of WERFL, Crestview 3rd grade, given by John Schroeder, Mark Conder and April MacDowell, 90 students, May 1998.
Presentation on in-residence shelters and missile shot by Dr. Kiesling, tour of WERFL by John Schroeder, Science Teachers of Region 17, 38 attendees, May 1998.
Presentation on Wind Engineering by Dr. Mehta, Chinese Electrical Engineering students sponsored by electrical power company, 51 students, August 1998.

Community Classes/Workshops/Seminars
“Tornadoes with Multiple Fatalities,” a seminar open to the community was held in the Lankford Laboratory. Moderated by Kishor Mehta, presentations were given by Ernst Kiesling, Partha Sarkar, Anna Gardner, and Russell Carter, 55 attendees, June 29, 1998.

Exhibits
“Winds of Destruction, Currents of Change” exhibit continues at the Science Spectrum. It was designed to inform the public about the twenty-five years of progress in wind engineering research carried on by the Institute for Disaster Research and the Wind Engineering Research Center. It includes photographs showing effects of wind and windborne debris and current research in progress. An interactive computer allows patrons to access instructional segments on thunderstorms, tornadoes and hurricanes.
Lakeview Museum of Arts and Sciences, Peoria, IL has an exhibit on tornadoes which uses photographs of Wind Engineering research facilities at Texas Tech and of damage documentation. The exhibits’ staff used a minivan tailgate to reconstruct a scene from one of the damage photographs showing a wooden board stuck through the back end of a van. For special tours, a miniature version of the missile launcher shoots pencils through 3/4” blocks of wood. Sheldon Schafer, Director of Science Programs and Facilities, explains Texas Tech’s larger missile launcher and its use in research.
The Franklin Museum, Philadelphia, PA organized a touring exhibit on the “Powers of Nature” which includes Wind Engineering’s model of a residence with an in-residence shelter.
Popular Print Media

Recent accomplishments section of Texas Tech Football, Sept. 13, 1997 included a section on Wind Engineering’s June appearance on Dateline NBC.

“Texas Tech University’s Wind Engineering Research Center gains national attention,” appeared in the fall 1997 issue of the ICASALS (International Center for Arid and Semiarid Land Studies) Newsletter. It highlighted the in-residence shelter and other research conducted at WERC.


Palm Beach Post, Jennifer Peltz interviewed Dr. Kiesling by telephone, February 24, 1998. Orlando Sentinel, Tim Barber interviewed Dr. Kiesling by telephone, February 27, 1998.

Petrochem Magazine, M.A. Bengston interviewed Dr. Mehta about research in the wind engineering area to prepare industrial sites to withstand severe windstorms, March 1998.

Tampa Tribune had an article on the in-residence shelter, March 1, 1998.

Houston Chronicle, Terry Kliwer interviewed Dr. Kiesling by teleconference regarding mobile home safety, March 5, 1998.

“Season for Twisters,” included interviews with Dr. Peterson regarding wind speeds in tornadoes and Dr. Kiesling regarding in-residence shelters, Lubbock Avalanche-Journal, April 1998.


Cincinnati Enquirer requested information and slides of the in-residence shelter for an article, April 1998.


“Here’s How to Save Roof, Keep House in Place if Tornado Whips up Wind,” The Wisconsin State Journal discussed the in-residence shelter in an article on tornadoes, Madison, WI, April 1998. This release went out on the AP wire.

This Tornado Shelter Comes Up to Snuff,” and “Build Me Shelter,” on the in-residence shelter,

Fort Worth Star-Telegram, April 1998; this went out on the AP wire and appeared in papers around the country including the two listed below.


“Tornado-Proof Room Design Works as Add-On, Stand-Alone,” on the in-residence shelter,


"Bridge Problem is Worrisome but of No 'Immediate Concern'," mentioned Texas Tech's involvement with the Fred Hartmann bridge project, Houston Chronicle, July 14, 1998.


"Wind Research Receives Grant," by Apu Naik, reported approval of funding by the U.S. Congress for FY1999 and interviewed Dr. Mehta regarding future plans, The University Daily, August 11, 1998.


"Feds Urging Tornado 'Safe Rooms'," by Richard Smith, discussed the in-residence shelter, Waco Tribune Herald, August 23, 1998.

"Tech Researchers Head to Coast to Study Hurricane," by Kara Altenbaumer, discussed the WEMITE project and interviewed Jamie Snelson on the road with the tower, Lubbock Avalanche-Journal, August 26, 1998. This release also went out on the AP wire.

"State Grant to Aid Reese Development," by Mary Alice Robbins discussed Wind Engineering's and Mesonet's role at Reese, Lubbock Avalanche-Journal, August 27, 1998.


News release by Dr. Frank Marks, Hurricane Research Division included the TTU mobile tower among the research platforms deployed during Hurricane Bonnie, August 28, 1998.

Visual/Auditory Media
Curt Lancaster from VSA, a statewide agricultural radio network based in San Angelo, interviewed Dr. Kiesling regarding tornado safety and the in-residence shelter, September 17, 1997.


KLBK-TV, Channel 13, Lubbock, TX used the Wind Engineering revolving sign as a backdrop for a live broadcast on the evening news, January 1998.

WBRC-TV, Birmingham, AL, Channel 6 interviewed Dr. McDonald and filmed a missile launcher shot and the Wind Engineering Research Field Laboratory, January 1998.

MSNBC, cable television, rebroadcast the Dateline segment featuring the missile launcher and in-residence shelter, February 1998.
Fox 7, Austin, TX interviewed Dr. Kiesling and filmed the missile launcher, February 24, 1998. Tuscaloosa, AL news featured the missile launcher and in-residence shelter, February 1998.

The NBC affiliate in Miami, Loren Goldfarb interviewed Dr. Kiesling and filmed the missile launcher for a special news segment, March 3, 1998.

CBS affiliate, Mark Hooper interviewed Dr. Kiesling and filmed a missile shot, March 3, 1998.

KOOCO-TV (ABC), Oklahoma City interviewed Dr. Kiesling and filmed a missile shot, March 10, 1998.

Monica Lloyd from Home and Garden television interviewed Dr. Kiesling regarding the in-residence shelter, March 18, 1998.


Tim Hetrick, WKRC-TV, Cincinnati, OH, interviewed Dr. Kiesling regarding the in-residence shelter, March 20, 1998.

ABC Affiliate, Atlanta, GA, interviewed Dr. Kiesling and filmed a missile shot, March 10-11, 1998.

KMAC-TV, Lubbock, TX interviewed Dr. McDonald regarding mobile home performance in tornadoes, March 1998.

KTRK-TV Houston requested a video of the tornado cannon and information on the in-residence shelter, March 1998.

WFOR-TV (CBS), Miami, FL, Gwen Silberstein interviewed Dr. Kiesling by telephone, March 20, 1998.

KAUZ-TV, Wichita Falls, Greg Speiland interviewed Dr. Kiesling and filmed a missile shot, April 2, 1998.

KTVT-TV (CBS), Dallas, TX interviewed Dr. Kiesling and filmed the missile launcher, April 13, 1998.

KTRV-TV, Houston, TX requested and received a video of the missile launcher for use on their news program, April 1998.

WFIA-TV, Dallas, TX, interviewed Dr. Kiesling and filmed the missile launcher and an in-residence shelter in progress, April 17, 1998.

Home and Garden TV, Steve Greenberg, Producer, filmed the missile launcher and a completed in-residence shelter for use on Dream Builders and other shows, March 21, 1998.

CNN filmed the missile launcher and WERFL and interviewed Dr. Kiesling for a special on tornadoes, April 1998.

Cleveland Fox News filmed the missile launcher and interviewed Dr. Kiesling, April 1998.

CBN News, Virginia Beach, VA requested information and a video of the missile launcher, April 1998.

KTXS-TV news, ABC affiliate, Abilene, TX interviewed Dr. Kiesling and John Schroeder and filmed the missile launcher and WERFL, April 1998.

NBC News interviewed Dr. McDonald through uplink at HeathNet regarding tornadoes and mobile homes, April 1998.

Cosmo Space of America, Ltd, Kenshi Fukuara filmed the missile launcher and interviewed Dr. Kiesling for a 30-minute documentary being produced on tornadoes to be shown throughout Japan, May 15, 1998.
Pioneer Production of Great Britain filmed the missile launcher and interviewed Russell Carter and Dr. Kiesling regarding the in-residence shelter and damage documentation events. They also visited an in-residence shelter under construction, May 29, 1998.

The Discovery Channel's weekly news program featured Larry Tanner and Russell Carter as they documented damage caused by the tornado in Spencer, Kansas, June 6, 1998.

WAFB (CBS Affiliate) Baton Rouge, LA filmed the missile launcher and wind tunnel and reporter Jennifer Donelan interviewed Dr. Kiesling and Dr. Oler for an upcoming hurricane special, July 1, 1998.

KAMC-TV interviewed Dr. McDonald and showed footage from the Tornado seminar held at Texas Tech, June 29, 1998.

KLBK-TV interviewed Dr. Mehta and Russell Carter at the Tornado seminar and showed video footage taken by Anna and Tom Gardner documenting tornado damage in Georgia, June 29, 1998.

KLBK-TV featured a live interview with Dr. Mehta on the morning show discussing the development of the Wind Engineering program from the Lubbock tornado until the current agreement with NIST, July 21, 1998.

KCBD-TV interviewed Dr. Doggett regarding the Mesonet project, July 30, 1998.

KCBD-TV, Jeannette Monroe interviewed Dr. Mehta, August 6, 1998.

KAMC-TV interviewed Dr. Doggett regarding the Mesonet project, August, 1998.

KLBK-TV interviewed Dr. Doggett regarding the Mesonet project, August 17, 1998.

The ABC Radio Network interviewed Russell Carter regarding the in-residence shelter and new booklet which will be available from FEMA, August 18, 1998.

KLBK-TV news interviewed Larry Tanner regarding the in-residence shelter and new booklet which will be available from FEMA, August 18, 1998.

CBS network news interviewed Larry Tanner regarding the in-residence shelter and new booklet which will be available from FEMA, August 19, 1998.

National Public Radio interviewed Russell Carter regarding the in-residence shelter, August 19, 1998. (Listen on-line with RealAudio Player from the NPR website at http://www.npr.org by clicking on All Things Considered, Archived files and choosing the appropriate date).

KLBK-TV interviewed Larry Tanner and Russell Carter regarding the in-residence shelter and new booklet which will be available from FEMA, August 19, 1998 for "live at 5," "live at 6," and 10:00 news segments.

KGNC Radio, Amarillo, TX interviewed Russell Carter regarding the in-residence shelter and new booklet which will be available from FEMA, August 19, 1998.

Sony Worldwide Network carried a story on the in-residence shelter and new booklet which will be available from FEMA, August 19, 1998.

WBAP Radio news, Dallas, TX interviewed Russell Carter live regarding the in-residence shelter and new booklet which will be available from FEMA, August 20, 1998.

KDCR, Sioux Center, IA interviewed Russell Carter regarding the in-residence shelter and new booklet which will be available from FEMA, August 21, 1998

KAMC-TV interviewed Dr. Peterson and discussed the mobile tower project, August 25, 1998.

KLBK-TV mentioned that the mobile tower team was headed to Hurricane Bonnie, August 25, 1998.

KCBD-TV interviewed Dr. Peterson and discussed the mobile tower project, August 26, 1998.
Canadian Broadcasting interviewed Dr. Doggett on why Bonnie was so big, August 26, 1998.

Headline News showed footage of the mobile tower as it collected data during Hurricane Bonnie and discussed the tower project, August 26, 1998.


On-line
Wind Engineering has a web page at http://www.ce.ttu.edu/wind.
FEMA has a link to the Wind Engineering web page to provide information on the in-residence shelter. The in-residence booklet can be downloaded from their web site at http://www.fema.gov/MIT/tsfs01.htm.
KVUE24, Austin, TX had a link to the Wind Engineering web page and the in-residence shelter brochure, April 1998.
The Science Coalition's web site featured Texas Tech University during the week of May 25-30. The Research section highlighted three projects, one of which was the Wind Engineering program.
Disaster Relief News Stories web page featured, “Specks of Dust Make Worldwide Impact,” by J. Gregg McNew. It included quotes from Tom Gill regarding the movement of dust from the duststorm in China, Dr. Gill's research on aeolian dust and a reference and link to the Wind Engineering Research Center. http://www.DisasterRelief.org/Disasters/980722wind
FEMA's web site featured the Tornado Forum with speakers from Texas Tech and an article entitled, “FEMA and Texas Tech Team Up for Tornado Protection in the Home,” on in-residence shelters, August 18, 1998.
Disaster Relief News Stories web page includes an article “When a Hurricane Nears, the DOW Rises (No, Not that DOW),” by J.Gregg McNew who interviewed John Schroeder regarding the mobile tower that will be deployed in front of landfalling hurricanes for a story, August 21, 1998. http://www.DisasterRelief.org/Disasters/98021dow

Other
Pillarstone Development, Inc., a real estate development company, plans to offer the in-residence shelter in new homes in the greater Houston area.
PROFESSIONAL ACTIVITIES

Classes/Presentations for Professionals
ASCE Wind Load short course; Raleigh, NC; Corpus Christi, TX; Seattle, WA; Las Vegas, NV; Atlanta, GA; Sept. 1997-Jan. 1998; Pittsburgh, PA; Orlando, FL; May-June 1998; K.C. Mehta.


Texas Tech Engineering for Extreme Winds short course, Lubbock, TX, February 1998 presented by K.C. Mehta, J.R. McDonald and D.A. Smith, and P.P. Sarkar, 24 professionals from 10 states and one from Europe participated.

Seminar on wind engineering research at Texas Tech University presented at University of Texas Civil Engineering department, Austin, Texas, April, 1998.


University of North Texas, Denton, TX, April 1998, presentation, “Storm Resistant Structural Characteristics and Market Prices,” by Kevin Simmons.

Roofing Consultants Institute Region IV meeting, Albuquerque, NM, June 1998 on tornadoes, presentation by J.R. McDonald, 25 attendees.


Special Seminars for Students

“Tornado Dynamics” seminars were presented regularly Tuesdays and Thursdays through the Summer, 1998, organized by Victor Shubov, Department of Mathematics and Statistics.

Awards/recognitions

Dr. McDonald received the 1997-98 Barnie E. Rushing, Jr. Faculty Distinguished Research Award from the Texas Tech Dads and Moms Association; he was again recognized for this award at the Faculty Honors Convocation.

Dr. Kiesling received the El Paso Energy Foundation Faculty Achievement Award for 1998.

Dr. McDonald was the Mace Bearer for the Spring 1998 commencement ceremony.

Dr. Mehta is listed in Who’s Who in Science and Engineering for 1998.

Dr. Norville received an “Excellence in Teaching” award from Halliburton for 1997.

Faculty members serve on the following professional committees:

Advisory Board to Hazard Response and Recovery Center of Texas A&M University American Association for Wind Engineering Board of Directors, Secretary/Treasurer American Meteorological Society ASCE Aerospace Division Committee on Aerodynamics ASCE Committee on Wind Effects ASCE Standards Committee on Wind Tunnel Testing of Bridges and Other Structures ASCE Task Committee on Wind Loads

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Building Seismic Safety Council/Institute of Building Science Steering Panel to develop
National Multihazard Mitigation Council Steering Committee
Institute for Business and Home Safety (formerly Insurance Institute for Property Loss
Reduction) Wind Damage Mitigation Committee
Institute for Business and Home Safety Retrofit Committee
Institute for Business and Home Safety Roofing Committee
Manufactured Housing Standards Advisory Committee of the Texas Dept. of Housing and
Community Affairs, Austin, TX
National Institute of Building Sciences, Wind Loss Estimation Committee
National Roofing Contractors Association Wind Committee
Roofing Industry Committee on Wind Issues
Steering Committee to Develop National Multi-Hazard Mitigation Plan, National Institute
of Building Science
Texas Department of Insurance Building Code Advisory Committee
Texas Department of Insurance Loss Mitigation Committee - Wind/Hail
U.S.-Japan Natural Resources Task Committee on Design for Wind and Wind Hazard
Mitigation

Meeting Participations
Kiesling, E.W.
Residential Land Development Practices workshop, ASCE, Dallas, TX, March 1998.
FEMA Region IV Tornado Symposium, Atlanta, GA, April 1998.
National Hurricane Conference, Norfolk, VA, April 1998.
Meeting with Greenhorne & O'Mara regarding in-residence shelter design, Greenbelt, MD,
May 1998.

Kruse, J.B.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering
annual TAAC Advisory Committee meeting, Fort Collins, CO, October-November 1997.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering
Co-PI meeting, Santa Fe, NM, May 1998.

McComb, R.
National Hurricane Conference, Norfolk, VA, April 1998.

McDonald, J.R.
Windload Subcommittee, ASCE, Chicago, IL, September 1997; San Francisco, CA, July
1998.
Wind Hazard Mitigation and Retrofit Committee, Institute of Business and Home Safety,
American Institute of Steel Construction Partners in Education Committee and Educators Session, New Orleans, LA, April 1998.
Satellite conference on characteristics of college freshman on campus.
IBHS Wind Committee and Retrofit Committee, St. Louis, MO, May 1998.

Mehta, K.C.
National Institute of Building Sciences, Committee on Wind Loss Estimation, Dallas, TX, September 1997; November 1997; February 1998, March 1998.
Workshop on Control of Damage to Transmission Lines Due to High Intensity Winds, London, Ontario, Canada, October 1997.
U.S./Japan Wind Committee workshop, University of Hawaii, Hilo, HI, October 1997.
CSU/TTU CPWE Technology Assessment and Advisory Council meeting, Ft. Collins, CO, October 1997
TTU Faculty Load Committee, September 1997
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering annual TAAC Advisory Committee meeting, Fort Collins, CO, October-November 1997.
Visit to National Severe Storm Laboratory, Storm Prediction Center and Oklahoma Weather Center at the University of Oklahoma, Norman, OK to discuss research topics and potential research collaboration, November 1997.
TxDOT bridge cable vibration project progress report meeting, Austin, TX, February 1998.
University Consortium workshop sponsored by the Idaho National Engineering and Environmental Laboratory, Idaho Falls, ID, March 1998.
National Hurricane Conference, Norfolk, VA, April 1998.
FEMA Region IV Tornado Symposium, Atlanta, GA, April 1998.
Universal Weather Seminar, Houston, TX, April 1998.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering Co-PI meeting, Santa Fe, NM, May 1998.

Norville, H. Scott
ASCE State Convention, Dallas, TX, co-advisor for student chapter, October 1997.
Peterson, R.E.
American Meteorological Society Conference on Radar Meteorology, Austin, TX, September 1997.
Meeting of Member Representatives, NCAR, Boulder, CO, October 1997.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering annual TAAC Advisory Committee meeting, Fort Collins, CO, October-November 1997.
Visit to National Severe Storm Laboratory, Storm Prediction Center and Oklahoma Weather Center at the University of Oklahoma, Norman, OK to discuss research topics and potential research collaboration, November 1997.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering Co-PI meeting, Santa Fe, NM, May 1998.

Sarkar, P.P.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering annual TAAC Advisory Committee meeting, Fort Collins, CO, October-November 1997.
TxDOT Cable Vibration Project meeting, Austin, TX, February 1998.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering Co-PI meeting, Santa Fe, NM, May 1998.
Texas Section ASCE Fall meeting, Dallas, TX, September 1998.

Smith, D.A.
Hurricane Shelter Focus Group meeting, Georgia Emergency Management Agency, Macon, GA, October 1997.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering annual TAAC Advisory Committee meeting, Fort Collins, CO, October-November 1997.
National Institute of Building Sciences Committee meeting, Dallas, TX, November 1997.
American Association for Wind Engineering meeting, Baltimore, MD, December 1997.
Hurricane Wind project conducted by Clemson University, Advisory committee, Clemson, SC, February 1998.
Colorado State University/Texas Tech University Cooperative Program in Wind Engineering Co-PI meeting, Santa Fe, NM, May 1998.
VISITING SCHOLARS AND DIGNITARIES

Dr. Neal Lane, Director, National Science Foundation, visited the Wind Engineering Research Field Laboratory, October 16, 1997.

The Texas State Legislature Line Item review committee visited the Wind Engineering Research Field Laboratory, the missile launcher. Dr. Mehta made a presentation on the Wind Engineering program, October 29, 1997.

Congressman Larry Combest spent two hours becoming familiar with the Wind Engineering program. After a presentation by Dr. Mehta, Mr. Combest viewed a test at the missile launch facility and toured the Wind Engineering Research Field Laboratory, November 24, 1997.

Greg Zarus, Atmospheric Scientist, ATSDR, visited the Wind Engineering Research Center to discuss research problems of mutual interest.

Sondra Ziegler, West Texas Regional Director for Senator Phil Gramm and Shea Woodard, Regional Director for Senator Kay Bailey Hutchinson spoke with Dr. Kiesling regarding the Wind Engineering program, January, 1998.

Drs. Emil Simiu and Shyam Sunder, National Institute of Standards and Technology, visited to discuss cooperative agreement with Texas Tech Wind Engineering as funded by the federal government, January, 1998.

Dr. Jim Russell, Institute of Business and Home Safety, visited to discuss cooperation with Texas Tech, June, 1998.


Carol Ansell and Chris Wallace, Lubbock Reese Rehabilitation Authority consultants discussed possibility of relocation of Wind Engineering at the Reese facility with Drs. Mehta and Kiesling, June, 1998.

Professors Mohamed Taha and Nahed El-Mahallaway from Ain-shams University, Cairo, Egypt visited WERC, June, 1998.

Drs. Charles Onstead, Ron Korcak, Clarence Richardson and June Williams representing USDA visited WERC and the Reese Center facilities planned for WERC.
RESEARCH PROJECTS

Following is a summary of projects which were active during all or part of academic year 1997-1998. Project summaries are given for completed projects, progress summaries for those projects which are in-progress and plans for future research are given for those projects that have just begun. More information can be obtained from the project directors. See the wind engineering web site (http://www.ce.ttu.edu/wind) for links to additional information available on-line.

Title: Cable Stay Bridge Vibration  
Sponsor: Texas Department of Transportation  
Amount: $145,277  
Duration: 9/1/97-8/31/98  
Director: Kishor C. Mehta  
Others: Partha P. Sarkar

The overall objectives of the project are to identify the cause of large amplitude cable vibrations on the Fred Hartman and the Veterans Memorial Bridges in Houston, TX and to develop strategies to control these vibrations. Personnel from the Johns Hopkins University, collaborators on the project, instrumented the Hartman bridge in the field to obtain vibration data and associated meteorological data during vibration periods. After preliminary analysis and interpretation of the data, they proposed mechanical strategies, i.e., dampers, to mitigate the vibrations. Concurrently, Texas Tech tested cable sections in the wind tunnel to measure the effectiveness of various mitigation devices: helical strake, elliptical ring and circular ring. These test results suggested aerodynamic solutions to the cable vibration problem. Data acquisition on the Hartman bridge will continue as various mechanical and aerodynamic solutions are tested. Additionally, the Veterans Memorial bridge will be instrumented as well. Solutions developed in the course of this project may have significant implications for other cable stay bridges in existence and for the design of new cable stay bridges in the future.

Title: Central and South West System Renewables Project  
Sponsor: Central and South West Services, Inc.  
Amount: $685,305  
Duration: 8/1/93-1/15/99  
Directors: Edgar A. O’Hair and Phil Nash

The Central and South West System (CSW) Renewables project is aimed at assessing the potential of solar energy and wind power as alternative energy resources through a multi-faceted research program. The wind energy portion of the project is focused on the 12 turbine, six megawatt wind farm southwest of Ft. Davis, TX. This wind farm began producing electricity in 1996. Since that time Texas Tech has monitored the performance of the turbines as recorded by three companies: West Texas Utilities, the host utility; ZOND, the maker and installer; and Metro, Inc., an independent meteorological company that measures and records the wind speeds and directions in addition to ZOND’s. Early analysis was directed toward resolution of the difference in comparable data as recorded by the three organizations. The turbines have been accepted by
CSW and the present on site activities are associated with long term operation and maintenance/repair evaluations.

The present research activities are focused on the forecasting of wind at a specific site by use of statistical methods and neural networks. The deregulation of electric utilities in the U.S. has significantly increased the interest in being able to project the elective output from wind farms by as much as 72 hours in advance. The Ft. Davis site is sufficiently remote such that it is not covered by the Weather Service forecasting service. Currently, the concept is to use the Lubbock airport as a hypothetical site with turbines that perform as those at the Ft. Davis location. The objective is to evaluate the two mathematical approaches with the same data set and determine the relative advantages and disadvantages. This should be completed by June 1999.

**Title:** CSU/TTU Cooperative Wind Engineering Program

**Sponsor:** National Science Foundation

**Amount:** $350,000 for 1998-1999

**Duration:** 1/15/95 - 1/14/2000

**Director:** Kishor C. Mehta

**Others:** Richard E. Peterson, Partha P. Sarkar, Douglas A. Smith, Jamie B. Kruse

The Cooperative Program in Wind Engineering with Colorado State University is in the fourth year of the second five year program (1995-2000). The program contains four interactive tasks related to wind effects on buildings: wind loads, wind flow around buildings, wind engineering meteorology and wind damage economics. Characterization of pressures and overall loads on the building are additional aspects of the wind loads task. Documentation of overall loads on WERFL continues; new data will be taken over the denser port array in the corner vortex region. The relationship between wind speed effects on minimum Cp for a range of wind speeds is being characterized. Flow visualization and roof pressures under the separation bubble are being examined. Wind angle appears to be important in pressure fluctuations.

In the Meteorology task group, the Wierenga formula is being applied to data from WERFL to create a chart of roughness lengths for all sectors of wind direction for the field site. The roughness lengths can then be compared to ones obtained from vertical profile and turbulence intensity methods currently employed. Work in the Economics task area has examined the market response to existing mitigation. Retrofit mitigation, in this case the presence of storm shutters, was found to be a significant variable to the selling price of homes in a coastal community. The history and rules governing WINDPOOL were researched and described by REU Damon Dade in his report, “Understanding the Texas Windstorm Insurance Association.” Progress on the project was presented and discussed with the Technology Assessment and Advisory Council in October 1997.
In 1996, Wind Engineering Research Center (WERC) personnel completed a study refining criteria for design of shelters from extreme winds for the United States and its territories. Four geographic zones were outlined for which the threat from hurricane or tornado winds was defined. Both intensity and frequency of severe winds were considered in defining the threat. Design criteria for reliable, economical residential shelters were then defined for each zone.

In 1997 the Federal Emergency Management Agency (FEMA) awarded a contract to G&O to produce a booklet to present designs and specifications for residential shelters. Texas Tech University was awarded a sub-contract to test various building component concepts and to develop shelter designs for each zone defined in the earlier study. The booklet presents design variations for three types of shelter: reinforced concrete block, poured in place concrete and stud wall infill. Door options were expanded to include prefabricated steel doors as well as the site-built design. These designs accommodate the needs of new construction as well as retrofit of existing homes. The booklet published by FEMA, “Taking Shelter from the Storm: Building a Safe Room Inside Your House,” is available free to the public.

The Wind Engineering Research Center is renowned for carrying out damage surveys immediately following hurricane events. Within the damage swaths it often appears that bands of more extreme damage occur. It has been speculated that in the vicinity of the hurricane eyewall (a region of very high winds) tornado-like vortices may develop and yield the damage extremes. The objective of this study is to examine Doppler radar data for landfalling hurricanes in search of tornado-generating features. We have in place the computer hardware (HP workstation) and software (WATADS) required for investigating the archived radar data. In addition data tapes have been obtained for hurricanes which have struck the U.S. in the last three years (e.g., Opal and Fran); tapes for Typhoon Paka which hit Guam in 1997 are on order. A graduate student has begun to work on the project.
Title: Detection of Tornadoes Using Neural Networks
Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program
Amount: $141,018
Duration: 1/1/98-12/31/99
Director: Donald Wunsch

Each spring and summer, tornadoes strike Texas and the nation, often causing substantial loss of life and enormous property damage. Early warning is critical for the safety of the populace; to provide this warning the National Weather Service (NWS) has recently deployed a network of NEXRAD pulse Doppler radar systems. These advanced radars provide nearly complete national coverage for immediate forecasts, as well as archiving immense amounts of data for future research. Unfortunately, the spatial resolution of the NEXRAD system is insufficient to resolve a highly localized event such as a tornado. Instead, NEXRAD signal processing relies on detection of much larger-scale circulations, such as mesovortices, as an indicator and precursor of tornadoes.

The detection of large scale circulations does provide a high probability of detection for tornadoes. Unfortunately, it also provides a high probability of false alarm, which lowers public confidence and has caused many to ignore the warnings. This project will examine tornado detection as a classical decision theory problem and apply neural network techniques to develop an improved detector. NWS records (including post-storm assessment of the presence or absence of a tornado) and archived NEXRAD data (collected only in the last several years) provide a wealth of data for neural network training. To provide the public with advanced warning, we will study special neural network architectures specifically for this time-evolving pattern recognition problem. Receiver operator characteristics will be calculated and compared for current NWS techniques and our new neural network detectors.

Title: Effect of Missile Impact on Internal Pressure
Sponsor: Metal Building Manufacturers Assn.
Amount: $32,000
Duration: 5/1/96 - 12/31/97
Director: James R. McDonald
Other: Partha P. Sarkar

The objective of this study was to determine the effect of windborne missile perforations on internal pressure in metal building systems. Various 2x4 wood and plywood sheet missiles were impacted against a 15 ft high by 18 ft long model of a metal building system wall. When perforation occurred, the size and shape of the opening was recorded.

The second phase of the project involved making full-scale internal pressure measurements at the Wind Engineering Research Field Laboratory (WERFL) test building. Selected openings made by the missile impact where installed in the window opening of the WERFL building. Internal pressure measurements were taken for wind blowing toward and away from the opening.
The results showed that for single openings typical of those produced by the missile impacts the change in internal pressure was small. Both the 24-gage and 26-gage metal panels rejected missile perforation according to the large missile impact criteria.

**Title:** Investigation of Load Factors for Combined Wind and Flood  
**Sponsor:** American Society of Civil Engineers/FEMA (Federal Emergency Management Agency) Part II/III  
**Amount:** $66,000  
**Duration:** 6/1/97-6/20/98  
**Director:** Kishor C. Mehta  
**Others:** Douglas A. Smith, Richard E. Peterson

The U.S. Naval Academy at Annapolis, MD, and WERC cooperated on this project. As part of Phase I, hurricane wind speeds and surge heights at eleven coastal sites were established using a coupled Gradient wind and Bathystrophic storm surge model and Monte Carlo simulation techniques. At each site 999 storms were generated and the results compared favorably to those developed by Batts et al. (1980) and to those given in ASCE 7-95.

During Phase II, the probability distributions for the annual maximum hurricane wind speeds and storm tides were established for each of the eleven sites. A two-parameter Weibull distribution was selected to model both the wind speeds and storm tides. The COV for uncertainties in wind speed and in storm tide were established based on investigations at four of the eleven sites. Formulation of ASCE 7 was used for wind load and those of FEMA for flood load. Monte Carlo simulation and the physics based equation which relates wind speed to wind load were used to generate data that established an Extreme Value Type I distribution for wind load. Monte Carlo simulations and statistics from the literature were used similarly to established distributions for flood loads.

Combined wind and flood load factors were established during Phase III of the project.

**Title:** Investigation of Wind Projectile Resistance of ICF Homes  
**Sponsor:** Portland Cement Assn.  
**Amount:** $9,196  
**Duration:** 8/15/97 - 12/15/97  
**Director:** E.W. Kiesling

Insulating Concrete Forms (ICFs) are hollow units of plastic foam that are assembled into the shape of a building’s walls. Afterward concrete is poured into the units and reinforced to form the wall. This type of wall has advantages over wood frame in terms of energy efficiency, sound dampening, design flexibility, strength, pest resistance and ease of construction. Texas Tech tested a variety of ICF walls of different thicknesses and structures for resistance to perforation by wind-borne debris. Concrete, wood stud framing and steel stud walls were also tested for comparison. Each wall assembly was subjected to the impact of a single 15 lb. 2 x 4” wood stud shot from the missile launcher. All insulating concrete walls tested withstood impacts of missiles traveling at approximately 100mph.
Title: Mathematical Analysis of Tornado Dynamics  
Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program  
Amount: $66,702  
Duration: 1/1/98-12/31/99  
Directors: Victor I. Shubov and David S. Gilliam

In the State of Texas alone, during the period 1950-1994 there were 5490 reported tornadoes resulting in 475 fatalities with damage estimates of about two billion dollars. There is an extensive meteorological and atmospheric science literature devoted to the study of tornado genesis and numerical studies of tornado dynamics. The resulting mathematical models are extremely beneficial in studying and predicting tornado behavior. Nevertheless, there remain many unanswered questions concerning tornado formation and dynamics and considerable controversy surrounding the proper mathematical formulation of the models. Furthermore, in the region of a tornado core, where sharp gradients of the velocity and pressure field occur, the numerical resolution of known computational schemes is inadequate. One of the most serious difficulties is the absence of rigorous mathematical results on existence of solutions and convergence of the associated numerical schemes.

The primary objective of this proposed research is to carry out a rigorous mathematical investigation of several well-known models of the tornado. In contrast to the existing literature which is primarily devoted to the numerical analysis of these hydrodynamic models, the objective will be to investigate the tornado models as free-boundary problems for Navier-Stokes equations based on special techniques developed by the Principal Investigators (PIs) over the past several years in their research for the AFOSR.

Title: Numerical Model Study of Hurricane Boundary Layer Winds  
Sponsor: Texas Higher Education Coordinating Board, Advanced Research Program  
Amount: $69,488  
Duration: 1/1/98-12/31/99  
Directors: Chia-Bo Chang and Arthur L. Doggett IV

Tropical cyclones are capable of causing catastrophic losses of property and life. In the U.S. alone, the damage bill from landfalling hurricanes between 1946 and 1995 averaged $2 billion per year. The effects of high winds are generally concentrated within tens of kilometers from the coast, while convection may affect areas hundreds of kilometers from the coast. The property damage caused by wind alone varies primarily with the quality of construction and maximum speed of the winds. The damage increases approximately as the cube of the wind speed in the boundary layer (BL) directly influenced by the presence of the earth’s surface. Airflow inside the BL is very turbulent and irregular. The locations and intensity of maximum surface wind speed as well as convection of a landfalling storm are significantly modified by the local terrain features and BL processes.

During this project, numerical weather models will be used to simulate landfalling hurricane BL conditions. We believe that as the simulations are carefully verified with the observations, the
simulations will enable us to investigate quantitatively the observable and some of the non-observable details and mechanisms important in depicting the surface winds and convection distribution as well as their relationships to the damage field. The research goal is to determine to what extent the existing weather modeling techniques and observations are capable of providing guidance with real-time applications for effective damage assessment and disaster mitigation during a landfalling hurricane event.

**Title:** Performance Evaluation of Essential Facilities in Severe Windstorms  
**Sponsor:** Georgia Emergency Management Agency  
**Amount:** $298,750  
**Duration:** 6/1/96 - 6/30/98  
**Directors:** Douglas A. Smith and James R. McDonald

This project is developing a PC-based expert system that will establish the relative vulnerability of an essential facility to hurricanes or tornadoes. The computer software will provide emergency management officials with a tool to establish mitigation and retrofit options and priorities for essential facilities. The product will produce a damage scenario and a vulnerability rating as a function of wind speed. The damage scenario will establish threshold wind speeds at which the building components and structural system will sustain damage. The expert system is being designed for use by emergency management officials, architects, engineers and other construction technologists.

Currently, work is continuing on redesign of the user interface to require less specific engineering expertise from the data collectors. A user’s manual is being developed and revised. Calibration of the expert system and development of the damage scenario remains to be accomplished. Some training sessions have been presented and were well received. Additional training will occur later this year.

**Title:** Regional Economic Loss Due to Windstorm  
**Sponsor:** State of Texas  
**Amount:** $6500  
**Duration:** 9/1/97-8/31/98  
**Directors:** Robert P. McComb and Jamie B. Kruse

Data provided for a coastal community will allow creation of a detailed geo-coded inventory of structures. The data includes some structural features, business activity in commercial buildings, and description of public buildings. The inventory will form part of a regional model which can be used to estimate economic damage due to tropical storms and hurricanes of different magnitudes. The completed model can also be used to compare alternative regulations and incentives for voluntary mitigation.
Title: Wavelet Analysis of Turbulent Flow in the Surface Layer
Sponsor: Texas Higher Education Coordinating Board (ARP)
Amount: $85,000
Duration: 1/1/96 - 8/31/98
Director: Richard E. Peterson
Others: James Dunyak, Douglas A. Smith

The surface layer comprises the lowest several hundred feet of the atmosphere. Quite often the winds are characterized by seemingly disorganized flow termed turbulence. Wavelet analysis is a technique rather recently introduced in meteorology to seek order in the surface layer turbulent wind flow observations as it localizes signals in space and scale. The Wind Engineering Research Field Laboratory has collected a large body of meteorological data in the surface layer with instruments on a 160 ft. tower. Quite often the wind records reveal bursts of momentum (which may be quite important when considering the effects on structures). Wavelet analysis was used to identify and analyze coherent structures. Additionally, a new technique (coherent structure detector) separates coherent structures in the wavelet transform from fluctuations due to incoherent noise. This technique has been applied in the detection of coherent gust, in the detection of localized structure in hurricane eyewall windfields and in other random fluid flow analyses in near-surface windfields.

Title: Wind and Building Pressure Field Data and its Simulation in the Laboratory
Sponsor: Idaho National Engineering and Environmental Laboratory (INEEL)
Amount: $75,376
Duration: 3/30/98-9/30/98
Director: Kishor C. Mehta
Others: Richard E. Peterson and Douglas A. Smith
Res Assoc: John Schroeder

A collaborative effort between three institutions; Texas Tech University (TTU), Clemson University (CU) and the University of Notre Dame (ND), is being pursued to conduct research in hurricane winds and building pressure data in the field and to develop a control algorithm to simulate hurricane winds. The three-year effort involves four interrelated tasks: (1) Develop a control algorithm to simulate wind turbulence and its validation through laboratory experiments (CU), (2) Conduct a global search for hurricane wind data and perform statistical analyses (in process), (3) Develop a portable tower system and pursue recording of high resolution wind data in land-falling hurricanes (see below), and (4) Measure wind and associated pressure data on a sloped roof in the field (in the planning stage).

A 35ft mobile instrumented tower was designed, constructed and tested. Additional information on the tower is given in the “New Research Facilities” section. The tower was deployed at Rockport, TX for Tropical Storm Charley and at the Wilmington, NC airport for Hurricane Bonnie. Good data on wind speeds, temperature, relative humidity and barometric pressure were obtained for both of these storms. In Bonnie, the tower was deployed near the NWS ASOS site and thus a comparison of the two wind records was possible. Roughness lengths upwind from the sites was calculated using a gust factor model developed by Jon Wieringa. The calculated gust
factors from the ASOS and WEMITE data (when the wind approached from an open exposure) fit well within the range of gust factors determined from other studies.

Title: Wind Damage Prediction Using Doppler Radar
Sponsor: Texas Higher Education Coordinating Board (ARP)
Amount: $148,850
Duration: 1/1/96 - 8/31/98
Director: Douglas A. Smith
Others: James R. McDonald, Richard E. Peterson

Predicting wind-induced damage to buildings using Doppler radar requires that the building damage observed on the ground be related to the Doppler radar signals and a relationship between the two be established. To establish these relationships, damage investigations have been performed for two hurricanes events and three tornado events. For Hurricane Opal a surface windfield has been generated from the Doppler radar data using the synthetic dual Doppler (SDD) technique. This surface wind has been compared with sources in the literature. Hurricane Opal was also run through the MM5 model which corresponded well to SDD in some respects but projected an earlier landfall fifteen miles off of actual landfall and lower wind speeds than SDD. Some adjustments will be made and the model run again. The model which proves most accurate can then be used for analysis of Hurricane Fran and future hurricanes.

In the future, with adequate surface windfield information, emergency management personnel may be able to determine where and what type of damage may occur as a hurricane makes landfall. Where surface observation data are sparse, these models may be able to utilize existing information to characterize the surface windfield in real time. Damage documentation data from Hurricane Opal have been used to develop damage functions for several types of roofing and wall cladding materials. A technique which relates the percent damage to a component (such as the roof covering) with the wind forces acting on the component is used to establish these damage functions. These component damage functions are being refined and the algorithm to accomplish their amalgamation to predict the damage to the entire structure is under development.

Title: Wind Engineering Research Center
Sponsor: State of Texas (Line Item Funding)
Amount: $261,000 annually
Duration: 9/1/93 - 8/31/98
Director: Kishor C. Mehta
Others: Faculty Investigators in Wind Engineering

The Wind Engineering line item is used to generate additional funds, provide a transition between projects, and fund small projects in various departments, some of which may later lead to additional funded projects. The projects partially or completely supported encompass faculty and students from Civil and Mechanical Engineering, Computer Science, Architecture, Atmospheric Science, Economics and Mathematics. Some of the projects are Development of Texas Tech wind tunnel, Numerical modeling of a hurricane wind field, Numerical simulation of turbulent wind flow over low-rise buildings using CFD, Economic demand analysis for Inresidence Storm
Shelters, and Calculation of response of residential construction under wind loads using appropriate finite element models.

The project provides support to Research Associates, Graduate students, Undergraduate students, WERC staff and a few faculty. In addition, publications and outreach activities are supported by this project. A reorganization and cataloging of the damage documentation archive was begun. Eventually slides and photos will be entered into a database for easier access. A web site has been developed which includes information on the graduate program in Wind Engineering, a brochure on the in-residence storm shelter, a listing of upcoming international conferences and local seminars, the Wind Engineering publications list and the Wind library catalog.

Title: Windstorm Mitigation Initiative  
Sponsor: National Institute of Standards and Technology (NIST)  
Amount: $3,601,942  
Duration: 8/1/98-7/31/99  
Director: Kishor C. Mehta  
PIs: Ernst W. Kiesling, H. Scott Norville, Douglas A. Smith, James R. McDonald, Jamie Kruse, Richard E. Peterson  
Faculty: Joseph Bilello, Arthur L. Doggett IV, James Dunyak, Marc Giaccardo, James Gregory, Glenn Hill, Robert McComb, Harry Parker, Partha Sarkar  
Res Assoc: Russell Carter, Tom Gill, Kathleen Gilliam, Larry Tanner

The objective of the project is to conduct research on mitigation of detrimental effects of windstorms on low buildings and structures and on wind damage economics and to facilitate technology transfer. The goal is to achieve life safety, to minimize community life disruption and to mitigate property damage consistent with the economics of construction.

A team of sixteen faculty members from the disciplines of civil and chemical engineering, architecture, atmospheric science, mathematics and economics has been assembled to pursue research and technology transfer activities. The team has developed seven interrelated research thrust (RT) areas to achieve progress toward the objective of the project. Specific RTs are: (1) Occupant protection from severe winds, (2) Debris impact research, (3) Windstorm damage documentation, (4) Integrated testing for wind effects, (5) Retrofit of existing buildings, (6) Wind damage economics and (7) Wind erosion. In addition, an Information and Outreach Center (IOC) will be developed to facilitate technology transfer. The RTs as well as the IOC concepts are outgrowths of twenty-eight years of wind engineering research conducted at Texas Tech University and of national needs elucidated in reports by the National Research Council, American Association for Wind Engineering, the National Institute of Standards and Technology and others over the past few years.
PUBLICATIONS AND REPORTS FROM WERC PROJECTS

Refereed Journals, Proceedings and Books


Schroeder, J.L., Smith, D.A. and Peterson, R.E. (in press) “Variation of turbulence intensities and integral scales during the passage of a hurricane,” Accepted for publication in *Journal of Wind Engineering and Industrial Aerodynamics*.


*Publications in Proceedings*


Reports


WIND ENGINEERING PERSONNEL
1997-1998

Wind Faculty

Joseph Bilello, Associate Dean for Research, College of Architecture
Chia-Bo Chang, Associate Professor, Atmospheric Science
Arthur L. Dotyett IV, Assistant Professor, Atmospheric Science
James P. Dunyak, Assistant Professor, Mathematics and Statistics
Marc A. Giaccardo, Assistant Professor, College of Architecture
Michael G. Giesselmann, Associate Professor, Electrical Engineering
David S. Gilliam, Professor, Mathematics and Statistics
James M. Gregory, Associate Dean for Undergraduate Studies, College of Engineering
Glenn E. Hill, Associate Professor, College of Architecture
Michael A. Jones, Associate Dean, College of Architecture
Ernst Kiesling, Professor, Civil Engineering
Jamie B. Kruse, Associate Professor, Economics
Jeff Lee, Associate Professor, Geography
Robert P. McComb, Associate Professor, Economics
James R. McDonald, Chairman and Professor, Civil Engineering
Kishor C. Mehta, P.W. Horn Professor, Civil Engineering
H. Scott Norville, Professor, Civil Engineering
Edgar A. O’Hair, Professor, Electrical Engineering
J. Walter Oler, Associate Professor, Mechanical Engineering
S. Parameswaran, Associate Professor, Mechanical Engineering
Harry W. Parker, Professor, Chemical Engineering
Richard E. Peterson, Chairman of Geosciences and Professor, Atmospheric Science
Partha P. Sarkar, Associate Professor, Civil Engineering
Victor Shubov, Associate Professor, Mathematics and Statistics
Douglas A. Smith, Assistant Professor, Civil Engineering
Milton Smith, Professor, Industrial Engineering
Donald C. Wunsch, Associate Professor, Electrical Engineering

Research Associates

Russell Carter
Tom Gill
Xiaoning Li (Kathleen) Gilliam
Phil Nash
John Schroeder
Larry Tanner
Jianming Yin
Zhongshan Zhao

Research Assistants

Erik Allen (CE)
Mark Berteau (Atmo)
Jeff Braun (Atmo)
Bin Cai (CE)
Yuzheng Cai (CE)
Russell Carter (CE)
Mark Conder (Atmo)
Aditya Darbhai (CE)
Ryan Donahue (CE)
Rebecca Fagan (CE)
Todd Flanagan (Atmo)
Mona Fritsch (CE)
Anna Gardner (CE)

Staff

Kim Aycock (Tech Ed)
Joyce Domansky (CS IV)
April MacDowell (Coordinator)
Tom Gardner (ME)
Rob Howard (Math)
Jawahar Kamarajan (CE)
Rohit Kaul (CE)
Chun Man (Johnny) Kwan (Math)
John McAnulty (CE)
Seth Nagle (Atmo)
Manoj Paul (CompSci)
Robert Pruitt (CE)
Staci Pruitt (CE)
Vidyanand Rajpathak (CS)
Anand Reddy (CE)
Anindya Sengupta (CE)
Kevin Simmons (Econ)
Gary Skwira (Atmo)
Robert Tisdel (Arch)
Fuqiang Wu (CE)
Bryan Ziegler (Arch)

Graduate Assistants
Carlos Company (CE)
Cai Gao (CS)
Ali Jabri (CE)
Ozlem Ozdemir (Econ)
Rhuulxin Zhu (CS)

Undergraduates
Rachel Aivano (REU, Atmo)
Vijay Akkaraju (CS)
Michael Anderson (CE)
Nadine Balcar (Educ)
Shawn Balcar (CE)
Scott Bole (CE)
Bryan Curry (CS)
Damon Dade (REU, Econ)
Mark Domansky (EE/CS)
Leticia Flores (Human Soi)
Mike Garcia (CE)
Chad Gardiner (CE)
Vanna Groves (CE)
Laci Hardin (CE)
Amber Harris (CE)
Todd Heinsch (Und)
Shannon Hutchison (CE)
Urmilla Jokhu (CE)

Mark Martinez (CE)
Jay Miller (Econ, REU)
Mary Ruth Moore (Bio)
Clint Moyer (CE)
Lawrence Peck (CS)
Shannon Reed (CE, REU)
Bryan Robertson (CE)
Anthony Rodriguez (CE)
John Shockley (CE)
James Snelson (ME)
Anson Thompson (CE)
Courtney Van Ingen (CE)
James Wofford (CS)
Tom Wuensche (CE)


PROPOSAL ACTIVITY

The following proposals were submitted September 1997-August 1998:

Characterization of Wind Erosion with Optical Profilometry, R.E. Zartman, J.F. Cardenas-Garcia, and J.M. Gregory, seed grant to Graduate School for proposal to be submitted to Department of Defense, Construction Engineering Research Laboratory, 1/98, $20,000 (not funded).

Development of a Non-Point Source Plutonium Water Quality Dispersion Model, T. Gill as Co-PI for Texas Tech, submitted by Texas A&M and USDA Texas Agricultural Experiment Station to National Resource Center for Plutonium, 8/98, $75,000 for Texas Tech (pending).

Experimental and Analytical Evaluation of the Performance of Controlled Descent Devices in Moderate Winds, submitted to International Window Cleaning Association, Rockville, MD, 1/98, $21,551 (not funded).

Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports-Phase II, J.R. McDonald and P.P. Sarkar, NCHRP, subcontract from University of Minnesota, 9/97, $68,750 (funded).


Use of Former Reese Air Force Base Facilities for Wind Engineering Program, Reese Center Committee, 1/98 (approved).

VBNX proposal for High Speed Internet Backbone for TTU campus, D.A. Smith, Co-PI, National Science Foundation, 1/98, $350,000 (pending).


Windstorm Mitigation Initiative workplan, submitted to National Institute of Standards and Technology, 3/98, $3.6 million (approved).