Structural Engineers Respond to Hurricane Katrina

By Greg Schindler and Dave Swanson

Most disasters and catastrophic events, whether natural or caused by man, have one thing in common; the biggest health, economic, and life-safety problems are the result of destruction of man-made buildings, bridges, and other infrastructure. Of course, structural engineers are at the heart of this built environment, even though the general public often doesn't recognize the important role of structural engineering in our society, and engineering isn't thought about much until a disaster occurs. In this most recent catastrophe on the gulf coast, structural engineers are playing key, if unrecognized, roles in the disaster's aftermath, and response/recovery efforts.

Urban Search & Rescue (US&R) Teams – An Elite National Response Asset

In the early 1990's, FEMA developed a system of Urban Search and Rescue (US&R) teams that can be rapidly deployed in times of catastrophic structural collapse. This system is a framework for assembling local emergency personnel into integrated disaster response task forces. These task forces are provided with the necessary tools, equipment, and specialized training and skills to safely enter collapsed structures to search for survivors. There are 28 such task forces distributed in key major cities throughout the US; many of them have responded to events such as the Oklahoma City bombing, the September 11th, 2001 terrorist attacks, and several earthquakes around the world. Several states (Illinois, New Jersey, and Michigan among others) also have state US&R teams and programs modeled after the FEMA US&R Program. For the first time in FEMA US&R history, almost all of the 28 FEMA task forces were mobilized and deployed at the same time to respond to Hurricane Katrina.

In this deployment, many of the FEMA US&R Task Forces were configured for light search and rescue, and water rescue operations. These "light configured" teams are made up of about 30 personnel. In a typical mobilization, each FEMA US&R Task Force is made up of 3 teams of 70 personnel, rotating their on-call status. The task force positions fall into four basic categories: search and rescue, medical, technical, and logistics. For obvious reasons the bulk of the team is made up of search and rescue specialists, medical personnel, and search dog teams with technical specialists in hazardous materials, logistical support, communications, and structural specialists rounding the team.

Considering the nature of large engineered structures like the Murrah Building, the Pentagon and the World Trade Center Towers, it was very wise of FEMA to include structural engineers on US&R teams. Who better to assess the type of construction, the stability of debris, and determine the best way to lift or shore a collapsed structure? Of course, these are not your "typical" structural engineers. They all have to undergo extensive specialized training in collapse assessment, debris pile stabilization, special shoring and bracing techniques, and construction equipment capabilities in this specialized environment, as well as basic search and rescue techniques, medical aid, and haz-mat awareness. These volunteers regularly donate hundreds of volunteer hours per year on required training and related activities to maintain their expertise. Structural engineers on these FEMA US&R Task Forces are there primarily to enhance the safety of the rescue workers and their operations. At first, some rescue workers didn't understand why they needed structural specialists on the team. However, time and again the engineers have proven their worth by helping teams determine the best and safest approach to entering an extremely hazardous situation.

NCSEA SEERProgram – A National Effort to Enhance Recovery

Immediately after the terrorist attacks on 9/11/01, the National Council of Structural Engineers Associations (NCSEA) undertook an ambitious plan to develop a Structural Engineers Emergency Response (SEER) program. A SEERCommitee was formed to investigate options and develop a plan for a rapid response by the structural engineering community to large disasters. The result of the first two years of effort was a document published by NCSEA in 2003 called the Structural Engineers Emergency Response Plan (SEERPlan) Manual. This manual is meant as a guide to assist state level structural engineering associations (SEA's) with the development of local SEERPrograms. The goal is that in the near future, the state SEA's can form an effective national network of volunteer structural engineers to provide damage assessment expertise. With Hurricane Katrina, the time to begin forming this national network is now.

As our nation's infrastructure ages and becomes more interdependent and complex, and our populations grow and become denser, the cost of disasters has skyrocketed. In the 1980's and

New Orleans, LA, September 9th, 2005 — Members of the FEMA Urban Search and Rescue team search for people that remain in areas impacted by Hurricane Katrina. Photo by Jocelyn Augustino/FEMA.

90's, FEMA has responded to these challenges with a focus on mitigation to reduce the cost of disasters. Structural engineers have had their own initiatives to reduce these costs by improving building codes and developing guidelines, standards, and training for post-disaster safety assessment of buildings. For many years, structural engineers, mostly on the west coast in "earthquake country," have been involved in some form of disaster assistance after major earthquakes. In the late 1980's, the Applied Technology Council (ATC) developed a process called ATC-20, which is a systematic approach for rapid post-earthquake safety evaluation of buildings. More recently, as a result of the extensive destruction caused by recent hurricanes, ATC developed a similar program (ATC-45) to assess building safety after hurricanes and floods. This document was released in August of 2004…a timely development, as it is getting its first test in the gulf region after hurricane Katrina.

One of the basic functions of the SEERProgram after Katrina was to help organize a structural engineering response to the disaster by developing rosters of volunteer engineers willing and able to go to the affected area, if invited by the local or federal officials, to assist with the safety assessment of damaged buildings. The NCSEA SEERCommittee started organizing its response almost immediately after the hurricane struck the gulf region, under the direction of committee co-chairs Gus Domel of SEAOI and Dave Swanson of SEAW. Within 10 days after landfall, the SEERCommittee was able to amass over 200 volunteer engineers from 14 states out of their 39 state membership pool. Many of these engineers have already had ATC-20 training and some experience in performing building safety evaluations after disasters. Additionally, the SEERCommittee facilitated training of NCSEA affiliated engineers, as well as many others, in the ATC-45 methodology.

With over 12,000 members in our grass-roots NCSEA organization, we have a significant opportunity to help improve disaster preparedness, response and recovery functions for our communities. With the timely efforts by structural engineers involved in disaster preparedness, response, and recovery, our structural engineering profession is well on its way to providing effective assistance in the wake of this terrible tragedy. For more information on the FEMA US&R Task Forces, go to the FEMA web site, **www.fema.gov**, or contact NCSEA or your local SEA for information on the SEERProgram. Order forms for the SEERPlan Manual are available on the NCSEA website **www.ncsea.com**.▪

Greg Schindler is a Past President of NCSEA and is a member of the Structure Magazine Editorial Board. Dave Swanson is Co-chair of the NCSEA SEERCommittee and Chair of the SEAW Emergency Preparedness Committee.

The Superdome Survives Hurricane Katrina

By Larry Griffis, P.E.

Hurricane Katrina slammed ashore early Monday, August 29th, 2005 just east of New Orleans with 145 mph winds as a Category 4 storm. The storm likely produced wind pressures for the New Orleans Superdome and nearby arena in excess of those specified in the current ASCE 7 load standard referenced by most modern building codes.

In as much as the Superdome was designated by the city as a hurricane shelter and contained over 20,000 people seeking shelter from the powerful and dangerous storm, its structural capacity to withstand such large hurricane winds came under question by many when its roof membrane was torn off. Two large holes measuring as much as twenty feet across appeared in the roof at two locations during the height of the storm. After all, the Superdome opened in 1975 and was designed before the first real wind standard was published in 1972 as ANSI A58.1-72 (the forerunner to the current ASCE 7 standard). It was not until publication of the 2002 version of the ASCE 7 standard that dome structures were addressed in the wind design provisions. Designers of the Superdome, Sverdrup and Parcel and Binkley Engineering, were left to their own judgment as to how to apply design wind pressures according to the New Orleans Building Code at the time, which specified 60 psf above 100 feet.

Records indicate that the structural steel trussed lamella dome, the same roof system as used in the worlds first covered dome stadium — the Astrodome, was designed for 150 mph winds and 200 mph gusts, and utilized a wind tunnel study in its design. It is not surprising then to see that the lamella trussed dome actually withstood the high winds with no apparent damage to the structural frame itself. However, high localized wind pressures tore off a substantial portion of the EPDM single ply membrane roof that had been applied in a re-roofing program in 1987, and pulled up two approximately 4- by 20-foot sections of the roof deck that had been welded in place to the steel roof members. Extensive flooding occurred in the playing floor level of the stadium when the downtown area flooded, as a result of storm tides breeching the levee system protecting the city.

The Superdome's classic lamella dome framing system supports nearly ten acres of a roofing system that originally consisted of a 20 gage 1½ deep roof deck with a one-inch layer of polyurethane foam insulation and a fluid applied 25 mil elastomeric coating. The roof is framed with 7-foot 4-inch deep shop welded steel trusses producing the classic diamond pattern inherent in the lamella dome system. The 680-foot diameter dome rests on top of 104 main steel columns that support the dome perimeter and the 8-foot 10-inch deep tension ring truss that resists the large thrusts from gravity load. The tension ring is mounted on 96 rocker columns 8 feet high with a 4-inch pin at each end to allow temperature movement. The dome rises to a height of 273 feet above grade, enough to contain a 25 story building. Vertical K bracing occurs around the dome perimeter that resists lateral loads. The building is clad in curved anodized aluminum giving the dome its characteristic shape well known all over the world. The final roof framing reportedly utilized about 26 psf of structural steel. The building is supported on 2100 precast piles approximately 160 feet deep with a 175 ton capacity.

There was no apparent structural damage at all to the nearby arena. Authorities representing the Superdome Commission report that the Superdome will undergo extensive inspection and evaluation prior to any decision regarding its future.▪

Larry Griffis is President of the Structures Division of Walter P. Moore and Associates, Inc. in Austin, Texas.

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Superdome, New Orleans, LA. Photo courtesy of Walter P. Moore. Troy Gomez Photography©

Observations from Biloxi

By Joe Weatherford

September 8th, 2005. To the right are some photos that I took in Bolixi. I was there to investigate the Sears Retail Store and Auto Center (an out building). Both structures are steel frame with precast concrete wall panels. The Auto Center is directly across Hwy 90 from the Gulf. The store is two stories, approximately 100 yards back from the Auto Center, and a part of the Edgewater Mall. The Auto Center got approximately 8 feet of storm surge; the store, 3 to 4 feet.

Damage

Auto Center: Storm surge gutted the building, broke 2 precast panels, bent 3 columns, and resulted in a lot of erosion at the front drive.

Store: A little roof uplift at SE corner. Three HVAC units blew off the roof, allowing rain water into the second floor. Surge caused approximately 18 inches of water in the first floor.
Some roof drains clogged and some ponding occurred.

Items of note in photos:

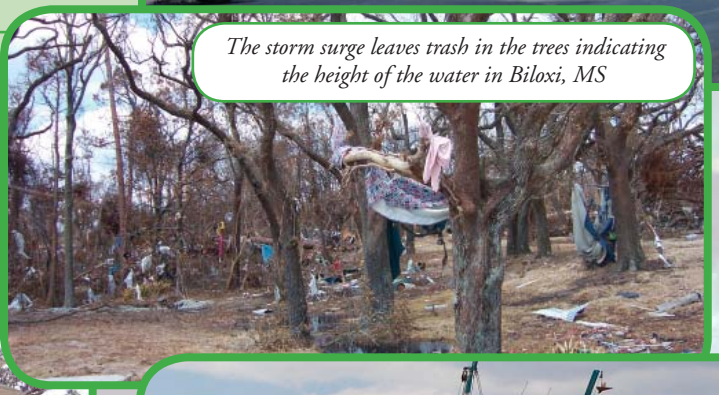
1. O'Charley's, another out building next to the Auto Center, is gone.
2. The Motel next to the Auto Center is gone.
3. The storm surge gutted the first story of new steel framed townhouses (that were next to the motel); note the erosion beneath footings.
4. Precast concrete panels are stronger than EIFS. See McRaes (Mall building behind Sears).

Other items of interest

Electricity was back on in the Mall. Looting had not been a problem. Sears had stored about 25 riding lawn mowers in the Auto Center for protection from the storm. Some of these mowers were as far as 300 yards from the store, and returned!▪

Joe Weatherford is a structural engineer with Weatherford & Associates, Inc. based in Montgomery, Alabama. Joe was in Biloxi making an investigation for Infinity Architecture PC.

The storm surge leaves trash in the trees indicating the height of the water in Biloxi, MS



Old house in Coden next to Bayou la Batre

Boat sitting ashore in Bayou la Batre

STRUCTURE magazine to continue Katrina "Observations"

[www.ncsea.com]

The destruction and turmoil left behind in the wake of Hurricane Katrina is, today, overwhelming. We at STRUCTURE magazine continue to keep all of the victims of this horrible storm in our thoughts and prayers, including the many NCSEA, SEI and CASE members who have been affected.

Structural Engineers will be a major factor in the recovery of areas impacted by the storm. Many of our readers have asked what they can do to assist those recovery efforts. Please go through your Member Organization for information on the proper channels for volunteering your services. For example, as noted in other articles in this issue, you can find information on the SEERProgram at www.ncsea.com.

STRUCTURE magazine will continue to print "observations" from our readers as they remain involved the process of investigation and rebuilding. We encourage you to provide these short overviews, personal experiences and photos. Visit the STRUCTURE magazine homepage, www.structuremag.org, for information on article and graphics submittals concerning Katrina.

But, most importantly, ***PLEASE***…exercise caution when obtaining information and images from the disaster area... your personal safety is much more important than a story or digital photograph.

Thank you for providing STRUCTURE magazine with your insights and observations on this devastating event. May your experience be productive and above all SAFE!▪

Christine Sloat, P.E.
Publisher, STRUCTURE magazine

One of the many homes hit by Hurricane Katrina in Biloxi, MS

Additional photographs courtesy of Marc Barter, P.E., Barter & Associates, Mobile, AL

Update: USPS Lifts Some Suspensions

September 2005. The suspension of Standard Mail (Letters and Flats) and Periodicals Mail destined for ZIP Codes 369, 393 and 394 has been lifted, but remains in effect for ZIP Codes 395, 396, 700, 701, 703 & 704.

Postal officials say that in the hurricane-damage zone, 188 post offices have returned to full service, 189 are providing limited service and 120 are still closed. Reportedly about 720,000 delivery points in Louisiana remain without service, as do about 100,000 delivery locations in Mississippi. All Alabama post offices have returned to service. The Postal Service is estimating a loss of $100 million in buildings, machinery and vehicles due to the hurricane.

With the coastal and inland areas of Alabama, Florida, Louisiana and Mississippi still experiencing the effects of Hurricane Katrina, FedEx services and operations continue to be significantly impaired, with shipments being delayed and services possibly suspended in those areas.

As a service to our readers, STRUCTURE magazine will be filtering out names to the effected ZIP codes. We will reserve copies of issues for these names until we receive notification from the USPS that mail services have been reinstated. At that time, we will forward "missed" issues to the address we have on file.

If you know of anyone who subscribes to STRUCTURE magazine in these affected areas, please remind them to read current issues on-line (www.structuremag.org) until such time as our regular mailings continue. Also, ask them to provide any address updates on-line as well.▪