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Forensic Engineering Investigation of 2004 Florida Hurricane Damages

Section I

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Florida was hit by four major hurricanes in six weeks during the 2004 season. Some areas had the eye of the hurricane pass over their location during three of the four storms. In some of those cases before repairs were completed, another hurricane hit the same area. This was the worst possible scenario. Preparation for the hurricane season is important and can be the difference between a reasonably comfortable survival and a miserable existence until your home is again livable. The planing should begin when you decide on the place you wish to buy, rent, or share with a friend or relative. Some of the important items to be considered are somewhat subtle, and should contain the following considerations:

Location Considerations

Main roads can be very helpful when power and other services are required to be restored. If the power has been disrupted, the crews concentrate their effort in areas that will get the maximum number of customers back in service quickly. Often remote areas may be delayed days to several weeks, depending on the amount of work and resources available. The main roads will be cleared and opened before the more remote country roads, that serve a only few homes. The main roads are needed for movement of emergency equipment and supplies.

Underground wiring for the main power lines can help with the decision to connect a whole neighborhood before re-building a line to serve a few remote customers. If your neighborhood, with underground wiring, is near a main road with the feeder lines you have a very good chance of getting power restored quickly.

Municipal water is preferable to well water because the power will be restored to the main water pumping stations before more remote areas electric service will be restored. Municipal services serve more customers than a private or small area of private wells. The Municipal water supply will be restored and tested with advisories for boiling water if required. Without power it is difficult to provide power to your well for water. Even with a generator it is often beyond the knowledge of the homeowner to safely provide power for the well pump from a normal home generator.

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Municipal sewer is also a plus because the service will be restored before some more remote areas have dried out sufficiently to make the septic tank function properly. Even with an elevated drain field, the septic tank will not function properly if high water prevents an area to drain. Areas near rivers and tributaries may take several days or weeks for the water to recede, before the septic tank can function properly.

Home location is important, even if you have municipal sewer. If you are located at the low end of the sewer line and the pump station fails, sewerage often will back up into the street, yard, and sometimes into the home at the low end of the neighborhood. Newer constructed subdivisions will usually have less problems than areas built decades earlier.

Getting Ready, Before The Storm Approaches

Radio Broadcast from TV broadcast is difficult to determine the storm conditions and locations. The TV broadcasters are not used to painting word pictures for radio listeners. Often repeated remarks such as, *"in a line along here, the highest winds are proceeding in this direction"* GET a Battery powered TV! Try listening to the local weather report without looking at the TV, you will experience the same problem when a hurricane has caused a power failure. The weather department broadcasts are simulcast on radio 24/7. Often they forget the radio audience can't see the normal TV screen. It was amazing how much comfort a 3 inch battery powered TV can provide.

Cell phones are the first line of communication that fails during an emergency. The towers get overused and fail. Land line telephones are still in operation; however, if your power has failed, the ringer and lights will not work. Often the telephone will still work.

Plywood, or storm shutters, and Attachments, TapCons or other fasteners and a battery powered drill can be very helpful to board up the windows. If you are using plywood or other shutters, have the supplies on hand before the last two days before the approaching storm is predicted to hit. Most storms will change courses slightly during the last couple days and many people wait, but if the storm comes to their neighborhood, they are the ones frantically at the lumber store trying to buy plywood and other supplies the last day. Construction grade plywood will be fine for preventing flying debris from breaking your window, but some people that waited until the last hours, often had to buy heavy duty, cabinet grade finish plywood at 4 to 5 times the cost.

Windows boarded with plywood provide no ventilation and you can't see what is going on outside without opening the door— not a good idea during the heavy wind part of the hurricane. When the power goes out, usually early dur-

ing the high winds, no A/C or even cross ventilation can be accessed until the storm's high winds have passed and doors and windows can be opened. This can take from several hours to a day or more. Taking off the storm shutters without electrical power is difficult; a battery powered drill makes the job easier.

A Screen Porch was a good place to watch storm if your porch was in an area sheltered from the highest winds by trees. However, this also provides a up close view of trees or limbs falling around or onto your home. Watching the storm from a screen porch, sturdily built, can be exhilarating but rather scary when a large tree crashes into the house or even worse the screen porch roof.

An amazing amount of light was available when the highest winds were blowing and the neighborhood was dark, without power. After about an hour your eyes are fully acclimated to the dark and can see things you did not know were visible in low light. Even the glow from a full moon looked like the sun rising.

Provisions To Have On Hand

Gas for vehicles and several cans of gas for chain saws and generators was prudent, even if you do not have a generator or chain saw. When the first of the four storms threatened the Tampa area, many people, including the weather department families and dependents evacuated to Orlando for safety. They arrived just in time for the first storm, Charlie, that changed course a few degrees to the East, and it hit the Orlando area instead of Tampa.

When the second and third storms threatened the lower East coast of Florida, thousands of people evacuated to the Tampa area, and arrived with gas tanks empty and motels and shelters full. The local residents were getting out of harm's way. The second two storms proceeded West through the Tampa area thereby trapping thousands of out of town travelers from the East Coast of Florida. With the high winds from storm stretching from the Atlantic to the Gulf coast at the same time, fuel ports were closed to gasoline tankers and the gas supply to local stations was delayed for a several days, making filling your vehicle with gas very difficult, even before and after the power failed.

It is prudent to have your vehicles with gas tanks topped for several days before the arrival of the storm. Also, several small gas tanks can be used for emergency if necessary.

Cash on hand, because ATM, Banks, credit cards, etc, must have power to access these facilities. Having cash on hand is necessary even long after the high winds have subsided and the power has been restored. Many stores, restaurants, motels, and other facilities cannot function with their computers out of service or delayed because of other power outages; therefore credit and debit cards are

useless. Many crews that can remove trees and temporalty repair your home and roof mostly work for cash first.

Food and Water are critical for survival, the time or recovery often depending on your location. You must provide non-perishable food such as peanut butter, bread, crackers, cookies, twinkies, soup, stews, and canned meats to last your family for a couple days to several weeks. Plastic containers are a good investment to protect your food from water and debris if the home has been compromised.

You should provide a gallon of potable water for each person per day. If you have a water source such as a pool, the toilet can be operational even if the water supply has been interrupted. If your are on municipal sewer, they will get the plant operational very soon. Septic tanks in low lying areas can be much more difficult to make functional.

Gas appliances, a charcoal grill, or wood can provide a place to prepare a hot meal in the event of electrical powered cooking facilities are non operational due to power failure. Don't forget to stock up on gas, charcoal, wood, lighter, and matches and old pans to cook your food.

Dry Ice, can help keep food from spoiling but eat all the ice cream first! Prior to the storm, locate the nearest Dry Ice vendor. 15 pounds of dry ice will keep a home freezer or refrigerator for approximately 3 days with minimal opening. One of the Florida storms hit on Saturday afternoon and the dry ice vendor was not open until Monday morning; however, the lines moved fast and our food was saved. You must handle dry ice with gloves and be careful because it will seriously burn the skin if contact is made. It is wrapped in paper when the vendor sells it to you, but the outside of the paper can still burn unprotected skin.

Plastic Containers with tight lids for clothes and valuables are inexpensive and provide a safe container to protect valuables from rain and the elements if the roof was blown off and rain infiltrates the home. Dry clothes and shoes are at a premium after the storm passes and the clean-up process starts. This is often before the power has been restored.

Generators and chain saws are generally sold out for hundreds of miles by two days before the storm arrives. With two mechanics and cans of gasoline to operate the gas powered items we simply repaired the generators and chain saws, that had not been started since the last hurricane scare, and provided some gas. The neighbors were glad to use their chain to saw our fallen trees and limbs for transport to the front curb for pickup. We didn't even have to do the work, just drag the debris to the front curb for pickup.

Generators are particularly dangerous. If the generators are operated inside the garage, the carbon monoxide often kills the occupants. If the generators are placed outside the home for safety, the generators are often stolen by unscrupulous persons and offered for sale to unprepared storm refugees.

Large animals can be a challenge during a hurricane. The most innovative solution was tested by a small horse farm owner during the first hurricane. Faced with the likely prospect of the barns would not survive the storm he decided the horses, if free could fend for themselves; but after the storm how would anyone know where the horses belonged? The very innovative solution was to spray paint the owner's telephone number on the side of each horse before setting them free. Within a couple days after the storm, all the horses were returned to the owner, unhurt and glad to be home.

Lessons

Shelters, motels and other places of refuge should be reserved for the people that must evacuate their homes because their homes are unsafe or in a likely flood zone. If your home is constructed of sturdy construction, it is more suitable to prepare and stay in your home and weather the storm. Shelters and other places of refuge have limited facilities to provide food, water, clothes and medicine to the displaced people. No provisions for pets are provided.

Even without water, power, or sewer it is often preferable to remain in your home if you have properly prepared to weather the storm. Sleeping on the floor in your home is preferable to sleeping on the floor in a shelter. If you evacuated to a shelter it may be several hours or days after the strongest winds are subsided before travel is safe and allowed. Barrier islands are often restricted for days after the storm passage.

If the hurricane winds suddenly are calm, with the sky often clearing, that is not the time to venture outside except for a quick look for emergency repairs. You are in the eye of the storm. Depending on the size of the eye and forward speed of the hurricane, the winds will suddenly be at the hurricane force or more in the opposite direction, often with devastating results because the trees and facilities are suddenly blown in the opposite direction.

The strongest winds are in the forward right side of the storm. The strongest hurricane winds are often in a small area around the eye. The cloud cover shown on TV does not contain hurricane force winds to the edge of the cloud cover. If you are 20 miles or more from the edge of the center of the storm, the winds will be considerably less. The hurricane force winds, 75 MPH or more, do not extend from Key West to Tennessee as people often assume from the weather casts.

Section II

by William C. Bracken, P.E., (NAFE 605M)

Introduction

From August 11, 2004 until September 26, 2004, the State of Florida sustained an unprecedented onslaught of four hurricanes. While all four storms were classified in excess of category 2, each hurricane exhibited very different characteristics and modes of damage. This paper represents a summary of each storm's characteristics and modes of destruction. This summary was made and compiled by Mr. Bracken who functioned as the lead Structures Specialist for the State of Florida. This summary was based on the initial reconnaissance made by Mr. Bracken personally.

As a FEMA trained Structures Specialist, Mr. Bracken was able to provide engineering expertise to the urban search and rescue efforts performed in support of Florida's recent hurricanes. Specifically, During Hurricane Charley Mr. Bracken served as the lead Structures Specialist (StS) to Florida's primary search and rescue team Florida Task Force 3, (FLTF3). During Hurricanes Francis, Ivan and Jeanne Mr. Bracken served as the lead StS to the State of Florida. As the lead StS, Mr. Bracken performed initial post-storm reconnaissance and assisted with the deployment of state and federal resources, the coordination of ground search operations and the presentation of findings to ground coordination team officials as well as state officials.

In his role as lead StS, Mr. Bracken was tasked with surveying large portions of the affected areas both from the ground as well as by air. While these surveys were conducted to identify those areas worst hit by the storms, these surveys gave Mr. Bracken the opportunity to make note of the various types and extent of damages wrought by each storm. These notes have been compiled and presented as follows:

Hurricane Charley

Hurricane Charley made land fall on the west coast of Florida in the Punta Gorda area on Friday August 13, 2004. The maximum sustained wind speed at landfall was recorded at 145 mph with gusts in excess of 175 mph. Although this hurricane was listed as a category 4 storm, its forward speed of nearly 20 miles per hour combined with its last minute turn ashore virtually eliminated storm surge damage. This storm did however include severe wind pressure damage and sporadic tornado damage. The damage resulting from this storm included missing and damaged roofs, blown down trees, blown down power poles, damage and partial collapses of older unreinforced masonry structures

and near total destruction of mobile homes. Noteworthy items included the fact that the storm managed to knockout Charlotte County's Emergency Operations Center (EOC), all but 1 of Punta Gorda's fire stations, half of Charlotte County's fire and police stations and 75% of the hospitals within Charlotte County were damaged and evacuated. The storm then traversed the state causing severe wind and flooding damage.

Hurricane Francis

Hurricane Francis made land fall on the east cost of Florida in the Stuart area on Sunday September 5, 2004. The maximum sustained wind speed at landfall was recorded less than 100 mph with gusts in excess of 110 mph. Although this hurricane was listed as a category 4 storm its strength had diminished to a weak category 2 by landfall. Its forward speed of less than 5 miles per hour never generated a storm surge. This storm did however include severe beach scour, moderate wind pressure damage and sporadic tornado damage. The damage resulting from this storm included missing and damaged roofs, blown down trees, blown down power poles, damage of older structures and significant damage to mobile homes. Noteworthy items included the fact that the storm managed to knockout Indian River County's Emergency Operations Center (EOC), 1 Bascule and 1 fixed bridge connecting the barrier islands, Brevard County's Fire Operations Center and 25% of the executive airports within Indian River and Brevard Counties were damaged and out of service. The storm also traversed the state causing moderate wind and flooding damage.

Hurricane Ivan

Hurricane Ivan made land fall along the Florida Alabama boarder in the Pensacola area on Thursday September 16, 2004. The maximum sustained wind speed at landfall was recorded at 125 mph with gusts in excess of 150 mph. Although this hurricane reached category 5 strength in the Gulf it came ashore as a category 3 storm. Its forward speed of approximately 12 miles per hour produced optimum conditions resulting in a 12-foot storm surge. This storm included severe wind pressure damage and severe tornado damage. The damage resulting from this storm included significantly damaged structures, missing and damaged roofs, blown down trees, blown down power poles, partial collapses of older structures and near total destruction of mobile homes. Noteworthy items included the fact that the storm cut two new passes within the outer barrier islands accompanied by the total destruction/removal of approximately 20% of the structures on the outer barrier islands. This storm also damaged or destroyed two major interstate bridges, the approaches to all of the bridges servicing the barrier islands and all of the homes within the Escambia County inter coastal waterway region. The storm traveled north into Virginia out into the Atlantic back across Florida and ultimately into Texas.

Hurricane Jeanne

Hurricane Jeanne made land fall on the east cost of Florida in the Stuart area on Saturday September 25, 2004. The point of recoded landfall was exactly 1/2 mile south of the point of landfall recorded for Hurricane Francis. The storm was listed as a category 3 storm at landfall with maximum sustained wind speed was recorded less than 115 mph and onshore gusts of less than 120 mph. Its forward speed of more than 15 miles per hour generated a negligible storm surge. Storm surge damage manifest as moderate flooding 3-5 feet along with pronounced/severe beach scour, moderate wind pressure damage and sporadic tornado damage. The damage resulting from this storm was less severe than that of Francis 20 days earlier. Noteworthy items included the fact that the storm managed to take 25% of the executive airports within Indian River and Brevard Counties out of service again along with washing out portions of US highway 1. The storm also traversed the state causing moderate wind and flooding damage to those areas hit 20 days earlier.