Journal of Coastal Research	13	1	246–252	Fort Lauderdale, Florida	Winter 1997

TECHNICAL COMMUNICATION

Property Damage Mitigation Lessons from Hurricane Opal: The Florida Panhandle Coast, October 4, 1995

Craig A. Webb, David M. Bush and Robert S. Young

Department of Geology
Duke University
Durham, NC 27708, U.S.A.

Department of Geology
West Georgia College
Carrollton, GA 30118, U.S.A.

Department of Geology
University of Vermont
Burlington, VT 05405, U.S.A.

Hurricane Opal passed over the Florida panhandle between the cities of Pensacola and Fort Walton Beach on the night of October 4, 1995. The storm weakened in the hours prior to landfall from a strong Category (Cat.) 4 to a Cat. 3 hurricane. On point of impact, Opal's winds were 201 kph (125 mph) and pressure was 940 mb. Maximum storm surges of 4–5 m were reported to be in the Navarre Beach/Pensacola Beach area; however, our field observations lead us to believe that the maximum storm surge values along the coast were closer to 3–4 m. The hurricane's impact was mitigated somewhat by the occurrence of dead low tide at the time of landfall (the local tidal range is approximately 40 cm).

Major beach erosion, storm surge flooding, and overwash occurred along a stretch of shoreline extending from Gulf Shores, Alabama to Mexico Beach, Florida, a distance of over 240 km. By and large, wave damage was restricted to the first row of buildings and it was severe in a stretch from Pensacola to Fort Walton Beach. Overwash deposits were over 1-meter thick in many places with pervasive overwash extending from Gulf Shores to Fort Walton Beach. To classify Opal in a few words, it was a "water storm" meaning most of the damage caused by the storm was in the form of storm surge, wave attack, and overwash. Contrast this to Hurricane Andrew in 1992, which was a more intense (though compact) storm and whose principal agent of destruction was wind.

Our observations of Opal's impact started the day after the storm and extended from Mexico Beach to Pensacola Beach. Navarre Beach, one of the hardest hit areas, was not included in this study because of difficulty accessing the area following the storm. Damage surveys were conducted both on the ground, and from the air.

Property damage from Opal was primarily the result of wave action and flooding. A number of property damage mitigation lessons can be learned from the pattern of structures damaged and those left undamaged along the Florida coast by the hurricane. These lessons from Opal and illustrated in Figures 2–8B include:

96075 received and accepted 6 July 1996.

(1) Building Above Grade

Structures built at grade suffered significantly more damage than those built on pilings. Building on pilings or (preferably) at higher elevations doesn't guarantee that no damage will be incurred, but it was observed that during this storm, those houses with more elevation, even just the sev-

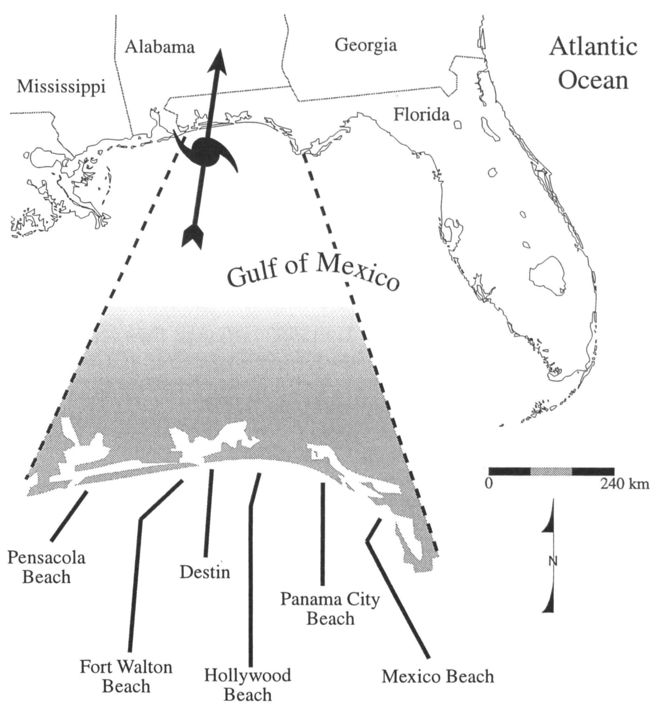

Figure 1. Index map of the Florida panhandle showing the field area and the communities discussed in the text. The path of Hurricane Opal is shown by the black arrow.

Figure 2. The importance of building above grade is shown by these four-single family homes in Mexico Beach. The two on the left were built at grade and completely destroyed by storm surge, while the two on the right are elevated on pilings and suffered no structural damage.

Figure 3. These houses west of Hollywood Beach illustrate the impact of removing dunes. Despite being elevated slightly and set back approximately 60 m from the shore, prior dune removal resulted in some structural damage to these single family homes during Opal. Had the houses been built behind the dune, damage would have likely been minimal.

Figure 4. Three adjacent buildings in Hollywood Beach provide a basis to compare the damage mitigation capabilities of seawalls, building above grade, and building setback. Elevation and setback provided greater protection than seawalls. 4A. This building is at grade and is farthest seaward of the three. The seawall protected the structure from being undermined, but did not prevent both floors from being completely destroyed by wave action. 4B. Built approximately 3 m above pre-storm grade and set back slightly landward of the structure in Figure 4A, this building suffered minor wave damage to the first floor. The water and waves that destroyed the structure in Figure 4A passed under this building. 4C. This building (left) is set back approximately 12 m further landward and is elevated slightly higher than the structure in Figure 4B. It received no structural wave damage.

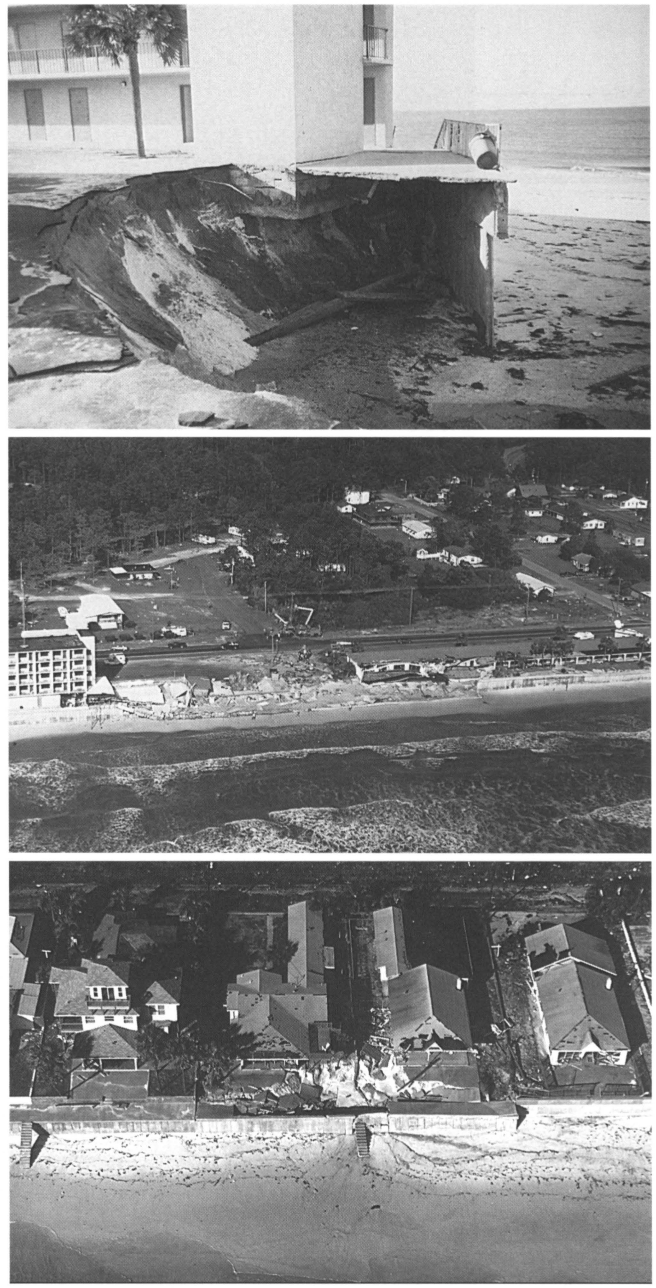

Figure 5. Seawalls prevented significant damage to many structures. However, failure of seawalls was not uncommon, indicating they may not be the best or most assured method of reducing damage. Three main types of failures were observed. 5A. End around failures of seawalls, like this one in Mexico Beach, resulted from erosive "flanking" of the seawall. 5B. This seawall in Mexico Beach did little to protect the structures behind it. The wall fell seaward, indicating overloading of the structure from behind. Loading by rain water, wave washover and insufficient drainage led to failure of the tiebacks. 5C. Seawalls can also be undermined, as shown by this Panama City Beach example. Scouring at the base of the seawall removed material from behind the wall, resulting in the wall falling landward, characteristic for this type of failure.

Figure 6. A. This picture from Fort Walton Beach shows the wide and flat post-storm beach. Most of the area was overwashed, leaving inland sand deposits up to 1m thick. The wide pre-storm beach and high dunes helped to reduce damage here. The large setback and immediate emplacement of overwash sand back on the beach will help mitigate against future storms. 6B. The wide, flat post-storm beach in Panama City Beach leaves all structures at a higher risk of damage by future storms. Mitigating some future damage to the single family structures in the foreground however, can be as simple as constructing an artificial dune. The seawalled structures in the background have few if any mitigation options.

Figure 7. Erosion along Panama City Beach seriously damaged the hotel in the background. Nearly the entire structure is now seaward of the 3 m dune, with part of the building in the surf zone itself. The structure is now extremely vulnerable to even a small storm. Prevention of future damage to this structure would most likely be attempted with beach replenishment but would be only a temporary solution to the problem.

eral meters offered by pilings, fared much better than those built at grade. We should add an important note. If your house is on pilings and those of your neighbors are not, your home is still at risk as those neighboring structures may very well be floated off their foundations and into your house during the storm.

(2) Dune Removal

All along the impact area dunes were destroyed. However, structures with pre-storm dunes received less damage than structures where the dunes had been entirely or partially removed during construction. Dune restoration should now be an early focus for future mitigation of storm damage in the impact area.

(3) Mitigation Capabilities of Seawalls

Seawalls, like natural dunes protected many structures from significant damage. However, failure of seawalls was not uncommon, indicating that they are certainly not foolproof. Three main types of failures were observed: (1) end-around failures resulting from erosive "flanking" of the seawall; (2) seaward toppling of the seawall by overloading from behind by rain water, wave washover, and insufficient drainage leading to failure of the tiebacks; and (3) undermining by erosive scouring at the base of the seawall which removes material from behind the wall resulting in the characteristic landward fall of the wall.

While seawalls did, in many cases, protect structures from being undermined, they did little to prevent the structure from being ravaged by waves and storm surge near the point of impact of the storm. As was the case with Hurricanes Hugo and Gilbert, all but the very largest seawalls are overtopped by storm surge and waves in the vicinity where the storm makes landfall. In some instances, the seawall remained intact while the structure being "protected" by the wall was damaged.

Hurricane Opal created a classic storm beach profile along the Florida panhandle coast—that is a wide to narrow, flat, post-storm beach. This extremely flat beach formed in Panama City Beach, and in many other areas along the coast, leaves all structures at a higher risk of damage by future storms. Another storm of this magnitude, or even a smaller storm, would cause quite a bit more damage, as the beach and dunes have lost most of their natural protective capabilities. Recovery will commence naturally, but it can be aided artificially by beach replenishment, dune construction with trucked in sand, and encouraging dune rehabilitation with sand fencing and vegetation. These efforts will not only provide protection for coastal property, but reinvest in the communities' primary economic resource as well, the beach.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of the following agencies and individuals who assisted

Figure 8. Storm surge flood scour occurred in many areas. By their nature, these areas are prone to repeat flooding and should be noted for future development restrictions. 8A. Channelized overwash of this area near Destin resulted in intense storm surge flood scour. 8B. In Fort Walton Beach, overwash scoured away Florida Route 98 and deposited washover fans in the lagoon.

with the post-storm reconnaissance: Florida County Sheriffs Departments, the Florida National Guard and Spc. Gary Begin, Michael Simmons and Brandon Richberg. The following provided at least partial support for this research: Natural Hazards Center, Boulder, Colorado; Federal Emergency Management Agency; and the University of Vermont (UCRS).