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U.S. Department of Transportation
Federal Highway Administration

U.S. DOT Gulf Coast Study, Phase 2

Engineering Case Study 8: Shipping Pier Exposure to Storm Surge

This is the eighth of 11 engineering case studies conducted under the Gulf Coast 2, Phase 2 Project. This case study focused on whether a shipping pier at the McDuffie coal terminal could be vulnerable to storm surge.

Description of the Site and Facility

The McDuffie Coal Terminal is located on McDuffie Island, 2.5 miles (four kilometers) south of downtown Mobile (see Figure 1). The facility is one of the largest import-export coal terminals in the United States. This coal terminal represents a vital economic and functional resource for the community, accounting for about half of the revenue of the Alabama State Port Authority and helping to supply coal to nearby power plants.

The coal terminal is located on Mobile Bay and is thus exposed to storm surge. This case study looked specifically at the vulnerability of Dock One, which is the southernmost pier at the McDuffie coal terminal and functions as a ship and barge loading facility. for coal.

Climate Stressors and Scenarios Evaluated and Impacts on the Facility

Storm surge can impart a significant amount of force on a pier. As such, this case study considered the 3 storm surge scenarios used in other case studies:

- Hurricane Katrina Base Case Scenario: This scenario represents the surge conditions that actually occurred in Mobile during Hurricane Katrina.
- Hurricane Katrina Shifted Scenario: This scenario estimates the surge levels that could have occurred if Hurricane Katrina's path was shifted east to make landfall directly in Mobile.
- Hurricane Katrina Shifted + Intensified + Sea Level Rise (SLR) Scenario: This scenario estimates the surge levels that would occur if Hurricane Katrina made landfill directly on Mobile, intensified with stronger winds, and came on top of 2.5 feet (0.8 meters) of sea level rise.

This study evaluated whether the pier would be able to withstand the quasi-static hydraulic loadings of the waves under each of these scenarios. The quasi-static loading consists of the wave's pulsing action in addition to the buoyancy force of the sea water.

It is interesting to note that there are no code requirements that impact the design of facilities such as Dock One with regard to storm surge. This is because berthing and mooring loads are typically much greater than the loads caused by storm conditions and, historically, the survivability of these types of structures has been very high during storms. Dock One in particular is oriented such that the narrow end of the pier would face the surge, rather than the pier being broadsided by the surge. The pier also has significant

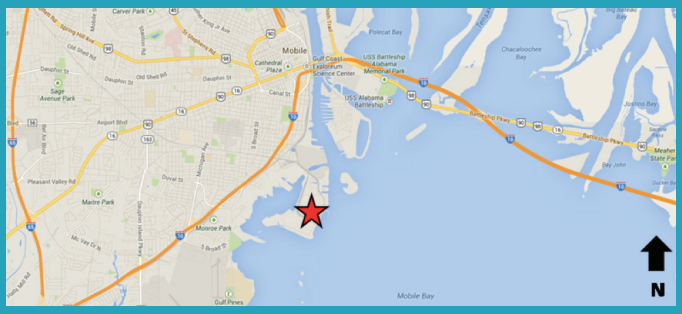

Figure 1: Location of the McDuffie Coal Terminal

Figure 2: Aerial Image of Dock 1

mass and strength which aid in resisting both wave uplift and lateral loads.

This study did in fact find that the pier would likely survive under all three storm conditions.

Identification and Evaluation of Adaptation Options

Since Dock One is sufficiently designed to withstand the surge forces analyzed, no adaptation options were evaluated.

Potential Course of Action

Equipment on the pier was not analyzed, and represents potentially vulnerable aspects of the Port. Therefore, additional consideration should be given to protecting the vulnerable equipment on the pier so there is minimal time required to get back online after a storm. The access bridge and mooring dolphin access walkway may be among the more vulnerable components. Consideration may be given to strengthening these elements or perhaps making them easily removable so that they may be properly stowed before the onset of a storm event.

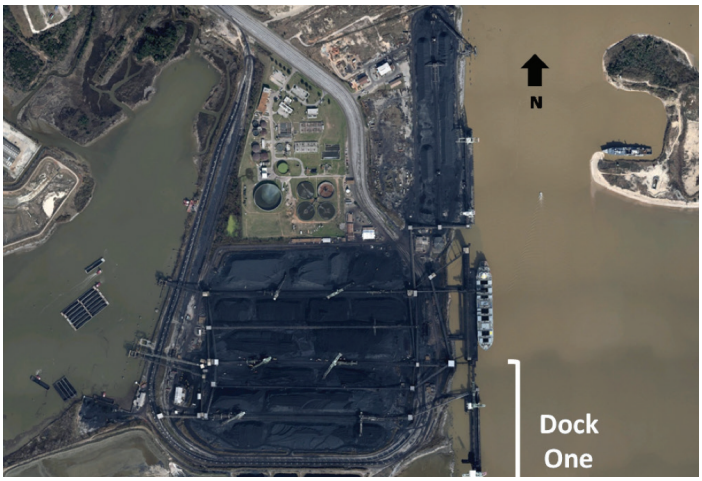

Figure 3: Aerial View of McDuffie Coal Terminal Showing Dock One

Lessons Learned

Although the more extreme storm scenarios tend to be thought of as the most damaging, in this case, the least extreme scenario (Hurricane Katrina Base Case Scenario) had the greatest potential to damage the pier. Under this scenario, the surge is lower, causing waves to break above all parts of the structure as well as creating uplift forces from the underside of the pier deck. Under the other storm scenarios, the surge is deeper, causing the pier to be completely inundated by the surge, and sparing it from the forces of waves breaking on the pier.

Piers tend to be fairly resilient against storm surges, however. More attention should be given to protecting and reinforcing the equipment on the piers, in order to reduce overall vulnerability of the port.

For More Information

Resources:

Gulf Coast Study:
Engineering Assessments of Climate Change Impacts and Adaptation Measures

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