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INSIDE THIS ISSUE…

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FEDERAL RESPONSE TO BRIDGE EMERGENCIES

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The United States Code, Title 23 – Highways, Section 125 – Emergency Relief authorizes special expenditure from the Highway Trust Fund for the repair or reconstruction of roads on federal lands and federal-aid highways that have suffered serious damage as a result of either natural disasters or catastrophic failures from an external cause. This program, commonly referred to as the emergency relief or ER program, supplements the commitment of resources by states, their political subdivisions, or other federal agencies to help pay for unusually heavy expenses resulting from extraordinary situations.

Natural disasters include floods, hurricanes, earthquakes, tornadoes, tidal waves, severe storms, or landslides. The applicability of the ER program to a natural disaster is based on the extent and intensity of the disaster. Damage to highways must be severe, occur over a wide area, and result in unusually high expenses to the highway agency. Bridge spans that are displaced or collapse as a result of hurricanes are examples of catastrophic failures caused by a natural disaster.

A catastrophic failure is defined as the sudden and complete failure of a major element or segment of the highway system that causes a disastrous impact on transportation services. To be eligible for ER, the cause of the failure must be determined to be external to the bridge. Failures due to an inherent flaw in the bridge itself, including gradual or progressive deterioration or lack of proper maintenance, do not qualify for ER assistance. Closure of a facility because of imminent danger of collapse is not, in itself, a sudden failure and, therefore, is not eligible for ER funding. A bridge that suddenly collapses after being struck by a barge is an example of a catastrophic failure.

Preventive work to avoid damage to a highway bridge in anticipation of a disaster is not eligible for ER funding. For example, work to prevent scour at a bridge site in anticipation of extremely heavy rainfall and potential flooding is not eligible.

The ER program provides for repair and restoration of highway facilities to pre-disaster conditions. Restoration in kind is, therefore, the predominant type of repair expected to be accomplished with ER funds. ER funds are not intended to replace other federal-aid, state, or local funds for new construction to increase capacity, correct non-disaster related deficiencies, or otherwise improve highway facilities.

All repair work falls under two major categories: emergency repairs or permanent repairs. Emergency repairs are made during and immediately following a disaster to restore essential traffic, minimize the extent of damage, or protect the remaining facilities. These repairs can begin immediately following a disaster, and prior Federal Highway Administration (FHWA) approval is not required. Properly documented costs will be reimbursed later once the FHWA Division Administrator determines that the disaster is eligible for ER funding. The federal share is 100 percent for emergency repairs done within the first 180 days after the occurrence of the disaster.

Permanent repairs are undertaken, usually after emergency repairs have been completed, to restore the highway to its pre-disaster condition. Permanent repairs must have prior FHWA approval and authorization. The federal share depends on the type of federal-aid highway being repaired. For interstate highways, the federal share is 90 percent. For all other federal-aid highways, the federal share is 80 percent. The federal share may be increased in states with a high percentage of federally owned public lands.

By law, the FHWA can provide up to $100 million in ER funding to a state (excluding American Samoa, Commonwealth of Northern Mariana Islands, Guam, and Virgin Islands) for each natural disaster or catastrophic failure event that is found eligible for funding under the ER program (commonly referred to as the $100 million per state cap). Because of the limited amount of money authorized annually for the ER program and the likelihood that a number of states will experience ER events, funding for large events is likely to be provided over a 2-year or longer time period. Also, the total ER obligation for American Samoa, Commonwealth of Northern Mariana Islands, Guam, and Virgin Islands is limited to $20 million in any fiscal year. For a large disaster that exceeds the $100 million per state cap, Congress may pass special legislation lifting the cap for that disaster.

The extensive damage and failures of roads and bridges caused by the hurricanes of 2004 and 2005 are examples of the application of ER funds to restore traffic and rebuild highways. The use of ER funds, coupled with the market-ready technology of prefabricated bridge elements and systems (PBES), has spurred accelerated construction and rapid recovery in record time on interstate routes with high traffic volumes.

PBES allow for safer and faster partial or total repair or replacement of bridges. The systems are manufactured under controlled conditions, either offsite at a prefabrication plant or adjacent to the project site, and brought to the location ready to install. Utilization of PBES in an emergency situation can be the selected course of action based on a decision framework recently finalized by the FHWA.

One shining example, where ER funds and PBES were used effectively, was the restoration of the I-10 bridges in Louisiana as described in the next article. Through the quick response of the Louisiana Department of Transportation and Development and the Department of Transportation (DOT)/FHWA, an aggressive timeline was developed to put the eastbound roadway back into service as soon as possible. DOT Secretary Mineta visited the bridge site to personally hand the state a $5 million check to jumpstart emergency funding for the project.

Damage assessments were completed less than a week after the hurricane reached land. A Phase I emergency contract was let less than a week later, calling for two-way traffic to be restored on the eastbound structure within 45 days. The contractor would receive a $75,000/day incentive (up to a maximum of $1.125 million) for opening the bridge early, and a $75,000/day disincentive for delays. In fact, the contractor completed the work 17 days ahead of schedule and received the full incentive of $1.125 million. The eastbound bridge was opened to traffic on October 13, 2005. Phase 2 consisted of erecting temporary panel trusses on the westbound structure within a 120-day time period. The contractor completed the Phase 2 work by January 14, 2006 — 4 days ahead of schedule.

The combination of timely federal ER funding and PBES technology was vital to the successful and rapid restoration of the I-10 bridges in Louisiana as well as the I-10 Escambia Bay crossing in Florida in 2004. Prefabrication can further accelerate bridge restoration by standardizing and stockpiling components at a common location for several states to use. Such considerations should be given to bridges that require rapid recovery from natural hazards, particularly coastal bridges similar to the ones damaged by recent hurricanes.

Further Information

Emergency Relief Manual, August 2003 update, available online at www.fhwa.dot.gov/reports/erm/index.htm.

I-10 TWIN BRIDGES IN LOUISIANA

Paul B. Fossier, Louisiana Department of Transportation and Development

In the early morning hours of August 29, 2005, Hurricane Katrina made landfall south of Buras, Louisiana, as a Category 4 hurricane. By 9:00 a.m., the eye of the hurricane was just east of New Orleans with wind speeds reaching 130 mph (210 km/h) and high storm surges reaching into Lake Borgne and Lake Pontchartrain.

The I-10 twin span bridge crosses Lake Pontchartrain northeast of New Orleans near Slidell, Louisiana. The I-10 bridge is 5.4 miles (8.7 km) long and is one of the few major routes in and out of the New Orleans metropolitan area. The twin bridges were constructed in 1963. Each bridge consists of 433 low-level simple spans and three high-level spans. The low-level 65-ft (19.8-m) long spans consist of AASHTO Type III precast, prestressed concrete girders that were connected with a 6.5-in. (165-mm) thick concrete deck before erection. The high-level portion of the bridge consists of two 100-ft (30.5-m) long and one 200-ft (70-m) long composite steel plate girder spans.

The substructure for the entire bridge consists of a cast-in-place reinforced concrete cap supported by either a single or double row of 54-in. (1.37-m) diameter precast, prestressed concrete cylinder piles. The finished grade elevation for the low-level spans was constructed approximately 12 ft (3.7 m) above mean high water elevation.

Emergency Repairs

The Louisiana Department of Transportation and Development (LA DOTD) staff inspected both bridges the day after the hurricane and found major damage that led to immediate closure of the structure. Storm surges from Hurricane Katrina damaged both east and west low-level bridges by misaligning 170 eastbound spans and 303 westbound spans. Thirty-eight eastbound spans and 26 westbound spans were displaced into Lake Pontchartrain. Due to the storm surge on the back side of the reinforced concrete bridge rails, 13,910 ft ((4.24 km) of railing failed on the westbound structure and 130 ft (40 m) on the eastbound structure. Approximately nine prestressed concrete cylinder piles were damaged when the superstructure was displaced into the lake and struck the cylinder piles. Most of the high-level approaches and the main navigational span were not damaged due to the increased bridge elevation above the storm surge.

The LA DOTD initiated an accelerated repair plan development so that competitive bids could be accepted to repair the twin bridges in a short time frame. An in-depth structural inspection confirmed that all the misaligned spans were in good condition and could be reused. However, all displaced spans that were located in the lake were required to be replaced. Since the eastbound bridge had fewer displaced spans, it was decided, during Phase I of the repairs, to realign all of the 170 eastbound spans and to replace the damaged eastbound spans by taking spans from the westbound bridge. The eastbound bridge then could be opened to two-way, single lane traffic in a short time period to reestablish traffic flow to New Orleans. Phase 2 of the repair contract consisted of realignment of the remaining westbound spans and replacement of the missing westbound spans with temporary steel truss bridges. Both phases also required the replacement of damaged bearing pads, repair of damaged cylinder piles, and repair of barrier rails on the eastbound bridge. Due to the amount of damage on the existing barrier rails on the westbound bridge, temporary precast concrete barrier rails stored in the LA DOTD District maintenance facilities were used as a temporary solution for the damaged bridge rails.

The spans that were realigned on both the eastbound and westbound bridges used a combination of barge and self-propelled modular transporters to perform the span alignment work. The same system was also used to remove, transport, and erect the selected westbound spans to replace the displaced eastbound spans

Accelerated Replacement Plans

The LA DOTD has also completed the design and planning to replace both bridges because of concerns with future hurricane storm surges. The new twin three-lane bridges will be built on an offset parallel alignment to the existing repaired bridge and will provide a long service life and better ability to withstand storm surge and vessel collision loads.

A bridge design using a cast-in-place concrete deck on BT-78 precast, prestressed high performance concrete (HPC) beams was prepared in-house by the LA DOTD. A precast concrete segmental design alternate using span-by-span erection was prepared by the LA DOTD's consultant to encourage competition among contractors and suppliers. To meet longer service life and structural efficiency requirements for the bridge structure, HPC was specified for both alternates. For permeability, a value no greater than 1000 coulombs was required. A minimum concrete strength of 8,500 psi (58.6 MPa) was also required for the BT-78 precast, prestressed concrete girders for span efficiency. Precast, prestressed concrete driven piles with either cast-in-place or precast caps will be used for the substructure of both alternates. Two bids were received on April 12, 2006 for the bulb-tee alternate with an apparent low bid of $379 million for the first phase. No bids were received for the precast segmental alternate.

Collapsed spans on the I-10 bridge.

I-10 BRIDGE OVER ESCAMBIA BAY

*Thomas A. Andres, Florida Department of Transportation**

Hurricane Ivan made landfall as a 130 mph (210 km/h) hurricane (Category 3) in the early morning of September 16, 2004, just west of Gulf Shores, Alabama. The east wall of the hurricane made a direct hit on the I-10 bridge over Escambia Bay located east of Pensacola, Florida. The 90 mph (145 km/h) sustained winds produced a 12.9 ft (3.93 m) storm surge, which topped the approach spans and created buoyant forces on the structure. As a result, the bridge suffered extensive damage with multiple spans and piers falling into the bay. Approximately 58 spans were completely destroyed and 66 spans were misaligned with 35 pile bents missing or destroyed.

Because the bridge serves as a vital east-west link for interstate commerce, immediate repairs were necessary. On September 17, 2004, an emergency contract was awarded by the Florida Department of Transportation (FDOT) to repair the existing bridges, so that the I-10 bridges could open to traffic. The repair consisted of constructing new pile bents and moving existing eastbound spans to the westbound bridge. This allowed the westbound bridge to be opened in just 17 days with one lane of traffic in each direction. The existing eastbound bridge was then retrofitted with 3,720 ft (1.13 km) of temporary steel trusses to replace the spans lost during the hurricane and the spans salvaged for the westbound bridge. On November 20, 2004, two I-10 westbound lanes and one eastbound lane were opened 27 days ahead of schedule.

Congress approved emergency funds to replace the existing retrofitted bridges and the FDOT issued a Notice-to-Proceed on April 20, 2005, for the $242.8 million Design-Build Project for the I-10 Bridges over Escambia Bay. Both the eastbound and westbound structures will be 13,868 ft (4.23 km) long with a 59-ft (18-m) wide deck consisting of simple span approaches and a three-span, post-tensioned unit over the channel. While the vertical clearance for the existing bridge is 10 ft (3.1 m), the

**Contributions to this article were made by Jonathan Van Hook and Rafiq Darji.*

new approach spans will have a minimum vertical clearance of 25 ft (7.6 m) to allow for storm surge and wave height from future hurricanes.

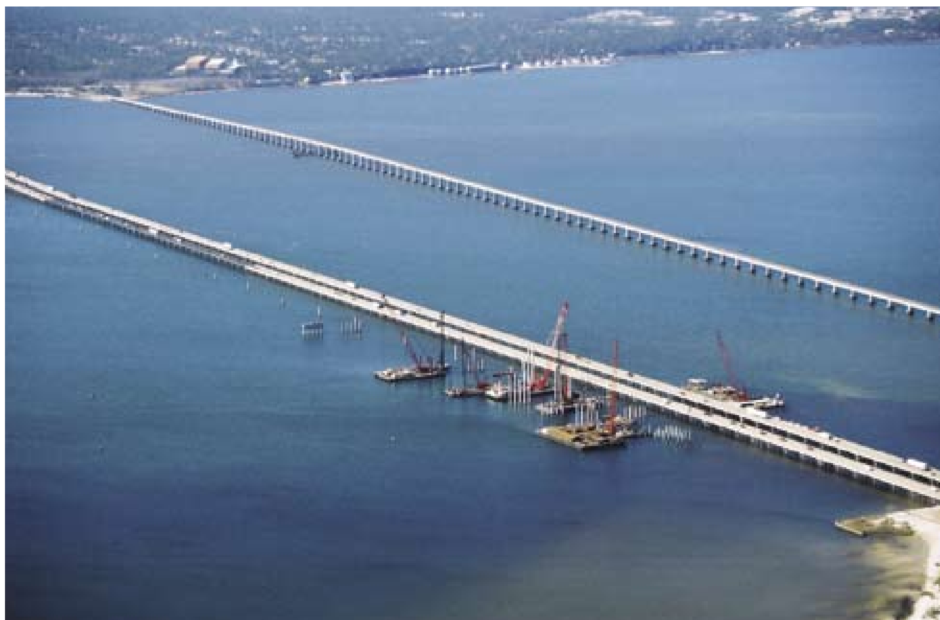
The superstructure of the typical approach spans consists of 78-in. (1.98-m) deep Florida bulb-tee girders at 12 ft 6 in. (3.81 m) centers with a span length of 136 ft (41.5 m). Specified concrete compressive strengths are 6000 psi (41 MPa) at transfer and 8500 psi (58.6 MPa) at 28 days. The deck thickness is 8.5 in. (215 mm) including a 1/2-in. (13-mm) thick sacrificial layer.

The three-span post-tensioned unit has span lengths of 166, 250, and 200 ft (51, 76, and 61 m) and utilizes a drop-in unit in the main span. The depth of the girders on either side of the main span taper from 9 ft 6 in. (2.90 m) over the piers to 6 ft 6 in. (1.98 m) at the drop-in unit. The specified concrete compressive strength is also 8500 psi (58.6 MPa).

The project makes extensive use of precast components for the pier footings, bent caps, pier caps, prestressed concrete piling, and Florida bulb-tee girders. Due to the extremely aggressive coastal conditions and in order to achieve a service life of 75 years, the high performance concrete (HPC) provisions of the FDOT's Standard Specifications were used. The HPC requirements include high-early strength, low permeability, workability through admixtures, low heat of hydration, and minimal shrinkage and thermal expansion. These attributes were achieved through the use of additives such as fly ash, silica fume, water reducers, and air-entraining agents. In Florida, durability is achieved through reduced concrete permeability and appropriate reinforcing steel cover. Low permeability concrete was achieved by using fly ash (18-22 percent by weight of cementitious materials). In addition, silica fume (7-9 percent by weight of cementitious materials) was added to the substructure concrete within 14 ft (4.3 m) of the mean high water elevation. In general, the FDOT combines the use of HPC with good detailing practices, crack control designs, and the employment of advanced concrete curing specifications to achieve durable structures.

The use of HPC in the superstructure combined with 0.6-in. (15.2-mm) diameter, Grade 270, prestressing strands at 2-in. (51-mm) centers allowed for longer approach span lengths with shallower members. Similar benefits were achieved in the post-tensioned, continuous, drop-in channel span.

The I-10 Escambia Bay project encountered a setback on August 29, 2005, when the 28-ft (8.5-m) high storm surge of Hurricane Katrina swept through the plant of one of the precast concrete suppliers damaging offices, production equipment, and the batch plant. Production has now resumed for the Escambia Bay Project. The first bridge is scheduled to be opened by December 2006 and the project completed by December 2007.



Construction of the new bridge alongside the existing bridge. Photo courtesy Parsons Brinckerhoff Construction Services.

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