

# Emergency Relief Program Resilience Case Study – Alabama

## U.S. Highway 231 Landslide Repair Project

From February 11 to 13, 2020, northern Alabama received over 10 inches of rain, triggering a landslide underneath U.S. Highway 231 (US 231). The landslide occurred 1.6 miles south of Lacey Springs, Morgan County. The event affected about 400 feet of the heavily used corridor that serves much of the traffic between the cities of Arab and Huntsville. The slide caused extensive damage to both the north and southbound roadways of US 231. Both roadways experienced extensive cracking; however, the damage to the southbound roadway increased significantly over the course of the storm. The southbound roadway suffered from pavement bulging and movement resulting in a 4-foot drop. The roadway had to be closed to traffic, resulting in a 16-mile detour for passenger cars and a 33-mile detour for trucks, which significantly impacted surrounding communities and added 30 to 60 minutes to travel times respectively.

Due to the geology of the surrounding area (i.e., Pottsville formation and ancient colluvial material), the roadway is frequently saturated during rainstorms. Most recently before the 2020 event, heavy rainfall caused cracking and moving of the roadway. As a result, portions of the roadway were repaved, smaller cracks were sealed, and inclinometers were installed to monitor continuing movement at the site.

### Resilience Features

In the days following the 2020 event, a consultant was hired to conduct a geotechnical investigation of the area. On March 4, 2020, the Federal Highway Administration (FHWA) Alabama Division Office, Alabama Department of Transportation (ALDOT), and the consultant met to discuss the options for repairing or replacing the roadway. The options included fixing in place, installing retaining walls or soil-nail walls, constructing a single bridge, constructing two bridges, and shifting the alignment. With the road closures and lengthy detours significantly impacting the public, the team sought a quick solution and considered the feasibility and cost effectiveness of each option:

- Repairing in place would have required installing retaining walls, purchasing extensive right-of-way (ROW), and increasing the limits of the project three-to-four times the length of the slide;
- For soil-nail walls, it was unclear if the topography of the area would allow for proper resistance to stabilize the material;
- The single-bridge option required extending the project to connect the 15-foot elevation difference of the north and southbound roadways;
- The two-bridge option required removing the existing 75- and 50-year-old roadway embankments to reduce loading on the slope; and

Shifting the alignment up the hill would have required purchasing ROW and may have encountered archeological issues that would affect the project timeline.

The ALDOT and their consultant performed, and submitted to the FHWA Alabama Division Office, an analysis that demonstrated that constructing two bridges was the most feasible and cost-effective approach. The other options would have required purchasing additional ROW, increasing the limits of the project, and maneuvering through the location's geological issues. The two-bridge option allowed the roadway to withstand future movements of the slope, while remaining within the limits of the project, maintaining the same ROW, ultimately costing \$30 million less than the other options.

### Project Snapshot



*Figure 1: Damage to the northbound lane of US 231 and the berm ALDOT first built along the roadway to minimize further damage and keep water away from the area. Source: ALDOT*

**Location:** Lacey Springs, Alabama

**Date of ER Event:** February 2020

**Nature of Event:** Heavy rainfall; Landslide

**Assets Impacted:** US 231 (SR 53)

**Cost of Repair:** \$27.4 million

**Type of Improvement:** Constructing two bridges to current standards

**Lead agency:** Alabama Department of Transportation

**Other agencies involved:** Federal Highway Administration, Alabama Division



Because it was economically justified, the cost of the betterment, which totaled \$27.4 million, was eligible for FHWA Emergency Relief (ER) Program funding. As part of constructing the two bridges, ALDOT installed equipment and developed an instrumentation plan to constantly monitor the load pressure and the movement of the slope. Several piezometers, inclinometers, and ground/structural deformation measuring tools were installed in the drilled shafts and in the free field. These monitoring tools are intended to help minimize the risk of overloading the bridges and mitigate future roadway damage. In May 2021, ALDOT received an FHWA Accelerated Innovation Deployment (AID) grant to monitor movement and capture knowledge related to the design.



Figure 2: Damage to the southbound lane of US 231 following the February 2020 rainfall event. Source: ALDOT

## Challenges and Lessons Learned

The repair to US 231 was the largest single site for ER in the State of Alabama. Since the bridges opened to traffic, they have performed well, withstanding three named storm events in the area. The bridges have experienced some continual movement—specifically, a tenth of a millimeter within the first six months of opening. However, it is hard to determine the nature of the movement. ALDOT eventually plans to re-install some of the inclinometers as water moves beneath the bridges.

Time proved to be the biggest constraint for this ER project. Identifying and implementing an efficient solution was necessary to address the immense travel inconvenience caused by the detours. The State of Alabama needed to work quickly and strategically while navigating through the uncertainties and challenges associated with the COVID-19 pandemic. ALDOT utilized many unique contracting mechanisms to streamline the project timeline. To significantly accelerate construction, ALDOT purchased drill shafts casings and bridge girders ahead of time to provide them to the contractor. Additionally, the project contract included an incentive of \$2.49 million to the contractor to open the bridges to traffic by November 2, 2020, and a penalty of \$2.49 million if the contractor did not open the bridges until after January 1, 2021. Through these efforts, the bridges were completed a month ahead of schedule and opened to traffic on September 28, 2020.

## Key Takeaways

The two-bridge option provided the State of Alabama with a cost-effective and lasting solution to a location susceptible to damage with each rain event. The two-bridge option bridging the slide area effectively adapts to the site location by allowing movement of the slope beneath the bridges. Additionally, through the instrumentation plan, ALDOT is able to monitor the bridges and surrounding area to mitigate future damage and potentially avoid a similar event. Furthermore, through the AID grant, ALDOT can capture lessons learned from this project and further the approach to resilience for future use across the country. Alabama intends to look at landslides differently moving forward. The instrumentation plan for monitoring the area should generate ways to better address these types of events before they occur, and ultimately may make the State's infrastructure more resilient.



Figure 3: Side view of the completed US 231 bridges illustrating the colluvial deposit and elevation difference of the two roadways. Source: ALDOT

## Contact Information

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