Large landslide occurred on US-231 near Lacey’s Springs in February 2020

Heavily used corridor for Huntsville commuters

Roadway was closed in both directions with detours adding 30 – 60 minutes to commutes
US 231 Slide – Lacey’s Springs, AL

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- Replacement bridges opened in September 2020
Site History and Geology
Site History

- Original unimproved SR-38 constructed on ancient slide and colluvium
Site History

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- SB roadway constructed as original SR-53 in ~1947
  - Loose sliding material noted on upslope side of roadway
- Roadway designated US-231 in 1953
- NB lanes constructed in ~1970 to create 4-lane roadway
  - SB & NB embankments constructed of waste material from cuts
Geology

Site Stratigraphy

- Pottsville Formation
  - Interbedded shale, siltstone and sandstone
- The Pottsville is underlain by the Pennington Formation
  - Interbedded limestone, dolomite, shale, and mudstone
- The landslide occurred within soils developed atop the Pennington Formation
- Bangor Limestone is exposed further down the mountain
  - Sinkholes have been observed in this area, but not at the landslide site

Geologic Map of Morgan County, Dodson et al. (1963)
Geology

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Pottsville Formation above slide area
Geology

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2019 Slide Movement
February 23, 2019: Pavement Cracking in NB Lanes
Movement and cracking in Feb. 2019 following heavy rains
- SB lanes are repaved, cracks are patched
- Inclinometers installed by ALDOT and BHATE
Movement and cracking in Feb. 2019 following heavy rains

- SB lanes are repaved, cracks are patched
- Inclinometers installed by ALDOT and BHATE

Rate of movements begin increasing following large storms in December 2019
2020 Failure
Heavy rainfall occurred across north Alabama on Feb. 11-13

Cracks were first noticed in the SB lanes on Feb. 11 resulting in a lane closure

Movements increased significantly over Feb. 12-13 resulting in a full road closure
February 13, 2020: Slide movement in SB Lanes
February 14, 2020: Slide movement in SB Lanes
February 14, 2020: Bulging in SB lanes
February 14, 2020: Cracks along shoulder of SB lanes
Landslide Investigation
Montgomery, J. and McDonald, B. – 2021 Alabama Transportation Conference

Preliminary Investigation

- Five borings performed in 2019
- ALDOT Materials & Tests and Auburn engineers met on site on Feb. 14 to plan geophysical surveys
  - 1D seismic profiles and 2D resistivity surveys
- DBA called on Feb. 14 to assist with repair
- ALDOT began drilling on Feb. 17
Geophysical Testing

- Seismic and resistivity surveys were performed on Feb. 17 and Feb. 20-21
  - MASW performed in NB and SB lanes using a landstreamer to easily move 24 geophones
  - Four 2D resistivity surveys with 56 or 112 electrodes and total lengths of 413 - 728 feet
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Geophysical Testing

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  - MASW performed in NB and SB lanes using a landstreamer to easily move 24 geophones
  - Four 2D resistivity surveys with 56 or 112 electrodes and total lengths of 413 - 728 feet
- Results from both methods were combined to identify stratigraphy
- Low resistivity, low velocity zone was found at depths of 30 – 40 feet below the road
Drilling Program

- 2020 landslide investigation program consisted of:
  - 15 borings
  - 13 inclinometers
  - 5 vibrating wire piezometers

- 3,712 feet of drilling for the landslide investigation and the bridge foundation investigation (coming up next!)

- Boring data, inclinometers and geophysical results were used to develop representative cross-sections for design
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Boring SB-4

- Auger refusal at 24 feet followed by NQ core to 52 feet
- Upper 30 feet is fill material and colluvium (alternating sandstone and clay)
- Slide plane is likely in a fat clay layer found between 30 and 40 feet
- Interbedded limestone and mudstone below
Preliminary Ring Shear Results

- Ring shear tests were performed on remolded samples of the purple fat clay found between 35.5 and 36 feet.
- Results show a curved strength envelope with a residual friction angle of approximately 12 degrees at higher stresses.
- This low residual strength is consistent with values back-calculated by DBA.
Summary
Summary

- The US-231 landslide required “all hands on deck” to gather the characterization data needed to design a repair.

- Much of the initial characterization was finished within two weeks of the closure.

- Geophysical and geotechnical data were combined to locate the likely failure zone.

- Preliminary ring shear tests show a residual friction angle of approximately 12 degrees in this zone.
Acknowledgments

- The information presented here was based on the work of countless individuals from ALDOT and their consultants and contractors
  - Any opinions are those of the presenter and do not necessarily reflect the views of these individuals or organizations

- The Auburn geophysical team included Chukwuma Okafor, Ashton Babb, Jeff Stallings, Frank Russell, Dan Jackson, and Michael Kiernan

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