Block Slide/Rockfall on I-75
Campbell County, TN

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Location of Slide
Location of Slide
February 2016 Slide

GEOLOGIC MAP AND SECTIONS OF THE PIONEER QUADRANGLE, TENNESSEE
Portion of the Pioneer 7 1/2 ' Quadrangle
Before and After
February 28, 2016

Sunday after slide
Toe of sliding block looking south
Head scarp/top of release joint/high wall
Low angle sliding block

Figure 1: Sliding Block Failure Model

- Sliding block composed of flat-lying thick bedded shale and siltstone
- Sliding surface (dip=2°) as located by visual observation and survey
- Water force/pressure on side of block
- Water force/pressure along base of block reduces normal force on sliding surface
Characteristics of Block

- Large – Approximately 90 feet thick/high along near-vertical release joint
- Near horizontal bedding, dipping toward roadway at 5 degrees or less
- Very low shear strength failure surface; coal seam or highly weathered clay shale
- Water assumed in vertical joint, pressure in joint and along base at time of failure unknown
- Well-defined sliding surface, shear strength of surface to be back-calculated
What has changed since the slope was built?
Clear cutting along transmission lines that removed undergrowth?
Increased precipitation? Progressive weathering of clay shale seam?
How did block travel so far? Momentum?
Debris collapsing at release joint pushed outer material over slope?
To stabilize intact material below transmission lines

Anchor and shotcrete projection of exposed joint

Passive anchors/nails and wire mesh over 1:1 slope

Reinforced concrete face with high capacity rock anchors

5' spacing in line of slope face and 10' horizontally

10' spacing in line of slope face and 10' horizontally

20' and 30' nails 25 degrees from horizontal

40 foot long nails 40 degrees from horizontal

Figure 3: Cross section at Station 106+50 with anchored wall along scarp

Figure 6: Cross Section of proposed nail/anchor configuration at top of 1:1 slope
Anchors/Nails installed at steeper angles to act in shear as well as tension
Analysis and Assessment of Failure Mode(s)

Sliding block movement along failure surface of known location, orientation and extent, back-calculated shear strength and assumed water conditions
Modified Bishop Global Stability – Location of lowest FOS surface

It should be noted that decreasing the nail spacing/increasing the number of nails reduced the nail head force calculation but did not increase the Global FOS.

Analysis Tools
SNAP-2
Excerpt from memo dated March 15
Analysis Tools

Ruvolum for analysis of material after weathering, shallow surface

Excerpt from memo dated March 15
March 3, 2016 - Removal of front of sliding block
March 4, 2016 - Removal of slide debris from slope
March 8, 2016, excavation of shaly clay at top of slope
Debris removal continues
March 10, 2006, southbound lanes open
March 15, 2016, release joint exposed/intercepted
Slope on March 18, 2016
Preparing to anchor and shotcrete lower slope 3/23/16
Northbound lanes reopened after construction of temporary lanes in median and removal of the least stable debris 3/26/16
Sandstone layers near top of slope, note dip of strata
March 28, insertion of anchors for combination shotcrete/wire mesh covered slope
March 29, grouted anchors for combination shotcrete/wire mesh covered slope
Anchors after grouting, prior to shotcreting
Drain strips, wire mesh, #4 bars, plates and nuts installed
Slope after shotcrete application
Removal of slide debris from lower slope nearing completion April 13, 2015
Drilling for anchors in upper 1:1 slope
Installation of nails in shaly clay, note closer spacing
Placement erosion control matting prior to placement of wire mesh, May 23
Anchored grade beam installed in front of wall as alternative to continuing to excavation along release joint
Grade Beam in Place
Questions

How rare (or common) is this?

Can these sites be identified 20 to 50 years after construction and mature vegetation has been established?

What do we do about them? Flatten the slopes?, Install drains? Installed anchored grade beams?

What have other DOTs encountered?