BRIERLEY ASSOCIATES
Creating Space Underground

IN DEPTH

June 2018

Landslide – Trinidad, Colorado

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Situated at the base Sangre de Cristo Range, near the New Mexico border is Trinidad, Colorado. This area of Colorado is within the Raton Basin, which contains significant reserves of coal bed methane. Natural gas extraction in the foothills west of Trinidad is a major economic contributor to the regional economy.

Regionally, during the first six months of 2017, total precipitation was about 50% more than average. Then, in August 2017 a sudden ground movement occurred which disrupted the use of an unpaved access road that hugs the side of a canyon. The landslide was approximately 200-ft long and somewhat parallel to the roadway, with a more active center portion about 100- to 150-ft wide.

Bedrock where the roadway is cut into is part of the Poison Canyon Formation and consists of sandstone, conglomerate, and shale. Upslope of the roadway are beds of near-vertically faced sandstone that ranges from 2- to 10-ft thick. Within the sandstone are interbeds of shale that weathers to an approximately 1:1 slope, which lends itself to the occurrence of frequent rockfalls that litter the roadway and lower slope sections.

By October 2017, the main scarp below the roadway surface had advanced several feet towards the road thus reducing the overall width. Formation of a secondary scarp further undercut the road resulting in a single travel lane. By December 2017, the top of the slide had advanced further toward the road and the secondary scarp had expanded horizontally several feet effectively closing the road.

Brierley Associates was retained by a specialty contractor to investigate and design a slope stabilization system that would allow roadway reconstruction and mitigate subsequent slide events.

Due to the relatively rapid movement of the landslide and impacts to the road, Brierley was requested to develop a stabilization scheme on an accelerated schedule. Based on surficial evidence of weathering processes in the adjacent slopes and subsurface ground characteristics revealed in test pits and test borings, the unstable area was interpreted as a relatively shallow wasting process of colluvium derived from weathered shale and fallen sandstone blocks moving across a shale erosional surface.

Although tiebacks are the traditional landslide stabilization technique, Brierley believed that a soil nail wall embedded in shale bedrock, below the slide surface would be feasible. For this remedy to work, it was critical to determine the slide plane depth and geometry. Typically, landslide geometry is determined by monitoring deformation over time with inclinometers. However, due to the need to reopen the road quickly, Brierley implemented the observational method to develop our design rather than extending the project timeframe by several months, which would have been needed if geotechnical instrumentation was installed and monitored. During soil nail wall construction, Brierley mapped the excavation. This information allowed us to adjust the soil nail wall bottom so it extended below the slide plane. Upon installation of the soil nail wall, the deepened portion was backfilled to protect the base of the stabilized ground mass from future erosion.

Although the landslide turned out to be significantly deeper than initially assessed, Brierley's observational approach led to a flexible design that allowed for modifications as conditions became apparent, which ultimately avoided construction delays. The final wall geometry ended up about 30-ft deep near the center of the landslide and was terminated within the underlying bedrock. The project required five weeks to construct, followed by final road grading and drainage work and was completed prior to the start of the 2018 snow/rain season.