4.3 S3 – COCHRANE

Background

The Cochrane site is located on Highway 22:16, south of Cochrane, AB and approximately 1 km south of the bridge across the Bow River.

The slope instability at this site appears to be relatively shallow, however it is affecting an area measuring approximately 50 m by 50 m downslope (northeast) of the highway. At this location the highway traverses a steep slope above the Bow River and the sliding is likely largely natural movements possibly with some contribution by side cast fill placement from the highway. Slope movements of up to 20 mm per year have been recorded in the slope inclinometers since installation in 1994 with relatively active movements occurring in 2005 and 2006. The timing and rates of the slope movements are judged to be sensitive to surface water running from the highway ditch to the slide area.

Site Assessment

The site assessment was performed on June 2, 2006. The weather at the time of the site assessment was sunny and clear.

Please refer to Appendix S3 for a site plan illustrating the layout of the site. The highway surface and the slope face below the road were inspected. The ground traverse extended to approximately 30 m below the fenceline downslope of the road.

Observations

The following points summarize the key observations made during the site assessment. Please also refer to Appendix S3 for a site plan and annotated photographs illustrating key observations.

- Cracking and settlement of an approximately 30 m long segment of the road along the east shoulder. The aperture and downdrop of the cracks were in the order of 50 to 100 mm (Photos S3-1 and S3-2). Cracking was visible into the middle of the northbound lane. This cracking developed since the road was repaved in the summer of 2005 in response to similar, but less significant, cracking that developed in June 2005 (Photo S3-3). The current cracking can be traced onto the slope to the north and south of the cracked segment of the east shoulder and overall forms a possible semi-circular slump headscarp as illustrated on Figure S3-1 in Appendix S3. At the point where the south flank of the cracking crosses the ditch there is a lateral separation of up to 100 mm and the buried ditch liner is exposed as shown in Photos S3-4 and S3-5.

- The previously-noted slope movement below the road with a headscarp slightly upslope of SI #3A appeared to have experienced additional movement since the previous annual inspection. Photos S3-6 and S3-7 show this area.

  - The slope face between SI #3A and the fenceline showed recent slumping and downdrop in the order of 50 to 100 mm.
  - There was fresh tension cracking in soil along the south flank of the visible slumping area on lower slope between SI #3A and the fenceline further down the slope.

- During the 2005 inspection there was visual evidence that during the heavy rains in June 2005 runoff within the ditch along the downslope edge of the road overflowed the ditch berm and flowed down into the instability area around SI #3A. It did not appear that this had occurred again since the 2005 inspection.

The most recent (spring 2006) readings of the slope inclinometers continued to show the previously identified shallow movement zones in all three functioning SI's. The non-functioning SI's have sheared off at shallow depths due to the accumulated displacements in similar, shallow movement zones. Overall, all of the inclinometers at this site have shown varying degrees of slide activity, generally at depths of less than 3 m. The rates of movements in the slope inclinometers appear to be sporadic, with different instruments showing movements at different times and at varying rates. This indicates varying degrees of slide activity, possibly induced by changing surface drainage patterns.

Assessment and Risk Level

The cracking and settlement of the road surface has worsened since the 2005 inspection and has further developed into a distinct pattern that is consistent with a slump failure affecting the northbound lane of the road. The heavy rains in June 2005 may have either triggered the slumping or worsened an existing but previously creeping slump at this location. It also appears that peak flows in the ditch along the east shoulder of the road during 2005 may have overtopped the ditch and flowed into the possible slumping area, which may have further worsened the stability conditions.

Therefore, AMEC recommends the following Risk Level factors for this site:

- Probability Factor of 9 in order to reflect the ongoing slope movement observed in the area around and downslope of SI #3. This is the same value that was recommended after the 2005 inspection.

- Consequence Factor of 3 in order to reflect the magnitude of the cracking and settlement that has occurred along the downslope edge of the pavement in the past year. Otherwise, no significant impacts to the highway are anticipated in the short term.

Therefore, the current recommended Risk Level for this site is equal to 27. This is the same value recommended after the 2005 site assessment.

Recommendations

AMEC recommends the following for this site:

The previously-recommended repairs to the downslope berm along the ditch should be implemented. The visual observations from the 2005 inspection showed that ditch flow overtopped the berm and flowed down onto the slope and into the unstable area around and downslope of SI #3A during the significant rainfall events in June 2005. The downslope berm height between SI #2 and SI #5 should be restored and if possible the carrying capacity of the ditch increased in order to avoid future overtopping of the ditch berm during peak rainfall events.

An overlay, patch and/or crack-sealing should be applied to the cracking and settlement area along the east shoulder of the road. This will serve as a short-term fix while awaiting further data to characterize the landslide movement at this site and design repair measures (see following recommendations).

Two new slope inclinometers should be installed – one as a replacement for SI #3A and the other to replace SI #2 which is expected to shear off in the near future. SI #3A sheared off at 4 m depth and has not been read since April 1997. SI#2 has continued to show movement over the years, and it is unlikely that the SI probe will continue being able to fit past the bend in the casing for much longer. The new SI's would be of value for checking if the active landslide movement around SI #3A is retrogressing upslope towards the highway and if it is related to the recent settlement and cracking along the downslope edge of the pavement. The installation of these SI's would also provide an opportunity to collect information on the soil and groundwater conditions (the borehole logs for this site from AIT's files contained very limited information).

A site survey should be performed. A current site survey of the site would be of value to replace the schematic site plan currently being used for this site. The survey should extend from the crest of the cut slope above the southbound lanes to the treeline along/downslope of the fenceline below the road.

The semi-annual monitoring of the SI's should be continued.
Annual assessments at this site should be continued.
The most effective geotechnical risk management strategy for this site is still considered to be a continuation of the instrument monitoring and periodic assessments of the slope condition. The recommended new boreholes with SI's will provide information on subsurface conditions and better characterize the landslide movement that is affecting the road. This information can then be used do design repair measures as necessary.