S3 – COCHRANE

Background

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

The slope instability at this site appears to be relatively shallow, however 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, however movements at various locations are sporadic (starting and stopping between successive SI readings). The timing and rates of movements are also likely sensitive to surface water running from the highway ditch to the slide area.

Site assessments, installation and monitoring of slope inclinometers has been conducted at this site since late 1991. Please refer to Section A of the site binder for a more detailed discussion of the site background.

Site Assessment

The site assessment was performed on June 27, 2005. The weather at the time of the site assessment was partly cloudy with a light breeze.

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

- The previously-noted slope movement below the road with a headscarp slightly upslope of SI #3A appeared to have experienced additional movement since the 2004 inspection. Photos S3-1 to S3-3 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 south flank of visible slumping area on lower slope between SI #3A and the fenceline further down the slope.
    - The same landslide block slope profile starting a few metres above the fenceline on the lower portion of slope that was noted during the 2004 inspection was present. There were numerous visual signs of recent

cracking and tearing of the surficial organic cover and shallow erosion due to surface runoff on the slope below the highway.
  - Groundwater discharge from tension cracks on north flank of visible slumping area just above the fenceline.
  - Standing water in the tension cracks in the visible slumping area, starting just above the fenceline and extending downslope.

- Disturbance to the vegetation on the slope face and minor gullying on the lower portion of the slope (just above fenceline) suggested that the 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.

- Cracking and settlement along the east shoulder of the highway with 50 to 100 mm aperture and downdrop where previous inspections had noted hairline cracking without significant downdrop. The open depth of the cracks was in the order of 300 mm. This cracking developed between the instrumentation readings in May 2005 and the site inspection on June 27, 2005. Photos S3-4 to S3-6 show this area and the approximate extent of the cracking is sketched onto the site plan in Appendix S3.

The instrument data from the May 2005 readings showed ongoing, slow downslope movement in shallow zones in each of the five operational SI's. The movement recorded between the previous readings in the fall of 2004 and the May 2005 readings was comparable to previous years, therefore it is likely that the cracking and settlement of the downslope shoulder of the road that occurred after the instrument readings was the result of more significant slope movement than indicated by the May 2005 instrument readings. Such slope movement likely occurred in response to the heavy rains during June 2005.

Assessment and Risk Level

As noted in previous assessments, the slope instability below the road at this site is largely a natural process for the overall valley slope. However, surface runoff from the highway appears to overtop the low point in the ditch berm between SI #2 and SI #5 on occasion (and particularly during the significant rainfall events in June 2005) and contributes to the ongoing shallow slope movement that has retrogressed to just upslope of SI #3A in recent years.

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 2004 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 an increase from the value of 18 (PF = 9 x CF = 2) from the 2004 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.

The open cracks along the downslope edge of the northbound lanes should be backfilled and repaired. This will mitigate the settlement on the road surface and also seal the cracks up to prevent water from flowing into them.

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 existing SI's (#2, #4 and #5) adjacent to the downslope edge of the road should provide some warning of significant slope movements retrogressing back from the visibly unstable area around and downslope of SI #3A to the downslope edge of the road in time to further assess the situation and plan any necessary mitigative measures.

A replacement for SI #3A should be installed to monitor for retrogression of the slumping towards the road. SI #3A sheared off at 4 m depth and has not been read since April 1997. A new SI at this location would be of value for checking if the active landslide movement around and downslope of 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 borehole logs from the SI's that were installed at this site should be reviewed and a site survey performed. AIT has provided electronic files of borehole logs for this area from their database, and this information should be reviewed in order to check if the borehole logs from the SI's at this site are included. Such information, combined with a current site survey of the site (to replace the schematic site plan without topography

currently being used) would help to further understand the slope stability conditions at this site.