

4.17 S20 – HIGHWAY 541 – HIGHWOOD HOUSE ROCK CUT

Background

This rock cut is located on the north side of Highway 541, approximately 800 m east of the junction between Highways 40, 541 and 940 at Highwood House. The seasonal closure gate for Highway 40 is located at the junction, therefore the highway is open year-round at this site. Please refer to Figure S20-1 in Appendix S20 for an illustration of the site location.

The cut slope is near-vertical to vertical with an estimated maximum height of greater than 20 m. The bedrock exposed in the cut slope consists of steeply-dipping beds of shale, coal and conglomerate. The dip direction is roughly parallel to the highway alignment and down towards the west (Photo S20-2 in Appendix S20). The soil and bedrock slopes above the crest of the rock cut are inclined at up to 35°.

There is a rockfall hazard to the highway at this site and there are warning signs in place (“Watch For Fallen Rock”) for traffic approaching the site from both directions. This site was initially inspected by AMEC in August 2004 and on three occasions between July and September 2005 as part of the geohazard review for the Highway 40 / Highway 541 corridor. Rockfall debris was noted in the north ditch during each inspection as follows:

- The rockfall debris in the ditch at the west end of the site consisted of individual rocks up to 2 m maximum dimension that had fallen from rock exposures in the cut slope as well as eroded out of the rocky soil face above the crest of the rock cut. The rocks had landed in various locations within the ditch, including a boulder along the edge of the paved surface of the road observed in August 2004 and as shown in Photo S20-8 in Appendix S20. Two large cones of accumulated rockfall debris were also noted in the ditch at the west end of the site.
- The rockfall debris in the ditch at the east end of the site typically consisted of talus cones of gravel sized rocks that had accumulated below gullies eroded into relatively weaker beds in the rock cut.

Furthermore, gravel-sized rocks were noted on the north shoulder and in the westbound lane of the road during each inspection. There was minor visible damage to the pavement which suggests that some larger rocks had been landing or rolling onto the pavement.

The June 2007 site inspection was the first annual site inspection under the Southern Region GRMP and the first site inspection since late 2005. This site was added to the annual site inspection tour because its recommended Risk Level was one of the highest in the geohazards review of the Highway 40 / Highway 541 corridor.

Site Assessment

The site assessment was performed on June 19, 2007. The weather at the time of the site assessment was clear and warm.

The site assessment consisted of a visual inspection of the cut slope and ditch conditions from the highway.

Observations

The following points summarize the observations made during the site assessment. Please also refer to Appendix S20 for photographs.

- As shown in Photos S20-2 to 5, there was a significant accumulation of rockfall debris in the north ditch at the time of the inspection. The pattern of debris accumulation was consistent with observations from the previous site inspections with largest volume of debris at the west end of the site. There were two very large talus cones in the ditch at the west end of the site that extended almost to the north edge of the pavement (Photo S20-4). This effectively negates the ditch capacity at these locations and rocks falling onto the upper portion of the talus cone could roll onto the road surface.
- Boulders with up to 500 mm maximum dimension were observed immediately adjacent to the north edge of the pavement. In addition, a baseball-sized rock was observed in the middle of the westbound lane (Photo S20-7) near one of the above-noted large talus cones.

Assessment and Risk Level

The rockfall conditions at this site and the associated risk to the highway have not changed since the 2005 inspections. There has been evidence that rockfalls at this site deposit up to boulder sized rocks along the north edge of the pavement if not into the westbound lane.

As noted in the 2006 report on the geohazard review for this highway corridor, the ditch sizing criteria shown on Figure A1 in Appendix A indicates that for a near-vertical cut slope with a height of 20 m, the ditch should be at least 6.4 m wide and 1.5 to 1.8 m deep. The north ditch at this site is typically 5 to 6 m wide and 1.5 to 1.75 m deep and is therefore slightly short of these size criteria, at least for the segments of the cut slope near the maximum height. However, the typically large volumes of rockfall that have been allowed to accumulate in the ditch reduce the effective depth and width of the ditch even further below the ditch sizing criteria.

AMEC recommends the following Risk Level factors for this site using the rock fall frequency-severity matrix (Table A2 in Appendix A). These recommended values have not changed since the previous inspections.

- Probability Factor of 15 based on the appearance of the debris that suggests that there is ongoing rockfall at this site.

- Consequence Factor of 3 based on:
 - The observed, relatively minor damage to the pavement along the north shoulder and in the westbound lane of the road.
 - The August 2004 observation (Photo S20-8) of a boulder that had landed along the north edge of the pavement. This illustrates that it is possible for rockfall debris of this size to be deposited at locations along the edge of the road where they could be struck by a vehicle (particularly under poor visibility conditions or at night) and cause damage in the order of a flat tire or a temporary loss of vehicle control at highway speed.

Therefore, the recommended Risk Level for this site is 45.

Recommendations

The following work is recommended for this site in order to manage the Risk Level:

As soon as possible and promptly/as required in the future:

1. The accumulated rockfall debris should be cleaned out from the ditch at this site in order to maintain the maximum ditch capacity, particularly in the areas at the west end of the site where the talus cones accumulate at the toe of the rock cut and fill the ditch. The frequency of cleaning will depend on future rockfall volumes. Ditch cleaning should be treated as an ongoing maintenance task and performed as required. If the ditch is consistently kept clean and near its maximum capacity, then it may be possible to reduce the Consequence Factor for this site.
2. The frequency of cleaning and approximate volume of debris should be recorded for reference during future site assessments (see further discussion re. this below) of whether or not additional measures would be cost-effective for managing the Risk Level at this site.
3. The large, individual rocks that fall into the ditch and onto the edge of the road at the west end of the site should be removed as necessary to maintain maximum ditch capacity in this area and in order to avoid a circumstance where subsequent rockfalls could land on one of these large rocks and break into pieces that could bounce onto the road.

Future Assessment and Possible Additional Measures:

1. The amount of effort required for ditch cleaning should be monitored over time in order to assess if it is practical and cost-effective to manage the Risk Level at this site by having the maintenance contractor treat it as an ongoing maintenance task.

2. The following additional measures should be considered to reduce the dependence on timely cleaning of the ditch:
 - a. Increasing the ditch depth if possible. There is a Telus pedestal in the north ditch at the west end of the site, therefore it would likely be necessary to relocate the buried Telus line if the ditch depth is increased.
 - b. Placing a line of jersey barriers along the north shoulder of the highway to increase the effective ditch capacity. This will help to contain rockfall debris in the ditch. This should only be done if AIT's requirements for a minimum clear width can be met (and also practicality with respect to snow-plowing). The barriers would also be effective in preventing vehicles that may run into the north ditch for other reasons from striking boulder-sized rockfall debris that has been contained in the ditch. It will be necessary to keep cleaning the rockfall debris from the ditch after the barriers are in place.
 - c. Consider scaling the cut slope in order to attempt to reduce the volume of rockfalls over the short term (e.g. a few years).