

4.15 S18 – HIGHWAY 40 – GALATEA CREEK THROUGH-CUT

Background

This site is located approximately 32 km south of the junction between Highway 40 and Highway 1 and just north of the Galatea Creek Provincial Recreation Area. Please refer to Figure S18-1 in Appendix S18 for an illustration of the site location along the west toe of a mountain labelled as “The Wedge” on published topographic maps.

There is a through-cut in bedrock along the highway at this site. The highway enters the north end of the through-cut along a bearing of 040, is aligned north-south (bearing 000) in the mid-portion of the through-cut, and exits the south end of the through-cut along a bearing of 346 (north 14° west).

The current alignment of Highway 40 at this site is reported to have been constructed in the late 1970's. There is a pole-supported power line running north-south on the slope above (east of) the through-cut.

There is a rockfall hazard along both of the cut slopes in the through-cut and there are warning signs (“Watch For Fallen Rock”) posted for both directions of traffic. This site was previously inspected by AMEC in June 2004 in response to a call-out request by AIT and again in 2005 as part of the geohazard review for the Highway 40 / Highway 541 corridor. The summary of the site description and key points regarding the rockfall hazard at this site from the 2006 report on the highway corridor geohazard review is listed below. The two cut slopes are referred to as the “East Cut Slope” and the “West Cut Slope” in the following discussion.

1. The exposed bedrock consists of dark grey shale to siltstone with occasional white quartz veins. The bedding of the rock has a strike of 140 to 150° and a dip angle varying between 35 and 45° down towards the southwest. From a slope stability perspective, this bedding orientation is unfavourable for the East Cut because it dips downwards towards the road and out of the cut slope face. Conversely, the same bedding orientation is favourable for the West Cut because it dips downwards into the slope and away from the road.
2. East Cut Slope
 - a. The East Cut is near-vertical with a maximum height of approximately 16 m. The cut slope was excavated using pre-split blasting techniques. There is a steep slope of exposed rocky soil and colluvium above the crest of the East Cut with an estimated typical height of approximately 5 m. Photo S18-1 in Appendix S18 shows a general view of the East Cut.
 - b. The ditch along the toe of the East Cut is relatively narrow, with some segments having a ditch width of less than 4 m as measured between the edge of the pavement and the toe of the slope. The depth of the ditch relative to the road surface is typically 0.5 to 0.75 m.

- c. There is a rockfall hazard at the East Cut slope due to the following reasons:
 - i. Weathering and the effects of freeze/thaw cycles on the exposed rock in the cut slope face.
 - ii. Release of rocks from the rocky soil exposed above the crest of the East Cut.
 - iii. The unfavourable orientation of the rock structure with respect to the orientation of the East Cut face. There is a potential for development of block sliding, wedge and toppling failures.
- d. During the 2004 and 2005 site inspections it was noted that a significant volume of rockfall debris had accumulated in the east ditch. The majority of the debris was gravel to cobble-sized and several boulder-sized rocks were noted in the ditch. It was judged that the vast majority of the rockfall debris was due to weathering and freeze/thaw cycles.
- e. The rockfall hazard along the East Cut is currently mitigated by the ditch along the east side of the highway. However, this ditch does not meet the sizing criteria illustrated on the Ritchie ditch chart (Figure A1 in Appendix A), which specifies a minimum ditch width of 5.5 m and a minimum ditch depth of 1.4 m for the maximum slope height at the East Cut Slope.
- f. At the time of the June 2004 site inspection there were several cobble-sized rocks deposited in the northbound lane as far west as the centerline of the road. There were also numerous locations along the east shoulder of the road where the pavement had been damaged by previous rockfall. It is not known when this area was last repaved prior to the June 2004 inspection, so the length of time that the visible pavement damage occurred over is not clear.
- g. The rockfall hazard due to the unfavourable bedding structure orientation has been mitigated by the installation of numerous rockbolts across the East Cut. However, the faceplates on some of the existing rockbolts were noted during the June 2004 inspection to not be in proper contact with the slope face and there were also a few locations where blocks of rock from around the rockbolts had broken free and fallen away after the rockbolts were installed. Also, as shown in Photo S18-6, there were also some locations on the slope without rockbolts where rockfalls were developing.
- h. There is also a possible rockfall hazard from the slope above the East Cut. There are several locations in the treed area on the slope between the crest of the East Cut and the power line right-of-way further upslope where boulder-sized rocks are wedged/embedded along the upslope sides of trees. It appeared that these rocks had rolled downslope during construction work along the power line

right-of-way and may not be indicative of a current hazard. If these rocks had not been stopped by the trees they could have rolled off the crest of the East Cut and onto the northbound lane of the road.

3. West Cut Slope

- a. The West Cut was constructed using pre-split blasting methods and has an estimated maximum vertical height of 10 m. The majority of the West Cut face has a near-vertical to vertical inclination. No rockbolts or other stabilization measures were noted on the West Cut.
- b. The rockfall hazard along the West Cut is mitigated by the west ditch along the road. The ditch is typically 6 to 7 m wide as measured between the edge of the pavement and the toe of the slope. The depth of the ditch relative to the road surface ranges between 1 and 1.5 m. The existing ditch meets the sizing criteria shown on Figure A1 in Appendix A.
- c. During the 2004 and 2005 inspections, there were gravel to cobble-sized pieces of rockfall debris in the west ditch along with a few boulder-sized pieces. The existing west ditch appeared to be sufficient to contain this debris and it did not appear that debris from past rockfall events had reached the west edge of the road.

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 cool with a blustery wind.

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 S18 for photographs.

- There was accumulated rockfall debris in the east and west ditches, as shown in Photos S18-2, 4, 5 and 8. The rockfall debris varied from gravel to boulder size, with some pieces around the south end of the East Cut Slope having a maximum dimension in the order of 1 m.
- As shown in the photos, virtually all of the rockfall debris was contained within the ditches at the time of the inspection. Some gravel sized rocks were noted along the east side of the northbound lane at the time of the inspection and there were visual signs of pavement damage from rockfall along the segment of the highway adjacent to the East Cut Slope.
- Based on a comparison with the photos from the 2004 and 2005 site inspections, it appeared that the accumulated rockfall debris in the east ditch had been cleaned at least once since the 2004 site inspection, e.g. the large rocks shown in Photo S18-7 from June 2004 were not noted during the June 2007 inspection. However, there is no information available on the timing of ditch cleaning, the volume of debris removed, and the rate/timing of subsequent rockfall debris accumulation.

Assessment and Risk Level

Overall, there has not been any significant change in the site conditions since the 2004 and 2005 site inspections. The previously-noted rockfall hazards described in the Background section remain in effect.

In theory, the short term risk of rockfall is partially mitigated by the “Watch For Fallen Rock” signs in place on either side of the through-cut to warn users of the highway. However, there remains the possibility that boulder-sized rocks could be deposited in the eastbound lane, particularly if the accumulation of rockfall debris in the east ditch is allowed to build up.

AMEC recommends the following Risk Level factors for this site using the rockfall frequency-severity matrix (Table A2 in Appendix A). These factors are unchanged from the 2006 report on the geohazard review for this highway corridor.

East Cut Slope

- Based on the site observations, it is judged that the hazard of rockfall due to weathering and freeze/thaw effects on the exposed rock is the primary geohazard for the East Cut. The Risk Level for potential rock block sliding, wedge or toppling failures along the East Cut is judged to be slightly lower, although it may increase in the future if the existing rockbolts continue to degrade.

- A Probability Factor of 15 is recommended based on the apparent frequency of rockfall due to weathering and freeze/thaw effects on the exposed rock.
- A Consequence Factor of 3 is recommended based on the history of cobble-sized rocks rolling onto the pavement at this site.
- Therefore the recommended Risk Level for the East Cut is 45.

West Cut Slope

- A Probability Factor of 12 is recommended based on the apparent frequency of rockfall.
- A Consequence Factor of 1 is recommended because there is no evidence of rockfall debris reaching the road.
- Therefore, the recommended Risk Level for the West Cut is 12.

Recommendations

AMEC recommended the following work in order to manage the Risk Level at this site. These recommendations are unchanged from the 2006 report on the geohazard review for the highway corridor.

Measures To Maintain The Current Conditions:

1. The east and west ditches should be cleaned in the future in order to maintain their capacity. This should be treated as an ongoing maintenance issue and cleaning done as required, rather than on a pre-determined, regular schedule.
2. Any rocks that are deposited on the road should be cleared as soon as they are noted. The most practical and efficient method of ensuring that the road is clear of rockfall debris on an ongoing basis would be to have maintenance contractor personnel visually inspect the site each time they travel by during their other work and stop to remove any rocks on the road by hand.

Proactive Measures To Attempt To Reduce The Risk Level:

1. The Consequence Factor for the East Cut could be reduced by increasing the capacity of the east ditch to contain rockfall debris. The ditch sizing criteria on Figure A1 in Appendix A should be used as an initial guide. A line of jersey barriers could also be placed along the east shoulder of the road in order to increase the effective depth of the ditch. This should only be done if AIT's requirements for a minimum clear width and/or sideslope angles 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 east 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 east ditch after the barriers are in place.

2. If the activities under Point 1 are insufficient to meet the ditch sizing/catchment criteria, then the East Cut might be scaled in order to remove loose rock and reduce the frequency of rockfalls for a period of time (hopefully in the order of a few years or more). The rocky soil between the crest of the rock cut and the treeline above the road should also be scaled to remove large rocks that will otherwise ravel out in the next few years. The east ditch should be cleaned out after the scaling is completed.

Follow-Up Inspections:

- The annual inspections at this site should be continued. The purpose of the site inspections will be to check the slope conditions, the rate of rockfall debris accumulation in the ditches, and note specific locations where large blocks of rock in the cut slope appear to be coming loose. The information from these inspections, particularly the rate of debris accumulation, can be used to determine if additional measures are necessary to reduce the Risk Level at this site and reduce the reliance on timely cleaning of the ditches. Additional measures could consist of mesh or draped rockfall nets to guide falling rocks to land close to the toe of the cut slope, additional scaling, or perhaps additional rockbolts to supplement or replace existing ones.