

Site 9 – Limestone Mountain Cut Slope

This site is located approximately 600 m south of the Galatea Creek Provincial Recreation Area parking area. The following potential geohazard features were noted at this site:

Cut slope along the highway

The cut slope along the east side of the highway exposes bedrock with bedding planes dipping down towards the road at approximately 45°, similar to the nearby Galatea Creek Through-Cut site. Along some segments of the cut slope the entire cut face consists of an exposed bedding plane (Photo 1). Along other segments, the lower portion of the cut slope is vertical and the upper portion exposes a bedding plane and/or rocky soil at around 45° inclination. The height of the cut slope varies between about 4 and 8 m.

The ditch at the toe of the cut slope varies between 3 and 8 m in width. The depth of the ditch relative to the road surface is approximately 1.5 m. The ditch roughly meets the sizing criteria illustrated on Figure B1 in Appendix B.

There is a rockfall hazard at this slope due to:

- Cobble to boulder-size rocks detaching and sliding down exposed bedrock dip planes.
- Cobble to boulder-size rocks eroding out of the exposed soil in the upper cut slope and falling/rolling downslope.

At the time of the site inspection, the temperature was around 0°C and had been rising from overnight freezing temperatures. Several minor rockfalls due to freeze –thaw effects were witnessed during the approximately 15 minute site inspection.

The rockfall debris is contained within the existing ditch (Photos 1 and 2). There were no rocks on the road at the time of the site inspection in October 2005 and there were no signs of damage to the pavement from previous rockfall.

AMEC recommends the following Risk Level factors for this site using the rock fall frequency-severity matrix for this cut slope:

- Probability Factor of 12 based on the evidence of multiple to several rockfalls each year at the cut slope along the highway.
- Consequence Factor of 2 based on the possibility of rockfall debris from the cut slope along the highway bouncing and rolling along the top of the accumulated debris in the ditch and being deposited along the east edge of the highway.

Therefore, the recommended Risk Level for this site is 24.

It is recommended that the accumulated rockfall debris in the ditch be cleaned out to restore the maximum ditch capacity and reduce the Consequence Factor to 1. The ditch should be cleaned as necessary in the future to maintain the catchment capacity. The timing and frequency of ditch cleaning will depend on the volume of future rockfall debris, and it appears that cleaning will be required at least annually.

Rock slope above the highway

There is also a rockfall hazard at the slope above the highway and adjacent to the south end of the cut slope described above. As shown in Photo 3, the slope in this area consists of two segments:

- A lower colluvium slope at approximately 35° with the toe along the east ditch of the road. This colluvium slope is approximately 15 m high.
- An upper slope of exposed bedrock at approximately 45°. This rock slope extends for a considerable distance above the highway. As with the nearby cut slope along the highway, the bedrock in the upper slope has bedding planes dipping down towards the highway at approximately 45°.

Portions of the colluvium slope are treed and most of these trees have curved trunks, which indicates that there is ongoing creep movement of the colluvium down towards the highway. There is a hazard of rockfall debris from the upper bedrock slope rolling down the colluvium and into the ditch.

The width of the ditch between the toe of the colluvium slope and the east edge of the highway is typically around 14 m and it was clear of debris at the time of the field inspection in October 2005.

When the minimum rockfall shadow of 27.5° – defined in Evans and Hungr (1993) as useful for the preliminary estimation of maximum rockfall reach – is applied to the assumed 15 m height of the 35° colluvium slope, the potential maximum rockfall runout distance beyond the toe of the colluvium slope is approximately 8 m. This is less than the width of the ditch along this segment of the highway, therefore it is judged that the hazard to the highway from rockfall debris rolling out beyond the toe of the colluvium slope is negligible.

Also, a series of concrete buttress blocks were noted on a portion of the upper bedrock slope and they appear to correspond to some design drawings for bedrock slope stabilization measures that were found during a review of AIT's files. Copies of the design drawings, which are dated from 1974, are attached as Figure E2. These drawings show reinforced and dowel-anchored concrete blocks to be installed to prevent

rock detachment and sliding along a bedding plane dipping towards the highway. No other design or construction documentation was reviewed. During the October 2005 site inspection it was noted that these stabilization measures are located a considerable distance from the highway. It is judged that even if they were not in place the rockfall hazard to the highway from this portion of the rock slope would be relatively low to negligible. It was not possible to safely access the concrete blocks to inspect their condition.

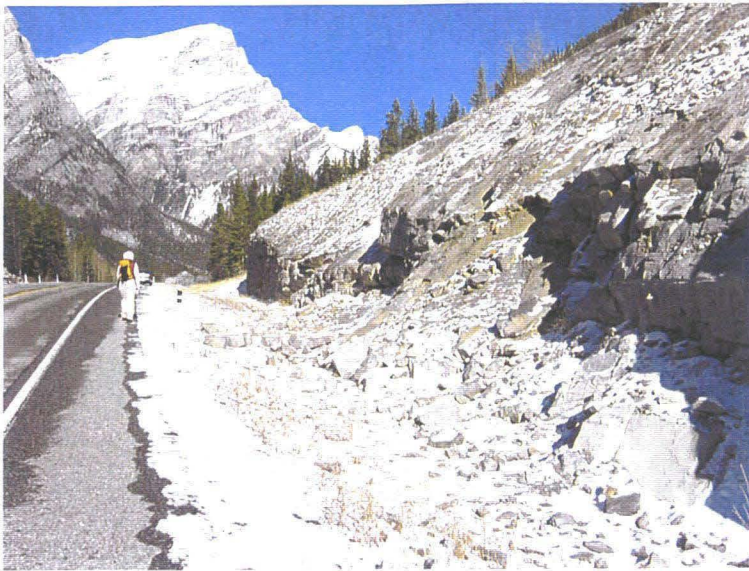


Photo 1 (top) – Facing north along Highway 40 at the Limestone Mountain Cut Slope site. The area in the foreground illustrates how the bedding of the rock dips down towards the highway in this area and in some areas boulder-sized rocks break off and slide down the bedding plane. The debris is contained within the existing ditch.



Photo 2 (bottom) – Facing south along Highway 40 at the Limestone Mountain Cut Slope site. Some segments of the cut slope at this site experience rockfall originating from the steep soil/rock slope above the crest of the near-vertical, lower cut slope. As shown in this photo, the rockfall debris is contained within the existing ditch.

This segment of the cut slope is adjacent to the area shown in Photo 1.



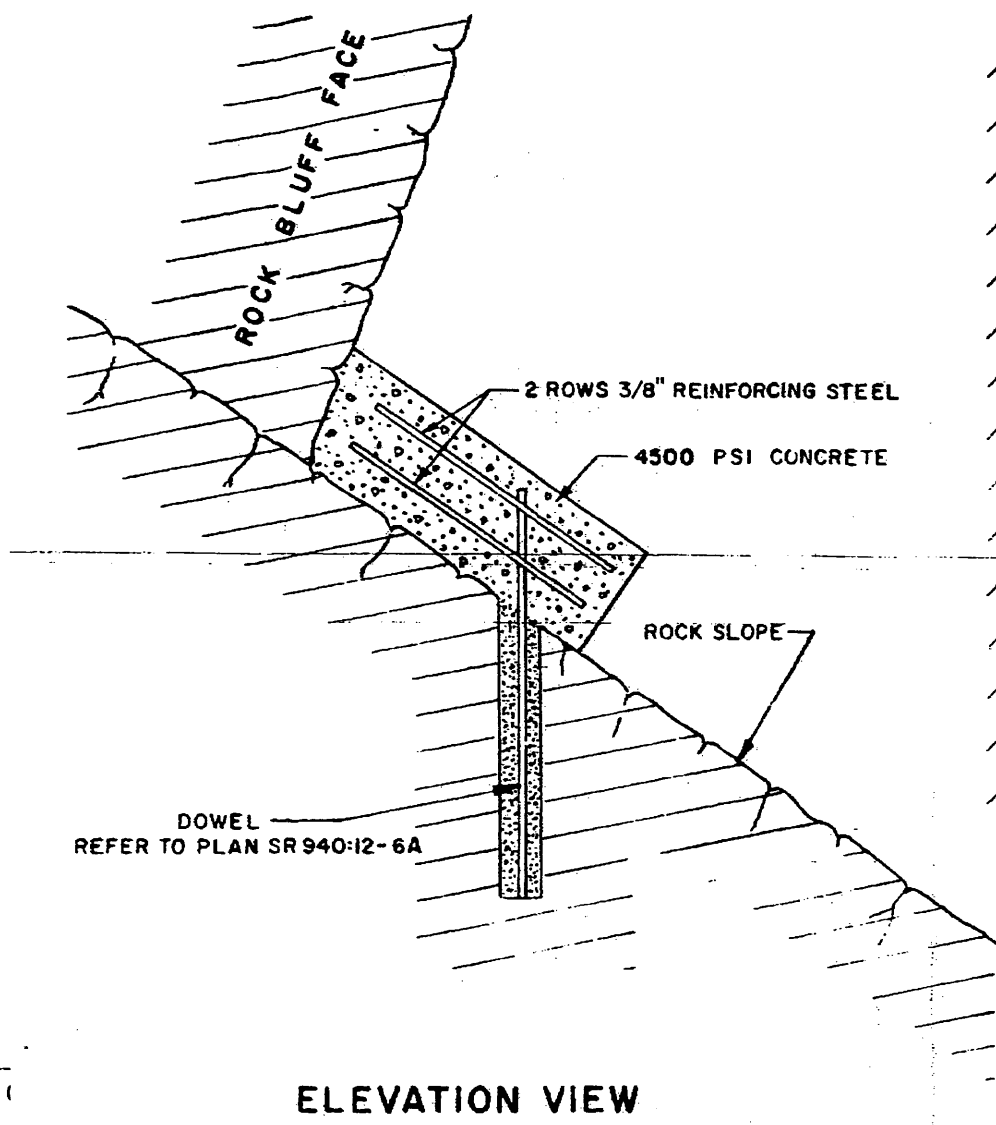
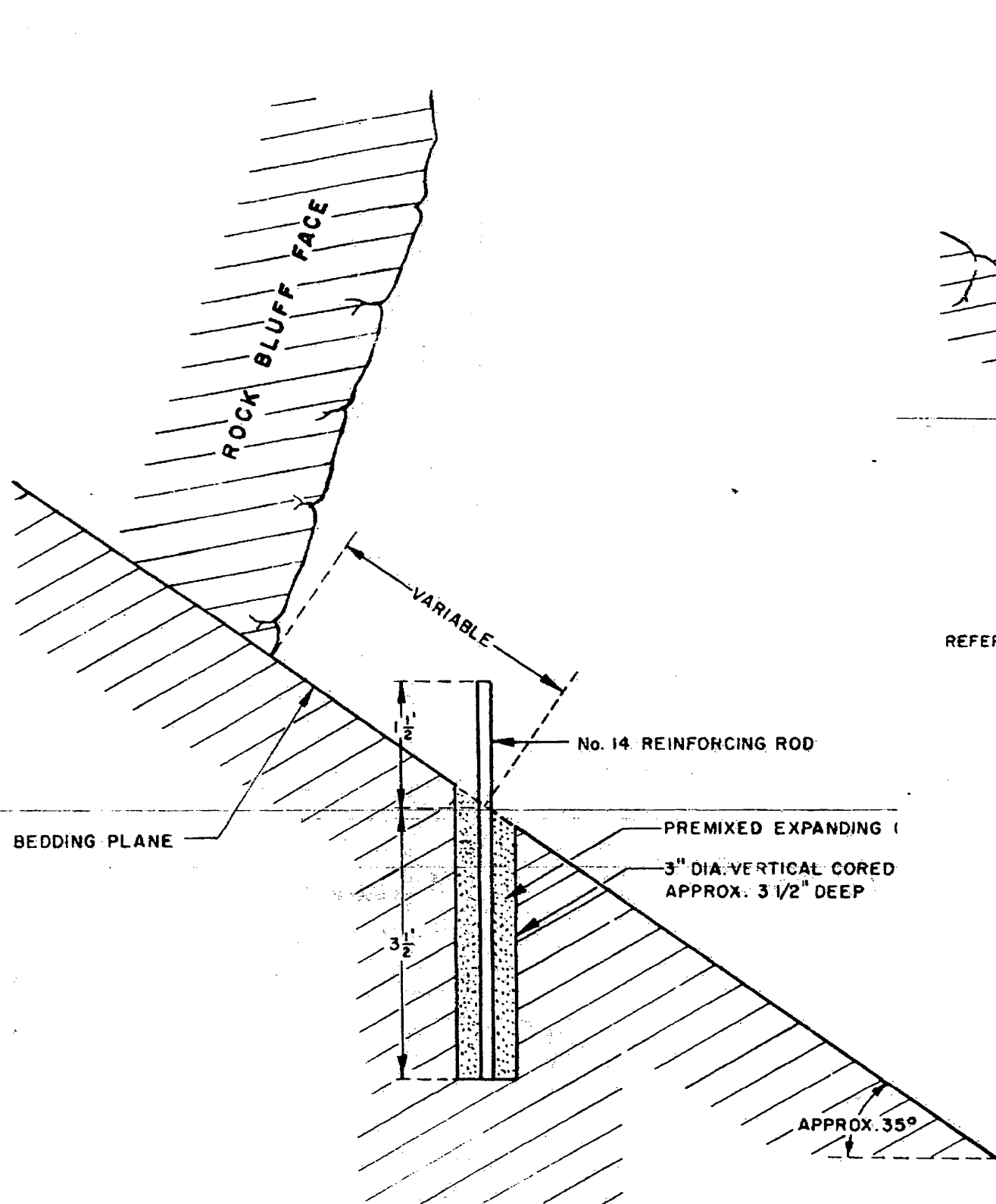
Photo 3 (top) – Colluvium slope above Highway 40 and adjacent to the south end of the cut slope shown in Photos 1 and 2. The vertical height of this colluvium slope is approximately 15 m and it is inclined at approximately 35°. Most of the trees growing out of the colluvium slope have curved trunks which indicates that there is ongoing creep movement of the colluvium down towards the highway. The rock slope above the colluvium slope is at approximately 45°. There is a hazard of rockfall from the bedrock slope rolling down the colluvium and into the ditch. The width of the ditch is typically around 14 m and it was clear of debris at the time of the field inspection.

The rock slope with the concrete buttress blocks shown in Photo 4 is just off the upper left edge of this photo.

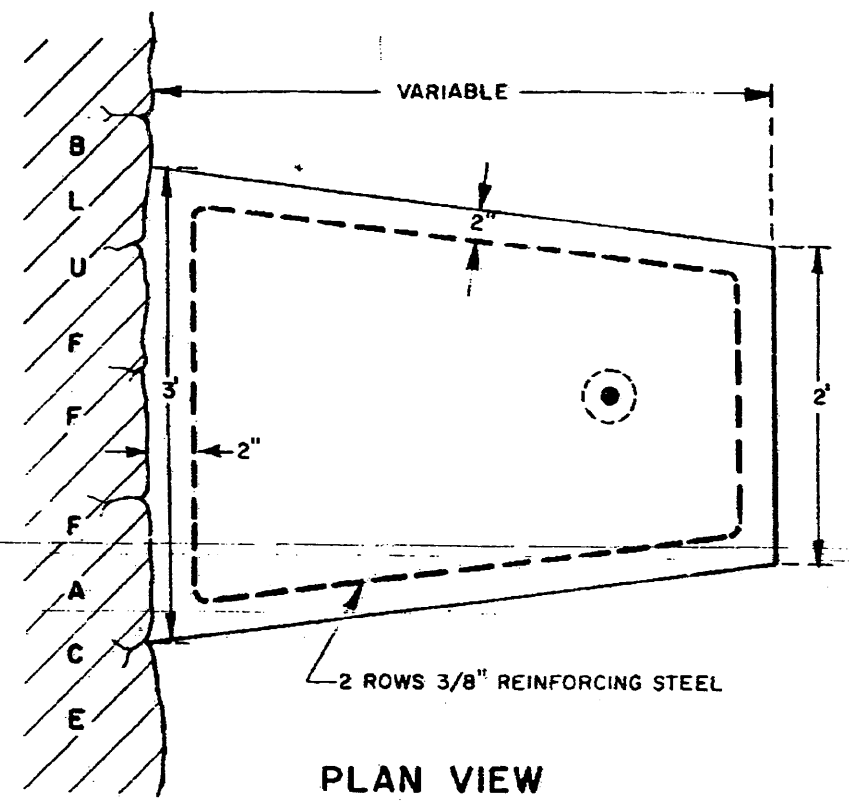


Photo 4 (bottom) – Concrete buttress blocks installed along a bedding dip slope above Highway 40. (Locations of blocks marked with white arrows.) Note the person in the lower right hand corner of the photo for scale. Please also see Figure D2 for an illustration of how the buttress blocks were constructed.

These blocks were installed approximately 30 m above Highway 40 in order to stabilize potential rock detachment and sliding along the bedding plane. Given the offset from the highway, it is judged that even without these buttress blocks in place the hazard to the highway from this slope would be very low.



ELEVATION VIEW



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| | | PROJECT: HWY 40/HWY 541 GEOHAZARDS REVIEW | | | |
| CLIENT: Alberta INFRASTRUCTURE AND TRANSPORTATION | | TITLE: LIMESTONE MOUNTAIN CUT SLOPE CONCRETE BUTTRESS BLOCK DRAWINGS (JANUARY 1974) FROM AIT FILES | | | |
| DATE: | JOB No.: | CAD FILE: | FIGURE No.: | REV. | |
| DECEMBER 2005 | CG25211 | 25211N01.dwg | FIGURE E2 | A | |