Ministry of Transportation

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Ontario

Memorandum Report

Date: November 8, 2011

Subject: Short-Term Remedial Measures for Embankment Instabilities
600m North of Innisfil Beach Road/ Hwy 400
W.O. 2011-11021
GEOCRES No. 31D-523

MERO Pavements and Foundations Section was requested by Central Region (CR) Geotechnical Section on October 31, 2011 to provide recommendations for the embankment instabilities that recently occurred at the southbound embankment of Highway (Hwy) 400, approximately 600m north of Innisfil Beach Road.

CR Geotechnical Section indicated that there are three separate slope instabilities areas along the southbound embankment, facing the Georgian Downs Race Track (See Figure 1) and that this condition was noticed and informed by personnel from Georgian Downs in mid-October 2011 after consecutive rainy days.

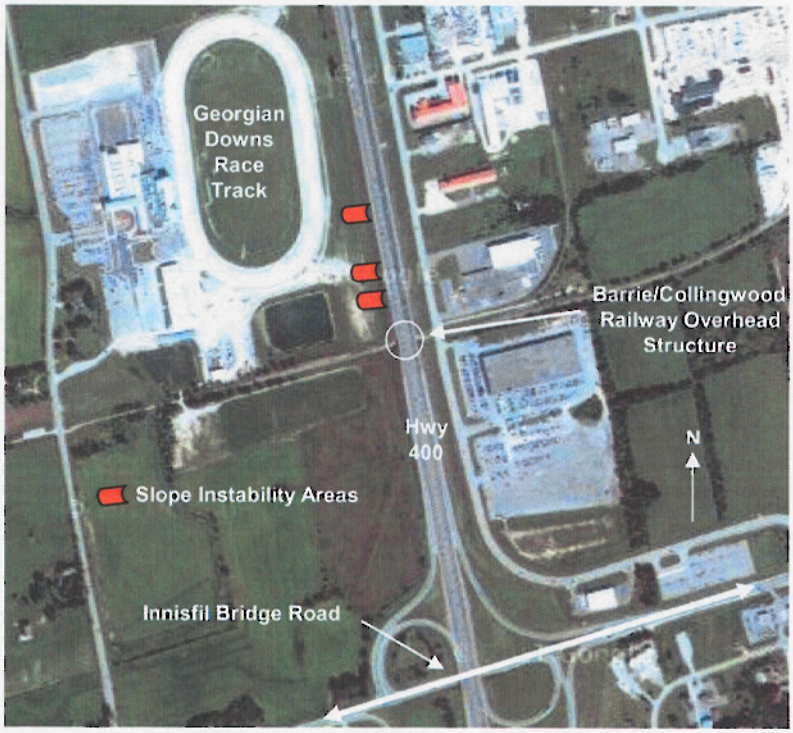


Figure 1: Location of Slope Instability Areas

Per the CR request, Senior Foundations Engineer Dave Dundas and Project Foundations Engineer Fiona Leung visited the site with Pavement Design Evaluation Officers Ken Payette and Kelvin Fong from CR Geotechnical Sections and CR Maintenance Co-ordinator Graham Robertson on November 2, 2011.

The slope instabilities embankment sections of Hwy 400 are in fill approximately 15m high with a slope that appears to be somewhat steeper than the standard 2H:1V and is estimated to be in an order of 1.2H:1V. The slope side and bottom of the embankment are covered by vegetation except where the slip failures have occurred. A catch basin and curb and gutter are located about 40m north of the north abutment of the Barrie/Collingwood Railway overhead structure (railway overhead structure). The catch basin is connected to a drainage pipe along the slope surface that outlets at the toe of the slope. However, no curb and gutter is installed north of the catch basin where the slope instabilities have occurred. Therefore, surface runoff is expected to flow over the side embankment and then to the bottom of the slope. A positive draining outlet path is not visible at the bottom of the slope. The highway shoulder behind the steel-beam guide rails (SBGR) has been treated with asphalt. From discussions with CR personnel, SBGR and asphalt behind the SBGR are newly installed along this section and appear to have been placed when SBGR were constructed, probably in the summer of 2011.

The three slope instability areas are located along the Hwy 400 southbound lanes, approximately 75m, 110m, and 175m north of the north abutment of the railway overhead structure, respectively. A 15m long asphalt pavement crack, located 145m north of the abutment, was also observed behind the SBGR. The spacing between slope instability areas and cracks is about 35m. Figure 2 illustrates features of the slope instability areas. The widths of these instability areas are about 16m, 8m, and 12m, respectively. The start of the slides varies from 0.3m to 0.5m behind the SBGR, which is also the edge of the asphalt shoulder treatment. The top 200mm thickness (approximately) of the slope material (including vegetation and topsoil) has slid to the bottom of the slope leaving exposed earth fill material. The features of the instabilities are typified by a deep scarp at the top of the slope and a mass of sloughing and debris at the bottom of the slope.

Figure 2: Pictures of the Slope Instability Areas

During the site visit, it was observed that a few slope failures apparently occurred and were re-established at the parallel section of northbound of Hwy 400. Cracks on the asphalt shoulder treatment behind the SBGR also were observed throughout this section of highway. A catch basin located about 40m north of north railway overhead structure abutment and was drained

through a pipe outletting onto the slope approximately 1.5m below the top of the slope. There are signs of erosion at the outlet that have been re-established with vegetation.

Based on the site observations and information received from CR, the instabilities are surficial failures of the embankment slopes, as opposed to deep-seated failures through the natural subsoil below the base of the embankment. These failures were triggered by the loss of soil strength due to the slope material being saturated with water from the consecutive rainfall in mid October 2011.

Since there were no reports of slope instabilities at this site prior to the newly installed SBGR, and since the before and after installation photos confirm the timing of instabilities, it is concluded that the installation of SBGR and asphalt shoulder treatment contributed to the surficial instabilities probably by accelerating the surface runoff. Figure 3 illustrates that vegetation was in place behind the guide rail before construction of the SBGR and the asphalt shoulder treatment. This vegetation would have provided a permeable surface for the surface runoff to slow down and be absorbed along the vegetated slope. However, the asphalt shoulder treatment behind the newly installed SBGR created an impermeable surface condition that may have increased the surface runoff volume and velocity to the slope and caused instability and erosion of the slope.

Figure 3: Before and After Steel Beam Guide Rail and Asphalt Shoulder Treatment Installation

Despite this, there is no immediate danger to the embankment. However, material will continue to be eroded by surface runoff, especially during the spring-thaw season, which could undermine the SBGR. In order to stabilize the instabilities and prevent further movement, these short-term remedial measures focus on reducing the amount of water flowing in an uncontrolled manner over the slope by improving drainage as specified. The following are our recommendations for short-term remedial measures, which will have to be re-evaluated after the 2012 spring thaw before deciding on the strategy for long-term remedial measures:

<u>For short-term (until Spring-Thaw 2012)</u>

- See Figure 4 for illustration.
- Remove slope instability debris at the bottom of the slope.
- Construct a ditch at the centre of each identified instability slope area and sump area as described. The depth of the ditch shall be 500 mm deep from the existing exposed grade and a minimum of 1m wide.
- Fill the entire ditch (to form an armoured drainage channel) and the rest of the instability area with Rip-Rap R-10 grading aggregates. No additional excavation is required outside the ditch for the armoured drainage channel. The minimum thickness of the Rip-Rap R-10 grading aggregate fill shall be 300mm. The armoured drainage channel

should outlet into a 0.5m deep 2m x 2m area sump at the toe of the slope, centred on the armoured drainage channel. The sump shall be filled with Rip-Rap R-10 grading aggregates. All Rip-Rap R-10 grading aggregates shall be placed using rock protection construction method from the bottom up (i.e. machine place and random manner and without geotextile separator). Refer to the following Ontario Provincial Standard Specifications for construction method and material selection:

  - OPSS 511: Construction Specification for Rip Rap, Rock Protection and Gravel Sheeting
  - OPSS 1004: Material Specification for Aggregates - Miscellaneous

- Construct an approximately 100mm high asphalt curb and with opening to direct surface runoff to the armoured drainage channels along the slope. The preferred location for the asphalt curb is immediately in front of the SBGR.
- Seal the pavement cracks behind the SBGR to prevent water seepage and movement.

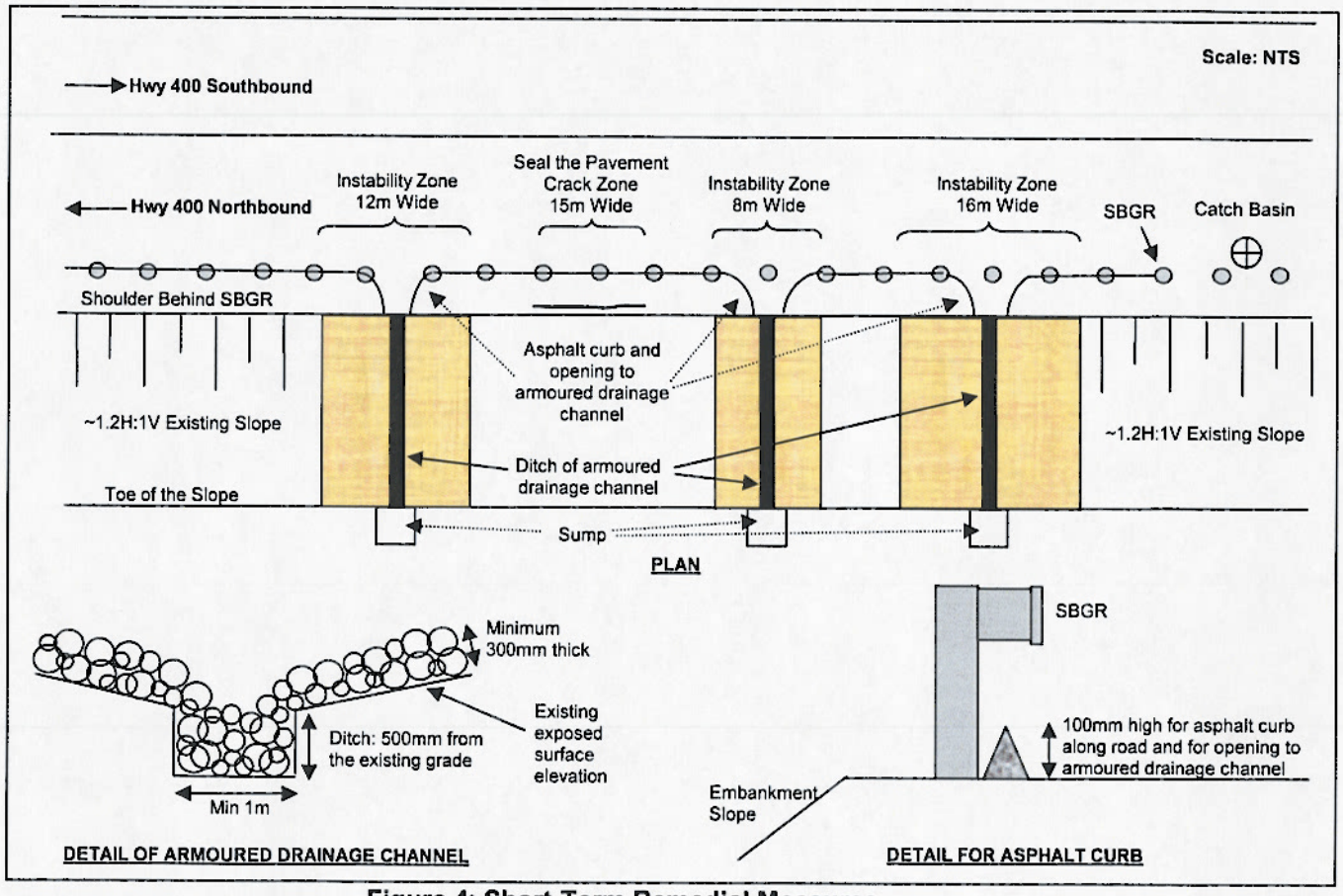


Figure 4: Short-Term Remedial Measures

For long-term (after Spring-Thaw 2012)

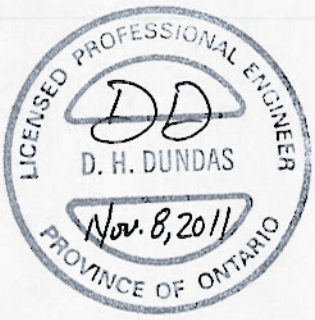
- Revisiting the site after spring-thaw 2012 is recommended to re-evaluate the performance of the short-term fix and the slope stability conditions for both northbound and southbound lanes. CR should contact MERO Pavements and Foundations Section in spring to arrange this site visit.
- A detail investigation and design may be required for long-term remedial measures and drainage control such as re-establishing the slope with vegetation or installing a positive outlet to a stream or a sewer for the ditch at the bottom of the slope.

If you have any questions on this memorandum report for the W.O. 2011-11021 Short-Term Remedial Measures for the Embankment Instabilities at 600m North of Innisfil Beach Road/ Hwy 400 dated November 8, 2011, please do not hesitate to contact us.

Written by

Fiona Leung, P. Eng.
Project Foundations Engineer

Reviewed by



Dave Dundas, P. Eng.
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