Memorandum Report

Date: April 18, 2012

Subject: Assessment and Recommendations for Remedial Measures for Side-Slope Erosion
Hwy 427 SB
North of Goreway Dr. and South of Club House Rd
Toronto

W.O. 2012-11017
GEOCRES No. 30M12-340

MERO Pavements and Foundations Section was requested by Central Region (CR) to assess the above-noted site and to provide recommendations for the embankment erosion.

The following Google Map satellite image (Figure 1) illustrates the location of the site.

Figure 1: Location of Slope Instability Area

Inspection

Dave Dundas (Senior Foundations Engineer), Danny Tari (Foundations Technician) and Diana Gomez Rodriguez (engineering student) visited the site on April 12, 2012.

Observations

The following observations were also made during the site visit.

The Hwy 427 southbound embankment slope is about 1H:1V and the embankment height is about 10m. Three problem areas were identified, located at 38m, from 77m to

110m and at 138m south from the HWY 427 bridge abutment wall, respectively. There are no erosion features south of the Problem Area Number 3 – that is,110m south from the abutment bridge beyond which the slope of the embankment changes to 2H:1V and is stable. The highway drainage runs along the concrete barrier at the west side road shoulder. The barrier/road interface is water tight and the water is drained through a catch basin located 110m south of the bridge abutment wall then through a 300mm diameter pipe onto the slope.

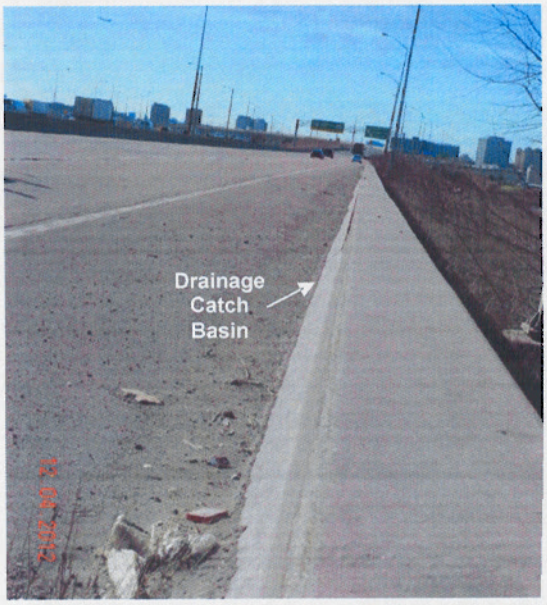

Figure 2: Drainage of HWY 427 Southbound. Left, road shoulder with watertight barrier, top, drainage catch basin

Problem Area Number 1:

- Located at 38m south of the bridge abutment wall, and 5m from the road shoulder
- The affected area has a triangular shape with the base at the top being two meters (2m) wide and extending five meters (5m) down the side of the slope.
- It is 1m deep which is difficult to observe in Figure 4 due to the geotextile covering the side of the slope. However, Figure 3 shows the undermining and biaxial geogrid which is exposed at this site.
- There is no catch basin or drainage from the road although there is runoff over the crest of the slope.

Figure 3: Close up of Slope Erosion Problem Area Number 1. Left, surface erosion; top, undermining and biaxial geogrid

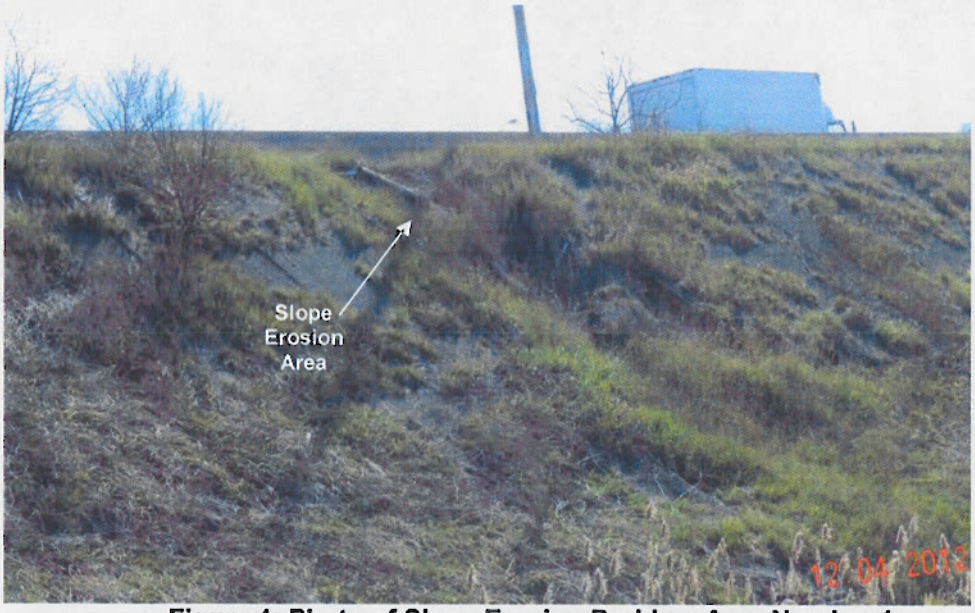

Figure 4: Photo of Slope Erosion Problem Area Number 1

Problem Area Number 2:

- Located from 77m to 110m south of the bridge abutment wall, and 5m from the road shoulder.
- The affected area has a rectangular shape with dimensions 3.5m down the side of the slope and 33m along the slope and with a depth of up to 1m.
- Geotextile is covering the side of the slope on the northern part (from 77m to 86m). However, from 86m to 110m south of the bridge abutment, the geotextile and the soil is being eroded away. Biaxial geogrid that has been installed at 1m lifts into the soil is visible at this part of the site and is evidence of similar reinforcement throughout the 1H:1V slope.
- No catch basin or drainage from the road is visible.

Figure 5: Photo of Slope Erosion Problem Area Number 2

Figure 6: Close up of Slope Erosion Problem Area Number 2. Left, northern portion, 77m-86m south of the bridge; right, southern portion, 86m-110m south of bridge.

Problem Area Number 3:

- Located at 138m south of the bridge abutment wall, and 8m from the road shoulder. The drainage catch basin is located at this point on the shoulder of the highway.
- The embankment, at this location is severely eroded. The distressed area is about 5m wide and up to about 3m deep. It also extends near the base of the slope.
- A 300mm diameter PVC pipe is visible. This pipe carries the drainage from the road to the embankment. The material around the pipe has been eroded away.
- The geotextile is has been washed away and the soil is also being eroded away. Reinforced biaxial geogrid is visible at 1m intervals but only around the affected area.

Figure 7: Material washed away around PVC pipe at the Problem Area Number 3

Figure 8: Photo of Slope Erosion Problem Area Number 3

Assessment and Recommendations for Redial Measures

Based on the site inspection, there are 2 categories of instabilities at this site. Problem Areas Number 1 and 2 are caused by uncontrolled drainage from the crest of the embankment (but not from highway drainage) onto the steep slope. Problem Area Number 3 is caused by undercutting of the embankment by uncontrolled outfall from the drainage pipe.

The erosion across the entire 1H:1V slope area is caused by uncontrolled drainage from the crest of the embankment. It is worsened by the steep 1H: 1V slope. As a result, there has been undermining of the embankment material under the geotextile and, in some areas, this surface geotextile has also been washed away and even the biaxial geogrid is showing.

For Problem Areas Number 1 and 2, the washout water is only the collected water from infiltration on the slope and is not coming from the highway. Therefore the erosion is not as severe as at Problem Areas Number 3.

At Problem Areas Number 3, there is a much higher quantity of drainage water that flows through over the area, being all the drainage from the highway which drains into the catch basin at the shoulder of the highway and then to the embankment through the

drain pipe that outlets onto the slope. At this site, the material from around the culvert has been eroded exposing an unsupported 2m length of the drain pipe at its outlet. If left alone, more material will be eroded away, which could ultimately increase the risk to the safety of the highway.

Problem Areas Number 1 and 2

The fix could involve one of the following options for problem site 1 and 2.

Reconstruction of the slope
As noted before, the steep slope is the major problem and a major cause of the erosion at these sites. It would be ideal to reconstruct the embankment with a slope of 2H:1V. However, a fence is visible at the end of the slope which indicates that MTO's right of way only extends up to the fence. Therefore, the slope of the affected area can probably not be constructed at a more stable 2H:1V geometry.

If reconstruction is carried out, it would probably have to be with the existing slope of 1H:1V. This would be expensive as it would require extensive reconstruction of the soil reinforcing.

Control of drainage
Drainage from the crest of the slope of the top of the embankment could be controlled to minimized future erosion of the slope. In order to prevent the water from running freely down the slope a curb would have to be built that will channel the water collected at the top of the slope and then release the water in an armoured outlet – probably at the existing Hwy 427 drain outlet at Problem Area Number 3.

Control erosion with vegetation
The embankment shows patches of grass growing on the side of the slope. However, growing long rooted plants would be beneficial to hold the soil in place. As it would be expensive to re-establish the existing geogrid slope to original condition, less expensive measures could be considered including judicious application or top soil and seeding crown vetch or legume (both of which tend to have long roots) along the crest of the slope so that the vegetation would eventually spread on the side of the slope.

- Crown vetch has been widely used in slope instability problem areas. It needs no maintenance and it is strongly rhizomatous. However, it takes from 2 to 5 years to become stable. They self propagate, which may permit initial seeding only along the top of the embankment.
- Legumes are also long rooted plants that might be considered.

Problem Area Number 3

This area has to be fixed and the following remedial measures are recommended:

Reconstruction of the problem area

- See Figure 9 for illustration.
- Remove slope instability debris at the bottom of the slope. The area should be trimmed to straiten out the edges for aesthetic reasons.

- Fill the entire affected area with Rip-Rap R-10 grading aggregates. The minimum thickness of the Rip-Rap R-10 grading aggregate fill shall be 300mm. 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
- The drainage pipe should be reinstalled as required connecting the catch basin with the sump. It will be discharging to armoured drainage channel specified above or onto the rock fill on the slope.

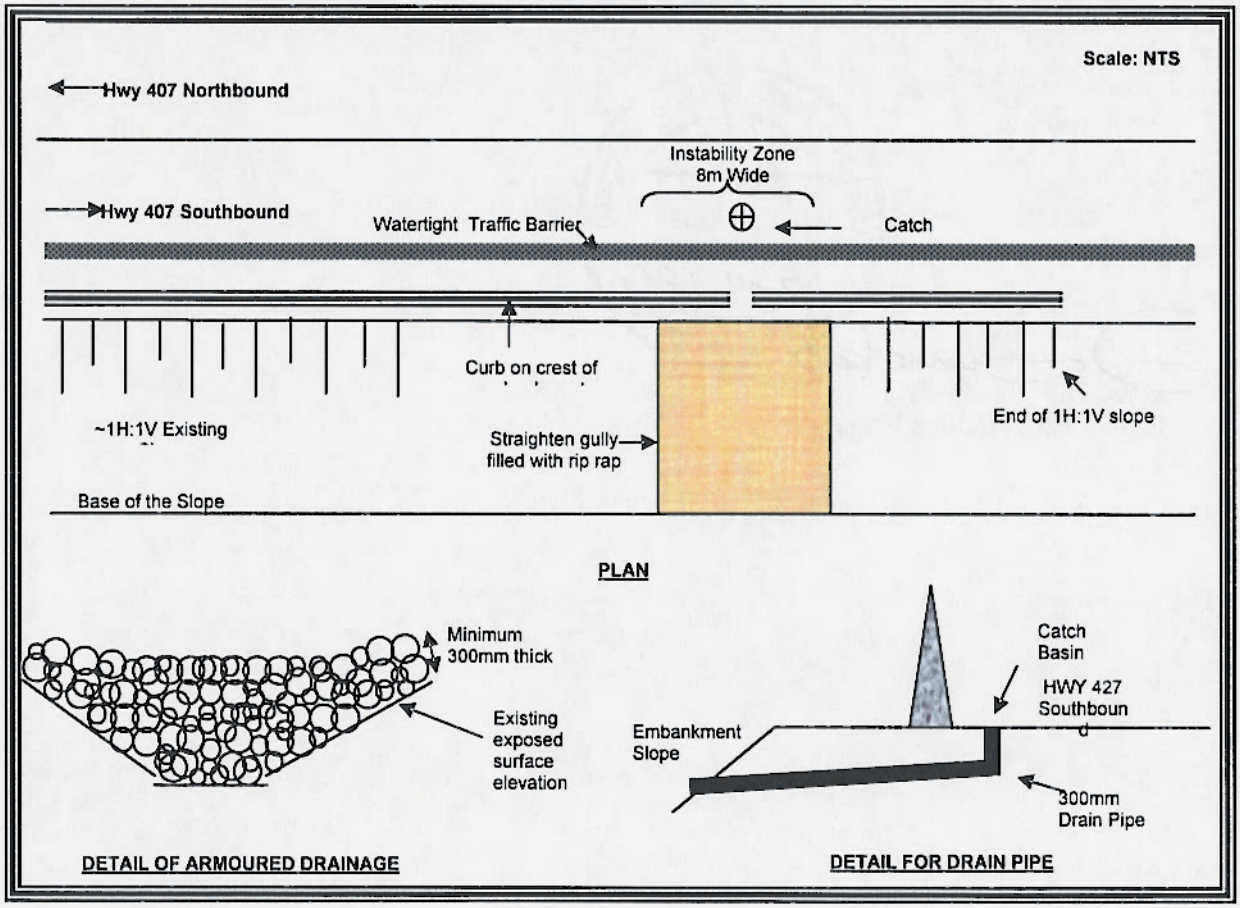

Figure 9: Remedial Measures for Problem Area Number 3

Written by

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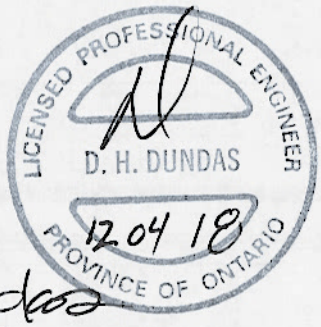
Reviewed by



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