Alberta Government

CENTRAL REGION
GEOHAZARD RISK ASSESSMENT
SITE INSPECTION FORM

Klohn Crippen Berger

SITE NUMBER AND NAME	HIGHWAY & KM	PREVIOUS INSPECTION DATE	INSPECTION DATE
C48 H575:04 Road Settlement	km 9	June 14, 2012	**May 16, 2013**

LEGAL DESCRIPTION	NAD 83 COORDINATES	RISK ASSESMENT
11-29-23-W4	N 5704031 E 351107	PF: 9 CF: 4 TOTAL: **36**

SUMMARY OF SITE INSTRUMENTATION:	INSPECTED BY:
None LAST READING DATE:	PROFESSIONAL ENGINEER OF ALBERTA DARREN W. RATCLIFFE

PRIMARY SITE ISSUE: Shallow slide in highway embankment fill resulting in settlement of pavement.

APPROXIMATE DIMENSIONS: main slump about 15 m long, total distressed area about 60 m long

DATE OF ANY REMEDIAL ACTION: 52 (4 rows) launched soil nails installed in July 2010

ITEM	CONDITION EXISTS		DESCRIPTION AND LOCATION	NOTICABLE CHANGE FROM LAST INSPECTION	
	YES	NO		YES	NO
Pavement Distress	X		A semi-circular crack extends into the eastbound lane. On-going slope movement and settlement necessitates continual patching and realignment of guardrail.	X	
Slope Movement	X		Shallow slope movement, as confirmed by the inclinometer installed in 2011, is on-going.	X	
Erosion		X			
Seepage		X			
Culvert Distress		X			

COMMENTS & RECOMMENDATIONS

Refer to attached photos and report for details.

Continue to monitor and patch pavement as required. A driven H-pile wall appears the best solution for this slide.

Klohn Crippen Berger

June 12, 2013

Alberta Transportation
Central Region
#401, 4902 – 51 Street
Red Deer, Alberta
T4N 6K8

Mr. Dennis Grace, P.Eng.
Construction Engineer

Dear Mr. Grace:

Central Region GeoHazard Assessment
Site C48B H575:04 Pavement Settlement
May 2013 Inspection Report

This site inspection report was prepared by Klohn Crippen Berger Ltd. (KCB) for Alberta Transportation Central Region under our Consulting Services Contract CON0013499. The site assessment was undertaken by Mr. Darren Ratcliffe, P.Eng. of KCB on May 16, 2013. A selection of photographs illustrating the site conditions are attached for reference.

1 PROJECT BACKGROUND

This site is located on Highway 575:04 at about km 7, approximately 7 km east of Highway 836:02. The highway is located on a relatively high fill, estimated to be at least 30 m to 40 m high. The site was originally noted during the June 2008 site tour; however, this area has been an issue for at least 15 years. The site consists of a distressed area of pavement in the south lane that is settling and has been patched numerous times. In 2008, the distressed area covered a length of about 10 m along the south edge of the road and extended from the shoulder to about 2 m into the eastbound driving lane. A deflection of the guardrail was also observed.

Due to the cost of continual patching of this site, it was recommended in 2009 that the slope below the highway be reinforced with launched soil nails. A total of 52 launched soil nails were installed over a 13 m long section of the slope immediately below the eastbound lane in July 2010. Nails were installed in 4 rows on a 1 m by 1 m grid pattern with an average penetration of about 6.0 m.

In May 2011, only minor settlement of the distressed area was observed. However, during the summer of 2011, the settlement increased and a crack appeared along the south edge of the highway over a length of about 60 m. It is understood that excavation and replacement with compacted gravel was attempted during the summer of 2011, but it had no effect on reducing the settlement rate.

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In November 2011, a site investigation program was conducted by KCB. Two drill holes were advanced in the shoulder of the road in the central portion of the main slump. A 20 m deep slope inclinometer and a 13 m deep standpipe piezometer were installed.

The investigation indicated that the road structure typically consists of about 0.5 m of asphalt over a 0.3 m thick gravel base course. Hard clay till was encountered at a depth of about 13 m below the road surface. Above the clay till, two layers were apparent: high plasticity clay fill from 0.8 m to 7.9 m (with slickensides at about 5 m below the road) overlying high plasticity clay, either fill or weathered till, with slickensides and bentonitic layers from 7.9 m to 13.1 m. In general, the subsurface materials were firm to stiff to a depth of about 13 m below the road surface, and hard below 13 m. Moisture contents of the high plasticity clay were about 40%, with liquid and plastic limits of about 90% and 30% respectively. The observed groundwater level was about 5.5 m below the road surface.

Inclinometer readings indicated that movement is occurring at a depth of about 3 m below the road surface. Initial readings in the winter of 2011/2012 indicated a relatively slow movement rate of about 2 mm per month. However, in the summer of 2012, the movement rate significantly increased to about 24 mm per month. The instruments are now lost due to highway patching.

Movement continued in 2012 requiring repeated patching and the resetting of the guardrail to the correct height. Timber sections were provided along the edge to support the asphalt patch.

2 SITE OBSERVATIONS

The following observations were noted for the site in May 2013:

- Settlement of the approx. 15 m long zone has continued with a semi-circular crack pattern extending into the road. Displacement of the reset guardrail to the south is also apparent.
- The slope below the highway is slightly undulating possibly indicating some surficial movement. An area of vegetation is also located in the slide area indicating a source of groundwater may be present at this site.

3 INTERPRETATION

The site observations indicate that the downslope movements continue at this site and are worse in wet years. The movement appears to be contained to the upper portion of the slope below the highway (less than 3 m depth). However, the fact that movement rates are increasing indicates that some form of repair will likely be required to mitigate movements and reduce the required patching frequency. The elevated water table may also be contributing to the movement observed; however, the water table is likely below the zone of movement at highway level.

Based on the risk level criteria provided by Alberta Transportation relating to safety, a risk rating of 36 was assigned to this site. This is based on a probability factor of 9 for an active slide with relatively high rate of movement, and a consequence factor of 4 due to the potential partial closure of the road.

4 RECOMMENDATIONS

Patching should be continued as required to reduce the hazard to traffic. To reduce the patching frequency, the following methods could be adopted:

1. Driven H-pile wall

H-piles driven side by side at a spacing of about 0.75 m will effectively create a wall on the south side of the highway. This approach was used at the NC33 H759:02 site using 12 m long HP310 x 110 piles in March 2013. The NC33 pile wall was installed at a horizontal distance of about 7 m from the south shoulder of the road and was about 70 m in length. It is considered that a similar remedial solution can be adopted for this site but shortening the piles to 9 m long (3 times the slide depth) and installing at a distance of about 2 m from the guardrail. This results in a line of 80 piles over the 60 m length of the slide area. Cost estimates were obtained from Red Deer Piling (attached for reference) and indicated supply and installation costs of about $207,000 for 9 m long piles and $237,000 for 12 m long piles. It is recommended that the piles be installed with a 0.3 m stickup so that the top deflections of the piles may be monitored by visual or survey methods.

- Pros: quick fix, no need to excavate highway, single lane closure during piling with the road open at night.
- Cons: further road patching will be required as piles pick up load of slide.

2. Grouted Nails

To overcome the bonding issues encountered with the launched soil nails previously installed, drilled and grouted nails could be adopted, which has now essentially replaced the launched soil nail for most applications. The proposed repair was provided in 2012 by Morsky Hyspeed Soil Nailing Ltd. (Morsky) of Saskatchewan who performed the original repair work at the site. The design includes 3 rows of approximately 46 self-drilling nails (10 m long) on 1.3 m centres horizontally and 1.0 m centres vertically, leaving the nail ends protruding from the soil. The drilling equipment is mounted on a track-hoe allowing the work to be accomplished from the south lane of the highway as part of a day-time single lane closure. The nailed area would then be covered with galvanized wire mesh secured to the protruding nail tips with 200 mm x 200 mm steel plates. The work can be completed without removing the guardrail or relocating the Telus lines adjacent to the existing fenceline. In 2012, the Morsky estimate was $176,000 for 138 grouted soil nails over the 60 m slide length.

- Pros: no need to excavate highway, single lane closure during nailing with the road open at night.
- Cons: further road patching will be required as nails pick up load of slide, launched soil nails were not successful at this site and it is uncertain how well the grouted nails will perform.

3. Deep Excavation

The slide is located at a depth of about 3 m below road and it is feasible to excavate the high plasticity clay fill and replace with compacted reinforced gravel fill to attempt to strengthen the upper portion of the slide area. The estimated costs for this approach range from about $150,000 for a single lane excavation to about $300,000 for full highway excavation over the 60 m long length.

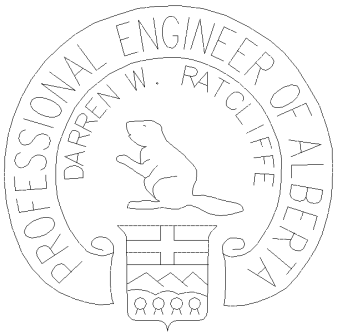
- Pros: vertical alignment of highway can be corrected, excavate below failure plane.
- Cons: lowest probability of success, deep excavation safety issues, road closed (full/partial), slide will continue on slope below replacement zone.

For this site, it is considered that the driven pile wall provides the lowest risk approach to reduce the slide movements at a cost similar to other repair methods. To reduce costs further, it is possible to install the piles only over the 15 m long critical section (say 20 piles) to assess the effectiveness of the approach. The estimated cost for this would be about $60,000.

Please contact the undersigned if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.



Darren W. Ratcliffe, P.Eng.
Project Manager

APEGA Permit to Practice No. 9196