1 February 2019

Alasdair Webb  
Quarry Manager  
Holcim Australia Pty Limited  
Sheraton Road  
Dubbo NSW 2830

Dear Alasdair

Dubbo Quarry - Stability Assessment - Pit Face

A senior geotechnical engineer from GHD has undertaken a site inspection at the above location on Tuesday 15 January 2019. We have subsequently prepared a report that discusses our understanding of the site conditions, presents observations made during the site inspection, and provides geotechnical advice. We have also conducted slope stability analyses for a critical section through the pit face and muck pile.

1 Project understanding

Dubbo Quarry is primarily a basalt quarry located to the south-west of Dubbo, NSW. According to the 1999 Dubbo 1:100,000 Geological Map (Sheet 8632) 1st Edition, the quarry is located within a Tertiary alkali basalt (Tb), and adjacent to Jurassic Purlawaugh Formation lithic quartz sandstone (Ju), both overlain by Quaternary alluvial sediments. It is interpreted that the basalt deposition is due to lava flow into an existing river channel. This basalt appears to be composed of two stages, a vuggy and sometimes ropy, altered basalt, and a more competent, fine-grained basalt that is the main ore targeted by the quarry. The altered basalt is directly adjacent to the lithic sandstone, and a chilled margin may be observed at the contact. A sketch of the rock mass in section is presented in Appendix A.

The current eastern high wall of the quarry has been developed over two benches. The first bench was approximately 8 to 12 m in height and was blasted and mined in two production shots; first the northern half and then the southern half. The second bench (approximately 8 m in height) was then blasted with a 3 to 5 m wide berm. This second bench was blasted in a single production shot and mining began at the southern end. This second bench is expected to be the final cut along this eastern high wall.

Around the end of October, cracks were noted by the pit supervisor as forming behind the crest of the eastern high wall. These cracks were not noted during the blasting or mining of the first bench, nor the blasting of the second bench. It was surmised that these cracks were potentially due to a large-scale circular or planar failure of the upper part of the high wall. In response, the Quarry Manager installed a prism monitoring regime adjacent to the line of cracking. Mining of the blasted material was also restricted to the southern end of the shot, away from the area directly beneath the cracks. GHD were then engaged to provide geotechnical advice regarding the potential failure of the eastern high wall.
2 Site Observations

A senior geotechnical engineer from GHD attended Dubbo Quarry on 15/01/2019, accompanied by the Holcim Quarry Manager. Photographs taken during the site inspection are provided in Appendix B. During the site inspection, the cracks behind the crest of the east wall were observed. Observations made include (note chainage refers to the chainage of the prism monitoring set-up):

- At approx. chainage 100 m, cracking was observed to be up to 20 mm wide and up to 300 mm deep. Wash out of the edge of the crack was observed, due to recent rainfall. Cracking extended into a nearby windrow.
- At approx. chainage 150 m, cracking was observed to be up to 30 mm wide and up to 600 mm deep.
- At approx. chainage 168 m, cracking was observed to be up to 15 mm wide and up to 50 mm deep.
- At approx. chainage 50 to 75 m, cracking appeared to be finer. This is corroborated by prism monitoring which shows relatively minimal movement in these prisms.

The cracks were generally observed to be between 5 to 18 m behind the crest of the east wall, and were generally sub-parallel to the crest. This is consistent with over break due to blasting.

When observed from the floor, the eastern high wall is generally composed of the altered basalt with some lenses of competent basalt still upon the face. In the area where cracking has been observed to have moved furthest to the west and downwards, the face is almost entirely composed of altered basalt. This altered basalt is generally orthogonally jointed, with some persistent defects being noted within the face, generally dipping at 30 to 40° to the west. A potential shear plane was also noted near the crest, against apparently dipping out of the face. Joint planes were observed to be stained to clean, smooth to rough, planar and tight.

Groundwater was not observed within the face at the time of the inspection. The standing groundwater level appears to be roughly the level of the water ponding in the goodbye cut at the base of the quarry, at approximately 277 mRL.

After the site visit by GHD, two slit trenches were excavated under the supervision of the Holcim Quarry Manager. The slit trenches were logged on site by the Holcim representative and photos of the slit trenches reviewed by GHD in discussion with the Holcim Quarry Manager. In general, the cracking appeared to be located within the vicinity of the contact between altered basalt and completely weathered sandstone to residual sandy clay. However, the cracking was also determined to be relatively surficial, extending to the depth of the compacted fill material that was used in the construction of the access road, but not into the natural soil profile.
3  **Prism monitoring**

Prism monitoring has been undertaken on a regular basis by a registered surveyor engaged by Holcim. Generally, the prisms located at chainages 75, 85, 100, 125 and 150 consistently showed total movement above the tolerance of 10 mm, trending to the west and down at a linear rate. As of 30/01/19, the previous two measurements have shown an acceleration down and to the west. Anecdotal evidence from the surveyor is that hot days or rainfall appear to exacerbate the movement recorded during the monitoring. Graphs of prism movement over time are presented in Appendix C.

4  **Geotechnical Advice**

Given the conditions at site as observed in Sections 2 and 3, and the mining sequence described in Section 1, some recommendations can be made to reduce the geotechnical risk associated with mining the muck pile below the eastern wall. These recommendations are detailed below.

4.1  **General Advice**

It is recommended that an exclusion zone be maintained at the crest of the eastern high wall, approximately 20 m back from the crest, for the duration of mining activities at the toe of the wall. In addition, it is recommended that an exclusion zone at the toe of the eastern high wall be maintained for 12 hours following blasting within the quarry.

4.2  **Mining Sequence Advice**

The table below presents three options for removal of the muck pile at the bottom bench of the eastern wall. Option 1 is further divided into two sub-options, depending on the availability of equipment.

<table>
<thead>
<tr>
<th>Options</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a) Push down crest with dozer</td>
<td>Takes load off ravelling mechanism, and provides the greatest reduction in risk to plant and personnel of the presented options.</td>
<td>Contamination of muck pile with altered basalt. Excavatability of the rock mass may be low. Increased time before ore may be accessed.</td>
</tr>
<tr>
<td>Using a dozer, push perpendicular to the open edge. Follow mining best practice for this task. Attempt to re-profile upper batter to 45°.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b) Push down or pull down crest with excavator</td>
<td>Takes load off ravelling mechanism, and provides the greatest reduction in risk to plant and personnel of the presented options.</td>
<td>Contamination of the muck pile with altered basalt, but may be managed better than with dozer. Excavatability may be lower for excavator than dozer.</td>
</tr>
<tr>
<td>Use an excavator to re-profile the batter. If scaling from below, this method will require a pad to be constructed to raise the excavator up to an appropriate height such that it can reach the crest. Material can be deposited to the side of the pad. Follow mining best practice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Safety bench for the excavator with catch capacity</td>
<td>Reduces exposure of plant and personnel during mining process. Better ore control during mining process. Access to material may be faster than Option 1.</td>
<td>Double handling of material when constructing the catch trench. No reduction of geotechnical risk of ravelling or sliding, though hazard potential reduced by means of catch trench.</td>
</tr>
</tbody>
</table>

Use the accessible part of the muck pile to create a bench for the excavator to sit on. The excavator then reaches towards the high wall and excavates material in front of the catch berm. This has the effect of creating a platform for the excavator to sit on, with a catch trench in between the excavator and the high wall. A minimum distance is maintained from the high wall, dependent on the reach of the excavator. Mining for each lift progresses as normal, but is sequenced from the catch berm towards the front of the bench.

| 3 Do nothing | Access to material is not delayed. Ore control is maintained. | No reduction to geotechnical risk of ravelling or sliding failure within upper batter of eastern high wall. Some ore is effectively quarantined. |

This option involves doing nothing to reduce the geotechnical risk of the upper wall. A section of the muck pile is left against the catch berm during mining as a means of producing an extra wide stand-off from the high wall.

It is further recommended that prism monitoring be maintained throughout the process. In addition, if possible, prism movement should be picked-up within 24 hours of a rain event of 15 mm over 4hrs or greater.

5 Limitations

This report has been prepared by GHD for Holcim and may only be used and relied on by Holcim for the purpose agreed between GHD and Holcim as set out in Section of this report.

GHD otherwise disclaims responsibility to any person other than Holcim arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.
The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has also prepared this report on the basis of information provided by Holcim and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Sincerely
GHD

<on file>
Jason Hellmuth
Senior Geotechnical Engineer
+61 2 9462 4854

Appendices
Appendix A – Sketches
Appendix B – Site Photographs
Appendix C – Prism Monitoring Graphs
Appendix A

Sketches
Appendix B

Site Photographs
Plate 1 Overview of Dubbo Quarry, with blasted muck pile and eastern high wall in shadow at far edge of the pit.

Plate 2 Cracking within asphalt access road behind eastern high wall.
Plate 3 Cracking within asphalt access road behind eastern high wall (facing north).
Plate 4 General condition of the altered basalt present in the face.
Plate 5 Cracking within shoulder of access road, in compacted fill.
Plate 6 Eastern high wall, from level of blasted bench to the south. Note the slight overhang.
Plate 7 Standing on blasted muck pile, looking at upper batter of eastern high wall.
Plate 8 Blasted shot with muck pile. Yellow line is approximate line of stand-off for Option 3.
Plate 9 Blasted material, looking down from eastern high wall. Yellow line is approximate line of stand-off for Option 3.
Appendix C

Prism Monitoring Graphs