



Highwall Inspection

Date: Wednesday, December 13, 2023

Project: 8-Mile Quarry

To: Wyatt Webster (Holcim)

From: Will Brandenberger, PE, PG and F. Davis Ray, GIT

Subject: Highwall Inspection of 8-Mile Quarry

HDR Engineering, Inc. (HDR) was contracted to provide a highwall inspection at 8-Mile Quarry (formally known as Byzantine Quarry) in Colorado on Wednesday, November 29th, 2023. The project location is shown in **Figure 1**, approximately six (6) miles north of Cañon City. This quarry was recently acquired by Holcim – WCR, Inc. (Holcim), formally owned by Tezak Heavy Equipment. HDR was contracted to perform an annual highwall inspection and document the past year of site development. The previous highwall inspection was performed on October 17th, 2022, by Azurite, Inc. The goal of the field assessment was to evaluate highwall/bench stability and the potential for future failure events that could place the quarry at risk. The primary objective of this inspection is to verify that quarry conditions are within permitted guidelines and to record any new rock failures or changes to the site that have occurred since October 2022. As this is the first time HDR has been on-site at this particular quarry, a certain amount of information on local rockfall and instability events is based on a review of previous memos and what the quarry operator discloses.

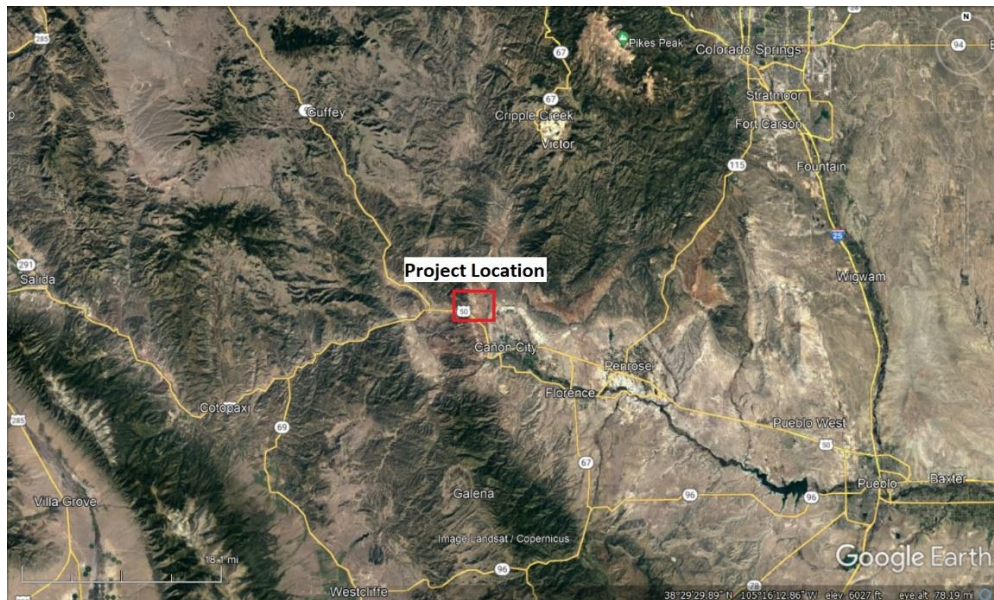


Figure 1: Project location map in satellite view.

HDR field personnel were escorted by vehicle to the quarry to evaluate the exposed benches and record measurements related to the local rock lithology, structure including orientations of foliations and discontinuities, prevalence of local and global cut slope failures, and other relevant information needed for preparing this technical memorandum. A brief site-specific safety training was performed prior to the inspection. The encountered weather conditions were clear/sunny with low winds and 55 degrees F. The site conditions were very dry, with no signs of active groundwater flow observed along the highwall/pit floor interface. Dry conditions have persisted throughout the past several months with only minimal precipitation.

HDR began the site visit by driving to the major focus area along the east-facing highwall. The quarry is very small and contains only three relatively short benches (~20-30 feet tall) along the north-south strike of the bedrock. The encountered material consisted of red carbonaceous sandstone, with a dip direction of approximately 30-67 degrees (NE) and a dip of about 16-32 degrees, as shown in **Figure 2**. The exposed east-facing benches contain various discontinuities, as shown in **Figure 3**, characterized by highly weathered, moderately infilled, well-developed seamy joints with a wide aperture and infrequent recurrence interval, followed by less weathered, more frequent narrow spacing with tighter aperture joints. The first two joint sets are present along the vertical fracture planes of the exposed bedrock (Orientation A). Joint 1A (not shown) is a vertical fracture with a dip angle of approximately 76-86 degrees and dip direction of 272-291 that exhibits a ½-inch to 2-inch aperture, 3-9 feet spacing, greater than 10 feet of persistence, and some silty/clayey infilling. Joint 2A is a vertical fracture that displays a tight aperture, 1-inch to 3-feet spacing, ½-foot to 5-feet persistence, and occasional calcite infilling. The second set of joints is present along the horizontal bedding planes of the exposed bedrock (Orientation B). Joint 1B is a wavy bedding joint with a dip angle of about 70-90 degrees, 6-inch to 1-foot aperture, greater than 30 feet spacing, and 10-20 feet of persistence. Joint 2B is a wavy bedding joint with a tight aperture, 1-inch to 10-foot spacing, and 6 inches to 3 feet of persistence. Based on field observations, the estimated Geological Strength Index (GSI) value of the bedrock is approximately 35-45. A small silty/clayey seam approximately half a foot wide and 3 feet tall was observed near the center of the east-facing highwall, as shown in **Figure 4**.

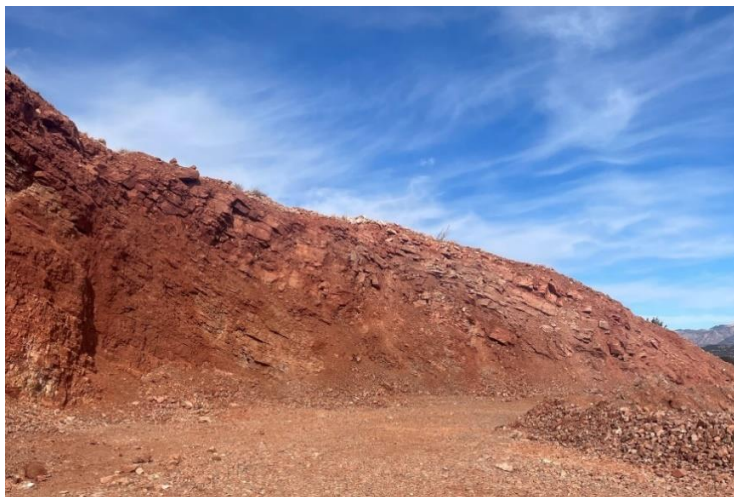


Figure 2: South-facing exposure of bedrock dip angle.

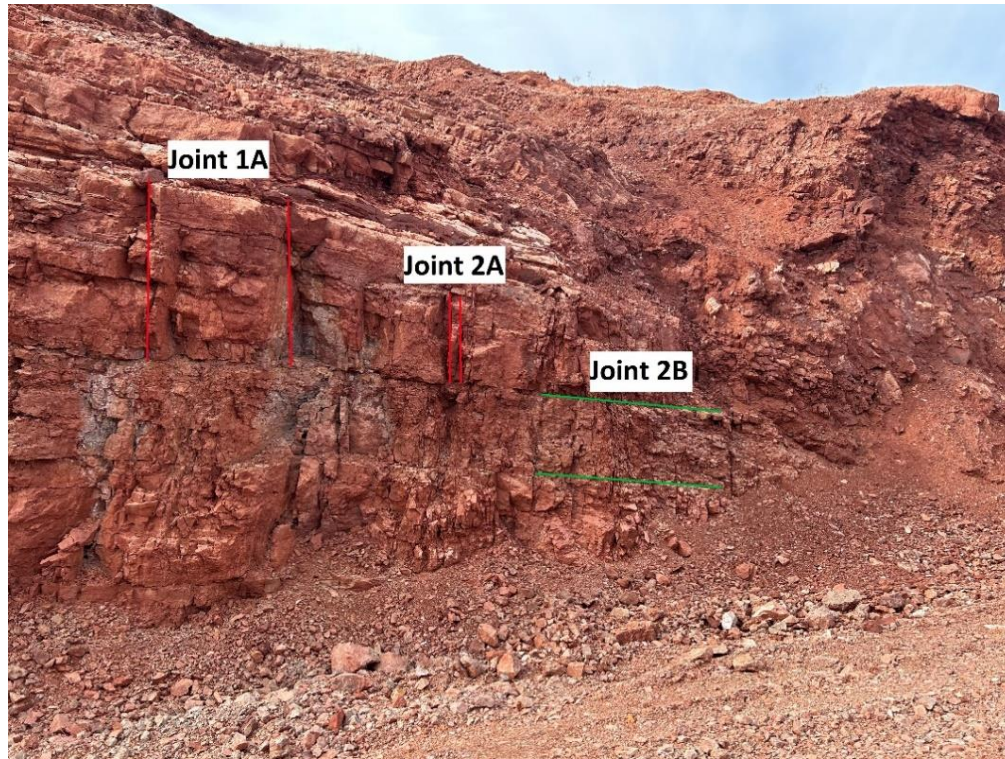


Figure 3: East-facing highwall with marked joint sets.



Figure 4: Silt/clay seam exposure along the east-facing highwall.



The quarry site has been maintained over the past year to result in mitigation of unstable highwall conditions. The working faces and bedrock exposed along the second bench appear stable. No pending issues regarding rock stability or potential for mass rock failure were found during this inspection. No water seepage or potential wedge failure planes were noticed, but some raveling was observed. The tendency for unstable rock raveling along the top edge of the topmost bench has been addressed by the site operator (through a contracted third party). This is an issue that was addressed after being noted by the previous report from 2022. The operator plans to continue mining efforts along the N-S direction in the future, which is close to parallel with the strike orientation (~30-degree difference) of the bedrock. Potential planar failures could occur when bedding planes exceed a 30-40-degree dip, depending on the friction angle of the rock. The anticipated rockfall is within conditions expected during mining operations, including minor but existing risks of planar and toppling failure. Based on a brief kinematic analysis, planar failure is the most likely mechanism of failure to occur within the site, but we don't expect any major failures due to the relatively short bench height and the preponderance of the overall rock mass to relieve in-situ stress via small-scale failures.

The information provided in this memo was based on a site reconnaissance and cursory data review of the region. This memo is specifically intended to address the region of interest previously specified. We have endeavored to complete the services identified herein in a manner consistent with that care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project.