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Design and Performance of a Pillar in a Mined Tunnel Y-junction

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ABSTRACT

This paper discusses the stability assessment and performance of a pillar situated at the headwall of a large cavern which accommodates a Y-junction between a TBM tunnel and merging drive of an entry ramp mined tunnel in moderately strong rock.

KEYWORDS

Mined tunnel, rock pillar stability, concrete pillar

1. INTRODUCTION

In the area of concern, a 3-lane-wide (15m) ramp tunnel starts at a cut-and-cover structure, reduces over a 3m long transitions to a 1 plus lane tunnel and finally connects with a cavern forming a Y-junction. The Y-junction is designed to merge the ramp tunnel with the 2-lane plus size TBM tunnel leaving a narrow rock pillar between the TBM and the ramp tunnel of approximately 1.5m. Both ramp tunnel and the cavern cross-sections in this junction are drained tunnels and were constructed as mined tunnels, which comprise cyclic sequence of excavation followed by installation of the temporary support within each cycle. The cavern itself was constructed by roadheader in top heading. Roadheader, drill-blast and breakers were used in the bench excavation depending on rock strength encountered along the alignment.
Due to encountered geology, the rock pillar stability was of a concern.

2. ALIGNMENT AND TUNNEL GEOMETRY

The ramp tunnel starts at a portal and reduces to an excavation span of 10.5m at the cavern headwall considering the enlargement for the concrete pillar. The cavern has a maximum excavation span of approximately 25m at the headwall section. The excavation diameter of TBM tunnel is approximately 12.5m. The maximum gradient is 5.0% within the ramp tunnel whereas it has a constant grade of 0.5% at the cavern and TBM tunnel.

3. CONSTRUCTION SEQUENCE

The construction was implemented through many steps (1 through 9) of excavations as shown in Figure 1 below. Firstly, the top heading of the ramp tunnel was advanced towards the cavern (Step-1). Following the actual ground conditions were inspected, an optimum width of rock pillar for replacement with concrete was selected from the designed options as required. The top heading was widened to the cavern headwall to be able to accommodate the concrete pillar (Step-2) and advanced towards top heading formation of the cavern (Step-3). Following a cross-cut within the cavern (Step-4), excavations were advanced in all opposite directions in the side drifts both into the cavern and towards to headwall (Steps 5, 6 and 7). The central drift excavation towards the headwall was commenced after side drift excavation was reached a certain distance (Step-8). Meanwhile, the concrete pillar was constructed within the widened profile (in Step-2) of the ramp tunnel as mentioned above. The excavation of TBM tunnel was commenced after concrete gained 30MPa 28-day compressive concrete strength (Step-9). Similar to above, bench excavations were completed in a sequential manner. A maximum slope of up to 12% was used in top heading excavations to be able to access the cavern.