

On the Development of Slump Slide around Reasi end Portal (P2) of Tunnel no. 1, Udhampur - Srinagar - Baramulla Railway Line Project

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Abstract

The 2700m long Tunnel No.1, located between Katra and Reasi is a part of prestigious Jammu - Udhampur- Srinagar - Baramulla Rail Link project. The tunnel for a considerable part of its length traverses through Reasi thrust zone. During heavy rains in the intervening night of 9th and 10th February 2005, a major slide developed around the P2 portal at the Reasi end, which caused heavy damage to portal as well as the part of tunnel. The study of the slide area indicated that the crushed dolomite being the main slope forming material there would have got nearly charged up with water because of the incessant rains in the area. The water pressure developed has in turn would have further degraded the already poor shear parameters of the slope forming material resulting into the failure of slope there.

Introduction

The construction of Jammu- Udhampur - Srinagar-Baramulla Rail Link project, with a total length of about 340 km has been taken up as a national project. The project has been divided into various sections.

- Jammu - Udhampur, 53 km in length, has been completed and commissioned by Northern Railway in April, 2005.
- Udhampur - Katra for a length of 30 km is nearing completion.
- Katra to Laole for a length of 90 km shall be executed by Konkan Railway and remaining Laole to Quazigund and Quazigund to Baramulla (20 km) shall be executed by IRCON.

The construction of 2700 m long tunnel No. 1 was started in Feb 2004. By Feb 2005, tunnel lengths 408 m & 236 m had been excavated from Katra and Reasi ends respectively.

In Feb. 2005, due to the heavy rains a major slide developed during the intervening night of 9th & 10th Feb. '05

around Reasi end portal of the tunnel. Geology and geotechnical factors responsible for the triggering of landslide has been described in this paper.

Regional Geology

The 90 km Katra - Laole section (km-stone 30 to 120) is a part of the Jammu - Udhampur - Katra - Laole - Quazigund - Anantnag - Srinagar - Baramulla Railway alignment and shall pass through the Siwalik rocks, Precambrian dolomite, Bauxite Formation, Eocene, Murree Rocks and Dogra slates. Rocks are soft to hard, massive to closely jointed, shattered and sheared. General trend of the northward dipping rocks is NW-SE to NNW-SSE, which is transverse to the rail alignment. However, at places, the alignment skirts around nals to get the required formation level in the process becoming nearly parallel to the trend of rocks, in these stretches.

Between Katra and Laole, besides general jointing, fracturing and shearing, rocks are folded and faulted. Three major tectonic discontinuities i.e., Reasi Thrust

(MBF), Murree Thrust, and Panjal Thrust are present in the area, which have badly disturbed the original structure of the rocks. The Reasi Thrust separates the youngest Siwalik rocks from the overlying oldest dolomite. From Katra to Reasi, the alignment passes through the thrust zone or parallel to it. Murree Thrust, which is located south of Baglihar Hydrel Project, passes through Peerah along the left bank of the river Chenab and crosses the alignment somewhere near the Dharam village, and separates the younger Murree rocks from the overlying older Dogra slates. Panjal Thrust crosses the NH-1A near Digdol, and the alignment beyond Laole i.e., after 120 km. However, due to the loop in the alignment along the *Sumbar nala*, it again crosses the alignment at two locations near Sumbar village, where Laole station is proposed now. Dogra slates have got sandwiched between Murree Thrust and Panjal Thrust. Panjal Thrust separates the underlying younger Dogra Slates from overlying older Salkhala group of rocks. These thrusts trending in zigzag way almost parallel to the trend of clay-stones, siltstone and sandstone of Murree Group and Dogra Slates consisting of mainly slates, phyllites and quartzite along with a few thick bands of gypsum, have rendered the slopes weak and slide prone. A number of slide zones have developed along the hill slopes made up of above described rock types.

Geology of the Tunnel-1 area

The whole length of Tunnel No. 1, under construction, lies on Reasi Thrust (MBF). Reasi Thrust separates the younger Middle Siwalik from the overlying older Sirban dolomite. Geological studies of the tunnel area have indicated that tunnel from (P1) i.e., Katra side shall be excavated through Middle Siwalik consisting of soft sand rock and thin claystone/soft sand for a length of ± 600 m and remaining 2100 m length through crushed dolomite charged with water. However, excavation revealed that, Siwalik

rocks extended up to a distance of 425 m and from 425 m to 875 m tunnel encountered dolomite scree, which was partially cemented and partially loose, but was mostly dry. The presence of dolomite scree below the high ground has indicated that the sandrock/ crushed dolomite might have got eroded in recent past and paving way for the deposition of dolomite scree in the area. However, RD 875m onwards, up to Piekhad and end of the tunnel, the area is made up of crushed dolomite (Reasi Thrust zone), charged with water. Reasi side (P2) of this tunnel is located within this Thrust zone, i.e. within crushed dolomite with some outcrops of Murree claystone.

Description of Slide Area

Reasi end portal (P2) of the tunnel was proposed at km. 32.685 but when excavation for approach to portal point was started, it was apprehended that high cuts in loose crushed dolomite may not remain stable. Hence, it was decided to erect a 18.50 m long false portal and shift the portal location from 32.685 to 33.000 m. After the construction of 18.50m long false portal, excavation of the tunnel was taken up (Photo 1) and about 236m tunnel was excavated within a period of one year. During tunnelling, heavy over-break and cavity formation was recorded due to the presence of crushed rock charged with water.



Photo 1

During the construction of the portal, excavation for working platforms to keep machine, office sheds, etc. was done in crushed dolomite. Due to the presence of loose rock mass, slowly cut slopes came under distress resulting in slope failure.

During the first week of Feb. '05, when heavy and continuous rains lashed the area, a major slide developed on the intervening night of 9th & 10th (Photo 2). The slide scar is located about 67 m from tunnel portal face. The maximum width of the slide zone is about 90 m. Besides arcuate cracks, mostly developed beyond the slide scar, tension cracks have prominently and developed at many places between toe of the slide and portal face. The impact of the slide was so strong that 18.75 m long face portal got partly twisted and partly collapsed. It appeared that most of the pressure came from right side. Right side ribs along with top concrete, got crushed and joined with left side erected rib. The false portal got detached from main tunnel. Beyond the false portal, about 40 m tunnel length was also expected to be damaged. In addition to above damage, post survey of the area revealed the tunnel including the false portal had got shifted about 8.50 m along the alignment and 5.50 m towards right side. During the excavation of false portal area in June '06, it was noticed old ribs 4-5 m in height had got thrust into the ground during slump slide.



Photo 2

Besides damage to the tunnel, following additional damages were recorded :

- PCL site office constructed on the right side of the tunnel face, got pushed by the slide material and came down over the road.
- Batching plant, kept ahead of the office shed overturned and fell near road.
- The longitudinal drain constructed on the left side of the tunnel got damaged. The entire base material got removed and concrete portion remained hanging in the air.
- The shed constructed just on the left side in front of false portal, housing generator and compressor, got damaged.
- It was informed that two JPCs and other water pumps were still inside the damaged tunnel.
- Upheaving of about 1m was noticed at the start of the false portal. Heaving was also recorded on the road and canal around KRCL office.
- The KRCL office located between water kul and road got damaged first by upheaval from the side and subsidence from other side.
- The breast wall provided in front of the KRCL office either completely collapsed or partly damaged. Breast wall also got lifted by 20 cm.
- Irrigation canal (Kul) close to the KRCL office has been damaged for about 100m length. Bed of the Kul also got uplifted by about half meter.
- The PHE water pipes got uplifted by about 1.5 m and got disconnected.

Meanwhile, during monsoon, about 8m diameter well was formed up to tunnel crown around km 32.660, which indicated that steel ribs had collapsed around this location. From Feb. '05 to Dec. '05, discussions at

various levels were held to tackle the problem created by this major slide. However, except one drain along the collapsed slope, no treatment was provided.

Probable Causes of Slide

The material, through which the tunnel is being excavated, is made up of sheared crushed dolomite pieces and rock powder (clay gauge). The approxi-mate density and water content on saturation of the material varies from 1.84 to 2.02 gm/cc and 14.50 to 19.10 percent respectively. The cohesion and angle of friction vary from 0.04 to 0.125 kg/sq. cm and 15° & 25° respectively. Outcrops of claystone were also encountered within crushed dolomite. Due to the heavy and continuous rains, the tunnel area would have got charged with water, which in turn owing to increased pore water pressure must have further reduced the already poor shear parameter values of the material resulting major slump slide.

Adopted Remedial Measures Till Date

After great deliberations, M/s Sohams Foundation Engg. Pvt. Ltd. came out in March '06 with the proposal of soil-nailing and pile grouting along the alignment between km. 32.700 to km. 32.730. Factor of safety, with various alternatives were studied with micro-piles. Finally, factor of safety was worked out as 1.462 with the following micro-piles schemes, which includes 300 mm micro-piles in staggered fashion 2.0m centre to centre.

Location : Micro-piles starts from 10 m
before the false portal face i.e.
from km 32.740

Depth of Micro-piles : 10 to 15 m

Steel used : 5 mm to 25 mm

Grout material : Cement & sand (1:2)

After the completion of 149 micro-piles along the alignment and at the toe of the

slope, excavation for false portal proposed between km. 32.700 & km 32.780 as shown in Photo-3, was taken up and steel ribs at 0.50 m apart were erected in entire 30 m length. When the preparations for 1m thick RCC raft were being made, monsoon rains started and further work was abandoned. Due to rains, boulder crated walls provided to prevent slope failure ahead of false portal, collapsed and loose material deposited over the erected ribs (Photo 4). Now, the loose material has almost covered the entire length of false portal erected ribs. Steel arch ribs for a length of 5-6 m got damaged. Part of drain constructed above the slide scar has also come down.



Photo 3



Photo 4