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A preliminary report on field visit to Ghatdhaar and Khotila landslides, Dharchula, Pithoragarh

By

Uttarakhand Landslide Mitigation and Management Centre (ULMMC)

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Preface

A team of ULMMC experts, including Mr. Kaustubh Barthwal (Assistant Engineers), Dr. Raghuveer Negi (Geologist), and Er. Pankaj Uniyal (Design Engineer), conducted a field expedition to assess the Ghatdhar and Khotila landslides from 13th to 14th March, 2024. The primary objective of the visit was to conduct a primary field investigation of these slope. During this visit various observation and field investigation was carried out. Some mitigations measures based on primary investigation and observation have been suggested which may be further implement with Detailed project report with and appropriate slope stability modelling (FEM or LEM). The site has their importance and they need to be investigated in detail for their mitigation measures.

Er. Kaustubh Barthwal

(Dr. Raghuveer Negi)

(Pankaj Uniyal)

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1.0 INTRODUCTIONS:

Landslides are very common phenomena in this geologically and tectonically active Himalayan terrain during rain and earthquakes due to its complex geomorphology and geological setup. A severe landslide occurred on October 4, 2016, near Khotila village in Dharchula. The landslide was possibly triggered by saturated slopes after receiving 88% more rainfall than the previous year, the landslide endangered villages downstream by partially blocking the Kali River (Solanki et al., 2019). The two main slope failure occurred in 2016 i.e. Ghatdhar and Khotila (*Figure 1*), both the slope are in close proximity to each other. The preliminary investigation of these slope was undertaken which have been discussed in this report.

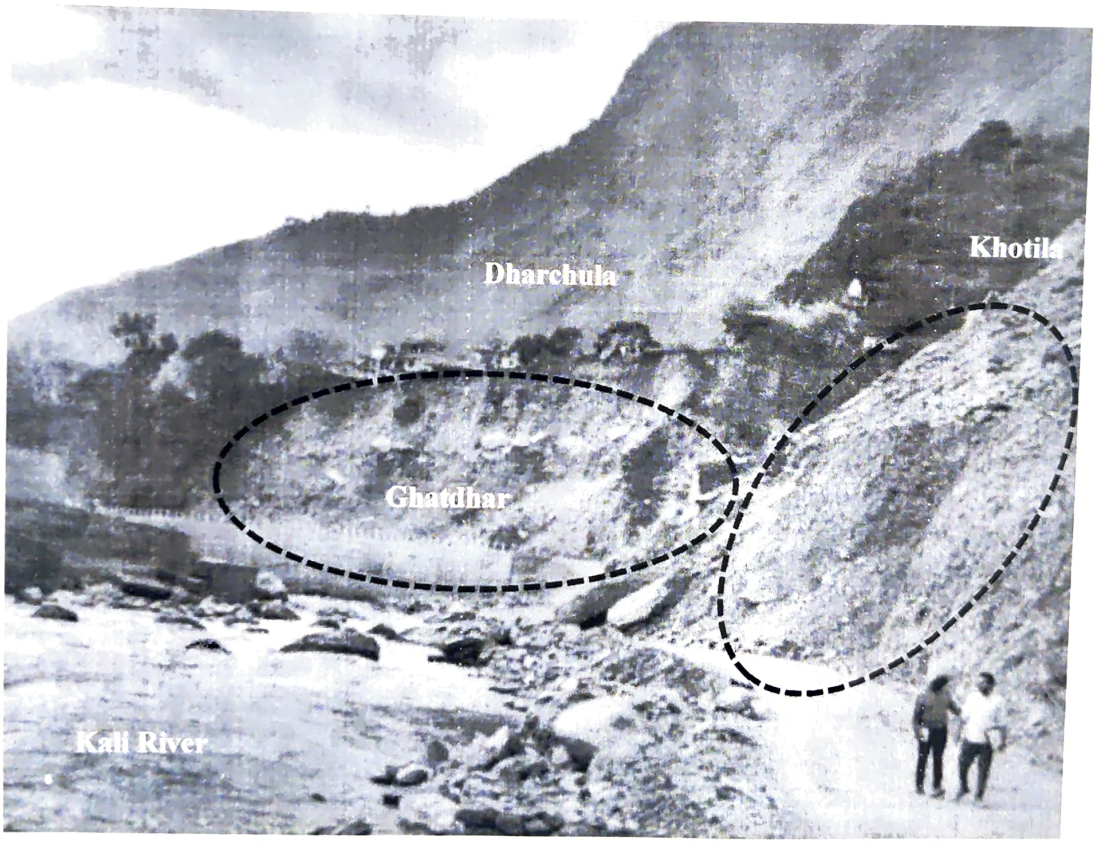

Figure 1: Slope failure along the Kali River near Dharchula, Pithoragh.

2.0 LOCATIONS:

The landslides are located near Dharchula town of Pithoragarh district. The Ghatdhar landslide is located (29° 50' 57" N; 80 °32' 49" E) just below the tehsil office of Dharchula (*Figure 2a*). While another landslide i.e. Khotila landslide (*Figure 2b*) is located in close proximity to the Ghatdhar landslide (*Figure 2b*) having a long stretch of the affected slope (29° 51' 01" N; 80 °32' 53" E).

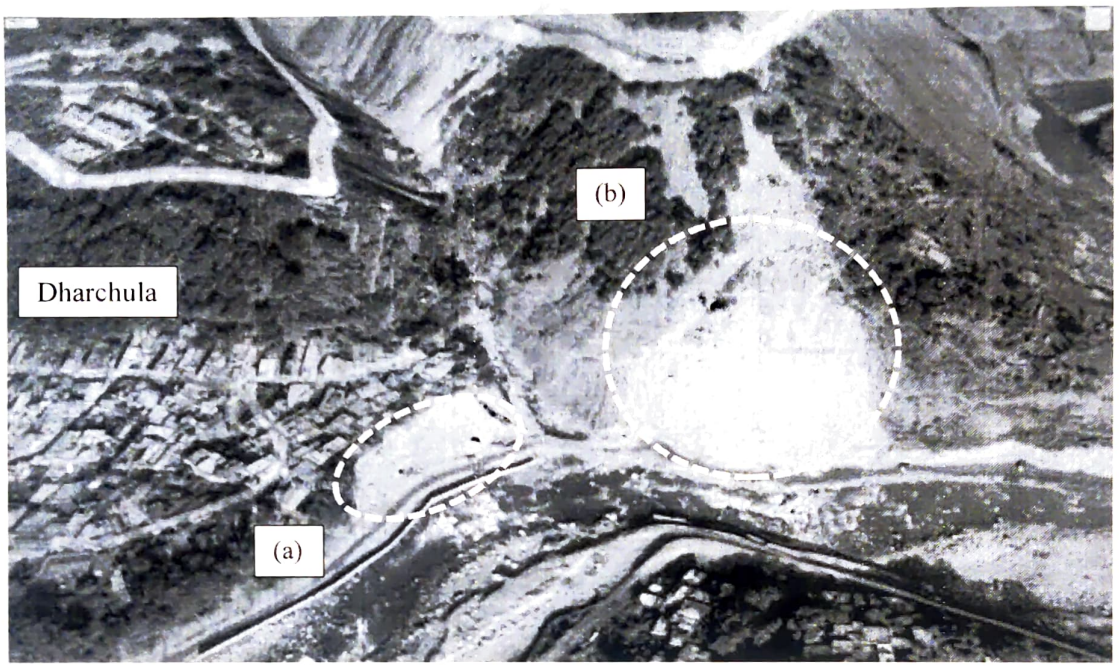

Figure 2: Google earth image showing location of the (a) Ghatdhar and (b) Khotila Landslides.

3.0 OBJECTIVES OF THE FIELD:

In response to letter no. 449/60/ULMMC/2023-24 dated 7th, March 2024, a field visit for the Ghatdhar and Khotila landslide was made on 13th and 14th march 2024 by A team of ULMMC experts, including Er. Kaustubh Barthwal (Assistant Engineers), Dr. Raghuveer Negi (Geologist), and Er. Pankaj Uniyal (Design Engineer). The primary objective of the visit was to verify the need for the mitigation measures to be provided at the site.

4.0 GEOLOGY:

The study area and its surroundings are geologically characterized by rocks of the Mandhali Formation of the Lesser Himalaya (Valdiya, 1980). The predominant country rocks comprise dolomitic limestone, calcareous slates, with lesser occurrences of variegated shales and pyritic phyllites. These rocks exhibit extensive folding, faulting, jointing, and fracturing. The Mandhali Formation is overlain by rocks of the Berinag Formation along the Berinag Thrust, primarily composed of quartzites, and the Chipplakote Crystallines along the Chipplakote Thrust, dominated by schist and gneiss. Beneath the Mandhali Formation lies the Deoban Formation, consisting mainly of limestone and carbonaceous slates. South of the Deoban Formation is the Rautgara Formation, characterized by predominantly fine- to medium-grained muddy quartzite and slates (Solanki, et al., 2019). The both the landslides (i.e. Khotila and Ghatdhar) lie within very close proximity to the Dharchula fault (*Figure 3*).

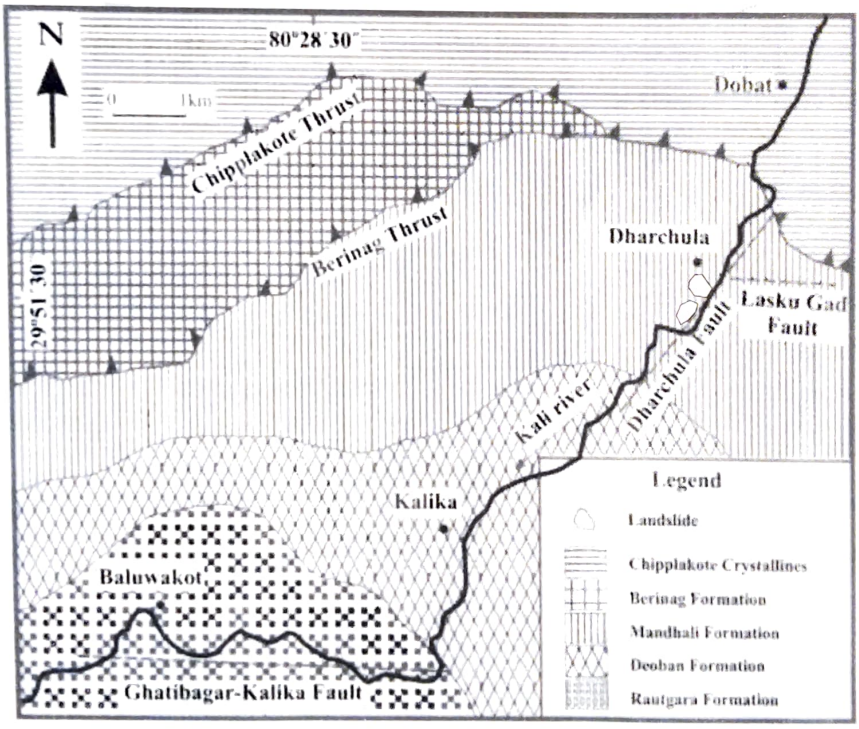

Figure 3: Regional Geology of Dharchula area (Solanki et al., 2019).

5.0 GHATDHAR LANDSLIDE:

- The slope is predominantly composed of loose material (cohesionless). The slope is steeply dipping with an average height ranging from 30 to 40 meters, and with an average stretch of about 100 to 130 m.
- The large size of boulders are embedded (*Figure 4*) within the slope which exacerbates instability during monsoon.
- The dense habitation, including administrative offices, is present in close proximity to the crown of the landslide.
- The slope lies in very close proximity to Dharchula Faults.
- Given the close proximity of the major settlement (Dharchula town), which encompasses crucial infrastructures like the Tehsil office and residential areas, it is imperative to address the significance of mitigating the slope.

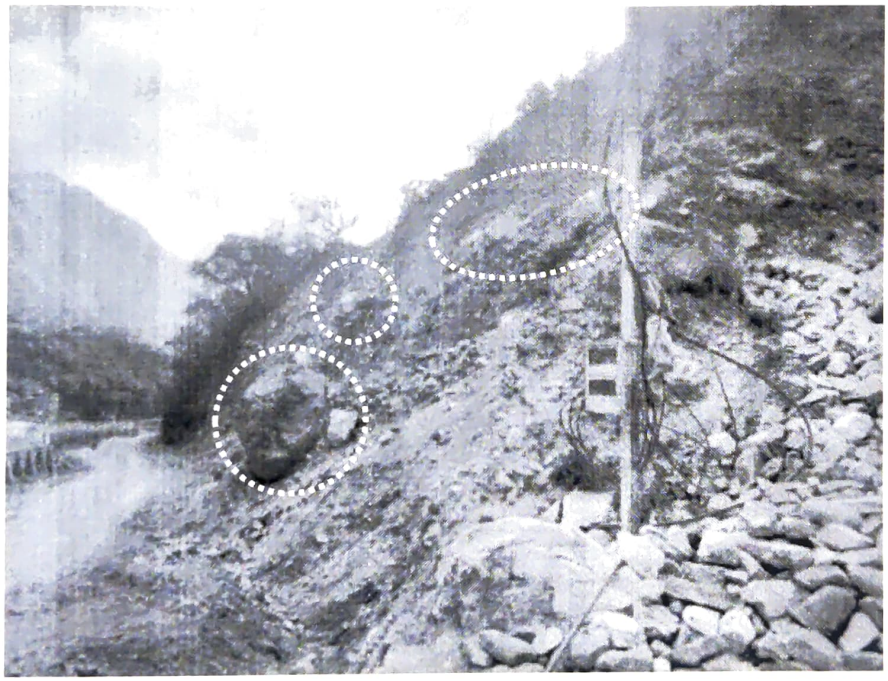

Figure 4: Ghatdhar landslide showing large size boulders at the toe & middle side of the slide zone.

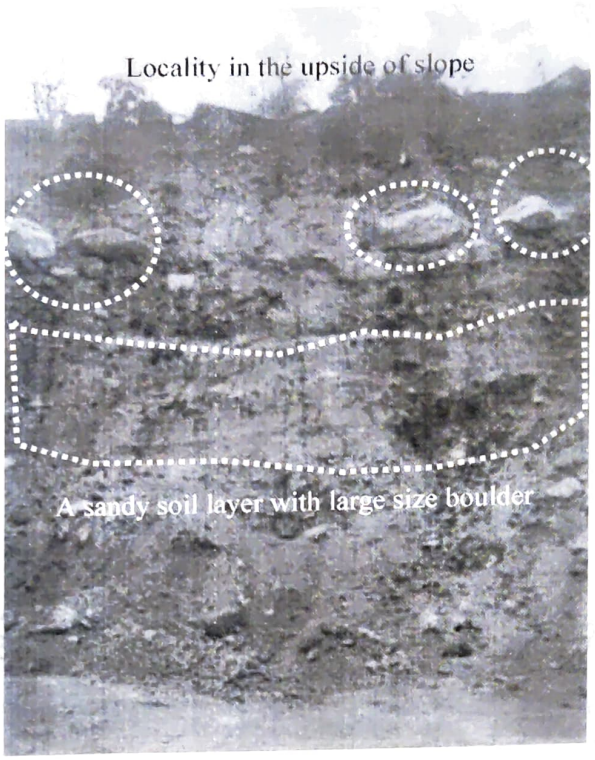

Figure 4: Ghatdhar landslide showing large size boulders and a sandy soil layer in of middle of the slide zone.

Figure 5: Figure shows the destruction of the bridge caused by the intense discharge during the monsoon.

6.0 KHOTILA LANDSLIDE:

- The slope is predominantly composed of Slate/ Phyllite dipping northerly. The slope is steeply dipping (N160) with an average height ranging up to 110 m, and with an average stretch of about 150 m.
- Large rock boulders are scattered across the slope, posing a risk of exacerbating instability, particularly during the monsoon season.
- The landslide on the footpath or trail leading to Khotila village poses significant challenges, especially during the monsoon.

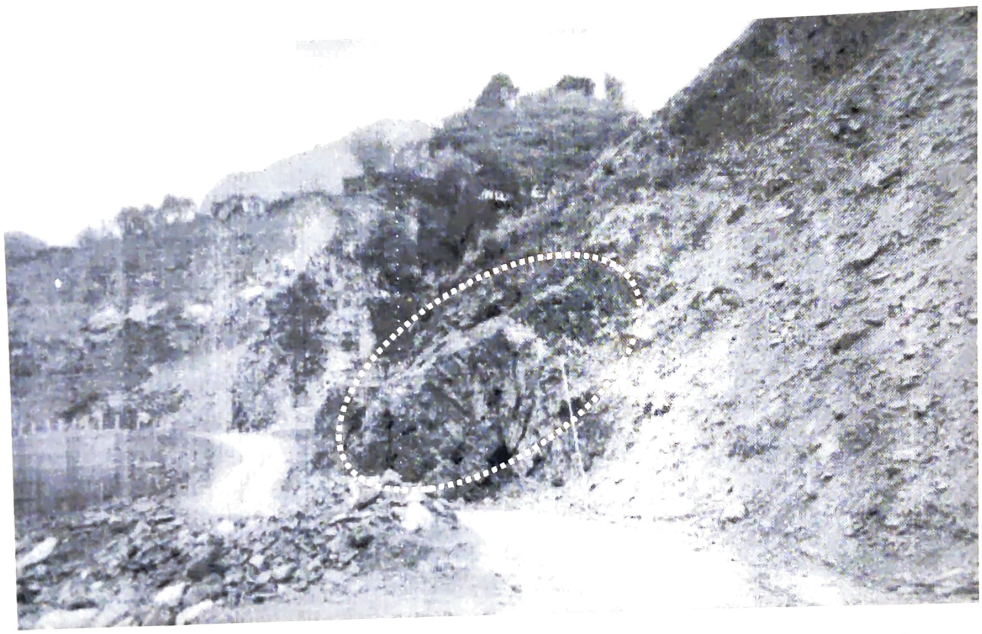

Figure 6: Figure shows the Khotila landslide with the presence of rocky strata at the toe.

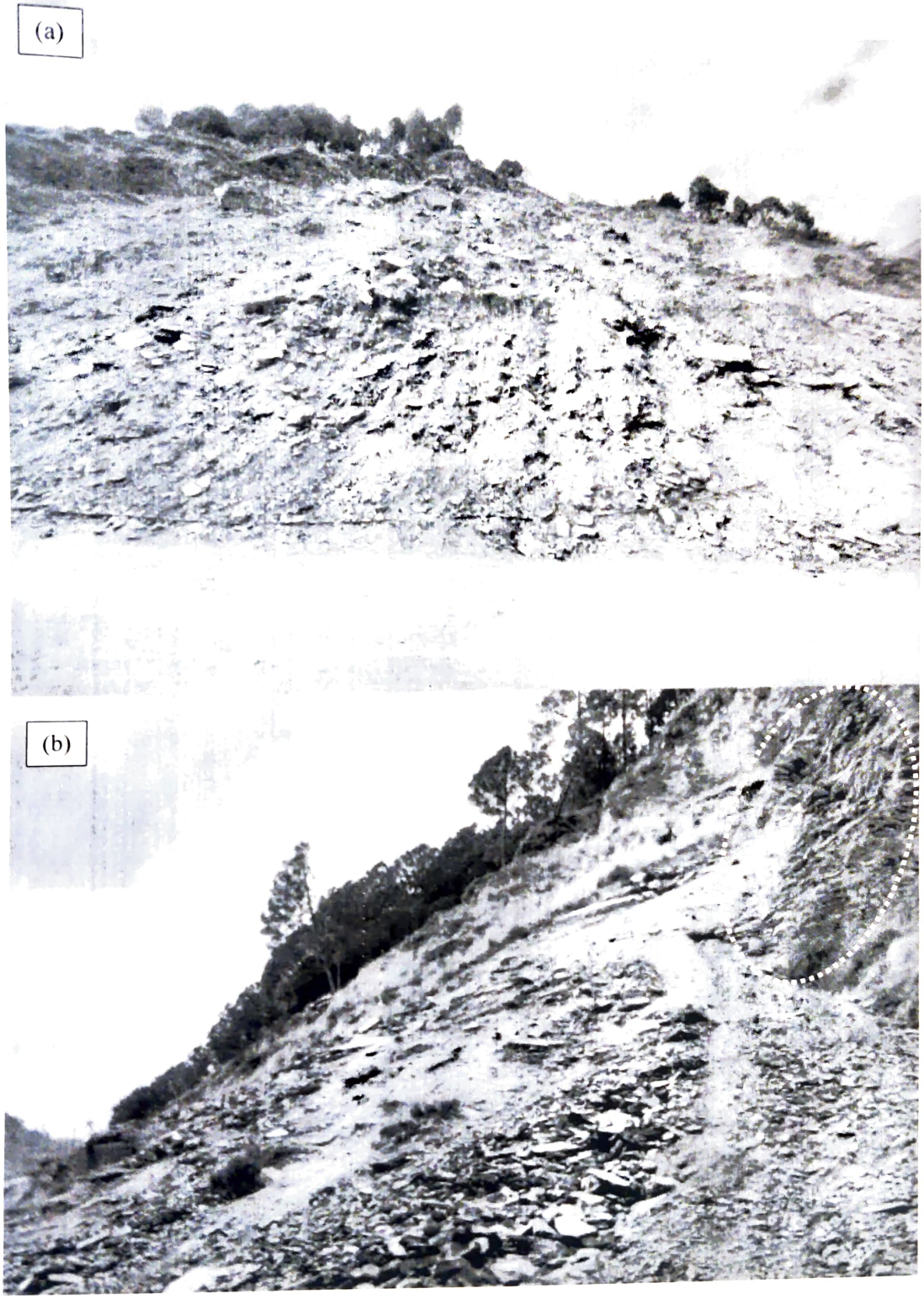

Figure 7: Khotila slope failure (a) landslide view from toe (b) rock strata at zone of detachment of the slope failure

Figure 8: Widely fractured rocks at the toe of the landslide.

7.0 CONCLUSIONS AND SUGGESTIONS

Comprehensive geological, geotechnical, and geophysical assessments are essential to mitigate the slope adequately, considering the potential risks posed by its proximity to the settlements. Both the landslide are of prime importance which need to mitigate with appropriate mitigation measures.

For Ghatdhar landslides

- Ghatdhar landslide underscores the necessity for thorough site investigations to evaluate and implement appropriate mitigation measures effectively.
- Reinforcement Concreate Cement (RCC) wall of adequate height may be one of the suitable mitigation measures at the site which may be design according to site conditions with appropriate geotechnical slope stability analysis.

- RCC Wall may be anchored with required yield strength and depth based on the failure circle.

For Khotila landslide

- The use of retaining wall with pile based foundation or counterfort retaining wall may be effective in control of toe erosion at the stretch of the Khotila slide.
- The height of the wall very crucial in order to attain long term stability of the slope due to high discharge in the Mahakali River during rainfall.
- Furthermore use of Rock Bolt/ Self drilling grouted anchor based on slope stability analysis and possible slip- circle. The slip circle need to understand using FEM modelling in order to attain the long term stability.
- The use of wire-mesh and high tensile rolled cable may be also effective to control rock slide and rock fall at the slide.

REFERENCES

Solanki, A., Gupta, V., Bhakuni, S. S., Ram, P., & Joshi, M. (2019). Geological and geotechnical characterisation of the Khotila landslide in the Dharchula region, NE Kumaun Himalaya. Journal of Earth System Science, 128, 1-14.

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