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Observations on Landslide Incidences in Himalayas in Kashmir Area

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OBSERVATIONS ON LANDSLIDE INCIDENCES IN HIMALAYAS IN KASHMIR AREA

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ABSTRACT

The Himalayas have been found to experience the heighest frequency of landslide incidences, thereby, causing loss of life and property. The rocks of Himalaya are repeatedly deformed and are affected by the periodic reactivation of deepseated faults. The experiences in the area of landslide investigations reveal that these lineaments are characterised by the frequent occurrence of landslides. Recently, studies have been carried out on a number of landslides falling between Murree and Panjal thrust along the Karole-Kastigarh road in Ramban area of Jammu & Kashmir. This paper is intended to present the sailient features of some of these landslide studies.

KEYWORDS

Landslides, Nature of Rocks in Himalayas, Geotechnical Investigation, Laboratory Investigations, Remedial Measures, Toe Erosion, Surface Erosion, Sealing of Tension Cracks.

INTRODUCTION

The construction of Karole-Kastigarh road in Jammu and Kashmir area was taken up in 1971-72. The work was stopped during August 1973 after construction of about 13 km of road stretch. The construction work was taken up again during the year 1977-78 for the improvement of road constructed earlier and also for its extension beyond Km.13. The road was constructed with a formation width of 7m. The road streatch remained open for light vehicles for a brief period during March 1987. The stretch was subsequently damaged due to various types of problems arising due to gulley erosion, debris flow, toe erosion and mass movements leading to deepseated landslides and has since been closed for all kinds of traffic. The floods during 1992 and unprecedented rains afterwards caused extensive damages to the road stretch. There are atleast 14 such locations where the road stretch has been completely damaged. The length of damaged stretches at these locations varies from 50m to 500m. The investigations were carried out to understand the problem of slope instability and suggest suitable remedial measures to stabilise the slope.

The geological mapping of hill slopes along the road stretch was carried out. The field investigations covered the geotechnical investigations, soil sampling, study about the degree of deformation of the rocks, the pattern of joints, the dip slope relationship, inter-relationship of fractures and joints etc. Geomorphic studies were carried out to relate the geomorphic characteristics with the geology of the site to assess stability of the slopes. Soil Characteristics of the foundation strata were determined for analysis and design of the remedial measures.

GENERAL GEOLOGY

The area represents a typical Himalayan terrain with high mountain ranges and deep vallies. The mountain ranges culminate into high peaks. The higher areas of the valley normally receive a heavy, long and continued precipitation in the form of rain as well as snow-falls. Most of the precipitation in the area takes place during monsoon season which lasts from middle of June to the end of September. The highest monthly rain fall data of the area recorded since 1991 on wards is of the order of 310.4mm for April 1991, 304 mm for September 1992, 412mm for July 1993, 238.6mm for August 1994 and 272.8mm for July 1995. The area is mostly covered by a thick mantle of soil cover. At places the road is passing over the river terrace deposits. The main rock types encountered in the area are given in Table 1.

Table-1. Main Rock Types in the Area

Foundation	Lithology	Age
Alluvium	Silt, Clay and debris (sands, angular to sub-angular chips etc.)	Recent
Terrace deposits	Rounded to subrounded boulder, cobble, pebble and granules	Recent to sub-recent
Ramban	Slates, greywackes, siltstone and ortho-quartzite	Cambro-Silurian

The rocks show three phases of folding. The slate at places is co-axially folded. Shearing and faulting which is indicative of movement is a common observation in the area. The rock types encountered in the affected landslide portion are as given below:

Rockfall Debris Material

The origianl derivative for this material is the source rock exposed in the near by area. The material is composed of angular to sub-angular rock chips of greywackes, slate, silt stone, quartz veins and ortho quartzite but mostly of slate being the dominant host rock in the area. This material is associated with loose fine grained soil and permits seepages and saturation due to water percolation.

Terrace Deposits

This formation over lies the slates, greywackes, silt stone and orthoquartzite formation. The terraces are located along the vertical cut of the slope. These deposits are characterised by bed load deposits of the river channel. It comprise rounded to sub-rounded pebbles, cobbles, gravels and boulders associated with brownish coloured siltysand with minor proportion of clay. This formation is underlain by thin mantle of alluvium.

Slates, Greywackes, Siltstone and Orthoquartzite

This lithounit underlies the deposits of the terrace formation. Slate and siltstone are brown to brownish black, light grey to dark grey or greenish dark grey in colour. The slate is low grade and easily splits into smooth thin sheets or slabs along the cleavage. The rock is crystalloblastic and fine grained with well developed slaty cleavages. The constituent minerals are chlorite with sericite and quartz as an important minor minerals.

The rock has suffered shearing movement along foliation planes at several places. Cross shearing is also noticed at certain spots. Greywackes are the arenaceous rock fragments consisting of fine to coarse, angular to sub-angular loose particles. Orthoquartzite is low grade and shows diagenetic effects. The rock is mainly cemented by the siliceous material.

Three sets of joints have been noticed in the exposed host rock. The joint planes dip across and parallel to the bedding planes. In quartzite and sandstone, vertical making joints intersect the joint plane of earlier generation.

CASE HISTORIES

Though there are 14 major slides along the road, only two typical slides are discussed in the present paper. The general view of the landslides area and the condition of road is depicted in Photo Fig. 1-3.

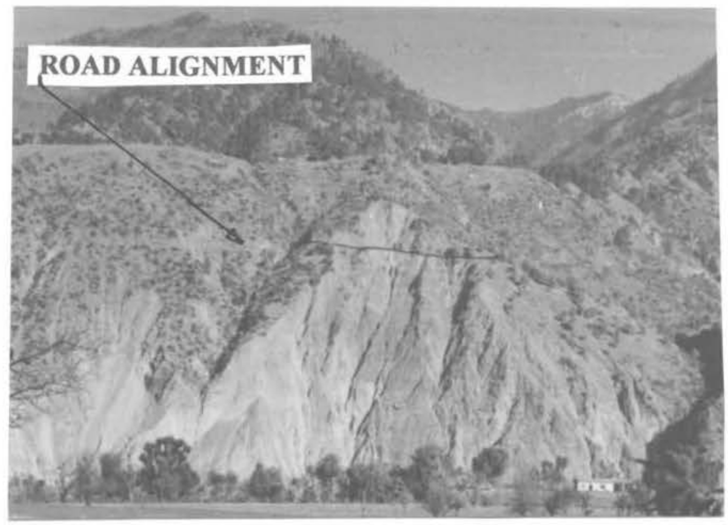

Fig. 1. General view of typical landslide

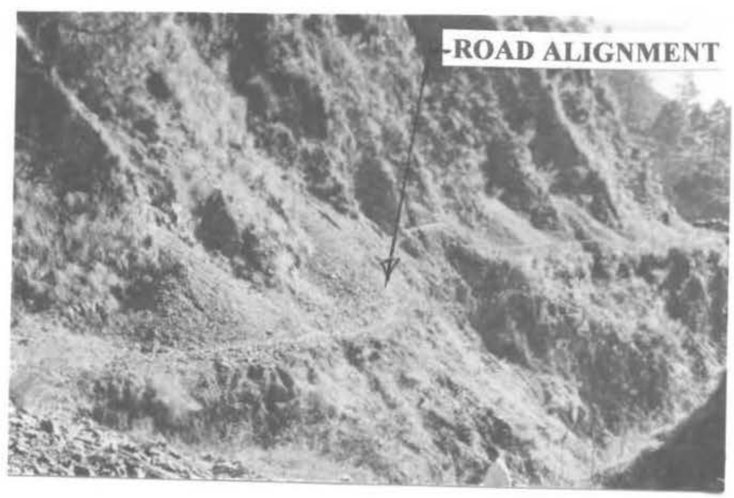

Fig. 2. View of road stretch damaged due to landslides

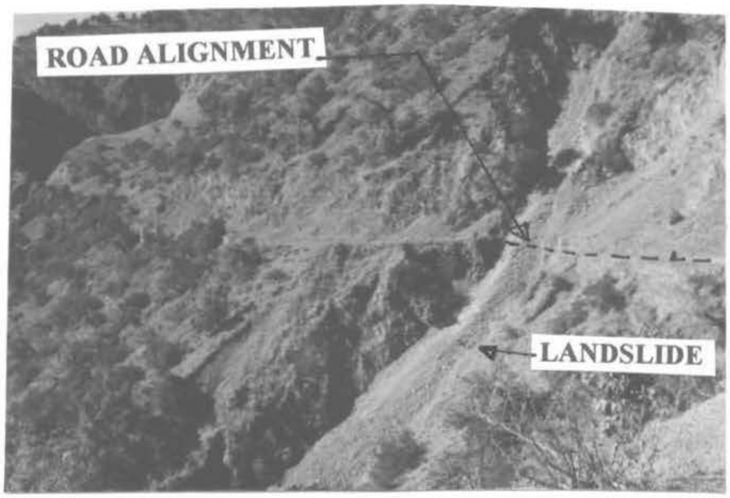

Fig. 3. Damaged condition of road stretch

LANDSLIDES AT SITE 'A'

The total length of the affected stretch is about 125m. The maximum width of the affected area is about 15m above the road. The inclination of up hill and down hill slope vary from 55 to 85. The slope surface is denuded and does not show vegetation growth. The road traverses through the terraces comprising of loose mass compacted with pebbles, cobbles and rock fragments of various dimension associated with sand and silt. The terrace material is less cohesive and permits percolation of water leading to saturation. A nallah originating behind the crown of left side drains through the slide area. In rainy season the nalla receives surface water from its tributaries on the top. A number of rills have been observed on uphill as well as down hill slopes. A big tension crack and a few small tension cracks were observed in the area adjacent to the nallah. The plan of the slide area is shown in Fig. 4.

Mechanism of Failure

The slide failure in this stretch has been assessed mainly due to toe erosion by river Chenab. Blowing wind, subsurface water and surface run off caused wear and tear on the denuded slide to create steep slope. The terrace material is sensitive to water and gets washed off easily, forming scar on the surface. Continuous flow of water along the scar results in the formation of rills and gullies. As mentioned earlier that the terrace material is conducive to water seepage. During rainy season the ingress of water in the terraces increases the pore water pressure and reduces the shearing strength of the material, thereby, causing the instability of the slope.

Remedial Measures

The measures were suggested for improvement of surface drainage and promotion of vegetation growth on the denuded slopes. The right side portion of the road comprised of less cohesive material with river terrace deposites, has been washed away. Slumping type of failures were observed in the downhill slope due to cutting of toe support by river Chenab. It was suggested to change the alignment of the road towards the uphill side, away from the river.

- Measures to provide a lined road side drain all along the length of the road to avoid the spreading of water on the road surface and downhill slope.
- In order to reduce the toe erosion of downhill slope due to river Chenab and to divert the flow of river away from the existing toe levels, two spurs were suggested on the upstream side of the toe of the slide area.

LANDSLIDES AT SITE 'B'

The affected stretch measures 250m along the road with the crown located at a height of about 60m above the road level. The affected area forms large steep slope consisting of highly jointed and disintegrated slate dipping inside into the slope. At places the rock is interbanded with black siliceous flags. The slope material comprised of small angular rock chips derived from the weathered shattered host rock. A number of seepage points were observed in the slide area. The plan of slide is given in Fig. 5.

Mechanism of Failure

The main cause of the slope instability may be described to be the debris flow and soil erosion. Failure of discontinuous plane by mechanical breaking was another factor. As the area experiences percolation of water and without proper drainage outlets, causes the accumulation of water leading to debris flow and other mass movements.

Remedial Measures

The debris flow and soil erosion are the main causes for slope instability. The stability analysis shows the present slope to be in unstable condition. The following remedial measures were recommended to improve the slope stability.

- Proper restructuring of the slope to bring the slope inclination at the angle of repose.
- Provision of lined catch water drains to divert water into main nallah.
- A lined road side drain all along the length of the road to discharge into the nearby natural nallah or culvert.
- A wire crated breast wall of 1.5m height all along uphill slope. The wire crated breast wall may be made with one step at one meter height.
- Levelling of the gulley and growing of grass/vegetation using the technique of coir netting/jute geogrid.
- Construction of wire crated check walls, at a few locations in the nallah bed upstream of road levels.
- A culvert is suggested at the road level of nallah to prevent damage to road pavement during rains.

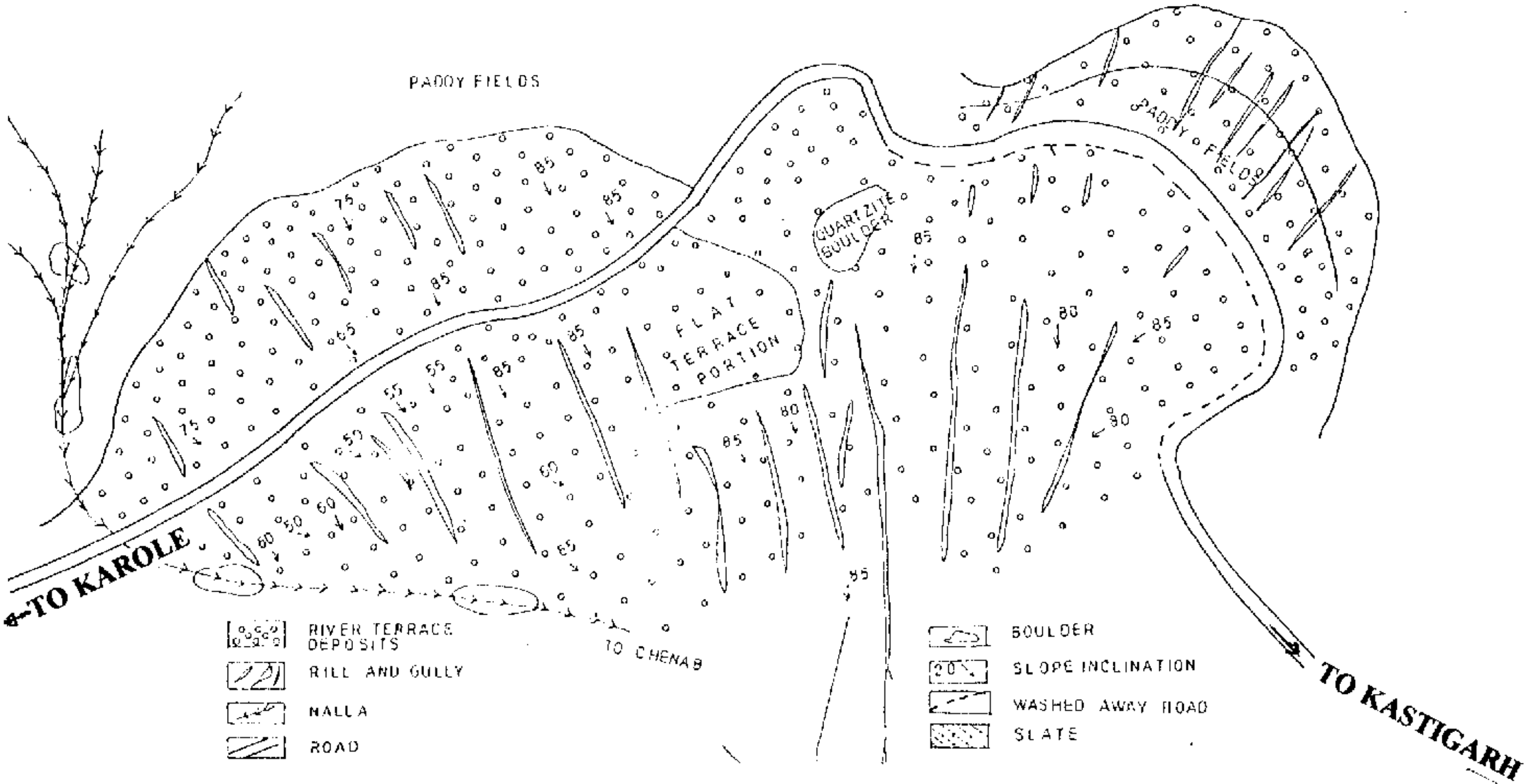

Fig. 4. Plan of landslide area at site 'A'

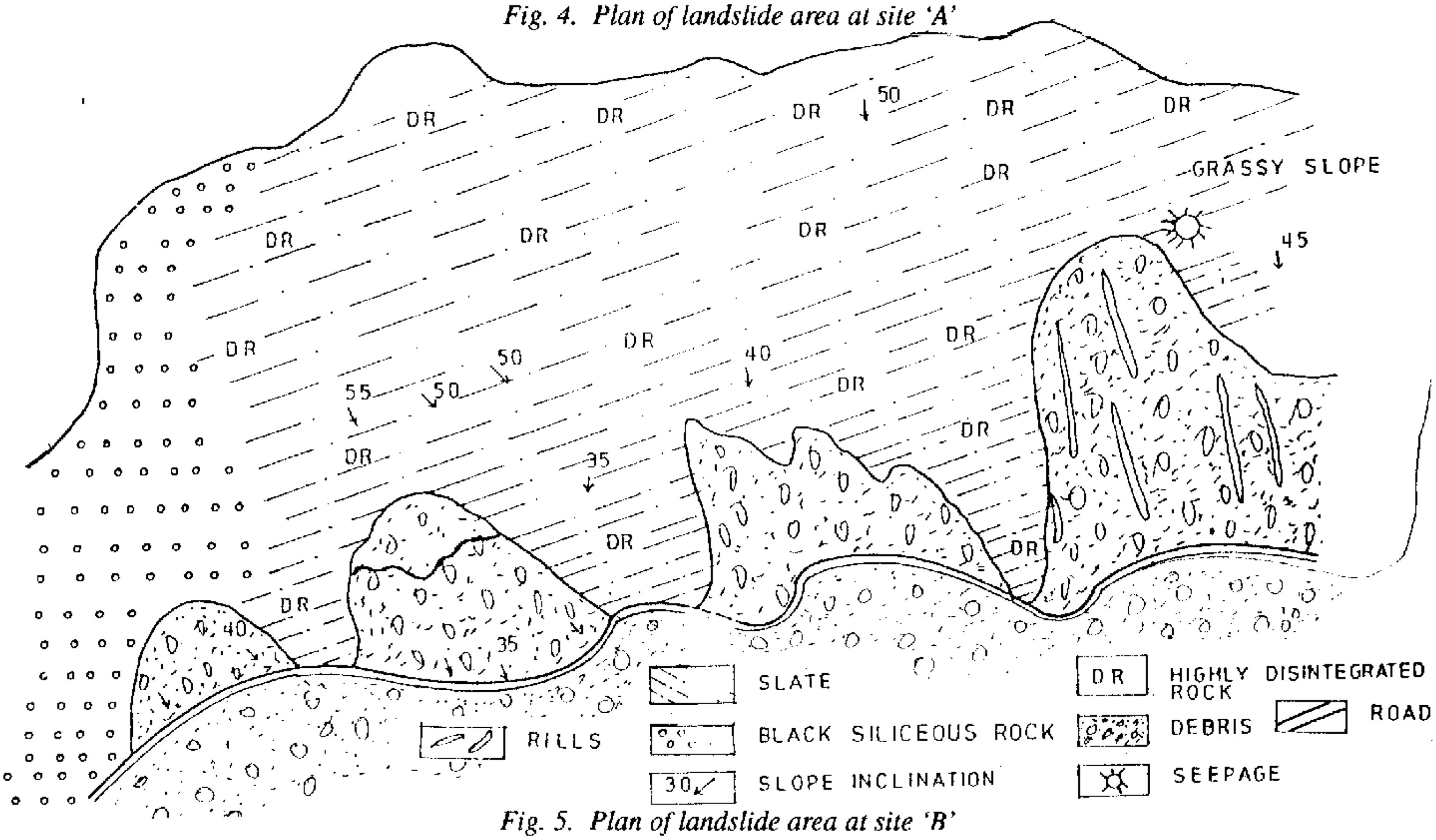

Fig. 5. Plan of landslide area at site 'B'

CONCLUSIONS

The remedial measures to prevent damages due to recurrance of landslides should be taken up only after proper geotechnical and geological investigations supported by analysis and proper design methods.

ACKNOWLEDGEMENTS

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