MANLE LANDSLIDES, PITHORAGARH, UTTARAKHAND- A CASE STUDY

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Abstract

At the H P Bend near Manle Market the rainfall-induced landslides occur resulting in damaging of the newly constructed road and house nearby the road. The study tells that joints and bedding planes of the slates helps for the infiltration of water which increased pore water pressure and seepage forces and caused landslides. The slope failure is rock slips and debris slides. An attempt has also been made how to take preventive measures for landslides during reconstruction of the road at this place.

Keywords

Landslide, H P Bend, Manle, Pithoragarh, Uttarakhand.

Introduction

Landslide/slope instability is a persistent problem of Himalaya especially during monsoon period. These landslides may be small as well as large. These natural disasters have occurred in all the divisions of the Himalaya from outer Lesser Himalaya to Higher Himalaya. Recurring landslides and slope instability play widespread destruction that affects communication, destruction of agricultural land, house and loss of human life. Manle market (Toposheet No. 62C/6; 29^0 38' 20": 80^0 18' 45") is located near village Manle along the Pithoragarh – Nanipatal – Marh Manle – Bhautari Road at a distance of 24.8 Km from district headquarter Pithoragarh (Fig. 1). From

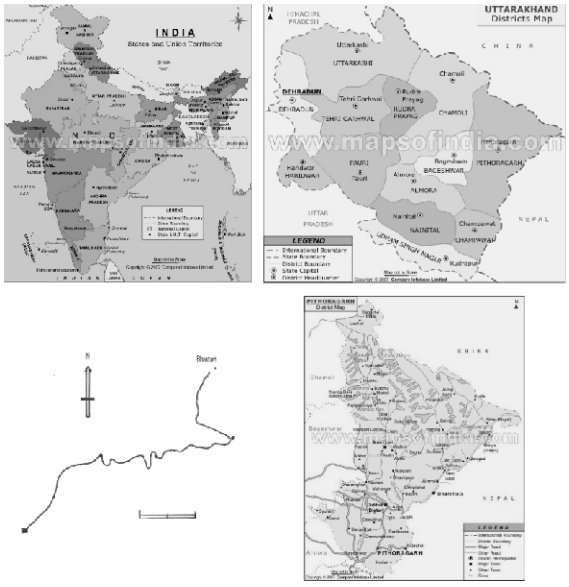

Fig.-1 Location map of the study area. Landslides occur at H P Bend near Manle

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Pithoragarh to Marh Manle the motor road is metalled and from Manle to Bhautari the motor road is under construction. At the origin point of Manle – Bhautari road there is an H P Bend (Hair pin bend). On this H P Bend the road turned from N 65^0 W – S 65^0 E to N 45^0 W – S 45^0 E (Fig.3). In the eastern side of this bend the Manle village is situated. Houses are present 15 feet below and just 10 feet away from this road. The height between road and houses increases as we move away from the road. During heavy rains on 15th of August, 2009 causes landslides in the night of 15th & 16th August which affect the H P Bend of the road near Manle Market in Pithoragarh district, Uttarakhand. The affected length of the road is 150 m. During these rainfall-induced landslides the discharge debris went up to the nearest houses after breaking the retaining wall of the road. The rock material and soil at the base of water tank moved down side (Fig. 2C). The road has been damaged (Fig. 2A, 2B & 2D) but fortunately there is no loss of human or animal lives. In this study an emphasis has also been given how to construct the road at this bend so that the landslides can be prevented in the future.

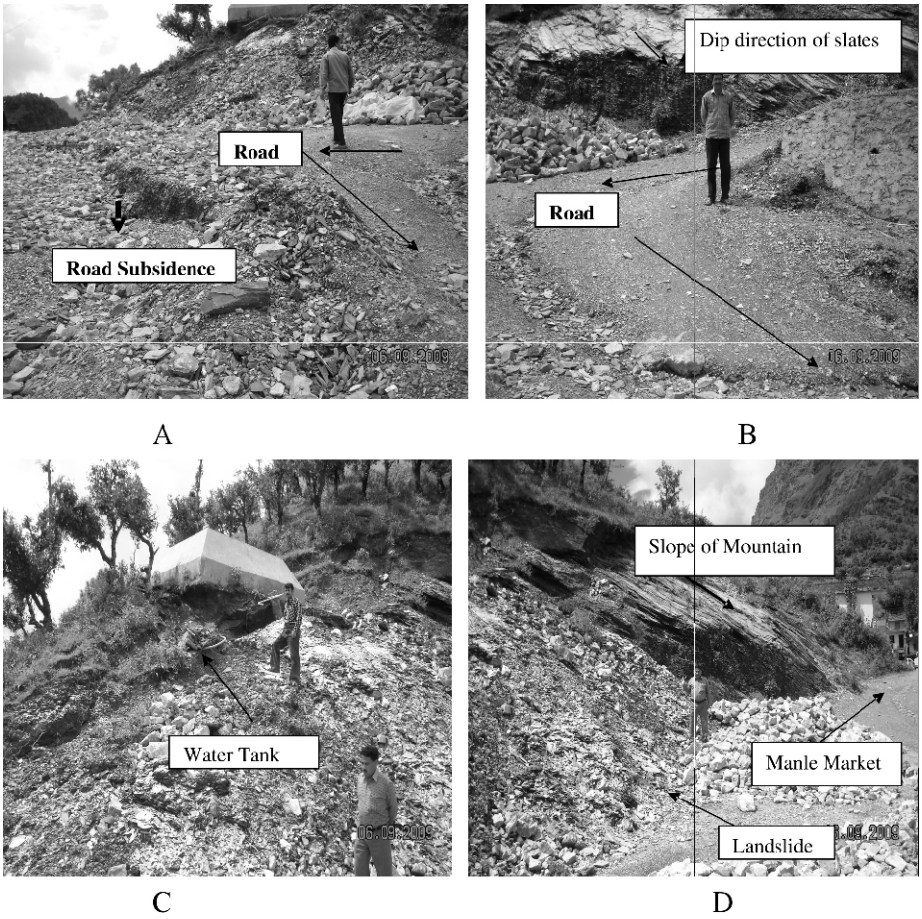

Fig.-2 A. Showing Landslides and Road subsidence B. Dip Direction of the rock and mountain slope are similar C. Rock material and soil at the base of water tank moved downwards D. Showing Landslides at the HP Bend.

Geology of the Affected Place and Surrounding Area

The study place lies in the Sor slates member of the Calc zone of Pithoragarh (Valdiya, 1962). Calc zone of Pithoragarh comprises four members from south to north viz., Thalkedar beds, Sor slates, Stromatolitic limestones and Magnesite beds, and Gangolihat beds. Thalkedar beds are cherty and dolomitic limestones and at places interbedded with calc silicate. These are conformably overlain by Sor slates. These are brown, grey, violet and black slates. Slaty cleavage is well developed in these rocks. At places argillaceous limestones occur as thin bands. Basic dykes are present at many places. Some of them have same orientation. At H P Bend where landslides has occurred slates are present dipping 24^0 to 40^0 in NNW to NNE direction and strikes in ENE – WSW to ESE – WNW. One set of prominent joint is present in this rock dipping 67^0 to 70^0 towards SSW to WSW and strike varies between ESE – WSW to SSE – NNE directions. Slope of the mountain at this place is same as the dip of the rock (Fig. 2B & 2D). Next in succession is the Stromatolitic limestones member. This member consists of dolomitic limestones with beautifully developed stromatolitic structures at many places. Crystalline magnesite is also present as interbedded with limestones. These rocks are overlain by Gangolihat beds. In this unit beds of dolomite are present along with bands and lenticles of chert. Elephant skin weathering is the characteristic feature of these dolomites.

In this area the rocks are inverted as evident by the downward arch of the laminae of the stromatolites and convex side upward of the current bedding in the Berinag quartzites (Valdiya, 1962) adjacent to this area. Thus the stratigraphic succession from oldest to youngest in the area are Gangolihat beds, Stromatolitic limestones and magnesite beds, Sor slates and Thalkedar beds. Sor Slates is equivalent to Slates stage of Simla Series (Pilgrims and West, 1928) and Shali Slates of Shali Series (West, 1939). On the basis of stromatolites the age of the Calc zone is somewhere between Late Algonkian and Late Cambrian (Valdiya, 1962).

Causes of Landslides at this place

The stability of any slope is defined in terms of factor of safety, which is the ratio of resistivity forces to the driving forces and the slope is stable when this ratio is equal or above to unity. Average annual precipitation in this region is about 125 ± 20 mm. During heavy rains the water of about 2000 m^2 area of the adjacent hill situated in the south of this road flow towards the road side because of the dip of the slate as well as mountain slope and causes landslides (Fig. 2) due to pore pressures and seepage forces. One set of prominent joint present in the slates are steeply inclined and nearly at right angle to the bedding plane and due to this the water infiltrate in the slate rocks and runs towards the dip direction of the rock. It results liquefaction along the surface, finally resulting in rapid movement of the debris. At 50 feet above the road level a small quarry of slate is also present on this hillock from where the villagers are extracting slates as building materials. This also increases infiltration of water in the rocks. Generally it is found that rainfall-induced landslides are caused by increased pore pressures and seepage forces during the time of heavy rainfall (Anderson and Sitar, 1995; Wang and Sassa, 2003).

There is no proper drainage system towards the road side. Due to this the pore pressure increases in undrained soil layers beneath the road at the eastern side of the H P Bend and subside nearly 1½ feet (Fig. 2A). For small scale landslides under laboratory condition, Sassa and Takei,

1977, and Sassa, 1984 have been also observed that the increasing pore pressure due to an undrained soil layer caused slope failure during rainfall and that the generation of pore pressure was a result of sudden initiation of subsidence.

Preventive Measures for Landslides during Reconstruction of Road at this H P Bend

At this place the main reason of landslides and land subsidence is intensive rainfall in short duration. Rapid infiltration of rainfall along joints in the slates increased pore pressure and seepage forces is believed to be the main mechanism by which landslides triggered at this place. Therefore for prevention proper water drainage system should be essential so that water should not be saturate in these rocks. Therefore for the road construction these methods may prevent the landslides at this place. The process is described along two sections PQ and XY (Fig. 3). (a) At PQ section

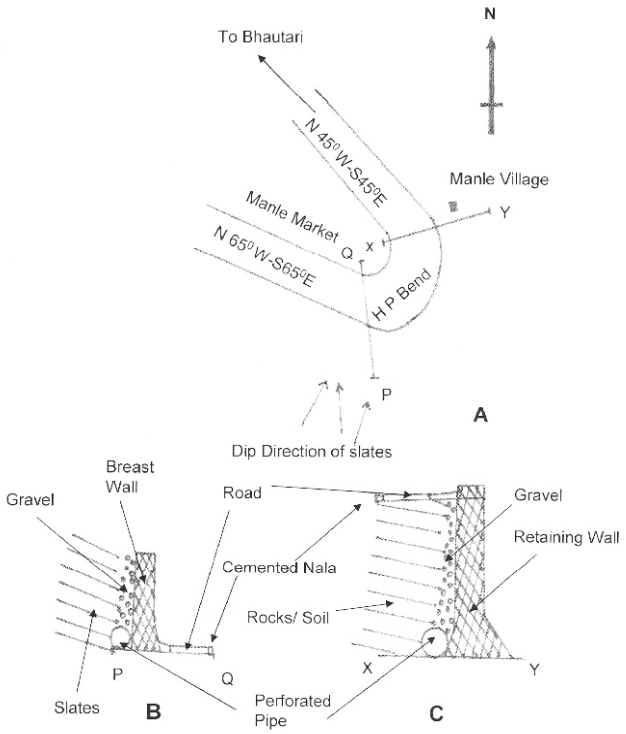

Fig. - 3 A. Showing orientation of roads before and after HP Bend,
B & C. Process of Road Construction

(Fig. 3B) towards the southern side of H P Bend breast wall should be prepared at the foot of the slope of the hill. Width of the wall must be large enough to make it stable and there should be adequate provisions for draining out water lodged inside the soil or rocks through weep holes or pipes in order to relieve with build up of pore pressures. At the base between hill and breast wall horizontal drains should be made using porous or perforated pipes. If required this horizontal drains may be used in combination with vertical drainage shafts or wells. The gravel mass filled

behind the breast wall allows accumulation of underground water without causing build up of water pressure. Cemented nala (side drain) should also be prepared towards the core side of the H P Bend so that surface water should be properly drained. (b) At X-Y section (Fig. 3C) towards eastern side of the H P Bend i.e. towards Manle village side, the retaining wall is prepared up to the firm beds provide support at the toe. Since a retaining wall has to withstand tremendous and unequal pressures and load, the width must be large enough to make it stable. Other things are similar as the P-Q section. (c) At the Bend the road surface should be cemented.

Conclusions

The study suggests that Manle landslides are rainfall-induced landslides. Joints and bedding plane in the slates have played a major role for water infiltration which increased pore pressure and seepage forces and causing landslides. The nature of slope failure is rock slips and debris slides. Dewatering near the H P Bend due to proper drainage system along with restraining and strengthening structure like breast wall and retaining wall is the main preventive measure should be taken for the reconstruction of the road, so that in future the landslides should not trigger at this place again.

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