

NOTE ON POST-DISASTER GEOLOGICAL STUDY OF THE LANDSLIDE AT NH-37, NEAR KOTLEN VILLAGE, MANIPUR

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Abstract

A landslide with an estimated dimension of 60m length x 10m width x 2m depth was reported along NH-37 which caused blockage of Imphal-Jiribam Road. The site is located at Lat. 24°46'54.10"N and Long. 93°46'33.80"E falling in SOI Toposheet No 83 H/13. Post-disaster study of the landslide was carried out on 10th June 2018 to collect the detailed attributes (42-points). The landslide occurred due to heavy rainfall which led to saturation of thick pile of weathered rock and debris resulting in a reduction of shear strength and cohesion. Moreover the presence of steep hill slope with highly permeable weathered rock and anthropogenic interference in the modification of the slope for road cutting also induced the landslide. The landslide categorised as rock slide is a reactivation of an old landslide.

Background Information

Road widening activities along NH-37 in recent times coupled with large scale quarrying of sandstones has reportedly destabilised the hillslopes and initiated a number of slope failures. The landslide reportedly occurred on 6th June 2018 and was reported in local newspaper "Nagaland Post" on 7th June 2018. On the basis of telephonic discussion with the Director, post landslide study was carried out by the officers to ascertain the cause of the landslide and to provide short term remedial measures.

Physiography and drainage

The area is a highly rugged terrain and has a youthful topography. The general trend of the hills is N-S which is similar to the trend of the lithology. At places, it swings NW-SE. The maximum elevation along Kotlen area is 1508m above msl. The area is drained by an E-W trending river the Haibirok Turei. The drainage pattern ranges from sub-dendritic to sub-parallel which is controlled by the lithology and the structural fractures - joints.

Site Geology

The slope forming material at the landslide zone comprises in-situ soil or overburden material ranging from 2 to 5m in thickness. Mainly lithic arenitic material of shale and sandstone of Disang Formation has been observed and are loosely distributed due to less content of soil. The soil cover is ranges from 2 to 8m in thickness and slided portion lies within soil cover without exposing the concealed rock of Disang formation. The bedrock is highly weathered wherein nearly 2-5 meters thick weathered rock is developed. Unscientific slope cutting along the major joint plane is the main cause of the landslide. Due to excavation and road cutting, the angle of the slope at approx. 60° has clearly exceeded the angle of repose.

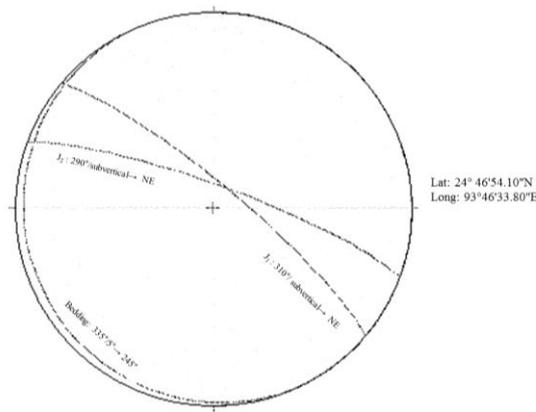
The residual hills consist of Disang Group of rocks which comprise mainly dark olive grey and buff coloured splintery shale. It is highly folded and often crushed and crumpled thus giving rise to its splintery nature. The shale is well bedded and highly jointed. Occasionally it shows nodular weathering. They are often seen interbedded with beds of fine grained hard and compact sandstone and siltstone. The thickness of these beds varies from a few centimetres to a few metres.

Slide Morphometry and Material

The slide failure is planar in shape, measures an approx. 60m length, 10m width, 40m height and 2m depth in dimension. A few prominent minor local scarps of variable length occurring within the body of the landslide have also been delineated. The slide material is of rock type in nature and it is fragmented, fractured and highly jointed.

Structural data

Structurally, the strike of the rock varies from $N15^{\circ}W$ to $S 15^{\circ}E$ to $N15^{\circ}E - S15^{\circ}W$; the general strike being $N10^{\circ}E - S10^{\circ}W$. The amount of dip ranges from 35° to 80° . Joints have been noticed in all the rock types of Disang Formation. They are better preserved in the competent bed of sandstone and siltstone, but massive sandstone shows poor development of joints. Some of the prominent joints recorded in the area are NE-SW with sub-vertical to vertical dip, NW-SE with sub-vertical to steep dip and E-W dipping towards either side. These are the prominent set of joints found in Upper Disang Formation. The third fourth order drainage controlled by this joint pattern. The sandstone-shale sequences of Disang-Barail Group show a variety of sedimentary structure and are folded into a sequence of anticlines and synclines with NNE-SSW trending axial traces.

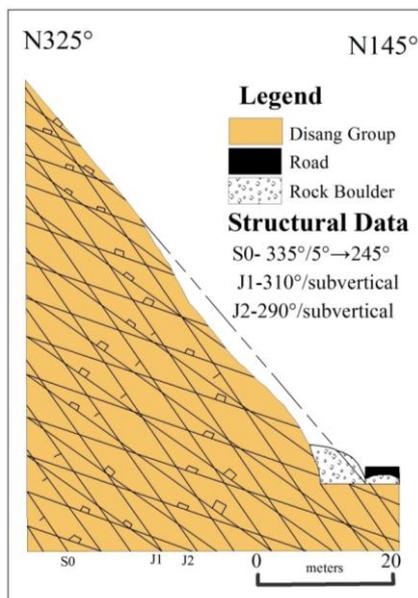


Failure Mechanism of the Landslide

Based on the disposition of the slide material as well as the visually estimated overburden thickness, a planar slide along secondary developed interface has been interpreted towards the up side of the landslide body. The primary triggering factor of the landslide is the rainfall. During the field study, it has been interpreted that the landslide has occurred due to combination of following factors

1. The bedrock is highly weathered wherein nearly 2-5 meters thick weathered rock is developed.
2. Unscientific slope cutting along the major joint plane is the main cause of the landslide. Due to cutting slope have become more than 60° which are above angle of repose. So the slope has become unstable due to this cutting and any triggering factor may lead to landslide.
3. After heavy rainfall the weathered rock absorbed huge amount of water which led to the decrease in the shearing strength of the material and it slid down.

L-Section of landslide



Field Observations

The following has been observed in the field:

1. The landslide has occurred on the northern slope of the east-west trending ridge.
2. The landslide is an active landslide and the rock fragments are falling continuously on the road.
3. General slope is 35°.
4. The slope hosts variably thick (2-5m) weathered rock overburden.
5. The dimensions of the curvilinear landslide are 60m length x 10m width x ~ 2m depth.
6. The height of the landslide is visually estimated at 40m and run out distance is 20m.
7. There is one flowing small nala which is well maintained and has no role in the landslide. Side drainage is not present on any side of the road.
8. Imphal-Jiribam Road is completely blocked from slided material, few trees on the slope are uprooted, and there is no other loss of human life and property.
9. Machineries from PWD, road and bridges were inducted for removing slided material.

Considering the above prevalent conditions as well as the inherent rock mass properties described, it is apparent that at this place landslide will occur in future and it will damage the road if the remedial measures are not taken immediately.

Recommended remedial measures

1. Immediate removal of the slided material.
2. Iron mesh of 7cm x 7cm grid size has to be placed immediately as the rock fragments are falling continuously on the NH-37 which is a busy road and it may be dangerous.
3. A breast wall with proper weep holes has to be constructed, keeping some gap between the toe of the slope and the wall so that further slided material remains as back fill material within the wall.
4. A retention wall with proper weep holes also has to be constructed along the downslope side of the road.
5. Benching/terracing of the slope.

Photographs



Photo 1: Landslide on NH-37



Photo 2: Run out material.



Photo 3: Weathered rock



Photo 4: View of landslide from distance.



Photo 5 & 6: Extensive slope cut

Annexure I: 42- Point detailed geoparametric attributes of the landslide.

1	Slide	Manipur/Noney/83H13/2018/001.
2	State	Manipur
3	District	Noney.
4	Toposheet	83H13
5	Name of the slide	Kotlen landslide
6	NH/SH/Locality	NH-37/Kotlen
7	Latitude	24° 46'54.10"N
8	Longitude	93°46'33.80"E
9	Length	60m
10	Width	10m
11	Height	40m
12	Area	600 sq. m
13	Depth	2m
14	Volume	1200 cubic meter
15	Run out distance	20m
16	Type of material	Rock
17	Type of movement	Slide and fall
18	Rate of movement	Very rapid
19	Activity	Active
20	Distribution	Retrogressive
21	Style	Single
22	Failure mechanism	Shallow translational failure
23	History	Initiated on 06.06.2018.
24	Geomorphology	Escarpment
25	Geology	Intercalation of Shale and sandstone.
26	Structure	S ₀ -335°/5°→245°, J ₁ -0°/sub vertical, J ₂ -290°/sub vertical, J ₃ -310°/sub-vertical
27	Landuse/landcover	Extensive slope cut.
28	Hydrological condition	Wet
29	Triggering factor	Rainfall
30	Death of persons	Nil.
31	People affected	Nil.
32	Livestock loss	Nil.
33	Communication	Communication between Imphal and Jiribam affected.
34	Infrastructure	Nh-37 blocked.
35	Agriculture/ Forest/ Barren	Forest.
36	Geoscientific process	<ol style="list-style-type: none"> 1. The bedrock is highly weathered wherein nearly 2-5 meters thick weathered rock is developed. 2. Unscientific slope cutting along the major joint plane is the main cause of the landslide. Due to cutting slope have become more than 60° which are above angle of repose. So the slope has become unstable due to this cutting and any triggering factor may lead to landslide. 3. After heavy rainfall the weathered rock absorbed huge amount of water which led to the decrease in the shearing strength of the material and it slid down.

37	Remedial measures	<ol style="list-style-type: none"> 1. Immediate removal of the slided material. 2. Iron mesh of 7cmx 7cm grid size has to be place immediately as the rock fragments are falling continuously on the NH-37 which is a busy road and it may be dangerous. 3. A breast wall of 150m length x2m height with proper weep holes has to be constructed, keeping some gap between the toe of the slope and the wall so that further slided material remains as back fill material within the wall. 4. A retention wall of 150m length and 3m height with proper weep holes also has to be constructed along the downslope side of the road. 5. Benching/terracing of the slope.
38	Remarks, if any	Lying of mesh is very important.
39	Photos, sketch of the plain and section of the slide	
40	Alert categorisation	Category-I
41	Summary	
42	Pdf	