IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN : 2278-1684, p-ISSN : 2320–334X
PP 50-59
www.iosrjournals.org

STUDY AND SUGGESTIVE MEASURES OF LANDSLIDES ON PUNE MUMBAI ROUTE

G. D. Indurkar[1], U. R. Saharkar[2], H. H. Ahire[3,] D.D. Kulkarni[4]

1. PG. Students in Construction Mgt. Dr. D.Y. Patil Institute of Engineering & Technology, Ambi, Pune
2,3,4. Faculty of Dept. of Civil Engineering, Dr. D.Y. Patil Institute of Engineering & Technology, Ambi, Pune

Abstract: *Landslide damages life and property. Pune Mumbai route is an important as it joins very important places in Maharashtra states. All along on the railway track and also along road some places are very prone to landslide. So it is necessary to locate and identify such places and give the corrective measure to save the life and property. One of the tragedies at last year that is landslide occur at village Malin near Pune city. This tragedy shows the impact of landslide on area affected. The area selected for the present study is between Talegaon (N18.741846 E73.629445) toKhandala tunnel (N180 88' E730 29') (Part of western ghat) Various part of the infrastructure are present along the Pune Mumbai route.For the study of landslide, it is necessity to consider the various factor which prone to landslide and also the physical condition at this place. In study area, some places require to study and make a corrective measure to stop the landslide.Here this study consist to locate the various landslide prone areas and suggesting proper measure to stop landslide.Geologically this region has weathered type rock near the surface due to highly oxidizing and humid climatic conditions, developing lithomarge clays and lateritic soil regolith.Loose cohesive soil matrix becomes soft and looses strength due to surface and subsurface flows during heavy precipitation. Regolithic mass of overburden became heavy, lost support / interlocking and slumped along the hill slope. During rainy season these loose soil masses when saturated with water causes sliding of the land. This paper also includes few suggestions about preventive / remedial measures for landslide.*

Keyword*–Disaster Management, Preventive Measure, Landslide Prone Area, metamorphic rocks*

I. Introduction

The investigation and study of landslides is to find ways to reduce their damages. This objective is possible via different ways such as landslides hazard zonation for determining the hazardous areas and providing recipes and regulations for appropriate uses of these areas or for keep away from them. Also it can be earned by studying a one landslide and presenting ways to control it.In this area there is most of earth sliding problem along roadways and railway route. The number of unusual incidents like rock fall,soilslides, soil mixed boulder slide, spread along the track causes extensive damages to the track structure and human lives. Thousands of passengers travel by railway which passes through deep cuttings along its route with gentle to steep slopes, loose rock and also some soil part and extreme climatic conditions. After the observation along route it is seen that there are lot of accident occur. Some implementation of safety measures for prevention of any failures in the future,Wadekar (2003)has described the nature of Konkan railway cuttings and various types of failure during rainy season, he also added that a continuous effort are made to stabilize cuttings to prevent boulder falls and soil boulder slides along the track by providing control measures like concrete retaining structures for soil cuttings and high strength steel nets for rock cuttings. Such type of activity is necessity for getting the proper implementation to make safe against landslide.

The study area are found very steep up to 85^0slope at some locations and the remaining slopes are with a minimum of 45^0, which also shows development of cracks during rainfall seasons. The frequency of train movement is high and the vibrations caused by the trains and minor tremors can trigger some local slides when the existing condition of the slope is highly prone to failure. So, it is necessary to study the region thoroughly and come out with the best result after a careful examination of all the contributing factors. Also there is roadways along route and as it blocks due to the rock fall or any kind of earth flow it block the traffic result in it gets impact on economy of this most tow most important cities.

Unless otherwise the evaluation is properly made on stability factors, the vulnerability is going to be high in future due to increasing traffic and developments. So, this area is taken into account for the study. Verandah Ghat of west coast of India concluded that the debris slide must have been due to a continuous cause

of heavy rainfall. The landslide hazard zonation map of various active slide zone has been drawn and finally, out of the total area the various vulnerable zone.

1.1 Theory about Landslide

Driving forces increase with increasing slope steepness and rock density, and, in the case of rotational failures, with increasing slope height. The resisting forces are due to the strength of the slope materials, strength added by roots, buttressing of the lower part of the slope by materials that have to be pushed or rotated out of the way before the upper part of the slope can move.

The factor of safety of a slope is the ratio of resisting forces to driving forces, if the factor of safety is less than or equal to 1 (i.e., $F \leq 1$), the slope will fail because driving forces will equal or exceed the resisting forces. If F is significantly greater than 1, the slope will be quite stable. However if F is only slightly greater than 1, small disturbances may cause the slope to fail. For example, if $F = 2$, the slope has resisting forces twice as large as the driving forces, and it will be extremely stable. If, on the other hand, $F = 1.05$, the slope's strength is only 5% greater than the driving forces, and slight undercutting or steepening, or very heavy rain, or seismic shaking may easily cause it to fail.

From above some technical concept it can says that there is different technique to be applied for different situation. So in studying area of consideration it to be examine and find the due condition. Also in this area due to there is different soil condition in different places and also cause of landslide is different.

There are various technique applied for landslide measure but in spite of that there is the landslide occurs so it can be conclude that that system is not efficient for to prevent the landslide. There are some landslide are as given in table 1 and there remedial measure are given in table 2. It very important to use this type of technique with proper planning and after some investigation of the physical and geological condition. This technique which are given work on some mechanism and save the movement of landmass.

It very important planning for the study for various places and identify them for landslide before occurring and damaging the property for this purpose various cases of landslide and the situation to be study so as to familiar to landslide activities and what points that to be included in the landslide, And also there are various technique to prevent landslide but these technique use to some specific condition that is for above type of landslide condition different technique to be use. Sometime these are use in proper combination.

Table 1 Types of landslides

Sr. no.	Types
1	Falls
2	Flows
3	Creep
4	Debris flow
5	Debris avalanche
6	Lahar
7	Lateral spreads Often
8	Slides
9	Rotational landslide
10	Translational landslide
11	Topple

Table 2 Types of technique to avoid landslides

Sr. No	Hazards type	Technique
1	Rock Slope Protection	Shotcreting of slopes
		Grouting
		Provision of Rock Collecting Trenches
2	Passive protection	Control of Instability effects

	system	Trenches, rock fences and
		Rock fall protection
3	Embankment	Surficial revetments
		Tie back anchors
4	Benching of Slopes	Provision of Rock fall fences
		Provision of Protection shades
		Provision of Rock Bolt
		Covering of slope with Coir netting or geo grid.
5	Soil bioengineering	Live Staking
6	Wall	Live crib wall
		Vegetated rock gabion
		Vegetated rock wall
		Geo cell for slope stabilization

1.2 Objective

1. Study of landslide on Pune Mumbai route consist of various spot on infrastructure and there impacts.
2. Locate landslide prone area on railway track as well as on road.
3. Present technique use at places of concerned area and identify the causes of landslide
4. Prepare landslide preventive technique
5. Suggest corrective technique which require to prevent the landslide.

II. Study area

The area selected for the present study is between Talegaon (N18.741846 E73.629445) to Khandala tunnel (N180 88' E730 29') (Part of western ghat) Various part of the infrastructure along the Pune Mumbai route. This covers linear distance of about 65km.Which shown in the location map. There number of spot of which very endangered to fall concerned and get affect to the present structure.

III. Methodology

First of all a methodology was framed for this project. A field survey was carried out on the various spot along the Pune Mumbai westered patch. Field survey included talk with the local people around the spot taken. A field survey sheet was prepared and factor such instability slope, loose soil, less vegetation, water content, some infrastructure, geological condition etc. were studied. Normal test on soil sample was conducted for properties such as permeability moisture contents shear test etc. Analysis of observation was done. At some spot the existing structure were found to be inadequate and preferable suggestion and correction were provided.

This study included study for landslide then find spot on patch and as per situation give measure.

IV. Data collection

Various maps and GIS Software has been use to study the + prone area. The study area is around 130 km^2. Topo sheets of survey of India have been utilized as main primary input to prepare the base map, drainage map and contour map. LANSAT imageries of IRS-1B and IRS-1D are used in this study to assess the landform features. As the rainfall is very important factor in landslide concerned so it is very necessity to get the data of of rainfall to concerned area so that to identify the spot and impact. Land use and Land cover thematic maps

have been prepared by using GIS software. During the data collection some spot are located to give remedial measure for safety against landslide.

Table 3 shows the data collection along study route. The remedial measure are given to that spot and there causes are describe briefly in this study. This data was collected in rainy season as the triggering factor of landslide seen at that condition. The data were formulated as per the GPS coordinates on a route also the data collected as soil condition seen there. The spot selected as per impact and its vulnerability at that point.

Along westered Ghat there are various places that are prone to landslide and there various causes which lead to landslide. Pune Mumbai patch is also a part of the westered ghat and contain the some important structure so some selective spot are presented here.

The actual condition are shown in Table 3 which shows the geological and physical condition of the various places

Table 3 Geological and physical condition of the various places

Sr. No.	Place Name	Coordinate	Condition and Remark
1	Between Vadgaon To Kanhe	N18.74184 E73.62944	Retaining wall exist but due to existing of pebbles and cobbles present with soil and heavy rainfall it does not sustain by the single retaining wall. Vegetation on top
2	Near Kamshet Railway Station on the highway	$N18^0$ 45.88' $E73^0$ 32.55'	At this place there two spot, at spot A which content lateritic soil cover at top and with vegetation coverThe portion have 100 m length and 6m height. At the B spot which content soft weathered basalt rack
3	Near Kamshet Rly Station at the base of highway	$N18^0$45.44' $E73^0$ 32.96'	This place is important because of small movement make highway collapse At this place soil containing black cotton soil with pebbles and cobbles which is covered with vegetarian. Here rainfall is high and ground water table is low.Geologically the rock present here is weak as presence of spheroidal weathering in basalt, the slope around 60
4	Boraj Village	N 18^0 44.51' E 73^0 30.12'	Boraj village is place at foot of hill and the soil contents small pebbles and very low shear strength as water content increases there may be mud flow. At the upper portion of hill content big trees also due to also wind it make shaking effect to the soil. No retaining structure.In 1975 there is small landslide occur.
5	At KhandalaRaiway Station	$N18^0$ 75.38' E 73^0 382'	There is basalt rock present which having fracture pattern. There is some loose material on the surface of the cut and it is 30m to 35m height.At this place due to vertical cut the loose material fall and so it require catch structure.
6	At Khandala Station on Highway	$N18^0$ 75.38' $E73^0$ 3720'	Here also the rock fall done due to the fracture in rock. Some places observe some fall of loose material due to vibrant action of train passingAt this site there is portion having unsupported which leads to rock fall. The height of the cut is 20m to 25m. and length is 100m to 150m on both side
7	Near Khandala Station on Highway	$N18^0$76.76' $E73^0$ 3559’	There is no any treatment provided for preventing the landslide. Also the road here is narrow and congested. The vegetation cover is there on the slope having approximately of 60 degree and above which is trigger to landslide and surface contents weathered soft rock which very low strength and stability.There is vegetation cover which reduce the possibility of landslide but due to heavy rainfall and no scope of drainage there it get fail to stabilize.
8	The spot on Express way Near Khopoli Tunnel	$N18^0$ 76' $E73^0$ 36'	Here very thin wall type structure contents soft rock basalt rock and fracture pattern. Due to thin and vertical structure it will collapse on the express way. There is rainfall and also the very high wind speed flow. This structure is treated with the bolting and wired mesh which having 150mm spacing.

9	A view on NH4 Which is example of subsidence	N 18^0 76' E 73^0 35'	There is clear sign of major crack development on the surface which shows the separation of wall from the road or movement of the wall from the fill. As in second images show as it is deep valley it very critical condition here due to the movement of wall. Here at this place it require to construct buttress wall instead of the plain retaining wall.
10	On side of Express Way at Khandala tunnel	N18^0 88' E73^0 29'	As there is very high surface which is not treated by any way this will collapse by means of vibrant action of wind tricks to the trees and it affects to the surface soil so it is lead to the collapse. Here this should be prepared by the applied by the wired mesh with bolting.

Sr. No.	Place	Spot	Photograph Photo
1	Between Vadgaon To Kanhe along NH4	N18.74184 E73.62944	
2	Near Kamshet Railway Station on the highway	N18^0 45.88' E73^0 32.55'	

3	Near Kamshet Rly Station at the base of highway	$N18^0$45.44' $E73^0$ 32.96'	
4	Boraj Village	N 18^0 44.51' E 73^0 30.12'	
5	At KhandalaRaiway Station	$N18^0$ 75.38' E 73^0 382'	

6	At Khandala Station on Highway	$N18^0$ 75.38' $E73^0$ 3720'	
7	Near Khandala Station on Highway	$N18^0$76.76' $E73^0$ 3559’	
8	The spot on Express way Near Khopoli Tunnel	$N18^0$ 76' $E73^0$ 36'	

9	A view on NH4 Which is example of subsidence	N 18^0 76' E 73^0 35'	
10	On side of Express Way at Khandala tunnel	N18^0 88' E73^0 29'	

The study area chosen is between Pune Mumbai Track in western Ghat due to excessive rainfall in that track. Also the soil condition getting there is very loose containing non- cohesive soil with small pebbles, and other loose material which is very prone to landslide. During the the mansoon this data of rainfall of study area.

4.1 Physiography

In western ghat there are various features which are very important in economical point of view. The Western Ghats or Sahyadri are a mountain range that runs almost parallel to the western coast of the Indian peninsula, located entirely in India.

The physiography of westered Ghat is typical for its irregular landscape, rugged and hilly nature of the terrain. It is a small and narrow strip of land with Sahyadri range on east and the Arabian Sea on the west. Deep valleys of east-west flowing rivers, study plays an important role in planning for the future developmental activities in the area. In this analysis hazard map is prepared to identify the areas susceptible to instability. The terrain is classified according to the degrees of actual or potential susceptibility to landslide hazard. So, that these areas can be given priority to take care to avoid or to mitigate the risk of landslides. Most of the area is having plateau region with steep slopes, these slopes are used for cultivation purpose. Most of the area is covered closer to these slopes, which are steeper in nature coming under high hazard zone.

Table 4 Measures of landslide at various places

Spot. No.	Place	Measure
1	Between Vadgaon To Kanhe along NH4	At this place retaining wall present but there is frequently landslide occur here some micro pilling to be inserted so as to compacting the ground.
2	Near Kamshet Railway Station on the highway	At this place there is no such structure of landslide avoiding, also here some part have soil so it treated with Gabion walls and at second place there is suitable of covering of slope with Coir netting or geo grid.
3	Near Kamshet Rly Station at the base of highway	Here as there is versed condition so at this place provision of Rock-fill buttresses type treatment is suitable.
4	Boraj Village	This place is similar case of Malin here proper drainage system with rerrace bedding is essential. And also regular inspection of the water content to be measure at rainy season.
5	At Khandala Raiway Station	At this place the cut surface is very high and it unsupported, as per the geological condition it necessity to provide bolting and netting with shot creating
6	Near Khandala Station on Highway	At this place there should provide a re-reinforcing structure and a retaining wall. Also the vegetation are grow on the surface.
7	A view on NH4 Which is example of subsidence	At this place there is subsidence seen on the side of highway and there is presence of plain retaining wall but it is not retain this here buttress type retaining wall to be prepared so as to avoid sliding also there should be soil stability treatment provide.

4.2 Geology

There are various forms of geological feature are seen in the study area contents rocks soil and also some combined feature. During study on the specify area the weathered rocks with pebbles and cobbles are found that is weak matrix of rock which loose and very prone to landslide. The westered region is fully covered by laterite and Deccan trap, which is formed due to volcanic eruption of about65 million years back. The study area characterized by moderate (7^0) to steep (60^0) slopes with a maximum relative relief of 280 meters. All over the area laterite formations common associated with lithomarge clays. The Dharwarian rocks mainly Granite gneiss. lithomarge clays.

V. Suggestive Remedial Measure

The above detected spot from study area on Mumbai Pune patch is required to detailed study and provide the corrective measure as per the physical and geological condition. Some places have some measures but they are unable to sustaine that condition that is sometimes it is necessity to construct combination of landslide arresting structure. So here some treatment have suggested to make a proper structure at some places. During the study the along the patch some places detected. Here above some spot detected and some of them suggested proper method of landslide treatment and some places. We have completing the study and it detecting the place no 8 and after that some part here fall down which having net bolting but it require some grouting treatment.

At this patch is very important as per the economic point of view and the recent tragedy about that patch due to rock fall along expressway shows that the impact of transportation along the road which result in heavy loss of people who are related with this project. So as cost involve in this project but as compared to tragedies due to landslide it is important.

VI. Conclusion

From present study, Pune Mumbai region requires a detailed investigation to prepare the surface hazards maps to save property and also beneficial to infrastructure along patch. Some places have landslide preventing structure but they are not sufficient to capable of that much load of sliding mass. As landslide occur mostly in rainy season so it also require to give pre monsoon treatment to surface under landslide.

References

[1]. Nagarjan. R., R., Khire. M.V., (1998), Debris slide of Varandhghat, West coast of India, Bulletin Engineering Geology and Environment, Vol: 57, pp.59-63.
[2]. Wadekar .V.S,(2003) Rock cuttings in konkanrailway"Geo technical issues of Konkan region" Konkan Railway corporation Mumbai
[3]. IOSR Journal of Mechanical & Civil Engineering (IOSR-JMCE)
[4]. ISSN: 2278-1684PP: 51-59 Department of Disaster Management, CARISM, SASTRA, Thanjavur-613
[5]. ISSN 0386-5878 PWRI Technical . Note No. 4077 on landslide prevention tech