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# A Study on Landslide Disaster Management

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**ABSTRACT** :Landslide Disaster Management study need for the particular area where it is frequently occur and also where its occurrence badly affected to the routine activity. Any route either it is of railway or roadway or any other structure require to geological study and engineering study. As the soil is natural material and containing very complex structure it is very important to make proper study and evaluation so that it does not fail in shear as it leads to landslide. here in this paper from studying along some route in Maharashtra region, India. In this study route contents very important projects such as National Highway and the railway route.

From surveying along this route there are various places are come under very danger condition. So here in this paper the various method of landslide mitigation technique are explain and what condition which to be suitable also explain.

**KEYWORDS**: Landslide, Geological, mitigation, complex structure, Disaster management.

### I. INTRODUCTION

One of the critical problem that facing by the people for landslide along important places which are very much affected to the daily traffic flow. Mostly landslide occur on the rainy as the water make the soil very loose and it get fail to sustain. This problems of landslides are very critical on traffic flow area such as along railway, road way and also at some important places. When we talk about soil it is very important to know its characteristic and physical condition also while suggesting the prevention technique, it require this soil characteristic. mostly landslide occur in rainy season due to excess water. Here landslide are classified according to various factor. Some places are search to study landslide characteristic and suggesting some treatment there. The most important method here explain and their suitability. The places selected from Lonavala to Panvel Area In Maharashtra Region. this is very important places as it flows very high traffic and also it contents connection between two important places. The soil characteristic along this route are soft rock and some places gravelly soil. In this region there is very heavy rainfall which very landslide triggering factor. The important thing along this study route is infrastructure. So it is important to study.

### II SOME POINT FROM KONKAN RAILWAY STUDY

The number of unusual incidents like rock fall, soil-slides, 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

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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  $85^{\circ}$  slope at some locations and the remaining slopes are with a minimum of  $45^{\circ}$ , 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.

### III. 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 landslide occur during the rainy season the landslide occur due to loosing soil mass it happen due to the water and the some other factor. What happened during summer season, sue loss of moisture the soil become very dry and the trees routs contracts due to this loosen the soil. And in rainy season water seeps under the soil in deep and slope fail.

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 2 and there remedial measure are given in table 1. 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.

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## IV. TECHNIQUE USE TO PREVENT LANDSLIDE

### Reducing the height of the slope

Reducing the height of a cut bank reduces the driving force on the failure plane by reducing the weight of the soil mass and commonly involves the creation of an access road above the main road and the forming of a lower slope by excavation. Also, it is possible to excavate deeply and lower the main road surface if the right-of-way crosses the upper part of a landslide. This method is moderately efficient in increasing stability of slope.

### Backfilling with lightweight material

A technique related to height reduction is to excavate the upper soil and replace it with a lightweight backfill material such as woodchips or logging slash. Then, covered with a thin layer of coarse aggregate, the backfilled material can form a foundation for limited-use traffic. **Strengthening Slopes**

There are numerous synthetic soil reinforcement materials in the market, and one example is a reinforcement material of plastic polymer stretched to form a lightweight, high-tensile-strength grid. The grid acts similarly to reinforcing mesh in concrete, adding strength to the shear strength of the soil.

### Rock-fill buttresses

A simple method to increase slope stability is to increase the weight of the material at the toe, which creates a counterforce that resists failure. A berm or buttress of earth fill can be easily dumped onto the toe of a slope. Broken rock or riprap instead of soil is preferable, however, because it has a greater frictional resistance to shear forces and is also free draining, which reduces the problem of impeding ground-water flow.

### Retaining Walls:

For all types of retaining walls, adequate drainage through the structure is essential because very high groundwater pressure can build up behind any retaining wall, leading to its failure. Drainage can be provided simply with a coarse backfill and foundation material. Timber crib walls are box structures built of interlocking logs and backfilled with coarse aggregate. They work by intersecting the critical sliding surface, thus forcing the potential failure surface to a deeper, less critical depth. The structure must be able to withstand: (1) shearing, (2) overturning, and (3) sliding at the base.

It must, therefore, be strongly built by burying to sufficient depth and extending beyond the critical failure plane. Crib walls are only effective where the volume of soil to be stabilized is relatively small. They are most efficient where a thin layer of unstable soil overlies a deeper, more stable layer of soil. Crib wall structures should have a volume equal to 10 to 15 percent of the volume of the soil to be stabilized. This relatively small volume provides little counterweight support at the toe; therefore, virtually the entire resistance to failure comes from the strength of the

### Steel bin wall

A steel bin wall is formed from corrugated galvanized steel components bolted together to form a box and then filled with earth. The stability of a gravity wall is due to the weight of the wall itself, perhaps aided by the weight of soil in front of the wall. The bulk of the weight is from the contained soil, not the steel, and this should be kept in mind when the foundation is prepared.

### Gabion walls

Gabions are wire mesh, boxlike containers filled with cobble-sized rock that are 10 to 20 centimeters (4 to 8 inches). A gabion retaining wall can also be constructed from stacked gabions. Gabion walls usually are inexpensive and are simple and quick to construct. Due to their flexibility, they can withstand foundation movement, and they do not require elaborate foundation preparation. Because of their coarse fill, they are very permeable and thus provide excellent drainage. Gabion walls work because the friction between the individual gabion rows is very high, as is the friction between the basal row and the soil underneath. When failure occurs, it is almost always in the foundation soil itself. Three-tiered walls up to 2.5 meters (8 feet) high can usually be constructed without consulting any detailed engineering analysis. Higher walls are very heavy by nature of their added bulk and need larger base foundations and possibly counter forts for bracing of the wall. (A counter fort is a buttress bonded to the rear of walls, designed to improve stability.)

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## Shear Piles Wall

Large-diameter piles can be placed into the toe of a slope to form a closely spaced vertical pile wall. Shear Pile walls are normally used as a pre excavation restraint system—the cut slope excavation takes place in front. Whereas large-diameter concrete pile and culvert pile walls have been used successfully on highways, wood or steel piles that are small in diameter have not. The piles should extend well below the potential failure surface and be firmly driven into firm subsoil. Surface drainage measures require minimal design and costs and have substantial stability benefits. They are recommended on any potential or existing slide. The two objectives of surface drainage are to prevent erosion of the face, reducing the potential for surface slumping, and to prevent infiltration of water into the soil, thereby reducing ground-water pressures. Subsurface drainage also is effective but can be relatively expensive.

## Slope Stabilization Using Vegetation:

Seeding with grasses and legumes reduces surface erosion, which can under certain conditions lead to landslides. Planting with shrubs adds vegetative cover and stronger root systems, which in turn will enhance slope stability. If not controlled, surface erosion and small, shallow slope failures can lead to larger problems that cannot be controlled. Large-scale erosion requires applied engineering technology to correct and control.

## Shotcrete and Guniting:

Shotcrete and guniting are types of concrete that are applied by air jet directly onto the surface of an unstable rock face. Shotcrete is an all-inclusive term to describe the spraying of concrete or mortar either by a dry- or a wet mix process. Guniting refers only to the dry-mix process in which the dry cementations mixture is blown through a hose to the nozzle, where the water is injected immediately before application. This is a rapid and relatively uncomplicated method commonly used to provide surface reinforcement between blocks of rock and also to reduce weathering and surface scaling. Shotcrete contains aggregate up to 2 cm in size and is more commonly used than guniting, which has smaller aggregate. Both materials can be applied rapidly by air jet so that large areas can be covered in a short time.

## Anchors, Bolts, and Dowels:

These are tools composed of steel rods or cables that reinforce and tie together a rock face to improve its stability. Anchors are post-tensioned members used to support large blocks of rock, whereas bolts are shorter and support surface rock. Dowels are similar to bolts but are not post-tensioned. Reinforcing a rock slope with steel requires a specialist's knowledge of rock stability analysis, of grouting techniques, and of testing procedures. The determination of the orientation of the potential failure surfaces is crucial to a successful anchor system and requires a considerable amount of engineering experience.

## Debris-flow basins:

They are used especially in areas where the debris must be contained so that soil and debris are stopped from flowing into sensitive ocean or river shorelines areas or where there are structures at the base of the slope that are vulnerable to debris-flow damage. These basins may eventually fill with the debris-flow deposits and must be emptied periodically or they will overflow. Commonly, large pieces of equipment such as dump trucks and power shovels are needed to empty the debris and carry it away. However, small basins can be emptied manually. They should be designed to be able to contain the maximum flow volumes of an area to prevent overtopping during a flow event.

TABLE NO.1 TREATMENT TO LANDSLIDE

Sr. No	Hazards type	Technique
1	Rock Slope Protection	Shotcreting of slopes
		Grouting
		Provision of Rock Collecting Trenches
2	Passive protection system	Control of Instability effects
		Trenches, rock fences and
		Rock fall protection

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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
		Geocell for slope stabilization

## V. 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.

## VI. DATA COLLECTION

The Data was collected along the study patch and evaluate for the measure. As the rainfall is very important factor in landslide concerned so it is very necessity to get the data 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 4 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.

While data collection the most important thing to be consider as a important of places and also the impact and effect of the landslide over there. The overall detection of the spots is observing the condition over there. From the study of the throughout over route spot detected. While collecting the data of spot from the various strategy and the internet data for information getting easy to work. The values due to landslide loss is very big as compare due to structure providing there. It is seen from various strategy it shows as due to landslide occur and it consume resources and property loss. Also during rescue operation it require high investment and get very loss.

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**TABLE NO. 2 PLACES FOR STUDY**

Sr. No	Place Name	Coordinate
1	Near Kamshet Railway Station on the highway	N18 <sup>0</sup> 45.88' E73 <sup>0</sup> 32.55'
2	Near Kamshet Rly Station at the base of highway	N18 <sup>0</sup> 45.44' E73 <sup>0</sup> 32.96'
3	Boraj Village	N 18 <sup>0</sup> 44.51' E 73 <sup>0</sup> 30.12'
4	At Khandala Railways Station	N18 <sup>0</sup> 75.38' E 73 <sup>0</sup> 382'
5	At Khandala Station on Highway	N18 <sup>0</sup> 75.38' E73 <sup>0</sup> 3720'
6	Near Khandala Station on Highway	N18 <sup>0</sup> 76.76' E73 <sup>0</sup> 3559'
7	The spot on Express way Near Khopoli Tunnel	N18 <sup>0</sup> 76' E73 <sup>0</sup> 36'

**TABLE NO. 3 TYPES OF LANDSLIDE**

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

### VII. 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 sustain 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.

**TABLE NO. 4 REMEDIAL MEASURE SUGGESTED**

Spot. No.	Place	Measure
1	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.
2	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.
3	Boraj Village	This place is similar case of Malin here proper drainage system with terrace bedding is essential. And also regular inspection of the water content to be measure at rainy season.

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4	At Khandala Railway 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
5	Near Khandala Station on Highway	At this place there should provide a reinforcing structure and a retaining wall. Also the vegetation are grow on the surface.
6	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.

### VIII. CONCLUSION

Study of landslide is necessity for proper treatment and also for avoiding the any disaster which occur. Landslide study is also very important to assess the landslide loss. From study through over it is seen from site and also from various events there are lot of places where landslide treatment is required and also some places is required to analyse the structure and give corrective measure. As consult to cost of structure it cleared from various events the loss due to landslide, that cost is very less. Because of huge loss in the form of Traffic Jam, property loss, infrastructure loss, human loss, resources and all other thing.

Here as very few spot are chosen to study but out of this spot there are lot of places to be study. Also some study require for Konkan Railway route which faces lot of problem during rainy season. Due to the geological condition and physical condition landslide occur.

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