GEOTECHNICAL INVESTIGATION OF LANDSLIDE OCCURRED IN CHARMADI GHAT: A CASE STUDY

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ABSTRACT

For centuries human has tried to control the nature for their advantages and to some extent, they have achieved in harnessing the Mother Nature. During the ancient times, human had a little knowledge about the nature and its functioning, but as the time elapsed more innovative technologies developed, population rate increased and the land become scarce, as a result human become greedy for their own needs, a lot of disasters other than natural calamities began to strike – the manmade disasters [3]. The project mainly aims at studying the geotechnical aspects of a landslide occurred in Charmadi Ghat, Dakshina Kannada district, Karnataka. The study includes the primary investigations of the site, collection of soil samples, testing of samples, and analysis of test results with scientific theories, mapping of the study area and finally proposing the remedial measures to mitigate landslide effects.

Keywords-*Landslide, Arc-GIS*

I. INTRODUCTION

A. General

Landslide refers to several forms of mass wasting that include a wide range of ground movements, such as rock falls, deep-seated slope failures, mudflows and debris flows. Landslides can occur underwater, in which case they are called submarine landslides, and in coastal and onshore environments. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting slope stability. Typically, pre-conditional factors build up specific surface or sub-surface conditions that make a slope prone to failure, whereas the actual landslide often requires a trigger before being released.

A massive landslide had occurred at Charmadi ghat 81km from Mangalore city in the Western ghat on June 12th 2018.Landslide had occurred due to heavy rain, has severely affected free flow of traffic on the ghat highway that connect Mangalore – Bangalore route (NH-234).As many as 210 vehicles mostly large vehicle, buses and four wheelers and 1500 people were stranded due to landslide and retaining wall constructed near drain in Sakleshpur was collapsed. Since June 12th nine landslides occurred in different places in Charmadi ghat

This thesis work involves the investigation of the geotechnical properties of the soil collected from a landslide prone area in Charmadi ghat. The collected soils were taken to the geotechnical laboratory and the properties are analysed by conducting corresponding experiments as per Indian Standards. Due to the increase of water content the stress increase and the strength decreases leading to landslide causing extensive damages. The susceptibility of slope to failure is dependent on many factors like slope, geotechnical property, cohesion and presence of discontinuity.

B. Mapping Of The Area

Advancements in computer knowledge, modeling, Remote Sensing (RS) and Geographical Information Systems (GIS) have particularly been handy to detect landslide zone. Through modeling coupled with RS and GIS use, landslides can be predicted and the landslide vulnerable as well as landslide zone areas can be mapped out. This information is not only important to the policy makers but also to the public especially in the affected areas, in terms of providing early warnings, evacuation exercises and general preparedness.

Generally, disaster management involves four stages of prediction, preparation, prevention and mitigation and damage assessment. RS and GIS techniques have been reported to be handy in all these stages. With the landslide problem

expected to escalate due to increasing climate variability and change and increased land use change, the ability to provide fast and accurate landslide information is/will be critical in order to minimize landslide associated damages

II. OBJECTIVES

- Characteristic study of soil.
- Collection of annual rainfall data of the area
- Mapping of landslide zone are
- Proposing remedial measures

III. STUDY AREA

. Charmadi Ghat starts from Charmadi village (11 km from Ujire) and ends at Kottigehara (14 km from Mudigere). Charmadi Ghat connects the north eastern part of Dakshina Kannada to Chikkamagaluru district and the prominent highway is connecting Ujire (9 km from Dharmasthala) to Kottigehara (about 50 km from Chikkamagaluru). Ballarayanadurga is a fort atop a hill located about 10 km from Sunkasale, on the Kottigehara - Kalasa route.

Ballarayanadurga fort can be accessed from 2 sides - the shorter route from Sunkasale, located on the way from Horanadu or the longer route from Bandaje. In the Charmadi ghat, there is a waterfall named Bandaje Arbi (arbi in Tulu means 'waterfall') which falls from a height of 200 feet. Gadaikallu peak has an elevation of 1700 feet. The Netravati River originates at Bangarabalike which lies between Charmadi and Kudremukh. This ghat section is very deep compared to the other Ghat sections of Karnataka. Compared to other places in Dakshina Kannada, the winter is quite chilly in Charmadi because of the elevation. The latitude and longitude of study area is N13.0581" and E75.4294" respectively.

Fig 1: Toposheet of study area

Fig 2: Landslide in Charmadi ghat

IV. METHODOLOGY

A. General

This work deals with the investigation of geotechnical properties of soil that are prone to landslide. For this an area identified to be a landslide prone area was identified. In this work the area considered is Charmadi ghat, Dakshina Kannada which is part of western ghat. By the survey and filed investigation locate the exact place where landslide had happened. Disturbed soil samples were collected from the sampling locations and were placed in polythene bags for transporting it to the laboratory. These soil samples were used for determination of various soil parameters as per IS

codes. Landslide susceptibility map is generated for a given area by correlating the principal factors that contribute to the landslide disaster with the past distribution of slope failures.

B. Geotechnical Experiments

The materials used for this study were soil and water. Soil samples were collected from slope failure location. These were kept safe and dry in jute bags in the Geotechnical laboratory of the Department of Civil Engineering. They were dried for two weeks to allow partial elimination of natural water which may affect analysis, then sieved with No.4 (4.75 mm opening) to obtain the final soil samples for the tests. The prepared samples is then used for the following tests:

- Sieve Analysis
- Field Density
- Specific Gravity
- Liquid Limit
- Plastic Limit
- Proctor Test
- Direct Shear

C. Methodology used for mapping

ArcGIS:

A GIS (Geographic Information System) is a powerful tool used for computerized mapping and spatial analysis A GIS provides functionality to capture,store,query, analyze display and output geographic information.

For this seminar we will be using ArcGIS Desktop 10, the newest version of a popular GIS software produced by ESRI. This course is meant to teach some fundamental GIS operations using ArcGIS. It is not meant to be a comprehensive course in GIS or ArcGIS. However, we hope this seminar will get you started using GIS and excited about learning more.

V. OBSERVATION AND RESULT

SITE OBSERVATION

Massive landslides that occurred on Charmadi Ghat (NH-234) due to copious rains, has severely affected the free flow of traffic on the ghat highway. Landslides occurred at nine locations of the ghat. A hillock that caved-in and blocked the road, following Monday night's incessant downpour, has led to a traffic piling up for several kilometres on either side of the ghat. Motorists travelling between Mangaluru and Bengaluru via Charmadi Ghat on Monday night underwent a harrowing experience as they were stuck in a traffic jam in the middle of the ghat all night. Road clearing operations were painfully slow and arduous because as one side of the road was being cleared of slush and huge trees a landslide would occur on the other side of the highway. Vehicles remained stranded for several kilometres on either side of the stretch since Tuesday morning. Following the closure of the Shiradi Ghat (NH-75) for the second phase of the work, the second phase of the work, the traffic on Charmadi Ghat had increased. All the vehicles bound to Mangaluru from Chikkamagalur have been diverted from Kottigehara. Following the closure of Charmadi Ghat, the alternative route to Mangaluru-Bengaluru via Karkala-Kalasa-Kottigehara or Puttur-Sullia-Madikeri.

Fig 3 : Condition of the site

The following were the test results for the soil sample :

Sl.No	Description of properties	Obtained results
1	Colour	Reddish-Brown
2	Field Density (kN/m3)	13.4
3	Specific Gravity	2.1
4	Grain Size Classification (%)	51% soil pass through 75 micron sieve
5	Liquid Limit (%)	32
6	Plastic Limit (%)	25
7	Maximum Dry Density (kN/m3)	18
8	Optimum Moisture Content (%)	16
9	Cohesion (kN/m2)	5
10	Angle of internal friction (ϕ)	45

Different maps are created using ArcGIS software such as drainage network, contour map, slope map, aspect map, hillshade map, triangulated irregular network map for the study area.

1. DRAINAGE NETWORK MAP

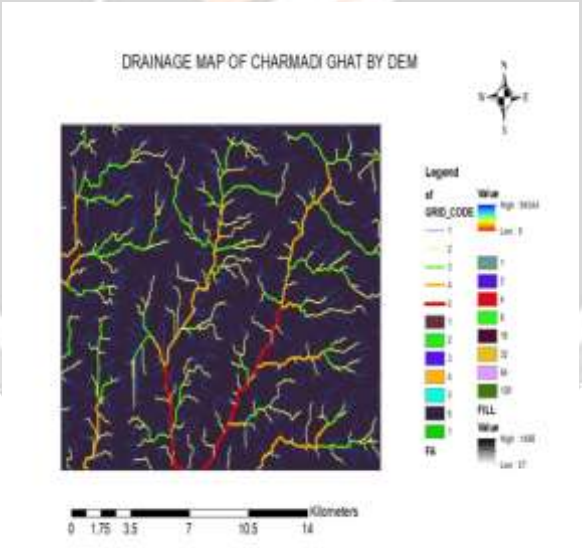

Fig 4: Drainage Map of Charmadi ghat

A drainage network map for the study area is prepared by digitization of drainage lines both perennial and non-perennial from the SOI topographic sheets containing the study area. The prepared drainage network map is then used for morphometric analysis of the drainage basins. These information are helpful in characterizing the basin parameters such as lithology, rainfall etc. on drainage network and examining the effects of variables on the drainage network. The analysis has been done by Strahler's method.

2. CONTOUR MAP

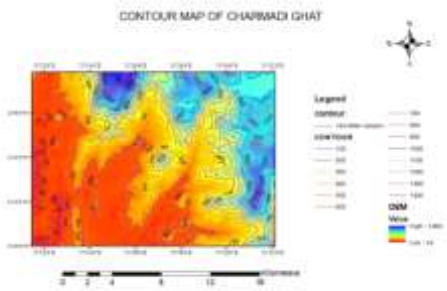

Fig 5: Contour Map of Charmadi ghat

Contours serve two main purposes on a map: first is to show lines of constant elevation, allowing a map reader to interpret a good estimate of the elevation for a place on the map; second is to show the shape of the landscape in terms of landforms, slope, and aspect.

ASPECT MAP

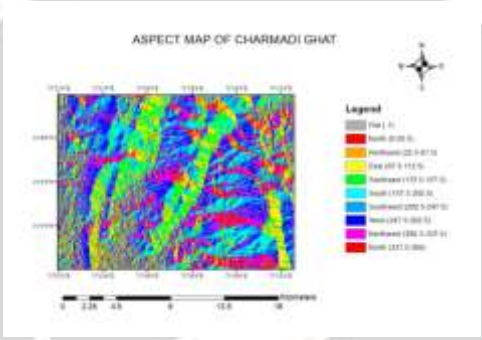

Fig 7: Aspect Ma of Charmadi ghat

Aspect identifies the down slope direction of the maximum rate of change in value from each cell to its neighbors. Aspect can be thought of as the slope direction. The values of the output raster will be the compass direction of the aspect. Aspect is the direction of the maximum rate of change in the z-value from each cell in a raster surface.

3. SLOPE MAP

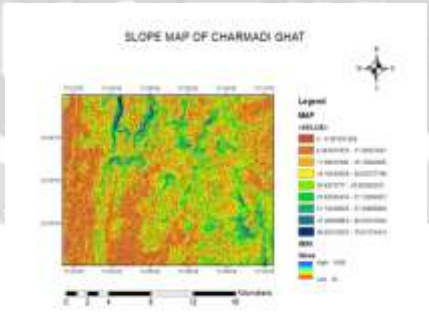

Fig 8: Slope Map of Charmadi ghat

Slope identifies the slope or the maximum rate of change, from each cell to its neighbors. An output slope raster data set can be calculated as a percentage of slope or degree of slope. GIS allows us to use the slope feature to assess areas that will be most susceptible to runoff from floods. The slope was classified into four categories based on its slope angle as gentle slope, moderate slope, steep slope and very steep slope. The lower the slope value the flatter the terrain; the higher the slope value, the steeper the terrain.

4. HILLSHADE MAP

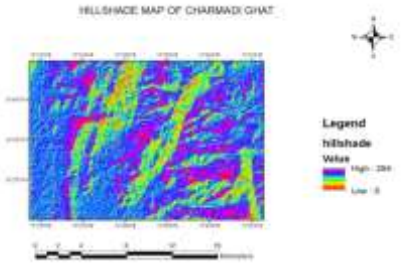

Fig 9: Hill Shade Map of Charmadi ghat

The hill shade tool creates a shaded relief raster from TIN. The illumination source is considered at infinity. Two types of shaded relief raters can be output. Having model shadows unchecked outputs a raster that only considers the local illumination angle. Having model shadows checked outputs one that considers the effects of both the local illumination angle and shadow. The analysis of shadows is done by considering the effects of the local horizon at each cell.

5. TRIANGULATED IRRIGULAR NETWORK (TIN) MAP

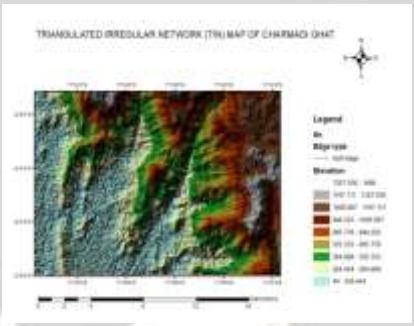

Fig 10: TIN map of Charmadi ghat

A triangulated irregular network (TIN) is a representation of a continuous surface consisting entirely of triangular facets, used mainly as Discrete Global Grid in primary elevation modeling.

V. REMEDIAL MEASURES

Many methods are used to remedy landslide problems. The best solution, of course, is to avoid landslide-prone areas altogether. Improving surface and subsurface drainage. Because water is a main factor in landslides, improving surface and subsurface drainage at the site can increase the stability of a landslide-prone slope. Removing the soil and rock at the head of the landslide decreases the driving pressure and can slow or stop a landslide. Landslide-prone soil and rock can be removed and replaced with stronger materials, such as silty or sandy soils. Trees, grasses, and vegetation can minimize the amount of water infiltrating into the soil, slow the erosion caused by surface-water flow, and remove water from the soil. Rock fall protection, Constructing piles and retaining walls, buttressing the toe are the major prevention to take against landslide.

VI. CONCLUSION

As per the case study, it can be concluded that the root cause of the landslide was due to the unscientific cutting of the hill and thus this incident can be regarded as a manmade disaster. Every hill is having its own natural slope, if any alterations are made which is worthy enough to disturb its natural condition without providing any assistance to support the remaining slope. On the basis of the survey conducted among the local people and also available rain fall data it can be concluded that the heavy rainfall occurred at midnight before incident initiated the landslide.

Based on the geotechnical study it is clear that the soil is having very low shear parameters. The increased pore pressure couldn't be balanced causing the collapse of hill. From grain size classification it can be inferred that the soil is fine soil. Field density of the soil is less than 15 kN/m3 hence the soil is loose soil.

Remote sensing and GIS together with landslide modeling technique have successfully been applied to prepare the landslide Risk Maps in support of disaster preparedness and mitigation activities. From the drainage map we can notice that the elongated drainage patterns present in the area destabilizes the slope, which is also a major cause of landslides.

Thus immediate preventive measures should be taken to stabilize the slope either by providing a stable slope or by constructing an economical retaining wall.

REFERENCES

1. **Dattatraya J. Khamkar (2018)** "Geotechnical and geological investigation of landslide in western GHAT of Maharashtra, India" *International Journal of Engineering & Technology, 7 (3.29) (2018) 524-528*
2. **Vaishali R (2018)** "Landslide Susceptiblity Zonation Using Remote Sensing and GIS" *International Journal of Engineering Research & Technology (IJERT) Volume 6, Issue 07*
3. **Ajin M Murali (2016)** "A Case Study on a Landslide: A Geotechnical Investigation*" International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 04 | Apr-2016*
4. **Lekshmi J Satheesh (2016)** "Investigation of Geotechnical Properties of the Soil Susceptible to Landslide" *International Journal of Engineering Trends and Technology (IJETT) – Volume 36 Number 9 - June 2016*
5. **Dr. R. Chitra (2016)** "Geotechnical Investigation and Slope Stability Analysis of a Landslide"*International Journal of Engineering Research & Technology (IJERT) Vol.5 Issue 02, February- 2016*
6. **Dr.P.D.Sable (2016)** "Landslide Investigation in Bhor Tahsil: A Case Study of Mahadevwadi" *International Journal of Engineering Science and Computing, April 2016*
7. **Mr. G D Indurkar (2015)** "A Study on Landslide Disaster Management" *International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Issue 12, December 2015*
8. **S. M. Sarvade (2014)** "Malin Landslide: A Case Study" *Proceedings of National Conference"GEPSID" held on October 11-12, 2014, Ludhiana*