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Stability Analysis and Stabilization of Recurring Slope Failure along Dewathang-Samdrup Jongkhar Highway, Samdrup Jongkhar: Bhutan

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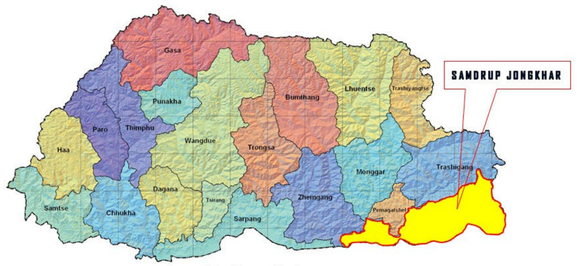
ABSTRACT

Slope Failures have always been an issue along the highway especially during monsoon where commuters face travelling issues. Even if responsible organizations provide feasible recommendation measures, slope failures were seen to recur after a certain period. This research aimed to analyze and stabilize few identified recurring slope failures along Dewathang-Samdrup Jongkhar Highway using Limit Equilibrium and Finite Element Modelling. Three locations were identified based on the recurring intensity of slope failure and were modelled into GeoSlope and Plaxis, which are slope modelling software. Slope Analyses were carried out for every identified locations from which factors of safety were derived. From the analyses, factor of safety for every slopes were below the permissible limit and needed immediate stabilization. The research provided suitable and feasible stabilization approaches such as structural mitigations such as retaining walls, soil nailing, etc. and non-structural mitigation such as bio engineering. Along with stabilization approaches, several recommendations were laid for responsible organization to attenuate slope failures along the road.



Source: https://www.vidiani.com

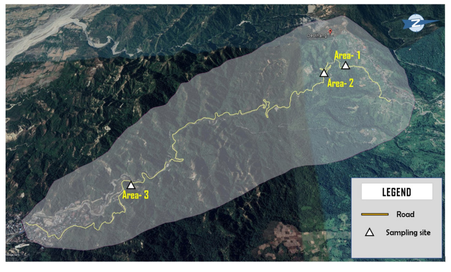
. INTRODUCTION

The Kingdom of Bhutan is situated on the southern slopes of the Eastern Himalayas. Being a part of young fold-thrust Himalayan mountain belt, more than 90 percent of the country's area is topographically rugged and geologically very fragile.

Monsoonal winds are most intense between June to September, making Bhutan the wettest country within the Himalayan range. Rainfall induced slope failure is the most common geo-environment hazard in the country.

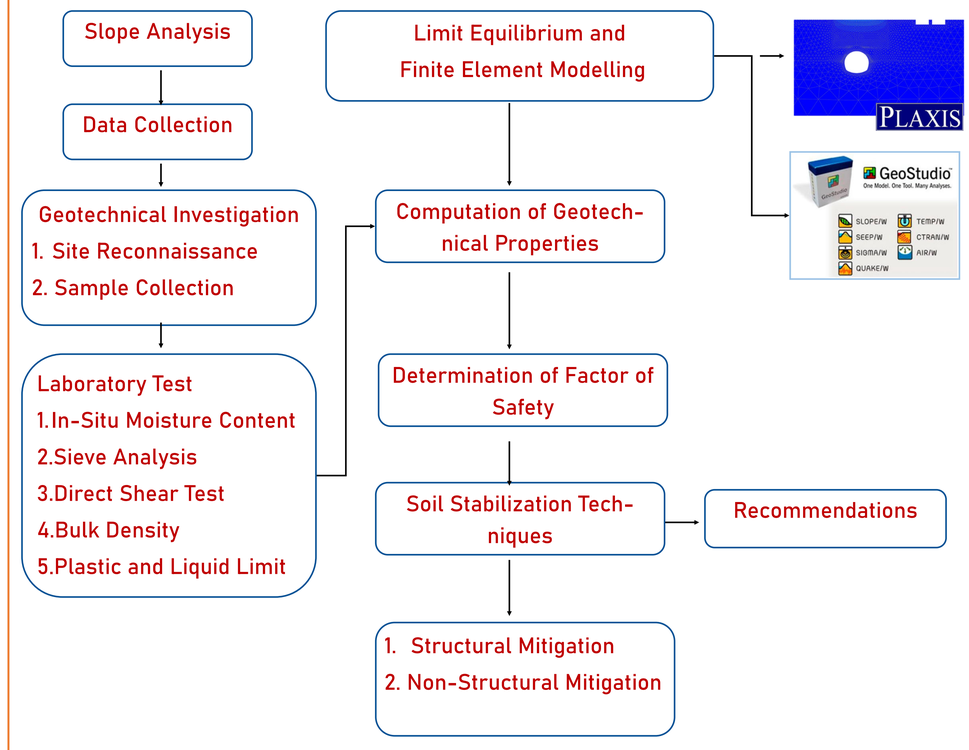
In a developing nation, highways excavated along the hill slopes are the only means of conveyance. Both, major and minor slope failure activities along these hills cut slopes can be of dire consequences.

In recent years, landslide related risks to lives, livelihood, infrastructure, properties and environment in the country is on the rise because of intense and erratic rainfall pattern most likely induced by climate change and human activities with the nature.



Picture 1 : Study Area

METHODOLOGY

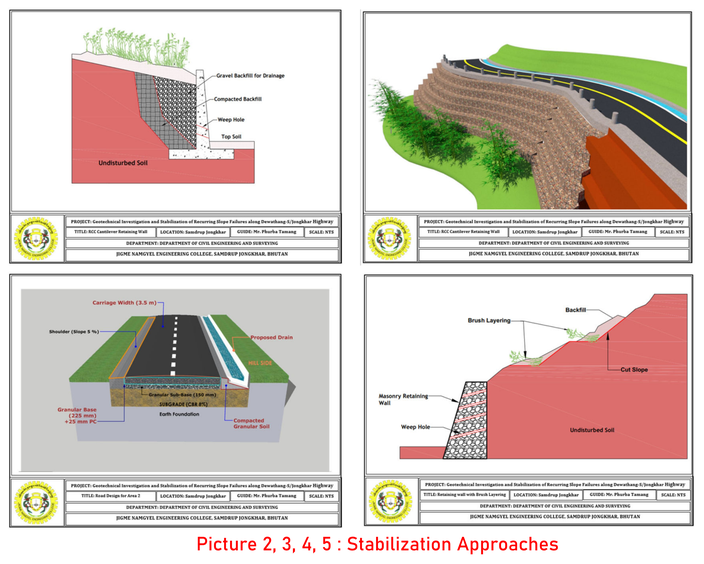


Areas	Latitude	Longitude	Remarks
1	26°51'23.40"N	91°28'5.23"E	14.6 km from Samdrup Jongkhar to Dewathang
2	26°51'5.62"N	91°28'7.80"E	12 km from Samdrup Jongkhar to Dewathang
3	26°48'46.58"N	91°29'45.09"E	4.1 km from Samdrup Jongkhar to Dewathang

Table 1 : Attributes of Study Area

Table 2 : Factor of Safety for Study Areas

Area	Factor of Safety from LEM		Critical (<1.5)	Remarks
	Spencer Method	Morgenstern-Price Method		
1	1.48	1.44	1.44 < 1.5	Subjected to Failure
2	1.74	1.75	1.74 >1.5	Safe
3	1.412	1.413	1.412<1.5	Subjected to Failure



Picture 2, 3, 4, 5 : Stabilization Approaches

RESULTS

1. Area 1 was found to have the FoS of 1.44 and is subjected for further failure
2. Area 2 was found to have FoS of 1.74 and the area is safe.
3. Area 3 was found to have FoS of 1.412 and is also subjected for further failure

CONCLUSION

1. For Area 1, RCC Cantilever Retaining wall is recommended along with suitable bioengineering measures.
2. For Area 2, Gabion Wall or Mortared Masonry wall is recommended along with road design.
3. For Area 3, Retaining wall along with Brush Layer is recommended.

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