

Date of Submission	Revised on 30 th March, 2022
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IPL New Project Proposal 2022

1. Project Title: Review of Rockfall Trajectories of Cut Slopes of Roads Using a Distribution Model Approach
2. Main Project Fields - 1. Technology Development (database and hazard assessment)
3. Name of Project leader :

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Core members of the Project

Ms. J. M. K. Herath – BSc. (Geology Special), MSc. (Water Resources Management)

Mr. E.H.Navoda Premasiri – BSc. (Civil Eng.)

Mr. A. A. Virajh Dias – BSc. (Civil Eng.); MPhil (Earth Science); C.Eng. MASCE, MIESL

4. Objectives:

The objective of this research is to study model the different patterns of rock fall failures and trajectories along cut slopes (rocks) of roads in hill country of Sri Lanka. Detailed interpretation of the safe fall-out area (distance to road payment edge) will be made using the numerical simulation model, RocFall.

5. Background Justification:

A relatively high density road network is a significant observation in Sri Lanka's mountainous hill slopes and is the island at its most scenic, a land of emerald peaks and stupendous views of hillsides carpeted with tea and agricultural plantations and also graced by astonishing waterfalls. During recent past, it has been recognized that the rocky slopes associated in road construction are frequently affected by small to medium volume fragmental rock falls, especially initiation during high to medium rainfall events in hill country, Sri Lanka (Herath H.M.J.M.K et.al.,2018). The associated failures are usually recognized as; a) falls in rock blocks, topples often due to the lack of support of the underlying layer affected by planar sliding, b) wedge failure and rock fall after detachment of cutting face or in hanging rock faces, c) Large translational rock slide involving both soil and rock layers, d) planar rock slide along the mains structural setting and one or more combined setting meeting at once above. The project proponent, the Natural Resources Management and Laboratory Services of the CECB has already studied geotechnical features of landslides and rock slope failures and carries a many research finding which are needed to be organized in design standards, guidelines and policy framework under the World Center of Excellence on landslide disaster reduction during the period of 2014-2017, 2017-2020 and will be continued 2020 – 2023, in Sri Lanka.

6. Study Area: Mountainous area of Sri Lanka, covering the Central, Sabaragamuwa, and Uva, administrative provinces.

7. Project Duration: Three years (January 2022–December, 2024)

8. Resources necessary for the Project and their mobilization:

Item	Description of Personnel and Facilities	Cost USD	Mode of Contribution
1	Database server and associated peripherals	1000.00	By CECB
2	Field data collection	2,000.00	By CECB
3	Dissemination of Information	2,000.00	Research grant
	Total USD	5,000.00	
	Total grantee contribution (USD)	3,000.00	By CECB
	Total expected through funding (USD)	2,000.00	Through a grant

9. Project Description:

Rock fall is a relatively small landslide confined to the removal of individual and superficial rocks from a cliff face (Selby,1982). The study will be performed by a comprehensive scheme of investigations including geotechnical characteristics of rocks, orientation records, mapping of rock joints and statistical analyses from various forms of available data or will be determined by means of geomechanical field surveys, rock mass classification through scan lines techniques, and laboratory tests on rock blocks shall be incorporated. Rock fall research has been popularized in the past by simpler point mass and 2D models because of their computational efficiency, which will be considered as initial simulations. The GIS based model will be made through the RocFall (4.0) (Wen-lian Liu et.all.2021) is a statistical analysis program designed to assist with assessment of slopes at risk for rock falls. Energy, velocity and "bounce height" envelopes for the entire slope are determined by the program, as is the location of rock endpoints. Distributions of energy, velocity and bounce-height are also calculated along the slope profile; Distributions can be graphed and comprehensive statistics are automatically calculated.

Since the proposed project carries information requirement through various other agencies including Road Development Authority (RDA), Department of Railways and Ministry of Transport and their collaboration will be made. Many records need further review or the expressing the accuracy levels shall be done by direct visiting to each site and conducting field survey, as applicable.

10. Work Plan/Expected Results:

January, 2022- December, 2022:

- (a) Scrutinizing already available information and continuing collection of data and if new rockfall occur, site visits and field data verification.
- (b) Determination of geotechnical characteristic of rock slopes, shear strength parameters and interpretation of parametric variation of rock properties in rocks.
- (c) Selection of locations and determination of different modes of rock fall trajectories related to the case model and identification of modeling parameters which are considered to be position dependent, such as the friction and restitution coefficients etc.
- (d) Conducting a full 2D (2Dhorizontal and 2Dvertical) simulation model for rockfall based on the non-smooth contact dynamics method with hard contact.

January, 2023- December, 2023:

- (e) Preliminary interpretation of rock fall trajectories using RocFall to assist of slopes at risk for rock falls including energy, velocity and "bounce height" envelopes for the entire slope.
- (f) Simulation of various patterns of road cut-slope rockfall trajectories.

January 2024-December, 2024:

- (g) Numerical verification, field verification and detailed interpretation of the study.
- (h) Detailed interpretation of the safe fallout area (distance to road payment edge) using the numerical simulation model, RocFall

11. Deliverables/Time Frame:

- July 2022 : Interpretation and statistical projection of rock slope failure along road sections at Central, Sabaragamuwa and Uva
- December 2022: Finding of locations for detailed interpretation of rock slope assessment
- July 2023 : Interpretation of properties of rocks including density, shear strength, point load index, poissons' ratio, elastic parameters and their relationship
- December 2023: 2D model simulation using RocFall
- December 2024: Verifying rock fall trajectories and distribution model approach

12. Project Beneficiaries:

The landslide professionals, academics, researchers, planners, road designers and people residing in landslide prone areas in Sri Lanka are the beneficiaries of this project.

13. References

- Selby, M.J., (1982), Hill slope materials and processes, New York, Oxford University Press.
- Herath H.M.J.M.K., Jayasooriya J.A.D.N.A., Virajh Dias A.A.,(2018), Pairwise comparisons of Geological evidences in rockfall hazard rating system (RHRHS) for the evaluation of road based potential slope failures in Sri Lanka ,Proceedings of the CECB symposium, Sri Lanka
- Wen-lian Liu, Jia-xing Dong ,Han-hua Xu,Su-gang Sui, Run-xue Yang and Lun-shun Zhou, Trajectory Analysis and Risk Evaluation of Dangerous Rock Mass Instability of an Overhang Slope, Southwest of China, Advances in Civil Engineering, Volume 2021, Article ID 7153535, 15 pages
- RocFall user guide 1998 - 2002 Rocscience Inc.
- Nimani S. Kulathilake L.K., Herath H.M.J.M.K.,Virajh Dias A.A.,(2018),Strength and Elastic Deformation of prominent load bearing Metamorphic rocks in Sri Lanka., Proceedings of the CECB symposium, Sri Lanka.