THE EFFECT OF ROCK JOINT SYSTEMS IN RAIN INDUCED SLOPE FAILURES

J. P. D. C. M. Karunarathne

198341R

Degree of Master of Science in Geotechnical Engineering

Department of Civil Engineering
Faculty of Engineering

University of Moratuwa
Sri Lanka

May 2024

THE EFFECT OF ROCK JOINT SYSTEMS IN RAIN INDUCED SLOPE FAILURES

J. P. D. C. M. Karunarathne

198341R

Thesis submitted in partial fulfillment of the requirements for the degree of Masters of Science in Geotechnical Engineering

Department of Civil Engineering
Faculty of Engineering

University of Moratuwa
Sri Lanka

May 2024

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

Also, I hereby grant to the University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Name of the candidate: J.P.D.C.M. Karunarathne

Signature of the candidate: Date: 08.05.2024

The above candidate has carried out research for the Master's thesis under my supervision. I confirm that the declaration made above by the student is true and correct.

Signature of the supervisor: Date: 08.05.2024

Professor S.A.S Kulathilaka,

BSc. Eng. Hons (Moratuwa), PhD (Monash), CEng, MIE (SL)

Senior Professor,

Department of Civil Engineering,

University of Moratuwa,

Sri Lanka

DEDICATION

This thesis is dedicated to my family members with heartfelt gratitude. Thank you for always being there for me with love and support. Your belief in me has fuelled my journey.

ACKNOWLEDGEMENT

I extend my deepest appreciation to Prof. S.A.S. Kulathilake, Senior Professor of the Department of Civil Engineering, for his unwavering support, invaluable suggestions, diligent efforts, and steadfast encouragement throughout the thesis endeavour. His profound insights and extensive experience in Geotechnical Engineering significantly enriched the outcome of this research.

As the course coordinator for the M.Sc. program, I have the great honor of thanking Prof. L.I.N. de Silva, Professor of the Department of Civil Engineering for his extensive advice and direction.

My sincere gratitude goes to Eng. (Dr) Asiri Karunawardena, Director General of the National Building Research Organisation (NBRO), for his mentorship and unwavering support throughout my master's journey. I am also indebted to Mr. L.U.M. Kanakanamge, Engineer, and Mr. A.M. Amarasinghe, Engineer, for their invaluable contributions to the research, offering insightful ideas and continuous encouragement throughout the process.

Special thanks are due to all staff members at NBRO for their assistance and cooperation.

ABSTRACT

In tropical countries like Sri Lanka, slope failures due to excessive rainfall are a common geotechnical hazard. These soils are typically stable during dry seasons due to the presence of matric suctions in the soil. However, with the infiltration of rainfall, matric suctions would diminish, perched water table conditions may develop and there could be a rise in the groundwater table. This series of events would eventually lead to a failure.

The extensive weathering of Metamorphic parent rock across Sri Lanka has given rise to residual soils that now cover much of the island's terrain. Sloping grounds in Sri Lanka exhibit significant heterogeneity owing to the inherited variable nature of the metamorphic rock, diverse levels of weathering, joint patterns of variable nature in the bedrock, the presence of relict joints in the residual soils, and the presence of colluvial deposits.

As a result, conventional techniques of slope stability assessment may yield misleading results. Therefore, a comprehensive understanding of the prevailing geological condition will be essential in doing a realistic study. In addition to the direct infiltration, the water flow that comes through a jointed rock mass at an upper elevation of a slope (exfiltration) can have further destructive effects on the stability of the sloping grounds at a lower elevation. Recent landslides at Malapattawa, Ihalakotte railway station, and Kadugannawa are typical examples.

In this study, the effects of exfiltration through the jointed rock on the stability of the sloping grounds at the lower levels of the slopes were studied through parametric studies conducted on two sites. The orientation of joints and the characteristics of joint infills were varied to study the response of the slope to critical rainfall that the site is likely to experience. The results of the study identified the critical orientations of the joints and the infill characteristics that would make a slope more vulnerable.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES