

**Numerical Modeling of Stone Piles installed in Soft Soils  
using Finite Element Method**

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Degree of Master of Science in Geotechnical Engineering

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University of Moratuwa

Sri Lanka

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

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## DECLARATION

“I declare that this is my own work and this thesis does not incorporate without acknowledgement 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 acknowledgement is made in the text.

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Name of the supervisor: Prof. N.H. Priyankara .....

Signature of the supervisor: ..... Date: .....

## ABSTRACT

Due to the scarcity of lands featuring favorable soil layers and the high-costs associated with deep foundations and other ground improvement techniques, Gravel Compaction Piles (GCP) have gained widespread popularity as a ground improvement technique globally. In order to maximize efficiency of GCP, it is essential have a thorough understanding of its performance on diverse soil conditions. Finite Element Analysis (FEM) can be considered as the most suitable method to comprehensively analyze the behavior of GCP-improved ground, prior to the implementation of this technique in field. Due to the complications associated with three-dimensional modelling, most of the researchers tend to do these analyses in two-dimensional mode. However, modelling a three-dimensional problem in a two-dimensional mode is quite a challenge. In this thesis, it was aimed to find a most accurate approach to model GCP improved ground in a two-dimensional mode using PLAXIS 2D Version 20 software. Based on the results of validation, Parameter conversion approach was found more appropriate to simulate GCP improved grounds under 2D conditions.

In this study, it was specially expected to investigate the behavior of GCP in Sri Lankan soft peaty soil. Moreover, parametric analysis was done to identify the behavior of GCP improved ground with the variation different GCP parameters. This thesis presents how permeability, stiffness and length of GCP affect the behavior of improved grounds.

After analyzing the effect of permeability ratios on the behavior of improved grounds, it was found that the most optimal and effective permeability ratio is 500. The effect of stiffnesses of surrounding soil was found for different permeability ratios. Most suitable soil conditions to install GCP was identified with those results. Finally, the critical length of GCP has identified as 11 m.

*Keywords: Gravel compaction piles, soft peaty soil, soil improvement, Numerical modeling, Parametric study*

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## **LIST OF ABBREVIATIONS**

|     |   |                              |
|-----|---|------------------------------|
| ABC | - | Aggregate Base Course        |
| FEM | - | Finite Element Modelling     |
| GCP | - | Gravel Compaction Pile       |
| OCH | - | Outer Circular Highway       |
| PWP | - | Pore Water Pressure          |
| PVD | - | Prefabricated Vertical Drain |
| RHS | - | Right Hand Side              |
| SCP | - | Sand Compaction Pile         |
| SGT | - | Soft Ground Treatment        |