

**EMBANKMENT FAILURE AT GRAVEL COMPACTION
PILE IMPROVED GROUND: CASE STUDY**

Lindamulage Newon Shervin De Silva

(198327F)

Degree of Master of Science in Geotechnical Engineering

Department of Civil Engineering

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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ABSTRACT

The rapid development and population growth in a country raise the demand for extensive infrastructure, leading to a scarcity of available land. This scarcity prompts the utilization of areas marked by weak soil deposits, often deemed marginal or inappropriate for construction. Weak soil deposits have challenging properties such as high moisture content, compressibility, and very low shear strength. To address these challenges, various ground improvement techniques are employed, with Gravel Compaction Pile (GCP) emerging as a soft ground improvement method.

GCP aims to increase load-bearing capacity, accelerate consolidation, and reduce settlement by densifying subsoil. While successfully applied in the Outer Circular Highway and Colombo-Kattunayake Expressway projects in Sri Lanka for soft soil improvement (5-10m thickness), the GCP technique failed in Section 1 of the Southern Expressway Extension Project (Matara to Beliatta), where the soft soil layer varied from 6-18m in thickness.

This research study aims to identify the causes of GCP failure in the trial embankment section. The study includes an analysis of geotechnical parameters in subsurface soil and an assessment of slope stability during construction using Matsuo and Kawamura's method based on field monitoring data. Additionally, the stability of the embankment is numerically analyzed using GEOSLOPE SLOPE/W software.

The study highlights improper site investigation, inadequate field monitoring, and insufficient precautions for the high-thickness soft soil layer as the main causes of failure. To prevent similar failures in the future, the research discusses possible stabilizing techniques and recommendations based on its findings.

Keywords: Gravel Compaction Pile, Slope stability, Soft soil layer thickness, Stabilizing techniques, Peaty soil

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LIST OF ABBREVIATIONS

ABC	-	Aggregate Base Course
ASTM	-	American Standard Testing Material
CPTu	-	Cone Penetration Test with pore pressure measurement
FOS	-	Factor of Safety
GCP	-	Gravel Compaction Pile
LHS	-	Left Hand Side
OCH	-	Outer Circular Highway
OCH-NS1	-	Outer Circular Highway Northern Section-1
OCR	-	Over Consolidation Ratio
PVD	-	Prefabricated Vertical Drain
PWP		Pore Water Pressure
RDA	-	Road Development Authority
RHS	-	Right Hand Side
RL	-	Reduced Level
SCP	-	Sand Compaction Pile
SEEP	-	Southern Expressway Extension Project
SGT	-	Soft Ground Treatment
SPT	-	Standard Penetration Test