OPTIMIZATION OF THE DESIGN OF GEOSYNTHETIC REINFORCED PILE SUPPORTED EMBANKMENTS USING A NUMERICAL MODEL

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DECLARATION

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Prof. S. A. S. Kulatilaka

ABSTRACT

The Geosynthetic Reinforced Pile Supported Embankment (GRPE) technique is an efficient ground improvement technique, that can reduce settlements and construction time drastically and is suitable to improve larger thicknesses of soft subsoils. Different design methods have their own assumptions and limitations that depart from actual field conditions eventually leads to a conservative design. Finite Element Analysis (FEA) could closely simulate the actual field condition, but further research is necessary in the area.

In this study parametric analyses were done related to the design with and without geosynthetic reinforcement using PLAXIS software based on FEA. The analysis was carried out according to BS 8006 and Collin's Method with manual calculations and the results were compared to optimize the design methodologies. The results need further studies with actual settlement data comparison with the FEA results to verify the applicability to actual conditions when analysing with PLAXIS software. Further, it can be said that BS 8006 leads to conservative designs for multiple basal reinforced piled embankments, but when using single basal reinforcement layer with appropriate pile and pile cap size, the efficiency can be increased to optimize the design outputs. Furthermore, when designing based on the Collin's method, it predicts the average stress values acting on reinforcement but needs to consider the stress distribution between the pile caps with suitable factoring when designing GRPE systems with multiple reinforcement layers.

Keywords: GRPE, Ground Improvement, Finite Element Analyses, BS 8006, Collin Method

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LIST OF PRINCIPAL SYMBOLS

GRPE – Geosynthetic Reinforced Piled Embankment

LTP – Load Transfer Platform

CPS – Conventional Pile system

PVD – Prefabricated Vertical Drains

FEA – Finite Element Analyses

P_c' - verticle stress on top of the pile caps

σ_v' - factored average verticle stress on top of the pile caps

C_c – arching coefficient (Marston 1913)

a – pile cap size

γ – unit weight of the emabnkment fill

f_{fs} – partial load factor applied to soil unit weight loads

H – embankmnet height

w_s – uniformly distributed surcharge loading

f_q – partial factor applied to external live loads

s – pile spacing between adjacent piles

ε – strain in the reinforcement

W_T – distributed vertical load acting on the reinforcement

k_a – active earth pressure coefficient

f_s – partial factor for reinforcement sliding resistance

f_n – partial factor governing the economic ramification of failure

α' – interaction coefficient related to soil/reinforcement bond angle

L_b – reinforcement bond length needed beyond the outer row of piles across the width of the embankment

f_p – partial factor applied to the pull-out resistance of the reinforcement

α'_1 – Interaction coefficient relating the soil/reinforcement bond angle to $tan\emptyset'_{cv1}$ on one side of the reinforcement

α'_2 – Interaction coefficient relating the soil/reinforcement bond angle to $tan\emptyset'_{cv2}$ on one side of the reinforcement

f_{ms} – partial material factor applied to $tan\emptyset'_{cv}$

ρ – Soil arching ratio

P_b – average vertical pressure above r/f or average vertical pressure transferred to soft soil in between piles

E – efficacy of the pile embankment

σ_{pc} – vertical stress on the pile cap

σ_{ss} – vertical stress on the soft soil

LCF – load concentration factor

Q_{pc} – Load on pile cap

Q – total load

T_D – design strength of the reinforcement

D_e – effective area diameter of column