STUDY OF PULLOUT RESISTANCE OF SOIL NAILS IN TROPICAL RESIDUAL SOIL

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(Index No - 118811k)

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(2011/2012 BATCH)

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Thesis Submitted To University Of Moratuwa In Partial Fulfillment Of The Requirements For The Degree of Master of Engineering in Foundation Engineering And Earth Retaining Systems.

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DECLARATION

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

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ABSTRACT

As a norm, most design engineers typically resort to theoretical and empirical approaches in order to determine the pullout resistance of soils while designing soil nailed retaining walls. The tendency to design based on actual field tests are minimal due to the time and cost involved while implementing such tests. Though results obtained through pull out tests done within the laboratory have been used to perform design calculations, the outcome of such test results are questionable, as such tests do not replicate precise site conditions.

This research primarily juxtaposes and establishes a relationship between the theoretical and on field practical pullout resistance of soil nails in unsaturated conditions with the use of information extracted from an extensive literature review and data obtained through an actual pull out test conducted on a set of soil nails installed in predetermined locations of a 25ft high embankment spanning 70ft.

This research also attempts to explore the effects of over burden pressure on the pull out resistance of the soil nails and the behavior of the actual failure surface of the soil nail, which has also been mentioned as the effective diameter in this report.

ACKNOWLEDGEMENT

It is my pleasure to take this opportunity to thank all those who have been supportive to me to successfully complete this research. First of all I sincerely express my gratitude to my research supervisor Prof. S.A.S. Kulathilaka for offering me the opportunity to carry out the project under his wise guidance.

Next my heartily gratitude goes out to the lectures and the supporting staff of the Geotechnical Engineering division of the Department of Civil Engineering, University of Moratuwa, who have assisted and supported me throughout the research period.

I would like to thank the management of the Central Engineering Consultancy Bureau for encouraging and assisting me to venture on this research, the Central Engineering Consultancy Bureau Laboratory services and the Engineering & Laboratory Services (Pvt) Ltd for rendering invaluable support while performing on field and laboratory tests.

Finally, I would also like to thank the site staff of the Operation Theatre Complex Building, Teaching Hospital, Kegalle for voluntarily involving themselves in the field during various stages of this research.

Eng Ranjan Kumara W.E.P (Index No: 118811K)

List of Symbols

$(u_a - u_w)$	Matric suction
$(\sigma_n - u_a)$	Net normal stress
A_S	Surface area of the nail
D_{eq}	Equivalent width of flat reinforcement
K_S	Coefficient of lateral earth pressure
$Q(u_a-u_w)$	Capacity of soil nails due to the contribution of matric suction
Q_f	Capacity of soil nails installed in saturated soils
C’	Soil cohesion
c_a	Soil adhesion at the grout/soil interface
d_i^d	Minimum grain diameter of the corresponding fraction
d_i^g	Maximum grain diameter of the corresponding fraction
k_Θ	Coefficient of lateral earth pressure with respect to soil nail inclination
q_s	Shaft capacity of piles
δ	Interface friction angle
Θ_s	Saturated volumetric water content
μ*	Coefficient of apparent friction of soil ($\mu^* = \tan \emptyset'$ and $c' = 0$ for granularsoil)
σ'_n	Effective normal stress
σ'_v	Vertical stress calculated at the mid-depth of the nail in the resistance zone
σ'_z	Effective overburden stress
T_{US}	Shear strength of unsaturated soils
∅’	Angle of internal friction of soil
$\emptyset^b$	The angle of shearing resistance with respect to matric suction
$\Delta_{.gi}$	Fraction weight in parts of the total weight
cu	Coefficient of uniformity
D	Nail diameter (m)
d_e	Dominant particle size diameter, *mm*
e	Void ratio
f_b	Coefficient of roughness
f_c	Coefficient defined by c_a/c'
f_s	Coefficient defined by $\delta/\emptyset$
Ls	Embedment depth of soil nail (m)

m	Soil parameter related to residual water content
n	Soil parameter related to the slope at the inflection point of the SWCC
P	*N*nail perimeter
S_r	Residual degree of saturation
$T_{pull-out}$	Failure load at which pull-out failure occurs (kN)
W_r	Residual gravimetric water content
W_s	Saturated gravimetric water content
w_w	Gravimetric water content
ψ	Dilation angle.
***C* (ψ)**	Correction factor that forces the SWCC through a suction of 1,000,000 kPa and zero water content.
S	Degree of saturation
β	Bjerrum –Burland coefficient
ɵ	Volumetric water content
K	Fitting parameter used for obtaining a best-fit between the measured and predicted values.
λ	Pull-out factor
κ	Parameter dependent on the degree of saturation (varies from 0 to 1)

List of Abbreviations

SW	Well-graded sand
SP	Poorly graded sand
CDG	Completely decomposed granite
CFEM	Canadian Foundation Engineering Manual
CU	Consolidated undrained
DAS	Data Acquisition System
FHWA	Federal Highway Administration
GSD	Grain size distribution
GWT	Ground-water table
HSS	Hollow Steel Section
NATM	New Austrian Tunneling Method
M	Silty sand
SPT	Standard penetration test
SWCC	Soil-water characteristic curve

TYP	Typical
USCS	Unified soil classification system
WWM	Welded wire mesh