EVALUATION OF EFFECT OF TREE ROOTS ON SHEAR STRENGTH OF SOIL DUE TO ROOT WATER UPTAKE

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(218075H)

Degree of Master of Science

Department of Civil Engineering

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Thesis submitted in partial fulfillment of the requirements for the degree
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DECLARATION

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ABSTRACT

Tree roots play a major role in ground and slope stabilization by increasing the strength and stiffness of the soil positively. When evaluating how vegetation affects ground improvement, tree roots are the primary factor because that they improve the strength of the soil with the help of their mechanical properties and provide the additional soil suction by the root water uptake.

Previous studies, however, focused on the mechanical and hydraulic impacts of tree roots separately when evaluating the impact of vegetation, which failed to yield reliable results because suction influences on mechanical characteristics of tree roots. Recent laboratory research has shown that the mechanical interactions between roots and soil, such as root tensile strength and root cohesiveness, are suction-dependent.

There are still significant gaps in knowledge regarding the effects of suction and root concentrations on root reinforcement despite these extensive previous research. This study investigated the influence of matric suction on root reinforcement of the *Alstonia macrophylla* with Sri Lankan Silty Sand using large-scaled direct shear tests.

Cohesion due to root reinforcement of the *Alstonia macrophylla* should theoretically equal to the difference between the apparent cohesion of reinforced and unreinforced shear strength in saturated samples. This value was 2.99 kN/m^2 when RAR, dry biomass of roots per unit volume of soil, and total leaf area of the plant were 6.22 x 10^{-3} %, 0.575 kg/m^3 and 1195 cm^2 respectively. However, the cohesion due to root reinforcement of the *Alstonia macrophylla* is slightly increased with the matric suction in the Sri Lankan Silty Sand as per the research outcomes.

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Supipi Kaushalya

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A	Total area of soil
A_R	Root area
c'	Effective cohesion
C_p	Specific heat capacity of air at constant pressure
D_a	Vapor pressure deficit of air
e	Void ratio
EC	Electrical conductivity of the saturated extract
$f(\beta)$	Root density function
f_i	Fractional of each leaf expressed in terms of the total leaf area of the canopy
g	Gravity on earth
h	Matric water suction
h_c	Elevation
h_{co}	Equivalent capillary rise
h_p	Water potential of roots
h_s	Water potential of soil
k	Fitting parameter
k	Unsaturated hydraulic conductivity
$L(z)$	Length of root per unit soil volume
m	Pore size distribution parameter of the model
$r_{a,i}$	Boundary layer resistance of each leaf
$R_{n,i}$	Net radiation flux density absorbed by each leaf
$r_{s,i}$	Stomatal resistance of each leaf
r_i	Mean pore radius

R_s	Radius of the curvature
S	Slope of saturation vapour pressure curve at the ambient air temperature
$Sa*$	Degree of saturation
Sc	Degree of saturation associated with capillary forces
T	Transpiration rate per unit of the soil surface area
T_s	Surface tension of the soil
$u_a - u_w$	Matric suction
u_w	Pore water pressure
Vvi	Pore volume of each fraction
W_i	Solid mass per unit sample mass in the i^{th} particle-size range
z	Depth below the soil
$zmax$	Maximum depth of the root zone
α	Scale parameter inversely proportional to mean pore diameter
$\beta(x, y, z)$	Root density as the length of root per unit of soil volume
γ	Psychometric constant
δ	Water potential of roots
θ	Volumetric water content
Θ	Normalized water content
θ	Angle of shear distortion in the shear zone
θ_r	Soil residual moisture content
θ_s	Saturated volumetric water content
θ_{vi}	Accumulated volumetric water content
ρ_a	Air density
ρ_{dry}	Dry density of the soil
ρ_p	Particle density

ρ_w	Density of water
$\sigma_n - u_a$	Net normal stress
σ_t	Mobilized tensile stress of root fibers developed at the shear plane
τ'	Shear strength of unsaturated soil
τ_{ff}	Shear stress plane at failure
ϕ'	Effective angle of internal friction
ϕ^b	Rate of shear strength growth in relation to a change in matric suction
χ	Parameter proportional to degree of saturation
Ψ_o	Osmatic suction
Ψ_{os}	Osmatic suction of saturated soil sample
Ψ_0	Suction at complete dryness
Ψ_n	Normalization parameter
Ψ_r	Residual suction