INVESTIGATION OF SUITABLE METHODS TO PROTECT MAIN ROADS ADJACENT TO WATER BODIES

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Declaration

I hereby declare that the research thesis entitled “Investigation of suitable methodsto protect main roads adjacent to water bodies” submitted by me in partial fulfillment ofthe requirements for MSc. (Research), is my original work and that it has not previously formed on the basis of any other academic qualification at any institution.

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The above candidate has carried out research for the Master of Science by Research (Part Time) thesis under my supervision.

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Date: 06.11.2024

Abstract

Main roads adjacent to water bodies often face significant stability challenges due to erosion caused by, heavy rainfall, increased water flow along riverbanks, the sudden drawdown of water levels after flooding, sand mining and various other human activities within river catchments. These conditions can lead to failures in the river banks disrupting the functioning of the road.

This thesis presents four such problematic locations, identifying the root cause of the problem and presenting appropriate different rectification measures adopted. Common features and different aspects at the four locations are elaborated. The locations all in the Western Province are; Kelani River bank along the low-level road, the right side of the Halwathura Phalakotasa stream bank along the Ingiriya-Halwathura-Ekgaloya road, Halkotiyawatta stream bank on Seelarathana Mawatha, and Diyawanna Lake bank on Denzil Kobbekaduwa Mawatha.

A comprehensive literature review was done on various techniques involving both hard and flexible solutions, including reinforcing techniques and integrating natural vegetation developed in different parts of the world over the last decade. Novel approaches appropriate for Sri Lanka were proposed based on the findings of the literature review. At each location, different alternatives were closely evaluated considering cost, constructability and sustainability to decide on the best to be adopted. Stabilization techniques evaluated are; (1) Gabionwall with rock packing at the toe, (2) vegetated live bamboo crib wall construction with Gabion at the toe, and (3) vegetated flapped soil bag with live stake retaining structure with a Gabion at the toe. The proposals were implemented at three locations and the performance is being monitored. The satisfactory performance over few years serves as an encouragement to adopt sustainable techniques in infrastructure development in Sri Lanka.

Keywords: Bamboo, Bio-slope engineering, Gabion wall, Slope stability, and Stream bank erosion

Delegation

I delegate this thesis to my beloved family members who are the pillar of my strength and existence.

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS & ABBREVIATIONS

A	Sectional area of sheet pile (cm^2/m)
B	Gabion wall width of the base (m)
C	Cohesion (kPa)
C_w	Design adhesion (kPa)
D	Depth of embedment of sheet pile wall (m)
e	Eccentricity (m)
e_0	Initial Void ratio
f_b	Allowable bending stress in mild steel (N/mm^2)
fy	Ultimate stress of pre stress anchor bar (N/mm^2)
G_S	Specific gravity of soil
H	Retaining wall height (m)
I	Moment of inertia (cm^4/m)
K_a	Active earth pressure coefficient
λ_{ah}	Coefficient of active lateral pressure
M_{max}	Maximum bending moment on sheet pile wall (kNm/m)
M_o	Overturning moment on retaining wall (kNm/m)
M_r	Resisting moment on retaining wall (kNm/m)
P_a	Total active force on retaining wall (kN/m)
P_{AN}	Active horizontal earth pressure (kN/m)
Po^1	Effective overburden pressure
q/p	Surcharge load (kPa)
$q_{allowable}$	Allocable bearing capacity below the retaining wall (kPa)
$qult$	Ultimate bearing capacity below the retaining wall (kPa)
q_u	Unconfined compression strength of soil
T	Anchor force (kN/m)
V_{max}	Allowable Shear force in steel sheet pile (kN/m)
Wg	Weight of the retaining wall (kN)
Ws	Weight of the soil (kN)
Z	Section modulus of Steel sheet pile wall (cm^3/m)

α	Wall inclination angle (degree)
β	Fill slope angle above wall (degree)
θ	Inclination angle to Vertical plane, (degree)
δ	Angle of wall friction (degree)
δ_b	Angle of base friction (degree)
ϕ	Angle of internal friction of soil (degree)
P_A	Active soil earth pressure (kPa)
$б_V$	Vertical soil stress (kPa)
$б'$	Effective stress (kPa)
U	Pore water pressure
P_p	Passive soil Side resistance (kPa)
γ_d	Dry unit weight of soil (kN/m^3)
γ_s	Saturated unit weight of soil (kN/m^3)
γ_{bulk}	Bulk Density of Soil (kN/m^3)
bv_{max}	Maximum stress at bottom of the retaining wall (kPa)
τ	Shear stress or mobilized shear stress (kPa)
τ_f	Average shear strength of soil (kPa)
ζam	Allowable stress of the retaining wall (kPa)
ASTM	American Society for Testing and Materials
FOS	Factor of safety
FEM	Finite element method
LEA	limit equilibrium approach
M	Mobilization factor
M-PM	Morgenstern-Price method
MSE	Mechanically stabilized earth wall system
N_{Field}	Field SPT blow counts
N'_{70}	Corrected SPT blow counts by energy method
RDA	Road Development Authority
SLOPE/W	limit equilibrium approach software for slope stability analysis
SPT	Standard penetration test
ULS	Ultimate Limit State

LIST OF APPENDICES