Management of Protecting the Side Slopes Adjacent to Archaeological Structures at Amman Downtown

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Authorization Form

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DEDICATION

I dedicate my humble efforts in this thesis:

To my Parents, as they are the source of my inspirations....

To my sisters, for their continuous support....

To my friends for their encouragement....

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Abstract

Running any project successfully requires integration between the processes for each of the engineering design, the engineering project management, and methods of execution for the proposed project.

Al-Qal'ah region, located at Amman downtown, is a national historical site that has been exposed to continuous erosion of side slopes and ground instability. This can be attributed to a number of factors, prominent among which are environmental and climatic conditions, in addition to the existence of different slope characteristics at this region which govern the behavior of these slopes and consequently have considerable effects on the overall stability of this site.

The major aim of this research is to conduct detailed geotechnical and management investigations for the side slopes adjacent to the archaeological site of Al-Qal'ah region, and accordingly to suggest the most appropriate solutions that can be adopted to protect and develop the study area.

The geotechnical part investigated the engineering evaluations for the study area, in addition to proposing and designing a number of engineering alternatives to be performed in developing the overall study area and achieving the required slope stability of this region. Thus, three alternatives are proposed as the most suitable and applicable for protecting and developing the faces of the existing side slopes of the study area, namely gabion retaining wall, reinforced concrete retaining wall, and gravity retaining wall.

In the management part of this investigation, the phases of construction project management were identified. Then the most appropriate and optimal alternative was chosen after conducting the development of the project plan required for each alternative. The cost and duration needed for carrying out each alternative were determined using Primavera Software and calculating the NPV for all alternatives.

The findings of this research revealed that gabion retaining wall proves to be the best alternative in terms of cost, duration, NPV and safety for developing and protecting the first zone of the area under study compared with the other suggested alternatives. As for the second zone, the side slopes can be developed and protected using riprap. In addition, a new sidewalk was proposed to be carried out for the study area. In general, the above suggestions revealed to be helpful in improving the study area, and strengthening the overall stability of the site.

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LIST OF ABBREVIATIONS AND SYMBOLS

A	Annual Expenses
ACES	Arab Center for Engineering Studies
A_i	Area of Wall Cross Section
B	Width of Base Slab
C_c	Cohesion of Cyclopean Concrete
C_f	Cohesion of Foundation Soil
EAS	Engineering Axis for Studies
e	The eccentricity of the Resultant Force
F	Future Value
FOS	Factor of Safety
GIS	Geographical Information System
H	Vertical Height of Cut
i	Interest rate
k_a	Coulomb's Active Earth Pressure Coefficient with Seismic Effect
KN	Kilo Newton
M_O	The Overturning Moment
MPa	Mega Pascal=KN/m^2
n	Years
P	Initial Value
P_a	Active Earth Pressure
PEP	Project Execution Plan
P_h	Horizontal Component
PMP	Project Management Plan
P_P	The Passive Earth Pressure
P_v	Vertical Component
q_{max}	Maximum Pressure
q_{min}	Minimum Pressure
q_{ult}	The Ultimate Bearing Capacity
SHA	State Highway Administration
T	Diameter of Reinforcement Bar

W	Weight of Gabion
WBS	Work Breakdown Structure
γ_c	Density of concrete
β	Angle of backfill slope
$\emptyset_2$	Friction angle for the foundation soil
$\emptyset_1$	Friction Angle for the backfill soil
$\sum V$	Normal components
$\sum F_d$	Sum of the horizontal forces driving the wall to slide
$\sum F'_R$	Sum of the horizontal forces that withstand sliding
$\sum M_r$	Sum of the moments due to forces tend to withstand overturning the wall about the toe, basically the soil backfill and the concrete forces.
$\sum M_o$	Sum of the moments that resulted from forces tend to overturn the wall
γ_g	Unit weight of a gabion wall
γ_1	Unit weight of the backfill Soil
γ_2	Unit weight for the foundation soil
$\propto$	Wall slope angle from horizontal
δ	Angle of friction between soil and wall