DESIGN OF MECHANICALLY STABILIZED EARTH WALL – REINFORCED EARTH WALL

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A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Engineering (Civil-Geotechnics)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2013

Dedicated

To

Almighty GOD

To

My beloved husband and family,

Employer,

Father and mother,

Brother and sisters,

Friends

For your love and support

ACKNOWLEDGEMENT

In the name of ALLAH SWT, first of all, I want to give thanks to Almighty God who is my source of wisdom and my provider.

I want to thank my supervisor Dr. Nazri Ali who has guided me so patiently in completing this project. Without his guidance, this project would not be completed in time and smoothly. He has assisted me in my difficulties of getting the work done. Without his patience I feel that I may not be able to complete the project in the time schedule. Thank you again to Dr. Nazri Ali.

Besides that, my sincere appreciation also extends to my employer, Ir. Mustafa Hj. Omar for their support and encouragements throughout my study and also in completing the writing of this project report.

Finally, I would like to thank you to my husband and all my friends who have given me encourage and strength to complete the project.

ABSTRACT

Mechanically Stabilized Earth (MSE) Walls are internally stabilized fill walls that are constructed using alternating layers of compacted soil and reinforcement such as geotextiles, metallic strips or rods of metal. Among the types of MSE Wall, Reinforced Earth (RE) Wall is commonly used in the construction industries nowadays. A reinforced soil should be stable overturning, sliding and bearing capacity and also respect to the internal stability. The main objective of this study is to investigate the factors that influence in the designing of reinforced earth wall through the input of case studies of project at Jalan Tumang, Fasa 1, Segamat, Johor Darul Takzim using spreadsheet. The result will be compared with field data to obtain the best solution of RE wall design for both safety and economic factors.

ABSTRAK

Tembok penstabilan tanah Mekanikal (MSE) merupakan tembok penstabilan dalaman yang dibina dengan menggunakan beberapa lapisan tanah terpadat dan melibatkan penggunaan tetulang seperti geotextiles, jalur logam atau rod logam. Antara jenis Tembok MSE yang digunakan ialah tembok tanah bertetulang biasanya digunakan dalam industri pembinaan pada masa kini. Sebuah tembok tanah bertetulang perlu dianalisis dengan kestabilan luaran seperti kestabilan dari keterbalikan, gelongsor dan keupayaan galas serta juga perlu mengambilkira keperluan semakan keatas kestabilan dalaman. Objektif utama kajian ini adalah untuk menyiasat faktor keselamatan yang mempengaruhi rekabentuk tembok tanah bertetulang melalui input kajian kes projek Jalan Tumang, Fasa 1, Segamat, Johor menggunakan spreadsheet yang direkabentuk. Hasil yang diperolehi akan dibandingkan dengan data lapangan bagi memperolehi penyelesaian yang terbaik keatas rekabentuk tembok tanah bertetulang bagi kedua-dua faktor.

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σ_v	-	Vertical pressure
σ_h	-	Horizontal pressure
γ	-	Effective unit weight of the soil
z	-	Depth
K_0	-	At rest earth pressure coefficient.
H	-	Height of wall
P_0	-	At rest total pressure
K_a	-	Active earth pressure coefficient
K_p	-	Passive earth pressure coefficient
q	-	Surcharge unit area
$\emptyset'$	-	Soil friction angle
P_a	-	Total active pressure
P_p	-	Total passive pressure
W	-	Weight of soil
b	-	Strip breadth
t	-	Strip thickness
$FOS_{(sliding)}$	-	Factor of safety against sliding
$\sum F_{R'}$	-	Sum of horizontal resisting forces
$\sum F_d$	-	Sum of horizontal driving forces
$FOS_{(overturning)}$	-	Factor of safety against overturning
$\sum M_R$	-	Sum of the moment of forces tending to overturn about point
$\sum M_O$	-	Sum of the moment of forces tending to resist overturn about point

$FOS_{(bearing\ capacity)}$	-	Factor of safety against bearing capacity
N_{γ}, N_{c}, N_{q}	-	Bearing capacity factors
FOS_B	-	Factor of safety against tie break
f_y	-	Yield or breaking strength of the material
S_v	-	Vertical spacing of reinforcement
S_H	-	Horizontal spacing of reinforcement
FOS_p	-	Factor of safety against tie pullout
$\emptyset_{\mu}$	-	Angle of friction of soil - strip
L	-	Tie length

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Reinforced Earth Wall is very significant and commonly used in construction industry especially in infrastructure projects. At present, the mechanically stabilized earth walls are probably the most used particularly for roadwork where deep cuts or hill side road locations require retaining wall to hold the earth in place.

The mechanically reinforced earth wall uses the principle of placing reinforcing into the backfill using devices such as metal strips and rods, geotextile strips and sheets and grids or wire grids (Figure 1.1). The three basic components of mechanically reinforced earth wall are:

1. The earth fills – usually select granular material with less than 15 percent passing the 200 sieve.
2. Reinforcement – strips or rods of metal, strips or sheets of geotextiles, wire grids, or chain link fencing or geogrids fastened to the facing unit and extending into the backfill some distance.
3. Facing units – not necessary but usually used to maintain appearance and to avoid soil erosion between the reinforcements.

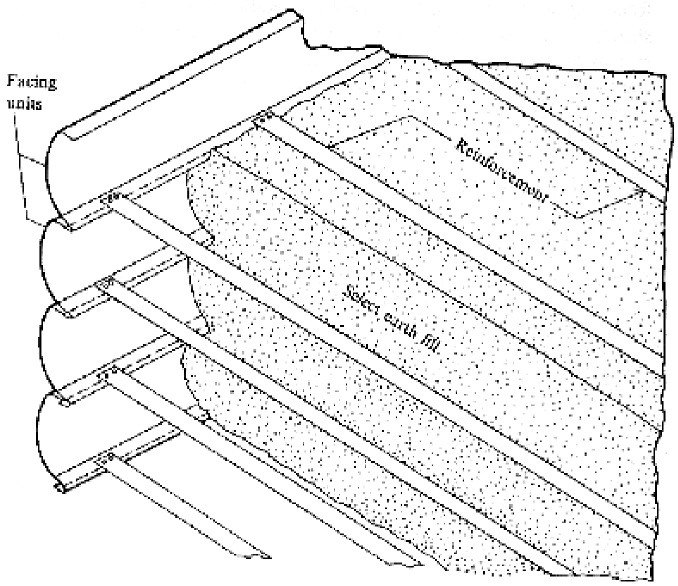

Figure 1.1: The Reinforced Earth wall concept (After Vidal 1969)

As stated by British Standard Institution (BSI) (1995), the design of reinforced earth wall shall involve internal and external stability checks. The general guidance by BSI is the reinforcing strip length shall be more than 70% of the height of wall. The external stability checks of the wall are performed on sliding, overturning and bearing failure. As for internal stability design, checking is done on the tensile strength of steel strips and frictional resistance against horizontal force (Figure 1.2).

1.2 Problem Statement

Reinforced Earth is a composite material which is formed by the association of soil and tension resistant reinforcing elements. The reinforcement suppresses the normal tensile strains in the soil mass through frictional interaction. Reinforced earth wall has widely been adopted due to its economy, ease of construction and flexibility in nature. The internal stability check and external stability check need to be calculated in designing the reinforced earth wall. These conditions are based on the same limit states that apply to design the gravity wall.

The external stability comprises of checking the safety of the wall as a rigid block against overturning, sliding, bearing capacity failure and overall stability. In internal stability, the competency of the reinforcements provided at different heights is examined against tension and pull-out failures. The internal stability analysis of a reinforced earth wall requires the identification of rupture surface behind the panels of the wall and during pull-out failure, and the effective length of the reinforcement contributing to the development of frictional resistance that lies outside the wedge. Further, the earth pressure distribution behind the wall is required to design the size and type of reinforcement.

This repeating process involves many varieties, hence they have to be carried out through trial and error until the design structures fulfils the standard requirement, safe and economic. Due to the repetition works, in this study, the usage of computer program can be developing to assist the design, hence accelerate the analysis and design process.

1.3 Aim and Objectives

The aim of this study was to review the design of reinforced earth wall in terms of safety and serviceability. This study will review the most important item in highway which is reinforced earth wall. The objectives of this study are as follows:

i) To analysis the factor of safety of Reinforced Earth wall in terms of internal and external stability checks.

ii) To validate with field data and structured the best solution of Reinforced Earth wall design using strip reinforcement designs.

1.4 Scope and Limitation of Study

To ensure that the study conducted will achieve the aim and objectives, the scope of study only focused on the strip reinforcement design. The Rankine's and Mohr Coulomb Theory are applied in checking the external stability of reinforced earth wall. For the internal stability, the analysis is to checking the tension failure, the stability is considered of an internal wedge of soil above each reinforcement level and the pullout failure, where the pull out capacity is checked by considering the bond length of reinforcement required belong each wedge of soil above that layer. The assumption to undertake in the program data sheet are the soil used are granular soil and there is no effect of pore water pressure. The scope of this study will focus on one case study which is the proposed slope stabilization works at Fasa 1, Jalan Tumang, Segamat, Johor Darul Takzim.

1.5 Significance of Study

From the study, the analysis and designing of reinforced earth wall can be established and it is expected to maintain the stability of slope at hillside. The most important aspect will be considered in this study is to investigate the factors that influence in the designing the reinforced earth wall and make a good comparison instead of economical and construction wise.

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