AN INTRODUCTION TO THE DESIGN OF REINFORCED EARTH RETAINING WALLS

by

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INTRODUCTION

Soil is the most abundant material in the world, and it has long been used as a construction material by human beings. The concept of strengthening soil by embedding reinforcing elements such as rods or fibers is not new. Chinese in ancient times were aware of the value of adding straw in the making of sun-dried clay bricks; this improved the strength of the brick which was used to build dwellings. For more than one thousand years, mattresses made of wood branches have been embedded in the soil to form dikes or revetments along the Yellow River in China. Bundles of brush wood called faggots were used in stabilizing the bank of the Mississippi River in the 1880's (7). However, not until the 1960's had this concept been developed theoretically. During that time a French engineer, Mr. Henri Vidal, developed a disciplined approach based on a reasonable design procedure for the use of reinforced earth in important engineering structures (14, 15). Since then, a variety of related studies have been undertaken, and many experiments have been conducted for the purpose of further understanding the nature and behavior of steel-reinforced earth as a construction material.

Reinforced earth mobilizes the friction between soil particles and the reinforcing strips which are placed at regular intervals horizontally and vertically to create an earth retaining structure. Reinforced earth is advantageous wherever the conventional retaining walls have to be built under difficult conditions, e.g., poor foundation soil with low bearing capacity, or where very high walls are needed, or in areas where concrete construction is uneconomical.

The large surface area of a reinforced earth structure spreads the load over a large area. The cost of a reinforced earth wall does not increase with height as rapidly as that of a concrete wall when the height required exceeds a certain limit. Reinforced earth walls have almost no limitation in height as does sheet piling (15).

Reinforced earth is a new construction process, and it is gaining acceptance in the construction of high walls and similar structures because it costs less than conventional retaining walls. Up to the present time, some 700 reinforced earth structures have been in service all over the world (11).

Purpose of the Study

The concept of reinforced earth is simple, but the application of this concept to design leads to different approaches (5). The purpose of this study is to review the pertinent literature on the theoretical studies and experimental tests, and to develop an approach for the analysis and design of reinforced earth walls.

Scope of the Study

This study initially consisted of a careful and comprehensive review of the available literature pertaining to reinforced earth structures. Then, based upon the analyses, a computer program was developed for the design of reinforced earth retaining walls for any given wall height and soil properties. Finally, a numerical example and the writer's conclusions complete the results of this study.

LITERATURE REVIEW

Theory of Friction

In 1699 a French engineer, Mr. Guillaume Amontons (1), published the results of an extensive series of friction tests from which he developed the basic laws of friction, namely:

1) The frictional force is proportional to the normal force.

2) The frictional force is independent of the surface area of contact.

3) The frictional force is independent of the rate of movement.

As shown in Fig. 1, a stationary block having a weight, W, and being pulled by a force, p, will reach a condition called limiting friction. This occurs when, as p is increased, the block is just on the verge of impending motion. The friction equation can be formulated as follows:

$$F = fN$$

where

F = friction force

N = normal force which in this case is equal to the weight, W and

f = coefficient of static friction ($f = \tan \phi$, where ϕ is called the angle of friction)

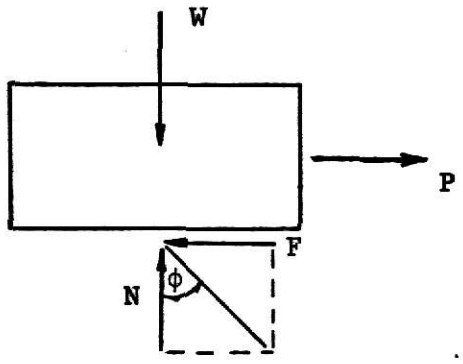

Fig. 1 - Friction Force at Impending Motion