STABILITY OF ROAD SUBGRADES AND SLOPES USING PLASTIC NETS

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CHAPTER I

INTRODUCTION

Frequently, the soil at a site can not meet the engineering and structural specifications which are required for a successful performance of pavement components and subgrades, such as strength and durability. Procedures such as selecting alternative routes or removing the undesirable soil and replacing it with a better one are common practice. Good soils at a certain site may not be available. Engineers resort to the improvement of the existing soils.

More recently, reinforced earth has become one of the means of improving soil properties. Reinforcement can vary greatly in form (strips, sheets, grids, bars, or fibers), texture (rough or smooth) and relative stiffness (high such as steel or low as polymeric material).

The concept is based on a simple principle: the separate grains in a block of reinforced earth are integrated by the reinforcements due to frictional stresses which are developed when the earth and the reinforcements are in contact.

The purpose of this investigation is to study the basic mechanism which operates when plastic nets reinforcements are placed in soil and to investigate the different factors which influence the behaviour of reinforced soil.

The main objectives are to ascertain the contribution of plastic nets reinforcement to the shear strength of soil and to investigate the function of such reinforcement in modifying the stress-strain response of sand. A related objective is to determine the significance of the improvement expected in the stability of sandy slopes as a result of using plastic net inclusions.

The investigation includes the study of the influence of a number of factors such as reinforcement properties (dimensions and longitudinal stiffness), soil type (sand in dense, loose state and sand with fines) and the reinforcement distribution.

The compressibility and shear strength of soil reinforced with plastic net inclusions were studied using the triaxial apparatus.

CHAPTER II

LITERATURE REVIEW

2.1 GENERAL:

The principle of soil strengthening by combining materials of relatively high tensile resistance with the soil is based on the load transfer between soil and inclusion. Hence, the key to the stability of a reinforced earth structure is the interaction between the soil and reinforcements.

A properly designed and constructed structure holds itself together as a coherent body because of this interaction which prevents the soil from spreading laterally in the direction of the reinforcements (Fig. 2.1).

This cohesion as reported by "French Road Research Laboratory" is proportional to the tensile strength of the reinforcements and in the direction of the tensile strength of the latter. As shown by recent studies, Bassett and Last (1978) and Jewell (1980), tensile reinforcements exert their greatest strengthening effect when oriented in the direction of principal strain extension.

Most of the research work carried out in the past few years has been directed towards the study of the properties of various types of inclusions, increase in the soil strength due to the presence of inclusions, soil-inclusion interfacial friction and behaviour of different soil-inclusion systems such as reinforced earth walls and embankments.

2.2 REINFORCEMENT FUNCTION OF INCLUSIONS IN SOIL.

Consider a semi-infinite mass of cohesionless soil at rest. If the surface of the soil is horizontal then, at a depth (h) below the surface

vertical stress $= \gamma h$ and,

lateral stress $= K_o \gamma h$.

where K_o = coefficient of earth pressure at rest,

γ = unit weight of the soil.

If the soil is allowed to expand laterally, the horizontal stress ($K_o \gamma h$) will be reduced to a limiting value ($K_a \gamma h$)

where K_a = coefficient of active earth pressure.

If the soil is compressed laterally, the horizontal stress will increase to a limiting value ($K_p \gamma h$).

where K_p = coefficient of passive earth pressure.

The three stress states are illustrated in Fig. (2.2). Consider a soil layer between two adjacent reinforcement strips. If enough friction is developed, the top and bottom of the layer will be attached to the reinforcements. If the strips are close enough then the whole soil layer will be more or less constrained and the maximum strain that can be expected in the direction of the reinforcements will be of the order of the strain in the reinforcements.

The types of reinforcement material must all have a Young's modulus much greater than that for the soil so that the resulting strains in the soil will be so small that the soil is essentially at rest and the lateral pressure within it can be assumed to be equal to $K_o \gamma h$.

This is the fundamental idea of reinforced earth as developed by Vidal in 1966.

Vidal (1969) demonstrated the increase in strength of the composite material by considering the equilibrium of two cubical specimens; one was formed of soil alone while the other contained a horizontal inclusion at mid height.

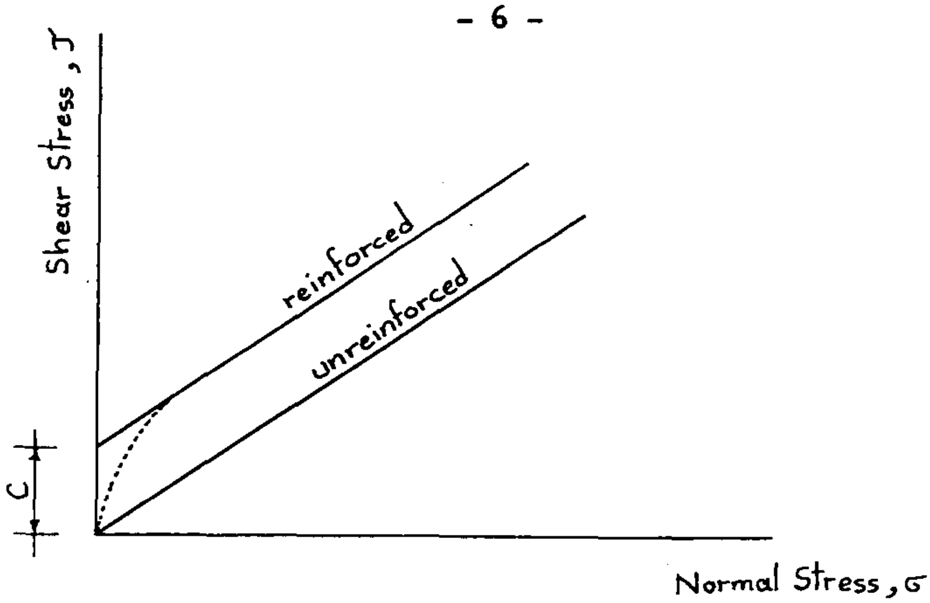

FIG (2-1) STRENGTHENING EFFECT OF REINFORCEMENT .

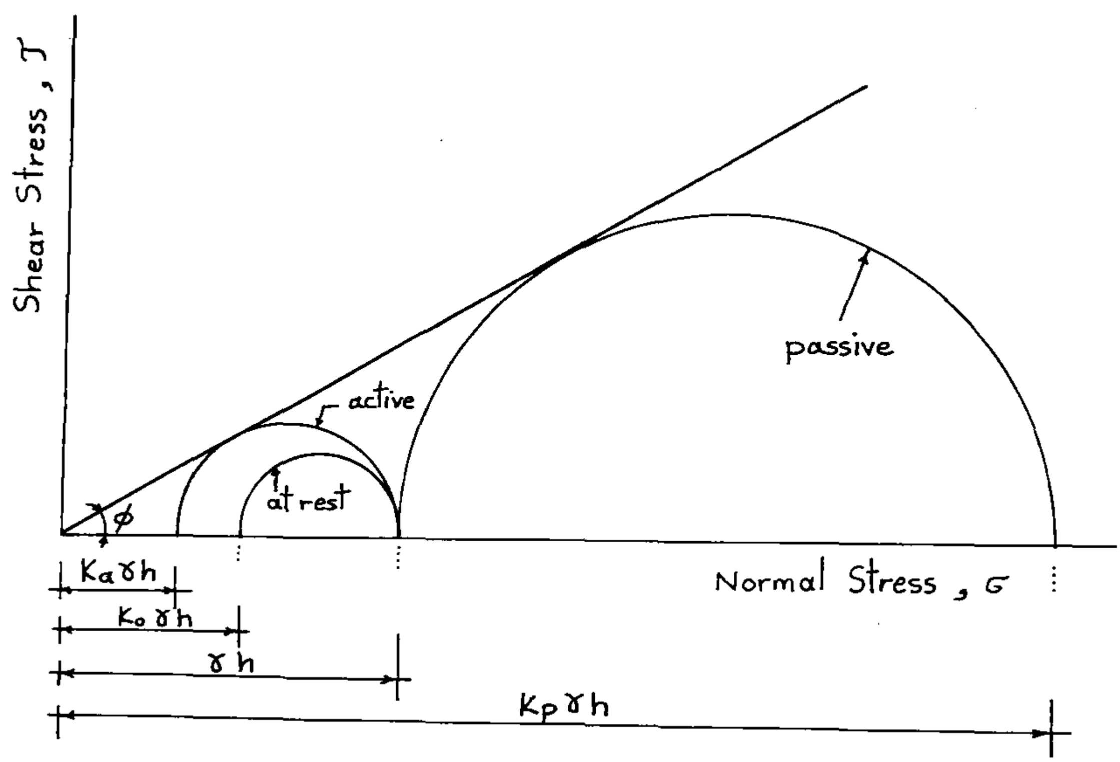

FIG (2-2) VARIATION OF LATERAL PRESSURE

If a cube of an isotropic and homogeneous granular soil mass without reinforcement is subjected to unconfined compression, the mobilized coefficient of friction (ϕ_m) will be higher than (ϕ) and thus it will fail;see Fig. (2.3a). For maintaining the stability of the cube, a lateral stress (σ_3) not less than $K_a \sigma_1$ must be applied;see Fig. (2.3b).

If the soil is reinforced in the direction of σ_3, the lateral strain caused by vertical loading will induce tensile strains in the inclusion through soil-inclusion interfacial friction and this in turn will induce tensile stresses in the inclusion.

If the inclusion is sufficiently rough and stiff compared to the soil, it will tend to restrict the soil movement. This restriction of movement is analogous to a confining pressure.

Accordingly, Vidal concluded that the reinforced sample will possess improved properties which will allow it to sustain higher vertical stresses than the unreinforced sample.

These suggestions were later confirmed by triaxial (Yang, 1972), plane strain (Mc-Gown, 1978) and

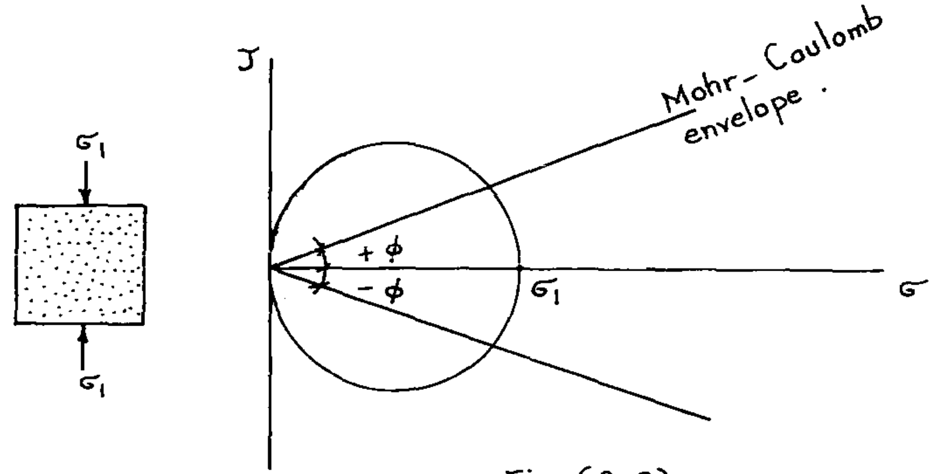

Fig. (2-3)$_a$

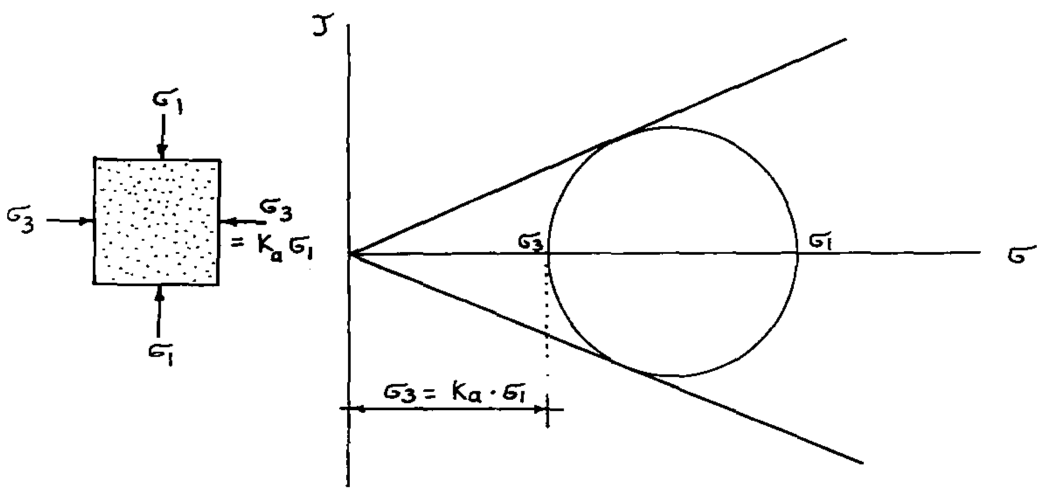

Fig. (2-3)$_b$

FIG. (2-3) FAILURE CONDITION FOR A SOIL SAMPLE .

shear box tests (Jewell, 1980) on reinforced soil samples.

2.3 STUDIES CONCERNING STRENGTH BEHAVIOUR OF SOIL-INCLUSION SYSTEM.

Mc-Gown and Andraws (1978), reported observations on the stress-strain behaviour of a unit cell of sand under plain-strain condition with and without inclusion. Various parameters were considered such as inclusion extensibility, initial sand porosity and the inclusion orientation.

Test results indicated that the peak stress ratio was maximum when the inclusion was placed in the direction of the maximum tensile strains whereas it was the same as that for sand alone when the inclusion was placed in the direction of the maximum compressive strains. A weakening effect was observed when the inclusion was oriented close to or along the directions of the zero-extension lines. This was attributed to the fact that the failure planes occur along these directions and that the angle of internal friction between the soil and the inclusion is usually smaller than the internal angle of friction of the soil.