AN EXPERIMENTAL STUDY ON THE COMPACTION OF SOILS

by :

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Title : An Experimental study on the Compaction of Soils

Objectives :

1. To discuss in general the importance of compaction in soils.

2. To discuss the various available compaction tests.

3. To investigate experimentally the effect of applying not standard compaction effort, on the test results.

4. To discuss the results of 3) above.

Terms and conditions :

1. The soil to be used shall be a "Havara" type.

2. Relevant Cyprus, British or U.S. standards may be used.

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1.0 INTRODUCTION

1.1 The improvement of soil

Usually the soil at a site to be developed is not ideal from the viewpoint of soil engineering. In some cases, the engineer can avoid potential soil problems by choosing another site or by removing the undesirable soil and replacing it with desirable soil. In the early days of highway construction this procedure was widely employed; e.g. highways were routed around swamps. As time went on, the decision to avoid bad soils was made less frequently. The increase in speed of vehicles forced stricter alignment standards on tracks, highways and runways. With the growth of cities and industrial areas the supply of sites with good foundation conditions became depleted. Increasingly the soil engineer has been forced to construct at sites selected for reasons other than soil conditions.

A second approach to the problem of bad soils is to adapt the design for the conditions at hand. For example, floating foundations and deep foundations can be designed to avoid many of the settlement and stability problems associated with soft foundation soils.

A third approach available to the soil engineer is to improve the soils. This approach is becoming more feasible and more attractive. Soil improvement is frequently termed soil stabilization, which in its broadest sense is the alteration of any property of a soil to improve its engineering performance. Examples of soil improvement are: increased strength (as for a pavement subgrade), reduced compressibility (as for the foundation of a structure), and reduced permeability (as for the foundation of a dam). Soil improvement may be a temporary measure to permit the construction of a facility, or it may be a permanent measure to improve the performance of the completed facility.

Soil improvement techniques can be classified in various ways according to the nature of the process involved, the material added, the desire result, e.t.c. For example, on the basis of process, we have mechanical stabilization, chemical stabilization, thermal stabilization and electrical stabilization.

The human mind is constantly searching for new ways to improve on existing conditions, and soil conditions are no exception. Since people began travelling, they have been confronted with the frequently undesirable conditions in which nature has left the terrain; and as wheeled traffic developed and began to increase, efforts were made to build roads and to improve the existing soil conditions. With the known troubles associated with soft ground, the early roads consisted of a hard surface placed over the natural ground. With time, the technique of compacting or densifying layers of soil before placing the pavement developed. The compaction is achieved by running heavy vehicles with special wheels or rollers over the soil. This is sometimes termed mechanical compaction or stabilization.

At first compaction was limited to a thin surface layer, but cutting and filling to create acceptable road gradients soon involved compaction of fills of considerable thickness. From this point, the development of a specialized trade occupied solely with excavation and compaction of soils has been very rapid, especially in the United States. It is of interest that, not withstanding the tremendously increased costs of labour and equipment and the vastly improved and upgraded standards for compaction, the cost (reduced to a standard reference) per cubic yard of excavating and recompacting soil has declined steadily since the beginning of the century. This fact, in combination with the high cost of building and the increased value of land, has led to the construction of large earth embankments where trestles would have been used before, to complete changes in topography by cutting off hilltops and filling in valleys to create level land for development, and to construction of earth-fill dams of enormous dimensions.

Compaction equipment has been improved and increased in size both to handle the large quantities of fill material at the same rate as modern grading equipment can move it and to attain standards of compaction which have been raised to accommodate the increased frequency and weight of vehicular traffic or to support the great loads of modern aircraft. The depths of fill in high dams and in developments in hilly terrain also demand a higher degree of compaction to minimize settlement of the fill under its own weight. Construction on land developed by extensive grading of steep ridges and deep valleys may result in a structure founded in recently cut bedrock on one side and on over fifty feet or more of compacted fill on the other side. Naturally the bearing properties of compacted fill and its foundation should be as nearly as possible similar to those of the bedrock in the cut.

In addition to mechanical compaction of soil, methods have been developed to stabilized soil by blending it with different soil or other materials. For instance, the grain-size distribution of a soil in place may be so pour that no amount of compactive effort can give the soil the necessary strength and stability. Blending with other soil can solve this problem quite economically in many cases. This is done frequently in earth-fill dams and also in highway construction where susceptibility to frost damage, the drainage properties, and the strength after compaction can be modified by mixing different soil types. In some cases the quality of a natural deposit for compacted fill can be improved by removing certain grain sizes, as by washing gravels used in pavement base and by removing boulders from soil fills. The strength of compacted fills can be increased chemically to a considerable degree with small quantities of cement, asphalt, lime or other additive. This course is followed particularly in highway and airfield pavement construction, and a description of this form of soil stabilization is a necessary preamble to another chapter, which covers pavement design.

The many techniques of soil improvement are discussed by Lambe (1962). A great many empirical data on soil improvent have been obtained from extensive field experience. Sherard et al. (1963) treat soil improvement for dams; The road research laboratory (1952) treats soil improvement for roads and airfields; Fruco and Associates (1966) treat soil improvement for deep excavations; Leonard (1962) and the ASCE (1964) treat compaction, dewatering and preloading. The ASCE Specialty Conference (1968) was limited to the placement and improvement of soil for foundations.

The most common and important method of soil improvement is densification. Three methods of densification are considered: a) Compaction of soils (densification with mechanical equipment, usually a roller); b) Preloading (densification by placing a temporary load); and c) Dewatering (removal of pore water and/or reduction of pore pressure). These techniques (as well as others) may be used alone or in combination with each other.

Soil Compaction is the method the project dealed with.

CONTENTS

PAGES