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Importance of Soil Pulverization Level in Lime Stabilized Soil Performance

Ilknur Bozbey[1], Birol Demir[2], Muhammet Komut[2], Ahmet Saglik[2], Senol Comez[2], Aykan Mert[2],

[1]*Istanbul University, Civil Engineering Department, Istanbul, Turkey*

[2]*Republic of Turkey, General Directorate of Highways, Department of Research and Development, Ankara, Turkey*

ibozbey@istanbul.edu.tr, aykanmert@yahoo.com

Abstract

In this study, effects of soil pulverization level on mechanical properties of a lime stabilized high plasticity clay were investigated. Unconfined compression strength tests were carried on lime stabilized samples which were prepared with two different soil pulverization levels. Fine soil pulverization consisted of 100% finer than No.4 sieve, as typical of laboratory applications. Coarse soil pulverization consisted of 60% of the soil passing No. 4 sieve and all finer than 20 mm, as typical of a high quality field gradation. 4%, 6% and 9% hydrated lime were used by dry weight of the soil for soil stabilization. Unconfined compression tests were carried out after 7, 28 and 56 days of curing. The results revealed that stress-strain behavior differed with soil pulverization levels. Unconfined compression strength and initial modulus values were also significantly affected by soil pulverization levels. Coarse pulverized samples had considerably inferior unconfined compression strength and initial elastic modulus values. This was valid for all curing days. The ratio of values obtained for fine and poor soil pulverization ranged between 1,5 to 2 for unconfined compression strength values and was about 1,5 for initial elastic modulus values. These differences may cause discrepancies between laboratory-estimated and actual field performances of the pavements. It should also be recalled that, in case, field soil gradations are coarser than that of this study, the differences may be larger. Therefore based on the results of this study, it is recommended that laboratory testing for mixture design of lime stabilized soils should be carried out with probable field gradations.

Keywords: P*avement, lime, soil pulverization level, unconfined compression strength, initial elastic modulus*

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1 Introduction

If natural subgrades are not suitable for pavement construction, excavating and replacing the soil with select fill material or increasing the base thickness to decrease the subgrade stresses may be an alternative. In this context, stabilization of clayey soils by lime may be an economical and environmental friendly alternative (Little, 1995, 2000). However, laboratory and field conditions are different by nature and one of the main differences that can occur between laboratory and field is soil pulverization level. Effects of soil pulverization level on mechanical properties of stabilized soils have been studied by some researchers (Grimer and Ross, 1957, Kennedy and Smith, 1986, Petry and Wohlegemuth, 1988, Bozbey and Garaisayev, 2010, Toohey and Mooney, 2011, Beetham et al., 2014) and these studies conclude that designing earthworks based on the parameters determined from laboratory tests could be misleading, because the maximum size of the soil tested in the laboratory is usually less than a few millimeters while clay aggregates in the field may reach the dimension of several centimeters. It is anticipated that if mechanical properties in the field differ from the anticipated values, this may lead to differences in pavement performance.

The experiments presented in this paper were carried out within a joint venture project between Turkish General Directorate of Highways and Istanbul University. The project is titled; "Investigation of the effects of field soil pulverization level on lime stabilized soils used for pavement construction and preparation of a design procedure based on resilient modulus". This project aims to fulfill two important aspects of the subject. The first one is to investigate the effect of soil pulverization level on performance of lime stabilized soils. In this context, unconfined compression strength, CBR, tensile strength and resilient modulus tests were carried out on lime stabilized soils prepared with different lime contents and soils pulverized at different gradation levels. Stress-state dependency of resilient modulus of lime stabilized soils was investigated. Correlations between resilient modulus, elastic modulus and CBR values were searched. Effects of curing, freeze and thaw cycles and wetting and drying cycles on performance of lime stabilized soils were also within the context of the project. Following the laboratory study, multi-layered elastic analyses are being run using the lime stabilized soils' parameters. A design procedure according to mechanistic–empirical pavement design approach will then be prepared related to lime treated subgrades. The results of the study will also be used to prepare a handbook on resilient modulus testing of lime stabilized soils.

The results presented in this study are based on the experiments carried out in this research project. In this context, results of unconfined compression tests carried on lime stabilized soils are summarized. A high plasticity clay was used. The samples were prepared with two different soil pulverization levels which were within the recommended limits in the relevant criteria. 4%, 6% and 9% lime were used by dry weight of the soil and the tests were carried out after 7, 28 and 56 days of curing respectively. Effects of soil pulverization level on unconfined compression strength and initial elastic modulus are evaluated and presented.

2 Literature Review

Lime stabilization is one of the most frequently used soil improvement methods in pavement design. In this context, it is very important that laboratory achieved improvement levels can be obtained in the field. Recent studies have shown that soil pulverization level is a very important parameter in lime stabilization of soils and in case, soil gradations used in laboratory are not met in the field, lime stabilization may not be as effective as targeted. There are some previous studies on effects of soil pulverization level on lime and cement stabilization, which mostly focused on strength and durability. They are summarized below.

The results of Grimer and Ross (1957) showed that coarser pulverization meant lower strength values in cement stabilization. Kennedy and Smith (1986) studied the effect of cement stabilization on