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STABILIZATION OF COHESIVE SOILS UNDER EFFECT OF NATURAL POZZOLAIC ASH AND LIME

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Abstract The current review explores the utilization of regular pozzolana joined with lime for ground improvement applications. Research center tests were attempted to concentrate on the impact of normal pozzolana, lime or a blend of both on the physical and the mechanical attributes of strong soils. Regular pozzolana, lime and normal pozzolana-lime were added to two durable soils at scopes of 0–20 and 0–8%, individually. Consistency, compaction, undrained triaxial shear and unconfined compressive strength tests were performed on untreated and treated soil tests to survey the physical and mechanical qualities of the dirt. Treated samples were restored for 1, 7, 28 and 90 days. The outcomes show that the strong soils can be effectively balanced out by consolidating normal pozzolana and lime.

Keywords Lime · Natural pozzolan · Cohesive soil · Stabilization · Compaction · Strength · Curing

1 Introduction

The reduction of available land resources and the increased cost associated with the use of high quality materials have led to a large need for using local soils in geotechnical construction. Many sites around big cities such as Algiers present poor engineering properties and land for construction projects is scarce. Hence, sites with poor soils have to be used. Poor engineering properties of some of these soils create difficulties during construction and hence the need to stabilize these soils to improve their properties.

More civil engineering structures are also built on soft soils, leading necessarily to the development of various ground improvement techniques such as soil stabilization. Soil stabilization is a technique introduced many years ago with the main purpose to improve the physical and chemical characteristics of soils and render the soils capable of meeting the requirements of specific engineering projects (Kolias et al. 2005). Several additives, such as cement, lime and mineral additives such as fly ash, silica fume, rice husk ash…, have been used for stabilisation of soft soils (Al-Rawas and Goosen 2006).

Lime as an additive is most commonly used to stabilise fine soils due to its effectiveness and economic usage. As an additive, lime improves significantly the engineering properties of soft soils. Lime stabilisation is achieved through cations exchange, flocculation agglomeration, lime carbonation and pozzolanic reaction. Cations exchange and

flocculation agglomeration reactions take place rapidly bringing immediate changes in soil properties, whereas pozzolanic reactions are time dependent. These pozzolanic reactions involve interactions between soil silica and/or alumina and lime to form various types of cementation products thus enhancing the strength.

The studies reported in the literature show that the addition of lime increased the optimum moisture content and strength, and reduce the plasticity index and maximum dry density of the soil (Guney et al. 2007).

Several investigators (Al-Rawas et al. 2005; Goswami and Singh 2005; Rahman 1986; Muntohar and Hantoro 2000; Attoh-Okine 1995; Nalbantoglu 2006; Lasledj and Al-Mukhtar 2008; Osula 1996; Ola 1977; Bagherpour and Choobbasti 2003; Kavak and Akyarli 2007; Manasseh and Olufemi 2008; Bell 1996; Okagbue and Yakubu 2000; Ansary et al. 2006) found that in most cases the effect of lime on the plasticity of clay soils is more or less instantaneous. The works reported by several researchers (Ola 1977; Rahman 1986; George et al. 1992; Bell 1996; Gay and Schad 2000; Hossain et al. 2007) indicate that soils treated with lime experienced notable increases in optimum moisture content while undergoing a decrease in maximum dry density. In addition, some investigators (Lin et al. 2007; Chen and Lin 2009) postulated that failure behaviours similar to brittle materials were observed in shear failure mode for soil specimens stabilized with lime. Moreover, some researchers (Ola 1977; Rahman 1986; Attoh-Okine 1995; Hossain et al. 2007; Manasseh and Olufemi 2008) found that the strength behaviour of soils was greatly improved after lime treatment.

In recent years, industrial by-products have been added and mixed with soft soils to improve their engineering properties. The improved characteristics of soft soils, resulting from the utilization of cementing additives like fly ash, rice husk ash and silica fume, bring about environmental and economic benefits. The effectiveness of these by-products for stabilization of soils has been investigated. The addition of such materials reduced the plasticity index (Parsons and Kneebone 2005; Goswami and Singh 2005; Kolias et al. 2005; Nalbantoglu 2004; Basha et al. 2003; Basha et al. 2005; Rahman 1986; Muntohar and Hantoro 2000). In term of compaction, several researchers (Senol et al. 2006; Kolias et al.

2005; Sezer et al. 2006; Prabakar et al. 2004; Basha et al. 2003; Muntohar and Hantoro 2000; Kalkan 2009; Basha et al. 2005; Rahman 1986) observed that soils treated with cementing additives show an increase in optimum moisture content and a decrease in maximum dry density. Furthermore, the studies (Sezer et al. 2006; Kolias et al. 2005; Senol et al. 2006; Basha et al. 2005) indicate that the strength of soils can be improved by addition of such cementing additives.

3 Conclusions

This study presents the effect of natural pozzolana, lime and their combinations on Atterberg limits, compaction, shear strength and unconfined compressive strength of cohesive soils. On the basis of the test results, the following conclusions can be drawn:

- The plasticity index decreased with increasing lime contents. Moreover, when both natural pozzolana and lime were added to the cohesive soils, an appreciable change of the plasticity behaviour was observed. However, the addition of natural pozzolana has a minor effect on the plasticity index of the grey soil. Both grey and red soils tend to change according to the unified soil classification system. The use of lime alone and the combination of natural pozzolana-lime, trans- formed grey soil (CH) and red soil (CL) into MH class soils.
- The maximum dry density of lime stabilized soils decrease with increasing lime content, in contrast with natural pozzolana stabilized soils. The combination lime-natural pozzolana increases the maximum dry density for grey soil and decreases that of red soil. On the other hand, the optimum moisture content of lime stabilized soils increased with the increase in lime content, in contrast with natural pozzolana stabilized soils. The combination lime-natural pozzolana decreased the optimum moisture content for the grey soil and increased that of the red soil.
- The failure modes were similar to that of brittle materials for both soils stabilized with lime or with a combination of natural pozzolana-lime. Furthermore, maximum shear strengths were observed for samples stabilized with a combination of natural pozzolana-lime compared to those stabilized with lime or natural pozzolana alone.

- The addition of lime improved the unconfined compressive strength. The improvement is more significant with increasing curing time. The combination natural pozzolana-lime can substantially improve the unconfined compressive strength.
- Combining two local materials (natural pozzolana and lime) can effectively improve the properties of cohesive soils and help in increasing land availability for construction projects.
- For future research it is recommended to test the influence of the addition of lime and natural pozzolana in cohesive soils, making more combinations on the quantities of the additives.

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