Study of clayey soils stabilized with ladle furnace slag as alternative binder for use in road works

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Abstract. Steelmaking industry generates a large volume of by-products that not always can be reintroduced into production processes, such as the steelmaking process itself or the production of cement. This is the case of ladle furnace slag (LFS), whose potential use is limited and usually ends up in landfill. This work investigates the feasibility of using LFS as binder for clayey soils stabilization in substitution of lime. The main parameters evaluated are plasticity index, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS). The results show that the strength behavior of the mixtures is remarkable, obtaining increases in the CBR index between 8-14 times above unmodified clays. The mechanical performance base on UCS results show improvements of 85 % relative to natural soils three days after mixing. Moreover, if the curing time is up to 90 days, the UCS doubles or triples its value. Depending on the chemical composition of the soils, the performances of the mixtures are different, but in all cases the results are positive and encourage further research for the incorporation of ladle furnace slag as stabilizing agent.

Introduction

The environmental sustainability pursuit is fundamental in all areas, and civil engineering is not an exception. Engineering projects should be planned following models that reduce the consumption of fossil resources. To mitigate the environmental impact, sustainable materials can be chosen, available close to the work area to reduce transport, and whenever possible it is advisable to reuse the materials in-situ.

In the last decades, the use of industrial waste or by-products has been introduced into the construction sector [1]. Different research lines have analyzed the possibility of building with recycled materials [2] [3], and many field experiences achieved very good results [4]. Governments have also taken a step forward by regulating the use and implementation of many of these new products.

Iron and steelmaking industry worldwide generates a large volume of by-products every year, most of them are suitable to efficient and sustainable applications [5]. Ladle furnace slag is produced in the secondary or basic refining of steel, whose global production volume is around 30 million tons per year [6], but its limited applicability means that solution large amount of it is simply landfilling. Because of this, it is urgent to look for environmentally and economically viable applications of this by-product.

Traditionally, the lack of bearing capacity of clay soils has generated large volumes of soil destined for landfill and the need for aggregates extraction, both with negative environmental consequences. However, the soil stabilization with lime, cement or polymers has allowed solving this problem. Nowadays, researchers from all over the world are analyzing the possibility of replace these natural stabilizers by different types of industrial by-products [7] [8] in order to improve this issue economically and environmentally.