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Soil stabilization using micro silica.

Estabilización de suelos mediante micro sílice

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ABSTRACT

Soil can make or break the structures. The ability of any soil depends on its properties. Soil stabilization in a broader sense, incorporates various methods employed for modifying the properties of a soil to improve its engineering performance. This project deals with the usage of micro silica for stabilization of a hilly soil sample. An attempt has been made to stabilize the soil sample with an addition of 10% of micro silica. The properties of soil have been tested for its shear strength, compressive strength, etc. And the results have been found to be productive.

Keywords: casagrande apparatus, direct shear test, compressive strength test, specific gravity.

RESUMEN

Soil can make or break the structures. The ability of any soil depends on its properties. Soil stabilization in a broader sense, incorporates various methods employed for modifying the properties of a soil to improve its engineering performance. This project deals with the usage of micro silica for stabilization of a hilly soil sample. An attempt has been made to stabilize the soil sample with an addition of 10% of micro silica. The properties of soil have been tested for its shear strength, compressive strength, etc. And the results have been found to be productive.

Keywords: casagrande apparatus, direct shear test, compressive strength test, specific gravity.

Introduction

Soil is the key factor which decides the stability of any structure on it. Soil stabilization is the process of enhancement of the physical properties of soil in order to improve its strength, durability, etc. Soil stabilization can be done with or without adding admixtures to

the existing soil. On the other hand, in a developing country like india, disposal of wastes and by-products have become a great challenge. Silica fume also known as micro silica is an ultrafine powder of average particle size of 0.15μm emerging as a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. An attempt of incorporating silica fume in stabilization of soil sample from a hilly terrain in order to meet its engineering properties which would be economical too. Various tests including liquid limit test, unconfined compression test, standard proctor test and direct shear test have been carried out on the soil sample and on the soil sample with 10% replacement by micro silica to identify the change in its properties and the results have been obtained.

The objectives of the study are: 1) to study the various properties of soil and its behavioural changes on 10% replacement by weight with micro silica; 2) to compare and analyse the properties of the original soil sample and soil sample with 10% replacement by weight with micro silica, 3) to study and compare the results.

MATERIAL AND METHODS

Selection of material: As per a recent study, about 5.10 billion tonnes of ferrosilicon alloys are manufactured in india per annum. Silica fume, an ultrafine powder is a by-product in the production of ferrosilicon alloys. Silica fume due to its fineness can be used as an admixture for stabilization of soils. Various properties of silica fume are also studied.

Material used – silica fume: silica fume is an ultrafine powder having an average particle size of 0.15μm. This makes it approximately 100 times smaller than the average cement particle. It is a very reactive pozzolan. The bulk density of silica fume depends on the degree of densification in the silo and varies from 130 (un densified) to 600 kg/m^3. The specific gravity of silica fume is generally in the range of 2.2 to 2.3.

Experimental study: This study was conducted to analyse the change in the behaviour of the properties of soil on 10% replacement by weight with micro silica and to determine the characteristics like grading by sieve analysis, atterberg limits i.e., liquid limit using casagrande method, optimum moisture content and maximum dry density using standard proctor, specific gravity and shear strength using unconfined compression for the soil sample and soil sample with partial replacement by micro silica.

Sieve analysis-a sieve analysis is a practice or procedure used in civil engineering to assess the particle size distribution of a granular material by allowing the material to pass through a series of sieves of progressively smaller mesh size and weighing the amount of material that is stopped by each sieve as a fraction of the whole mass.

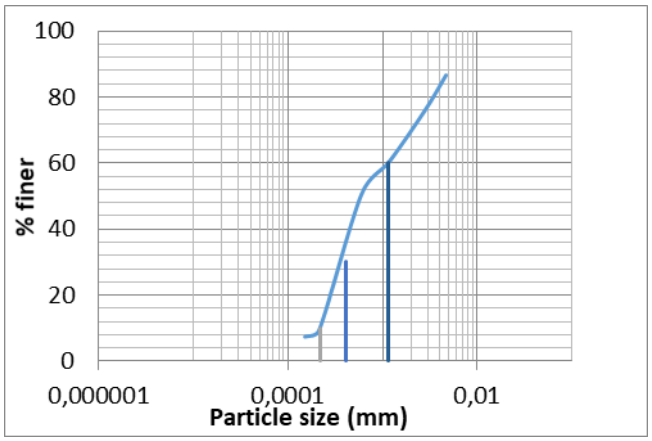


Fig 1: particle size distribution graph

Liquid limit test: the water content where the soil starts to behave as a liquid is known as liquid limit of soil sample.

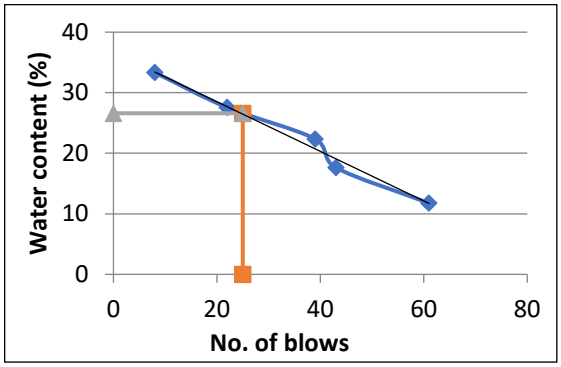


Fig 2: Liquid limit curve for soil

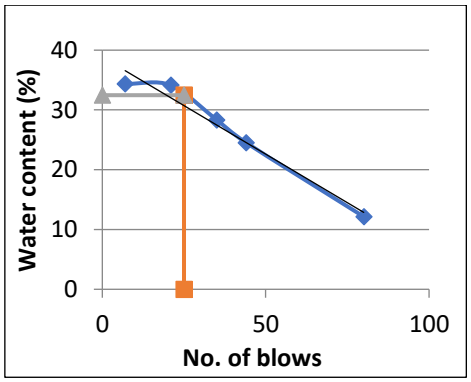


Fig 3: Liquid limit curve for soil with partial replacement by microsilica

Unconfined compression test- the unconfined compressive test is a laboratory test used to derive the unconfirmed compressive strength (ucs) of a specimen. Ucs stands for the maximum axial compressive stress that a specimen can bear under zero confining stress.

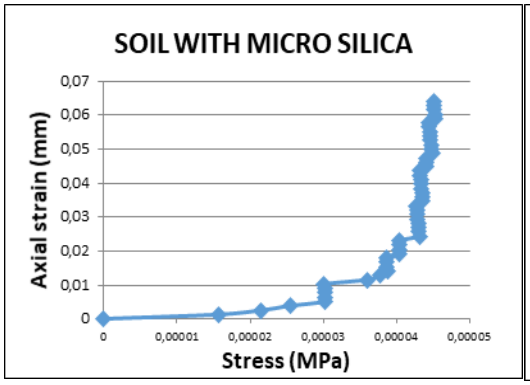


Fig 4: UCS curve of soil sample

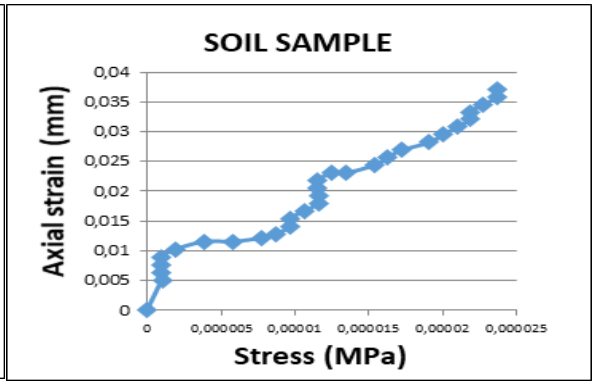


Fig 5: UCS curve for soil sample with partial replacement by micro silica

Standard proctor test-the proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density.

Direct shear test*:* the direct shear test is an experimental procedure conducted in geotechnical engineering practice and research that aims to determine the shear strength of soil materials.

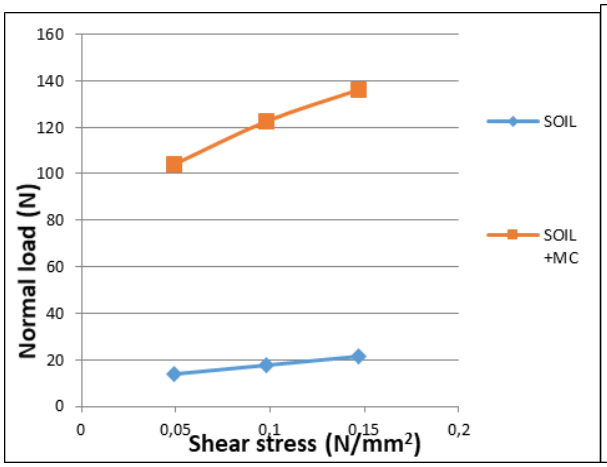


Fig 6: direct shear test graph

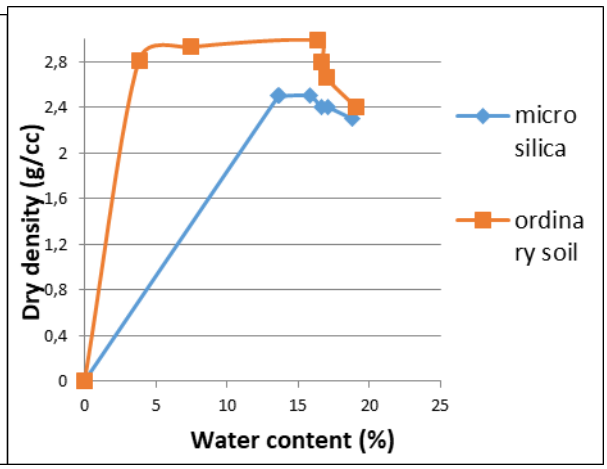
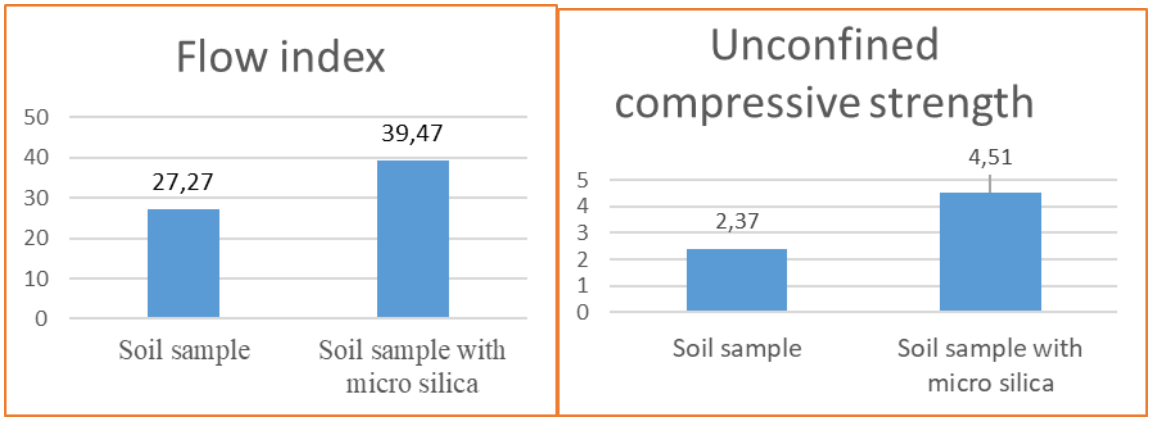


Fig 7: standard proctor test graph

Specific gravity test: specific gravity, also called relative density, ratio of the density of a substance to that of a standard substance. The specific gravity of soil was found to be 2.4.

RESULTS AND DISCUSSION

An attempt was made to stabilize the soil using micro silica and the following results were found. A comparison between soil and soil mixed with 10% of micro silica is done for various properties of soil.



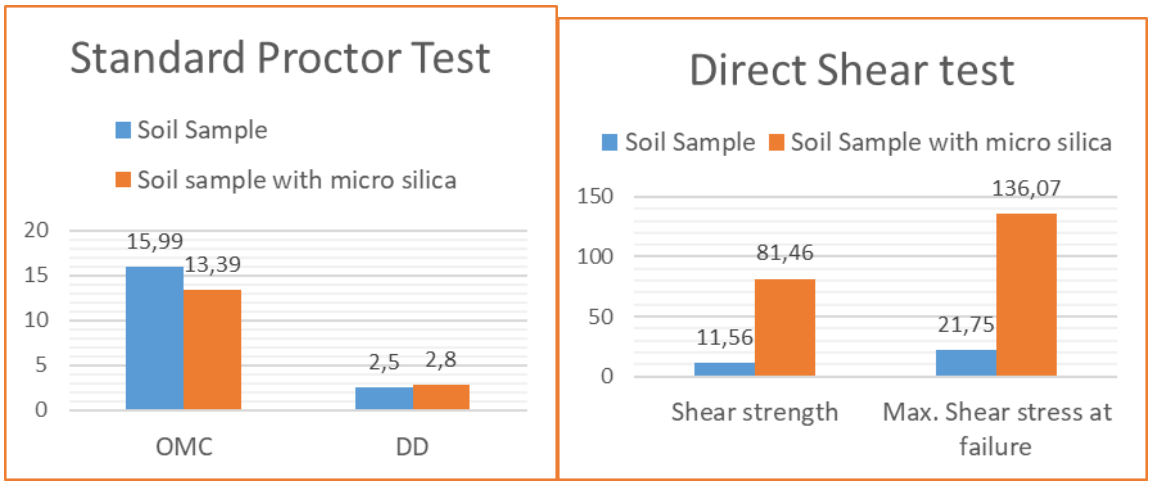


Fig 8: comparison charts of various engineering properties

From sieve analysis, the type of soil was found to be poorly graded coarse grained soil.

Liquid limit: the flow index of soil sample was 27.27 and on addition of 10% of micro silica to the soil sample there was an increase in flow index and the value was found to be 39.47.

Unconfined compression strength test: it was found that the unconfined compressive strength of the soil sample was 2.37mpa and on addition of 10% micro silica to the soil sample the unconfined compressive strength increased to 4.51mpa.

Standard proctor test: the optimum moisture content and maximum dry density of the soil sample was found to be 15.99 and 2.5g/cc respectively and the optimum moisture content and maximum dry density of soil sample with partial replacement by micro silica was 13.39 and 2.8g/cc.

Direct shear test: the shear strength of soil sample was 11.56n/mm^2 and the maximum shear stress at failure was 21.75n/mm^2.the shear strength and maximum shear stress at failure rose to 81.46n/mm^2 and 136.07n/mm^2.

The specific gravity of soil was found to be 2.4

As conclusions, from the above results it can be concluded that micro silica is a good alternative that can be used for soil stabilization as it has enhanced the properties of the soil on 10% replacement by micro silica. The flow index of the soil sample on addition of 10% micro silica by weight increased 1.5 times its original value. The unconfined compressive strength of the soil sample improved twice than the actual value. There was triple times reduction in the optimum moisture content and 0.3g/cc increase in its dry density. Shear strength being the most important engineering property of soil rose up to 7 times its original value and the maximum shear stress at failure increased by 6 times. So, it can

be concluded that micro silica is a good alternative that can be used for hill soil stabilization.

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