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A REVIEW ON SOIL STABILIZATION USING SILICA FUME AND RICE HUSK ASH

Chinmayee Senapati, Research Scholar, Department of Civil Engineering, Institute of Technical Education and Research, Siksha'O'Anusandhan (Deemed to be University), Odisha, India. Email: chinmayees3752@gmail.com
Swagatika Senapati, Assistant Professor, Department of Civil Engineering, Institute of Technical Education and Research, Siksha'O'Anusandhan (Deemed to be University), Odisha, India. Email: swagatikasenapati@soa.ac.in

ABSTRACT
Expansive soils are one of the most problematic soils available in India. The presence of expansive soil causes huge damage to the structures i.e., pavements and buildings etc. Damages are more due to the expansive soils compared to other natural hazards like floods, cyclone etc. This soil shows high swelling and shrinkage characteristics as well as very poor shear strength. To improve its strength properties, different soil stabilization techniques are adopted such as chemical stabilization and mechanical stabilization. In chemical stabilization, different additives were added which improves the soil properties like liquid limit, plastic limit, optimum moisture content (OMC), maximum dry density (MDD). Swelling and shrinkage behavior of soil, changes due to absorption and evaporation of water, need to be improved by adding chemical additives. Main aim of this paper is to review the stabilization techniques using additives such as silica fume and rice husk ash. Various papers were studied and reported in this review paper to know the effectiveness of these two additives.

Keywords:
Soil stabilization, Silica fume, Rice Husk Ash (RHA)

I. Introduction
The term soil engineering is defined as the un-aggregated or un-cemented deposits of minerals and organic particles or fragments covering large portion of the earth crust. Some soils are expansive in nature which has excessive swelling clay minerals such as montmorillonite. Abhijit et al. [13] studied the effect of waste materials obtained from construction sites on montomorillonite clay. Presence of montmorillonite in expansive soil causes excessive swelling when it encounters water and when it undergoes drying, shrinkage occurs. One example of expansive soil is black cotton soil which has fine grained clay particles which causes a great change in volume with change in moisture condition. It also bulges unreasonably when wet and shrinks when dried. Black cotton soils are formed by fissured volcanic rock. The void between the soil particles may carry water, air or both. Soil particles may get separated by mechanical process and water. Deposits of soil in earth crust exist in a vastly inconsistent manner. So, there are many varieties of attainable combinations which can improve the strength of soil and give different procedures to make it useful. The construction site having black cotton soil is a challenge for construction work. Mineralogical configuration of coarse grained soil rarely affects the index properties of soil feasibly its grain to grain friction. The deposition of soil particles connected to each other and the forces acting jointly between soil grains to grip them in their position is known as soil structure. We can find expansive soil all over the world. Mostly, expansive soil we find in India is called black cotton soil. It covers an area of 0.81million sq. km. The states where we can find black cotton soil in India are Maharastra, Andhra Pradesh, Gujarat, and some districts of Odisha also. In India these soils we can find up to a depth of 3.7 meters. This type of soil undergoes differential settlements because of its swelling and shrinkage behavior. When water content increases, swelling of soil occurs and it loses its strength, and shrinkage occurs with decrease in moisture content. Because of this behavior it damages the foundation of structure, roads, canal linings etc. If construction work undergoes in expansive soil, water perforates from different sides of undergoing excavation or constructed structure because of capillary action [11-12]. So the surfacing of construction work should

be impervious, with boundaries covered and water from capillary rise should be treated as well. If water enters inside the foundation of structure then it saturates the soil and decreases the bearing capacity of soil and also settlement occurs. To overcome this challenge in black cotton soil, stabilization is indeed necessary. By chemical stabilization we can check the swelling behavior of soil and engineering properties of soil can be improved. Many researchers investigated soil stabilization using industrial wastes, as these wastes are now days creating a major problem in the environment.

II. Soil Stabilization Using Additives

a. Soil Stabilization

Soil stabilization is needed to overcome the problems of expansive soil in construction sites. Stabilization of soil is done by using different waste materials as additives by many researchers. Now a day's waste materials produced from industries causes many issues and are not safe for the environment if left unused. The waste originating from animal and human activities thrown as garbage and prevailing at the place of disposal are called as solid wastes. These solid wastes are four types, Industrial solid wastes, Agricultural solid wastes, Domestic solid wastes and Mineral solid wastes. Industrial solid wastes contain Silica fume, Fly ash, Blast furnace slag, Red mud etc. Agricultural solid wastes contains Rice husk ash, Ground nut shell etc. Domestic solid waste contains Incinerator ash, Waste tire etc. Mineral solid wastes contain Quarry dust, Marble dust etc. Traditionally, researchers used sand, stone, aggregates for stabilization but now a day's people are looking for alternative chemical treatments by using different materials like silica fume, rice husk ash, fly ash etc. Stabilization is done to enhance the strength and resilience of expansive soil, which is not suitable for geotechnical applications prior to treatment. By using these additives as soil stabilizer, improves the engineering properties of soil which include permeability, compressibility, plasticity and durability. Mostly we prefer stabilization by using chemical admixtures. Literature related to chemical stabilizer such as silica fume and rice husk ash used for soil stabilization is reported below.

b. Rice Husk Ash (RHA)

Rice husk is paddy crop's waste material. After burning, it gives a huge amount of silica which can be used as soil stabilizer. The void created by coarser particles of soil will be occupied by rice husk ash and increase the bearing capacity of soil. Using rice husk ash as soil stabilizer is a great benefit to the environment. Various experiments are studied by using rice husk ash.

Hanifi, Aram and Celik [1], treated black cotton soil with lignin percentage varying from 0% to 20%, rice husk powder (RHP) and rice husk ash (RHA) varying from 0% to 10%. Swelling test, unconfined compressive strength and atterberg limit tests were performed. Unconfined compressive strength and atterberg limit test value shows outstanding effect on strength values. Prakash et al. [2], studied stabilization of soil using rice husk ash. RHA mixed with various percentages from 0 to 20% and various tests were conducted in which liquid limit of soil decreases from 50.20% to 39.60%. The results obtained show that, optimum moisture content increases and maximum dry density decreases. CBR value increases by adding 10% of RHA. Sabat [3], investigated rice husk ash and lime sludge stabilized expansive soil as liner material in engineered landfill. He found that by adding 10% RHA and 15% lime sludge restored for seven days assures a standard to use as a liner material in engineered landfill. Roy [4], studied about stabilization of soil by adding rice husk ash in different percentage and small amount of cement. The increase in percentage of rice husk ash increases the optimum moisture content and decreases the maximum dry density. The CBR value is also increased. Rao [5], added two additives as lime, gypsum along with rice husk ash in expansive soil to know the engineering properties and his study found that unconfined compressive strength increased by 548% at 28 days of restoring. CBR values increases by 1350% at 14 days curing by adding rice husk ash 20%, lime 5% and gypsum 3%.

c. Silica Fume (SF)

Silica fume is also called micro silica. It is an amorphous polymorph of silicon dioxide and silica. It is a byproduct of the silicon and ferrosilicon alloy production. It consist of spherical particles. Its average

particle diameter is 150nmandcontains 90% of silicon dioxide. Other constituents are carbon, sulphur, iron, oxides of aluminium, sodium and potassium. It is an ultrafine powder. Ali Jamal Alrubaye [6], researched about soil stabilization of a soft clay soil (Kaolin S300) stabilized with varying percentage of lime and 4% of silica fume. Percentage of silica fume is fixed at 4% and lime varies from 3% to 9%. The results showed that the maximum shear strength occurred at 5% and 6% lime and silica fume, respectively. Optimum percentage for increasing shear strength and angle of friction was 7-4% lime-silica fume. Muzamir Hasan [7], studied about stabilization of kaolin soils mixed with silica fume and egg shell ash. The result shows the decrease in plasticity index and maximum dry density, increase in optimum moisture content. Undrained shear strength of treated soil increases up to 68.8% with 6% of silica fume and egg shell ash. Venkatesan and Swaminathan [8], conducted laboratory tests on clay soil samples mixed with micro silica to determine the unconfined compressive strength to use as solid waste landfill liner material. Micro silica added in different proportions increases the strength of clay liners and covers. Pratyasha and Sandeep [9], studied the effect of silica fume on engineering properties of expansive soil. They found that optimum moisture content increases and maximum dry density decreases with increase in cohesion and angle of shearing resistance. Kalkan and Akbulut [10], studied the positive effect of silica fume on the permeability, swelling pressure, and compressive strength of natural clay liners. The test results showed that the compacted clay samples added with silica fume exhibit quite low permeability, swelling pressure and significantly high compressive strength as compared to raw clay samples.

III. Conclusion

From the literature, it can be concluded that expansive soils stabilized using silica fume and rice husk ash enhances the mechanical properties of the soil. However, the research related to soil stabilization using silica fume and rice husk ash are limited. Experiments using silica fume and rice husk ash together as additives need to be carried out to know the potential of these additives in stabilizing soft soil.

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