Choice and Feasibility of Stabilization Methods based on Soil Properties

Eldhose M Majummekudiyil[1], Arsha James[2], Fasal Mustafa[3], Jyothi S[4], Syamkrishna K M[5]

[1]*Assitant Professor, Mar Athanasius College of Engineering, Kothamangalam, India*
[2,3,4,5] *Under Graduate Students, Mar Athanasius College of Engineering, Kothamangalam, India*

Abstract - *Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. Many methods for soil stabilization have already been put forward but different types of soil require different materials to stabilize it. The project aims at finding the best and most effective materials for stabilizing each category of soil. The soil samples are classified into cohesive, cohesionless and cohesive-frictional soil. The materials selected for stabilization are flyash, coir fiber, slag and wood shavings. The improvements in the properties of each category by the addition of different proportions of these materials are studied. The properties considered are maximum dry density, cohesion and angle of internal friction. Flyash was found to improve the cohesion and addition coir fiber was able to improve the friction of any category of soil. Maximum dry density was obtained by the addition of the combination of 5% flyash and 0.5% coir fiber into cohesive-frictional soil, a combination of 5% slag and 5% flyash to cohesionless soil and 10% flyash to cohesive soil.*

Key Words: **stabilization, flyash, coir fiber, slag, wood shavings**

1. INTRODUCTION

Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. Unstable soils can create significant problems for pavements or structures, therefore soil stabilization techniques are necessary to ensure the good stability of soil so that it can successfully sustain the load of the superstructure especially in case of soil which are highly active, also it saves a lot of time and millions of money when compared to the method of cutting out and replacing the unstable soil.

Many methods for soil stabilization have already been put forward by many researchers. It involves a large number by using both cheap and costly materials. But for different types of soil, different materials should be used to stabilize it. Finding the most suitable material for a particular type of soil is still difficult. If the materials for stabilization are not carefully selected, it may make the efforts for stabilization worthless.

The project focuses on finding the best and most effective materials for stabilizing each category of soil by classifying them on the basis of shear strength parameters such as cohesion and internal friction. It will help to select between the numerous methods available. It will also ensure the maximum improvement of the properties with least effort and economy.

2. MATERIALS USED

Different materials that can be used as additives for soil stabilization were identified. All the materials are not suitable to be used in soil. So, the material properties need to be studied before using it. The focus is on waste materials of different industries so that the waste accumulation which is harmful for the environment can be reduced. Due to time constraints, the number of materials used was limited to four.

2.1 Flyash

Fly ash is a byproduct from burning pulverized coal in electric power generating plants. . Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products. The cementitious property helps the soils to improve its cohesion. Flyash was added to each soil in 5%, 10% and 15% by weight of the soil and tests were conducted.

2.2 Coir Fiber

Coir is a versatile natural fibre extracted from mesocarp tissue, or husk of the coconut fruit. These fibers are biodegradable which take 20 years to degrade in ground and environmentally friendly. It has the greatest tearing strength among all natural fibers and retains this property in wet conditions. Therefore, coconut fiber is selected as the reinforcement material. The different percentages added to the soil were 0.5%,1% and 2%. The fibers were cut into smaller lengths of about 2cm and mixed with soil. The fibers were arranged randomly in the soil.

2.3 Slag

It is the waste product of steel industry. The waste slag is commonly used as a landfill material for its disposal. So by using it in soil stabilization, it reduces the amount of waste produced. The slag that we used is having size between 4.75mm and 75microns. Instead of improving the cohesive property of soil, the slag used improved the internal friction. It is due to the increased particle size. The slag was added in different proportions such as 5%, 10% and 15% to the soil by weight. The improvement in properties was identified by testing the soils after proper mixing.

2.4 Wood Shavings

Wood shavings is the waste obtained when wood is shaped or planed using carpentry tools or machines like planers and milling machines. The wood shavings has wooden fibers in it which acts as reinforcement in soil. It improves the stiffness and strength of soil. The wood shavings was crushed in smaller size and randomly mixed with the soil and compacted well to find out the improvement in strength.

3. TESTS CONDUCTED

3.1 Sieve Analysis

A sieve analysis is a practice or procedure used 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.

3.2 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. The maximum dry density is an indicative of the bearing capacity of soil. After adding each percentage of additives into the soil, the maximum dry density is determined and it compared to that of original soil sample for analysing the improvement.

3.3 Trixial Test

Triaxial shear test is a common method to find out the shear strength parameters of soil such as cohesion and angle of internal friction. The shear parameters are determined inorder to classify the soil into different categories. Improvement in cohesion and friction points to the increased shear strength of soil. The materials that can be added to improve shear strength is found out by comparing the results of triaxial test for cohesive and cohesive-frictional soil.

3.4 Direct Shear Test

Direct shear test is conducted to determine the shear strength parameter of cohesionless soil. For cohesionless soil, mould can be made so this test is adopted. The improvement in cohesion and angle of internal friction is analysed after the addition of each materials in different proportions.

4. RESULTS AND DISCUSSIONS

Three samples of soil were collected, one from each category namely cohesive, cohesionless and cohesive-frictional soil. The properties of the samples were determined by conducting the different tests. The properties and given in Table 1.

Table 1: Properties of soil samples

Sample	*Cohesive-frictional soil*	*Cohesionless soil*	*Cohesive soil*
Maximum dry density (g/cc)	*1.8*	*1.79*	*1.48*
Optimum moisture content (%)	*14.85*	*17.57*	*25.48*
Cohesion (KPa)	*5*	*1*	*18*
Angle of internal friction (^{0})	*16.7*	*23.63*	*2.86*

The selected materials are then added to the soil in different proportions and the changes in the properties are determined. The materials are also added in different combinations to achieve higher amount of improvement. The comparison of the results is shown in figures. Fig. 1,4 and 7 shows the maximum dry density after inducing different materials in cohesive-frictional soil, cohesionless soil and cohesive soil respectively. Fig. 2,5 and 8 shows the improvement in cohesion of cohesive-frictional soil, cohesionless soil and cohesive soil respectively. Similarly, Fig. 3,6 and 9 shows the changes in the angle of internal friction.

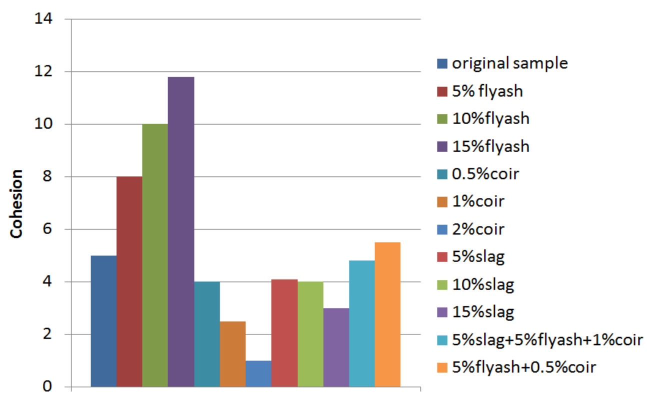

Fig 1: maximum dry density of cohesive frictional soil

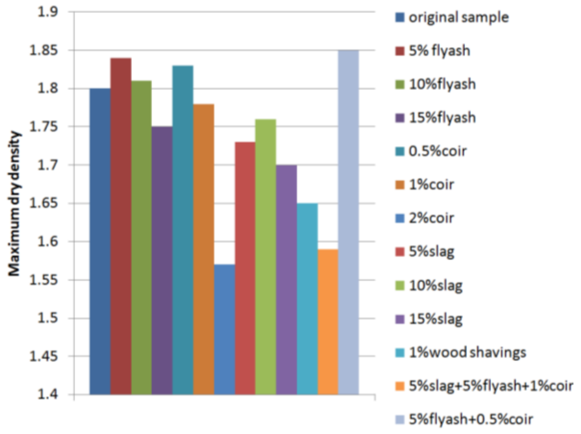

Fig 2: cohesion of cohesive-frictional soil

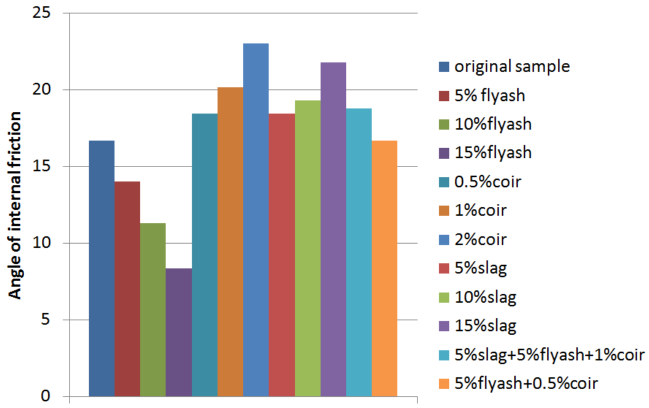

Fig 3: Anlge of internal friction of cohesive-frictional soil

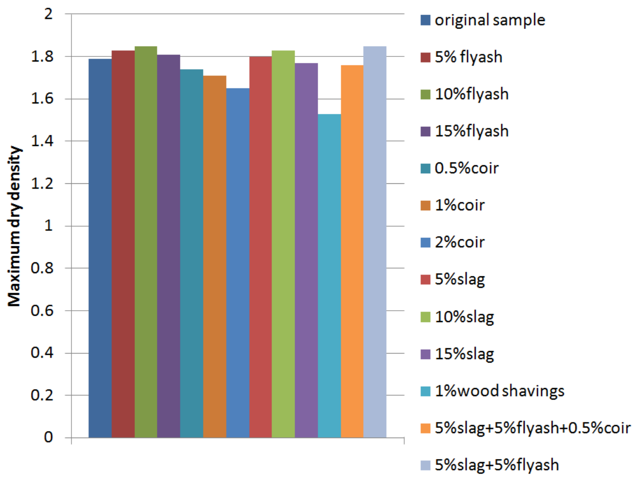

Fig 4: Maximum dry density of cohesionless soil

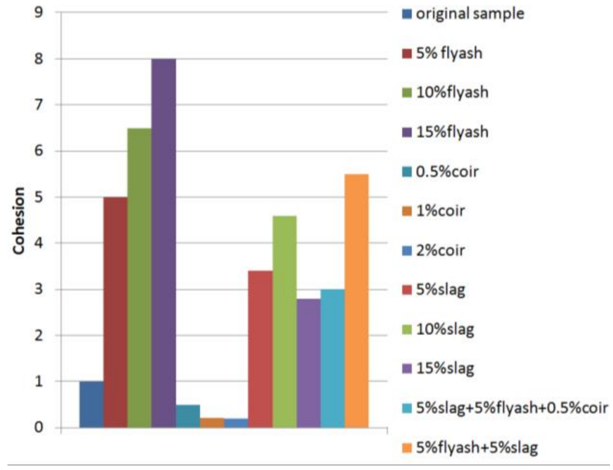

Fig 5: Cohesion of cohesionless soil

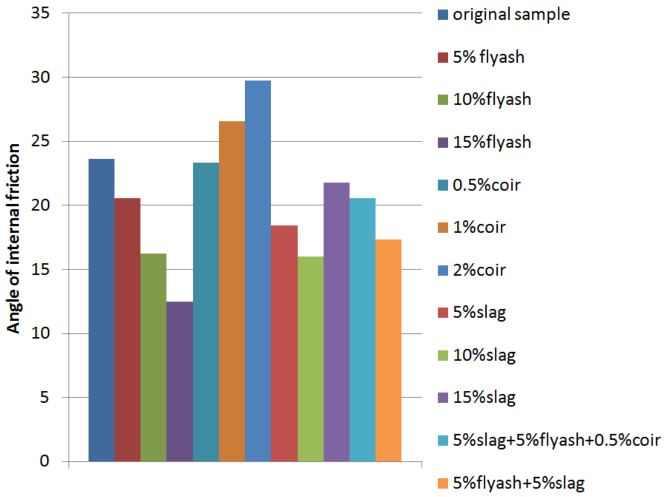

Fig 6: Anlge of internal friction of cohesionless soil

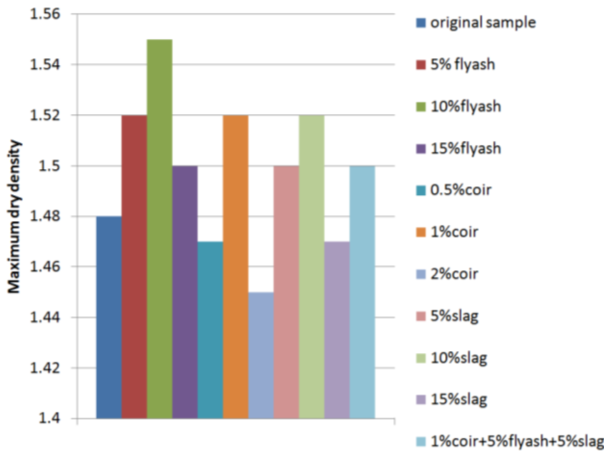

Fig 7: Maximum dry density of cohesive soil

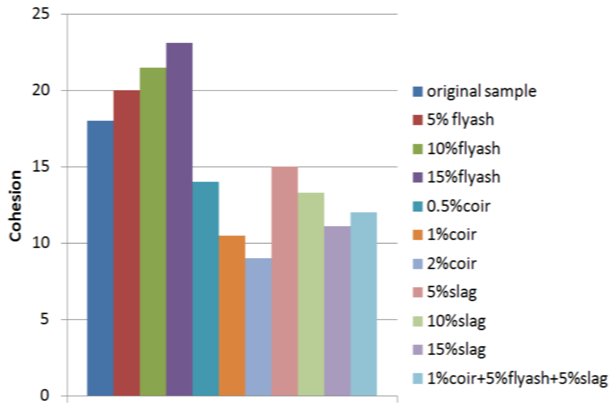

Fig 8: cohesion of cohesive soil

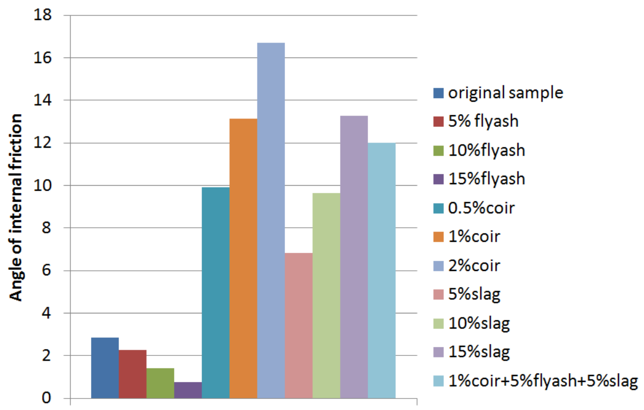

Fig 9: Angle of internal friction of cohesive soil

3. CONCLUSIONS

The materials adopted for stabilization are waste materials of different industries. So it has two advantages; the stabilization method becomes less costly and amount of waste accumulated can be reduced.

Maximum dry density is indicative of bearing capacity of soil.

Improvement of bearing capacity of cohesive-frictional soil can be achieved by the addition of flyash upto 10%, coir fiber of 0.5% and the maximum improvement in achieved by the addition of the combination of 5% flyash and 0.5% coir fiber.

Bearing capacity of cohesionless soil can be improved by adding flyash or slag upto 10% but the maximum improvement is achieved by the combination of 5% slag and 5% flyash.

Bearing capacity of cohesive soil is improved by the addition of flyash and slag in 5% and 10%. Addition of coir fiber in 1% also improved the bearing capacity. Maximum improvement is brought by the addition of 10% flyash.

Flyash was found to useful in improving the cohesion of the cohesionless soil. As the percentage of flyash is increased, the amount of cohesion achieved also increase.

Coir fiber was found to be most effective for improving the angle of internal friction. Slag can also improve friction but in a smaller amount.

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