# STABILIZATION OF BLACK COTTON SOIL USING FLYASH AND RUBBER POWDER

**M. Siva Parvathi[1], B. Anusha[2], G. Vimalatha[3], B. Shayam Kumar[4]**

[1]Assitant Professor, [2,3,4]Student-B.Tech
Department of Civil Engineering
Holy Mery Institute of Technology and Science,
Keesara, Hyderabad, TS, India

***Abstract*: Soil stabilization is the alteration of soil to enhance their physical and mechanical properties. This improvement includes increasing all the Engineering properties like load bearing capacity, tensile strength, shear strength etc. however recent technology has increased the number of traditional additives used for soil stabilization purpose. Non-traditional stabilizers include rubber-based products such as EPDM (ETHYLENE PROPYELNE DIENE MONOMER) and fly ash. In this research the soil samples are collected from Bogaram village, Medchal district, Telangana and the Stabilizers are waste rubber powder and fly ash. In the collected soil sample, randomly mix the both rubber and fly ash in different percentages say 4%, 8%, 12%, 16% and 20% based on the weight of the soil. mix proportion will be subjected to CBR testing machine to test properties of that selected soil sample .Finally we get the results by comparing the soil sample properties before and after stabilization of it.**

***Keywords*: Bearing capacity, tensile strength, shear strength, Non-traditional stabilizers, EPDM, fly ash, waste rubber powder.**

## 1. Introduction

Every structure must rest upon soil and the soil at that particular site should be satisfactory for the intended use. But unfortunately now a days finding such satisfactory soils is of rare occurrence. Generally the soils, which are unsatisfactory, and are not suitable for the intended uses are mostly expansive clayey soils. Expansive soils are swelling soils and are most problematic because of their drastic changes in volume with addition or removal of water. Hence stabilization of these soils is very essential. It is highly difficult to work on such soils. Since construction on these soils cannot be avoided, we have to identify and modify them to be suitable for our construction works. Soil stabilization is the alteration of one or more soil properties, by mechanical or chemical means, to create an improved soil material possessing the desired engineering properties. Soils may be stabilized to increase strength and durability or to prevent erosion and dust generation. Regardless of the purpose for stabilization, the desired result is the creation of a soil material or soil system that will remain in place under the design use conditions for the design life of the project.

## 2. Methodology

1. Collection and study of data.

2. Materials used.

3. Preparation of soil sample.

4. Testing of soil sample.

5. Results and Conclusions.

In this research the soil samples are collected from Bogaram village, Medchal district, Telangana and the Stabilizers are waste rubber powder and fly ash. In the collected soil sample, randomly mix the both rubber and fly ash in different percentages say 4%, 8%, 12%, 16% and 20% based on the weight of the soil. mix proportion will be subjected to CBR testing machine to test properties of that selected soil sample and subjected to Liquid Limit(LL), Plastic Limit(PL), Plasticity Index(PI), Shrinkage Limit(SI), Specific Gravity(G), Optimum Moisture Content(OMC), Maximum dry density ($\gamma_d$), Unconfined Compressive Strength(UCC), California Bearing Ratio(CBR) Value .Finally we get the results by comparing the soil sample properties before and after stabilization of it.

## 3. Literature Review

This paper investigates the feasibility of using fly ash and rubber powder as an alternative source for the partial replacement of soil. This project is supported with the related research papers. Although earlier studies has been conducted on using these waste in soil. But in those studies both the materials has not been used together some studies use only partial replacement of soil with rubber powder or partial replacement soil with fly ash but in this project both components has been used parallel at various percentages. Some of the related studies are as follows

**Umar et al**., (2015)carried out on soil and soil-tire mixtures, the following observations and conclusions are drawn: i) The optimum moisture content as well as maximum dry density is found to decrease with the increase of the percentage of rubber tire content. This might be due to light weight nature of tire waste. ii) Shredded rubber tire mixed with soil showed enhancement in CBR value with adding up to 8 % and there beyond decreased with additional increment in tire content in unsoaked condition. Hence the optimal value of shredded rubber tyre is 8 % of size 25mm×50mm in unsoaked conditions. iii) The percentage enhancement in CBR value of stabilized soil is 66.28 % in unsoaked condition whereas an increase in CBR value can considerably trim down the total thickness of the pavement and hence the total cost concerned in the project.

**Sathwik and Arti** (2016) Disposal of scrap tires is environmental dilemma as the utilization of automobiles is in the increasing trends which therefore cause damage to the eco-system. As the tires are manufactured with synthetic rubber, disposal of these wastes have become difficult. It is approximately estimated as 60 to 70% of waste tires are disposed in improper way in various areas. To avoid this damage we can utilize the tire wastes with technical development in different fields like using them in construction project However, they can improve the characteristics of soil which is one of the essential materials used for construction. A program of Standard Proctor tests, Unconfined Compression tests and California Bearing Ratio tests were carried out on the specimens of cohesive soil-tire mixtures, by varying tire powder content like 4%, 8%, 12% and 16% by weight of the soil. This paper discusses the shear strength characteristics of cohesive soil after adding various percentages of tyre powder. The aim of the study is also to analyze the seepage velocity of the soil by adding different proportions of tyre powder.

**Ravi and gayarthri** (2018) studied the effect of rubber powder on expensive soil. They carried out investigations using rubber powder and added it to expensive soil at 0-10% increases the shear strength and CBR value. This investigation evaluates 10% is the optimum rubber powder for the stabilization of black cotton soil.

**Nandini et al**., (2018) An immediate benefit obtained by the addition of tire powder to swelling soils is to reduce the potential for swelling upon contact with water. The plastic nature of the soil decreases and the stiffness of the soil increases as the tire powder content increases. For improving the properties described in this paper, the optimum tire powder content was found to be within the range of 4% to 6% .

## 4. Materials Used

### 4.1 EPDM

EPDM rubber is used in seals for example; it is used in cold-room doors since it is an insulator, as well as in the face seals of industrial respirators in automotive paint spray environments. EPDM is also used in glass-run channels, radiators, garden, and appliance hose, tubing, pond liners, washers, belts, electrical insulation, vibrators, O-rings, solar panel heat collectors, and speaker cone surrounds.

It is also used as a medium for water resistance in electrical cable-jointing, roofing membranes (since it does not pollute the run-off rainwater, which is of vital importance for rainwater harvesting), geomembranes, rubber mechanical goods, plastic impact modification, thermoplastic, vulcanizates, and many other applications. Colored EPDM granules are mixed with polyurethane binders and toweled or sprayed onto concrete, asphalt, screenings, interlocking brick, wood, etc. to create a non-slip, soft, porous safety surface for wet-deck areas such as pool decks and as safety surfacing under playground play equipment (designed to help lessen fall injury).

### 4.2. FLY-ASH

Fly ash is the ash removed from the exhaust gas of burning coal at power plants to generate electricity. The ash is removed from the exhaust by air pollution control equipment such as electrostatic precipitators before the exhaust is emitted through stacks or chimneys into the atmosphere. Fly ash , is also known as flue-ash, it is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is classified into two classes as Class F fly ash: Fly ash normally produced by burning anthracite or bituminous coal, usually has been than 5% CaO. Class F fly ash has pozzolanic properties only. Class C fly ash: Fly ash normally produced by burning lignite or sub-bituminous coal. Some fly ash may have CaO content in excess of 10%. In addition to pozzolanic properties, class C fly ash also possesses cementations properties.

## 5. Results and discussions

**Table 5.1: Geotechnical properties of un-treated soil.**

| **Property** | **Value** |
|---|---|
| Liquid Limit(LL) | 75% |
| Plastic Limit(PL) | 20% |
| Plasticity Index(PI) | 58% |
| Shrikage Limit(SI) | 9.92% |
| Specific Gravity(G) | 2.85 |
| Optimum Moistuire Content(OMC) | 18% |
| Maximum dry density ($\gamma_d$) | 1.18kn/M$^3$ |
| Unconfined Compressive Strength(UCC) | 0.006828kg/Cm$^2$ |
| Califonia Bearing Ratio(CBR) Value | 3.0% |

### 5.2. Geotechnical properties of treated soil.

**Table 5.2.1: Liquid limit test results**

| **Mix Proportions** | **Liquid Limit** |
|---|---|
| 100% Soil | 68% |
| 5% R+5%F + 90% Soil | 72% |
| 10% R +10%F+ 80% Soil | 75% |
| 15% R +15%F+ 70% Soil | 79% |
| 1 | 81% |

**Table 5.2.2: Plastic limit test results**

| **Mix Proportions** | **Plastic Limit** |
|---|---|
| 100% Soil | 29% |
| 5% R +5%F+ 90% Soil | 16.92% |
| 10% R+10%F+ 80%Soil | 13.92% |
| 15% R+15%F + 70% Soil | 11.67% |
| 20% R+20%F + 60% Soil | 10.26% |

**Table 5.2.3: Plasticity Index test results**

| Mix Proportions | Plasticity Index |
|---|---|
| 100% Soil | 39% |
| 5%R+5%F+90%Soil | 55.08% |
| 10%R+10%F+80%Soil | 61.08% |
| 15%R+15%F+70%Soil | 67.33% |
| 20%R+20%F+60%Soil | 70.74% |

**Table 5.2.4: Shrinkage limit test results**

| Mix Proportions | Shrinkage Limit |
|---|---|
| 100% Soil | 9.50% |
| 5%R+5%F+90%Soil | 8.90% |
| 10%R+10%F+80%Soil | 9.62% |
| 15%R+15%F+70%Soil | 10.25% |
| 20%R+20%F+60%Soil | 11.33% |

**Table 5.2.5: Effect of rubber powder and fly ash on differential free swell (DFSI) test**

| Mix Proportions | DFSI |
|---|---|
| 100% Soil | 65% |
| 5%R+5%F+90%Soil | 51% |
| 10%R+10%F+80%Soil | 42% |
| 15%R+15%F+70%Soil | 38% |
| 20%R+20%F+60%Soil | 35% |

**Table 5.2.6: Effect of Rubber Powder and Fly Ash on OMC and Dry Density**

| Mix Propositions | Optimum Moisture Content | Maximum Dry Density |
|---|---|---|
| 100% Soil | 16% | 0.89 |
| 5%R+5%F+90%Soil | 18% | 1.10 |
| 10%R+10%F+80%Soil | 18% | 1.24 |
| 15%R+15%F+70%Soil | 20% | 1.49 |

**Table 5.2.7: Effect of Rubber Powder and Fly Ash on Unconfined Compressive Strength**

| Mix Proportions | UCC In Kg/Cm$^2$ |
|---|---|
| 100% Soil | 0.006828 |
| 5%R+5%F+90%Soil | 0.00712 |
| 10%R+10%F+80%Soil | 0.00785 |
| 15%R+15%F+70%Soil | 0.00846 |
| 20%R+20%F+60%Soil | 0.00955 |

**Table 5.2.8: CBR values of 100% soil**

| Penetration | Load Dial Reading | Load |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 2.4 | 14 |
| 1 | 5 | 25 |
| 1.5 | 7.3 | 38 |
| 2 | 14.5 | 54.5 |
| **2.5** | **15.0** | **75** |
| 3 | 21.5 | 97.5 |
| 4 | 32 | 144.5 |
| **5** | **41** | **193** |
| 6 | 49 | 245 |

**Table 5.2.9: CBR values of 90% soil+5% fly ash+5%rubber powder**

| Penetration | Load Dial Reading | Load |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 1.2 | 7 |
| 1 | 2.3 | 13 |
| 1.5 | 4.25 | 22.5 |
| 2 | 7.1 | 36 |
| **2.5** | **10.2** | **52** |
| 3 | 13.3 | 68 |
| 4 | 18.4 | 94 |
| **5** | **24.3** | **123** |
| 6 | 31.3 | 158 |

**Table 5.2.10: CBR values of 80% soil+10%fly ash+10% rubber powder**

| Penetration | Load Dial Reading | Load |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 1.45 | 9.5 |
| 1 | 3.25 | 17.5 |
| 1.5 | 4.1 | 21 |
| 2 | 5 | 25 |
| **2.5** | **5.4** | **29** |
| 3 | 7 | 35 |
| 4 | 9.1 | 46 |
| **5** | **12.1** | **61** |
| 6 | 15.4 | 79 |

**Table 5.2.11: CBR values of 70% soil+15%fly ash+15% rubber powder**

| Penetration | Load Dial Reading | Load |
|---|---|---|
| 0 | 0 | 0 |
| 0.5 | 1.2 | 7 |
| 1 | 2.3 | 13 |
| 1.5 | 3.3 | 18 |
| 2 | 4.3 | 23 |
| **2.5** | **5.3** | **28** |
| 3 | 7 | 35 |
| 4 | 9.4 | 49 |
| **5** | **11** | **55** |
| 6 | 12.5 | 65 |

## 6. Conclusions

Hence in this investigation we made an attempt to know the effect of addition of rubber powder and fly ash on the geotechnical properties of expansive clays. Based on the following conclusions are drawn.

- Increase in liquid limit.
- Decrease in plastic limit.
- Increase in plasticity index and shrinkage limit.
- Decrease in differential free swell index of clay.
- Increase in optimum moisture content and decrease in maximum dry density.
- Increase in unconfined compressive strength.
- Increase in CBR value.

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