EJETMS

Erudite Journal of Engineering Technology and Management Sciences

Vol. 1, No. 2, December, 2021, pp. 10-13

Journal homepage: http://www.ejetms.com

Stabilisation of Soil by using Ultra-fine slag and Waste Plastic Strips

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Received: 10 August 2021

Accepted: 01 November 2021

Keywords:
Environmental impact, Plastic strips, Ultrafine slag, soil stabilization.

ABSTRACT

If the earth is not suitable for the construction project, then soil stabilization is an option. This process involves stabilizing a soil mass by adding cement, lime, or other stabilizing agents. Since the use of plastic bags and bottles has become more prevalent, it has also contributed to the environment's concern. This paper presents a new technique which is called as soil stabilizer using plastic waste and ultrafine slag.This paper aims to analyze the properties of plastic waste and alccofine used in soil stabilization.

1. INTRODUCTION

Soil stabilization is a process used to transform a natural soil into a construction material. This procedure involves altering the engineering properties of the soil to make it more stable.

When the soil is not suitable for construction, stabilization is carried out by adding a material such as cementitious or chemical. This process helps improve the soil's shear strength and reduce its permeability.

In addition to these, some of the commonly used additives such as asphalt, cement, and rice husk ash are also used to improve the soil's properties. In addition, the use of plastic waste has become a widely used method to reduce landfill waste.

The layer of the Earth that encloses the payment structure. Its well-designed subgrades prevent settling and distributing the load evenly.

Subgrade should be able to handle the load bearing capacity of the vehicle without excessive settlement.

The high amount of fine content in the soil can react with the excess moisture and cause the soil to change its volume.

When the soil is not suitable to support heavy traffic loads, additional work should be performed on it to improve its subgrade performance.

Quality fill should be used to remove and replace the poor subgrade soil. An appropriate material such as lime or Portland cement can help minimize soil swelling and improve its stiffness.

2. LITERATURE REVIEW

The study conducted by P. Manjusha and her group revealed that the addition of plastic strips and the content of lime can improve the soil's CBR values.

The study revealed that after increasing the plastic content in the soil, the percentage of CBR goes up. The next step is to decrease the plastic content and increase the lime content.

Tom Damino (2016) and his colleagues conducted a study on the test results when they added plastic strips into soil with a percentage by weight of less than 0.3%. They concluded that the CBR value was obtained when the plastic strips were added at an aspect ratio 3.

Anas Ashrof (2011) and his colleagues conducted a study to determine the effects of adding plastic strips to soil stabilization. The researchers noted that the soil stabilization benefit of adding plastic strips was significantly improved after they used them. The researchers discovered that the CBR value of soil was reduced from 1.969 to 1.687 after the addition of plastic strips.

The study revealed that when plastic granules are added to the soil, the resultant MDD is obtained. However, the OMC and California bearing ratio are decreased when the plastic is added.

The effect of solid waste on the index properties, shear strength, and compaction values of clay soil was studied by Lovedeep Singh et al (2018). The results revealed that the addition of solid waste increases the maximum dry density of the soil by around 19%. The maximum dry density of soil increases from 197 to 21 kilo Newton per meter square. In addition to this, the unsoaked CBR value of soil also increased from 3 to 8%.

The study conducted by the laboratory of Jeevan Singh revealed that the addition of 10% Alccofine and 20% silica fumes can increase the CBR strength of red soil. The study also showed that the addition of the right amount of these substances can decrease the swelling of the soil and increase the unconfined compressive strength.

Sachin dev et al (2017) concluded that the increasing percentage of marble dust can also decrease the amplitude of the OMC and the minimum devaluation. The improvement in the strength of the soil and the percentage of marks contest is achieved by increasing the content of 5% Alccofine and marble dust. They stated that the proportion of marble dust and

Alccofine in a soil should be 10% and 8% respectively to achieve a high level of CBR value.

3. Materials

3.1 Plastic waste strips

Waste plastic bottles that had been obtained from various industries in Andhra Pradesh were used as reinforcement material for the proposed research. These bottles featured transparent coloands.

3.2 Ultrafine slag

Alccofine 1108SR material (Ultra-fine slag) is finer than ordinary Portland Cement in terms of particle size. It is also used for hydraulically setting activities.

Figure 1. Under laboratory condition at 27ºC

2.3 Soil

In this study the soil used is obtained from Tirupati rural area, Andhra Pradesh, India.

2.4 Methodology

The following experiments were performed:

- CBR test
- Standard proctor test
- Permeability test
- Free swelling index
- Specific gravity
- Plasticity index (PI)
- Liquid limit (LL)
- Plastic limit (PL)
- Sieve analysis

Table 1. Physical properties of soil

Properties	Result
Grain size analysis	
D_{90}	96 µ
D_{60}	32 µ
D_{10}	15 µ
C_u	6.8
C_c	0.75
Sand+Gravel (%)	55
Silt+Clay (%)	47
Specific Gravity (G)	2.46
Consistency limits	
Plasticity index (PI) %	21
Plastic limit (PL) %	23
Liquid limit (LL) %	43
Standard proctor test	
Optimum moisture content (OMC) (%)	16.2
Maximum dry density (MDD) (g/cc)	1.78
CBR value %	
5 mm penetration	2.3
2.5 mm penetration	2.5
Coefficient of permeability k (cm/sec)	$3.5 * 10^{-6}$
Swelling index	42%

Table 2. Compaction test results for soil: Alccofine

Ultra-fine slag: Soil	OMC%	MDD (g/cc)
0:100	16.5	1.78
3:97	17.2	173
6:94	17.9	1.72
9:91	18.9	1.68
12:88	19.5	1.65

4. EXPERIMENTAL AND RESULTS

Standard proctor tests and CBR tests were performed on soil that had been admixed with ultrafine slag and waste plastic strips at varying percentages by weight of soil.

3.1 Mix Proportions:

Only ultra-fine slag was used as a stabiliser in the first stage of the investigation, with percentages of 3 percent, 6 percent, 9 percent, and 12 percent by weight of soil.

Waste plastic strips were used as a stabiliser in the second step, with percentages of 0.25 percent, 0.50 percent, 0.75 percent, and 1 percent by weight of soil, and in the third step, a mixture of ultra-fine slag and waste plastic with ratios of 100:0:0, 94.75:5:0.25, 94.50:5:0.50, 94.25:5:0.75, and 94:5:1 respectively was used.

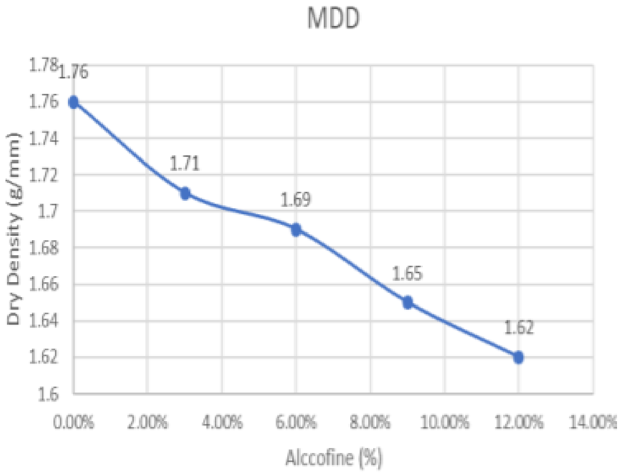

Figure 2. Variation of maximum dry density with Ultra-fine slag

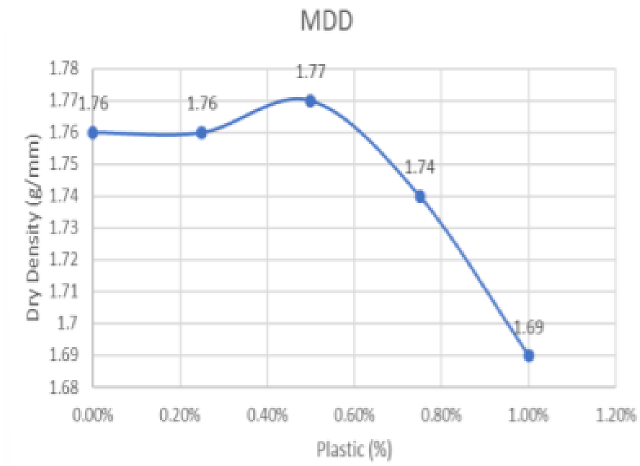

Figure 3. Variation of maximum dry density with waste plastic

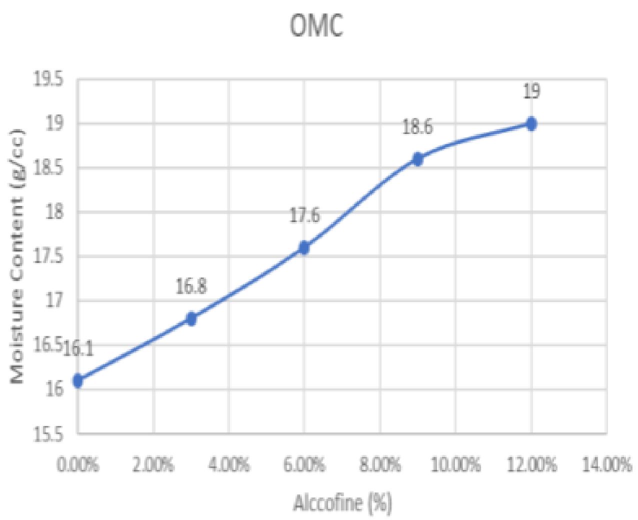

Figure 4. Variation of optimum moisture content with Ultra-fine slag

Figure 2 indicates the MDD of soil with the addition of ultrafine slag up to 12%.

Table 2. Compaction test results for soil: Plastic

Ultra-fine slag: Plastic	OMC%	MDD (g/cc)
0:100	16.3	1.78
3:97	16.3	1.78
6:94	15.7	1.79
9:91	16.1	1.75
12:88	16.7	1.71

Waste plastic strips was utilized as a stabilizer in the second step, with 0.25 percent, 0.50 percent, 0.75 percent, and 1 percent by weight of soil, and in the third step, a mixture of ultra-fine slag and waste plastic with ratios of 100:0:0, 94.75:5:0.25, 94.50:5:0.50, 94.25:5:0.75, and 94:5:1 respectively was used.

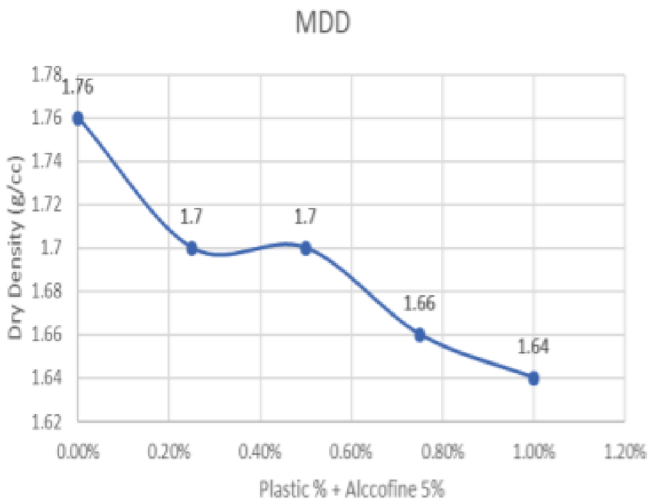

Figure 5. Variation of maximum dry density with ultra-fine slag and waste plastic strips

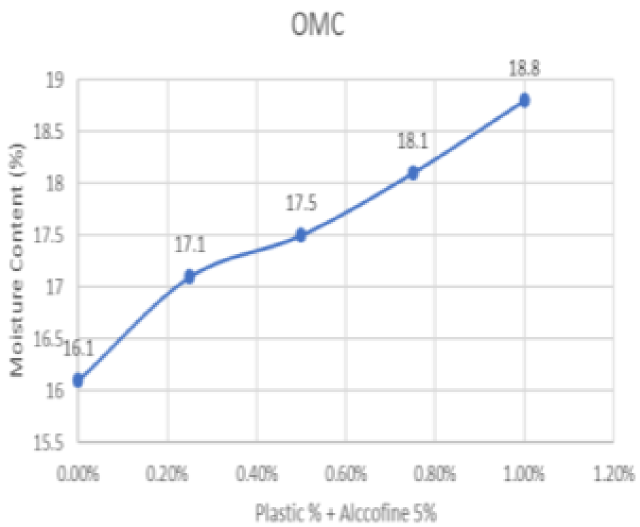

Figure 6. Variation of optimum moisture content with ultrafine slag and waste plastic strips

Figure 5 indicates that the MDD of soil decreases with ultrafine slag and waste plastic strips upto 5% and 1%, respectively. Figure 6 represented that the OMC of soil increases with ultrafine slag and waste plastic strips up to 5% and 1%, respectively.

The effect of ultrafine slag and waste plastic strips on the density of treated soil may be influenced by the specific gravity of the soil.

The addition of water to a soil contributes to the bulking of the soil which may cause lower density of treated soil. The test results also showed that the optimum moisture content of OMC was increased when the soil was added with 12% ultra-fine slag. The increase in OMC may be due to the high req. of water used for exothermic reaction.

5. CONCLUSION

The study also analyzed the properties of soil, alccofine mix, and waste bottle plastic strips.

- The results indicated that a combination of these additives is needed to obtain the best results.
- To stabilize the soil, a dose of 0.75% and 5% of waste plastic and ultrafine slag by weight of soil might be used.

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