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Using Waste and Polymer for Soil Stabilization

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Abstract:- Soil stabilization is a technique for improving and refining engineering qualities. Expansive clay soils are those whose volume fluctuates as the amount of water in the soil changes. In civil engineering, soil is one of the most regularly encountered materials. When constructions are discovered atop expanding soil, geotechnical engineers all over the world face major challenges. Stabilization of soil is the process of enhancing soil strength by artificial means. They have a tendency to inflate and shrink, posing a major threat to anything placed on top of them. The results of an attempt to fortify and stabilize clay soil with plastic strips are presented in this research. The plastic strips were produced and added in three different aspect ratios and three different mixing ratios (0.4%,0.8%,1.5%) by weight (4mm x 7mm, 8mm x 14mm,12mm x 18.5mm). The experimental findings revealed that shear strength parameters improved significantly. The soil's swelling and desiccation cracking tendencies were also significantly reduced. The optimum moisture content was reduced significantly, but the maximum dry density increased little. Based on the importance of the selection criterion for a specific engineering activity, the ideal plastic size (aspect ratio) and plastic content that produces the best outcomes can be chosen. The difficulties are solved concurrently by stabilizing vast soils using waste plastic bottles. The findings of this study point to the possibility of using this material in expanding soils to increase ground stability in geotechnical engineering.

Keyword:- *Clay Soil, Plastic Strips, Plastic Powder, Soil Stabilization, CBR Test.*

I. INTRODUCTION AND MATERIAL USED

A strategy for improving the qualities of poor soil is soil stabilization. Mechanical strength, permeability, compressibility, durability, and plasticity are only a few of these characteristics. Polymers interact with clayey particles in the soil, increasing soil strength. Many of the polymers currently in use have the ability to improve the soil's water retention and shear strength. Building on expansive soils necessitates stabilization to prevent swelling and increase mechanical capacity. Soil stabilization is the process of enhancing the soil's engineering qualities and making it more stable. It is used to reduce unqualified soil properties such as permeability and consolidation potential while enhancing shear capacity. The approach is most commonly used in highway and airport construction projects. Compaction and pre-consolidation are commonly employed to improve types of soils that are already in good shape. Soil stabilization goes a long way in encouraging the use of weak soil and reducing the cost of weak soil renewal. PET bottles are common plastic bottles. Waste, soft drinks, liquid snacks, and a variety of other beverages are packaged in them. Their disposal is becoming more challenging as their demand grows. In nature, waste PET bottles take a long time to degrade (more than a hundred years). Recycling and using these plastic bottles to stabilize expansive clay soil are positive steps forward, and the construction industry is an ideal choice due to its enormous consumption capacity. This will be a good way to clean up and preserve the environment from discarded plastic bottles. Adding plastic strips to the floor as a stabilizer increased shear strength, tensile strength, and California bearing ratio.

II. MATERIAL AND METHOD

A. Materials

This study used two materials: a representative clay soil rectangular PET bottle strip and a representative virgin soil rectangular PET bottle strip. The strips were made from scrap plastic bottles found in the neighborhood. After collecting, the bottles were cleaned properly and manually sliced into three different sized strips (figure 1), with the strip sizes listed in Table 1.

Fig 1:- Image of different shapes of PET

B. Methods

➢ *Material Characterization*

The particle size distribution, Atterberg limit, and specific gravity of the soil tests were all used to characterize the soil sample for this investigation. The soil sample taken was sieved to remove any remaining contaminants.

Table 1 Different size of strips

STRIP	WIDTH(MM)	LENGTH(MM)
1	4	7
2	8	14
3	12	18.5

The Atterberg limit test was used to assess the soil's plastic limit, liquid limit, and plasticity index. The test was performed according to Casagrande's instructions. The soil's specific gravity, on the other hand, was determined through a geotechnical laboratory test. The specific gravity was calculated using the ratio of soil density to water density at the same temperature.

➢ *Material Mixing Method*

The plastic strips, which are believed to act as soil reinforcements, were put to the soil in three different percentages by mass of the soil (0.5% , 1%, and 2%).

➢ *Method of Testing and Discussions*

After both materials had been characterized, the plastic bottle strips were placed in the soil sample. The effects of adding plastic bottle strips to the soil were studied using standard proctor compaction tests, direct shear tests, and California bearing ratio (CBR) test.

Fig 2. Casagrande's Aperture

Fig 3.Plastic Limit

Particle size distribution, Atterberg limit tests, and soil specific gravity tests were used to collect soil samples. The results revealed that the soil was fine-grained, with a specific gravity of 2.59, a liquid limit of 136 percent, a plastic limit of 21.16 percent, and a plasticity index of 114.84 percent.

III. LITERATURE REVIEW

1) Anjaneyappa et.al(2015) studies character action of polymer stabilization. The construction of pavements is becoming costlier due to the very high cost of quality construction materials and transportation cost from long distances. Conclusion made by this paper was reduction of about 41 to 47%in radial strains below bituminous layers and 38 to 47% in vertical compressive strain on subgrade were observed for soil stabilized with polymer. The use of polymer for stabilization pavement layers can be considered for low volume roads.

2)Athulya p.v.et.al. (2015) investigates subgrade soil stabilization utilizing additives as a case study. The goal of this study is to conduct an experimental study and analyze the strength properties of plain soil, soil with terrasil, and soil with cement kiln dust separately using consistency limit tests, CBR tests, Triaxial tests, and permeability tests. It was discovered that increasing doses decreased consistency limits. As a result, it is apparent that the chemical stiffens the soil.

3)Bibha Mahtr et al. (2015) published a review paper on the influence of RBI Grade 81 and pond ash on silty and clayey soil. The goal of the study is to determine the impact of RBI Grade 81 at 1%, 2%, 3%, and 4% mixed with pond ash at 3%, 6%, and 9% on silty and clayey soil. The RBI 81 is successful in adjusting most types of soils, according to this paper's conclusion.

4)Basanta Dhakal and colleagues (2016) The influence of liquid polymer on the geotechnical properties of fine-grained soil was investigated in this work. The polymer was combined at various percentages of the dry weight of both soils (2 %, 3 %, 4 %, and 5 %). The results reveal that when polymer is added to soil B samples obtained at OMC, the

UCS value increases from 12 to 14 % in a confined air environment.

5)P.K.KOLAY,et al. (2016) investigated "the influence of liquid polymer stabilizer on geotechnical parameters of fine grained soil," using two types of soil for stabilization purposes: Carbondale soil and Galatia soil. The polymer was applied at 0.5 %, 1 %, 1.5 %, and 3 % to both soil and other tests in order for the results to be favorable and meet the study's conclusion. With polymer, the maximum increase in UCS value was around 23%. 2.54 has a 200 % improvement in wet CBR value over untreated soil.

6)Sameer Vyas et al. (2016) investigated the stabilization of dispersive soil by blending polymers to stabilize dispersive soil from Udaipur. The soil sample was treated with 0.5 % and 1 % polyvinyl alcohol and urea formaldehyde, 0.5 % polyurethane and epoxy resin, and 1% styrene rubber latex. As a result of adding polymer aggregates to the soil, the size of the soil increases, indicating that the polymer utilized in the study is successful in binding soil particles.

7)N.Shoaib et al. (2018) investigated the usage of acrylic polymer in clayey soil stabilization. Acrylic polymer was mixed with chloroform to make the acrylic paste and put to the soil in the research as a stabilizer, which was mixed with clayey soil for soil preparation. The best percentage of acrylic solution for soil stabilization is 6% by weight.

8)T.Raghavendra and colleagues (2018) investigate the use of terrasil and zycobond to stabilize black cotton soil. Specific gravity, liquid limit, plastic limit, sieve analysis, and hydrometer analysis were all included in the variation experiment. The nano compounds terrasil and zycobond are applied in a constant proportion of 3% of the soil volume. When 0.6kg/m3 of terrasil and zycobond is added, the free swell index drops from 30% to 27.5%, and when 0.8kg/m3,1.0kg/m3,1.2kg/m3 is added, the free swell index drops from 30% to 27.5%.

IV. CONCLUSION

This study looked at how plastic bottle strips could be used to stabilize clay soil-

1)The maximum dry density and optimum moisture content. As reinforcement percentages and sizes rose, the angle of internal friction and the cohesion intercept grew dramatically.

2)An increase in plastic size for the same percentages has resulted in an increase in soaked CBR value, whereas a rise in plastic content for the same plastic size raises the soaked CBR value before decreasing. The best plastic size and composition for a given engineering task can be chosen based on the importance of the selection criteria.

3)The strips served as reinforcement, preventing volume variations in response to changes in water content. Incorporating discarded plastic bottles into the building sector is also an important strategy to address the problem of inadequate plastic waste disposal.

4)The laboratory findings in the study point to the feasibility of using plastic material as a tensile inclusion in clay soil to improve shear resistance, CBR value, and swelling reduction.

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