

SOIL STABILIZATION USING PLASTIC WASTE

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ABSTRACT

The process of improving the physical and engineering properties of soil, such as shear strength and bearing capacity, is known as Soil stabilisation. Indian terrain is mostly occupied by black cotton soil. It is highly expansive soil which shows more swelling, shrinkage and settlement problems. Thus, the Construction of buildings and other Civil Engineering structures on this soil is risky. Use of compaction technique or suitable admixtures like cement, lime and waste material like fly ash, etc can bring out the soil stabilisation. But these are expensive additives. That we obtained here suggest and prove that the use of plastic waste for the stabilisation of soils would reduce the problem of disposing of plastic waste and also reduce environmental problems. It is seen that CBR test, Proctor test, and Sieve analysis are performed to check the suitability of plastic waste as a soil stabiliser. Sieve Analysis gives the physical properties of the soil sample. Modified Proctor Test gives the OMC and Dry Density of the soil sample. CBR Test results for the Optimum Plastic content. Optimum Plastic content is the percentage of plastic added to the soil sample above which the CBR value falls. Modified Proctor Test is recommended over the Standard Proctor Test because the soil which is tested will be used for road construction, which requires high compaction. Soil stabilisation is possible with plastic waste, which is a cheap method of soil stabilization.

I. INTRODUCTION

Due to the omnipotent scope of plastic, other materials such as paper and others are being replaced with it, which is used for different purposes like household packing purposes, used by restaurants and all. It has omnipotent use in today's context, but the use of plastic and its effect on the environment has made the use of this material in ambiguity. It has become one of the major problems for the environment. The use of plastic has to be limited by now; otherwise, there would be harsh circumstances that humans and the environment would have to face in the near future. It is the fact that we can reuse the plastic and make it usable for a number of times, so that its wastage will be reduced remarkably. These steps are still in progress, but this has only been able to pace up as expected because the use of these materials has increased in such a way that it is very difficult to limit them; instead, the alternative for those must be identified, and the process must be taken accordingly. India itself has witnessed a substantial growth in the consumption of plastics and an increased production of plastic waste. It has become a very tedious job to limit it. It is a fact that plastic waste is now considered an environmental hazard due to the "Use and throw" mechanism. It can be used for the alternative method where its importance will be counted

II. METHODOLOGY

To conduct a project on soil stability using plastic waste, you must first characterize the soil through tests like sieve analysis and Atterberg limits. Then, prepare plastic waste by cutting it into strips of consistent dimensions and mix it with the soil at varying percentages by weight. Evaluate the effectiveness by performing standard geotechnical tests, such as Modified Proctor Test to determine compaction characteristics and California Bearing Ratio (CBR) Test to assess the improved strength and stability.

1. Material Collection and Preparation

Soil Sample: Collect a representative sample of the soil you intend to stabilize.

Plastic Waste: Collect waste plastic, such as bottles or chairs, and clean it thoroughly. Cut the plastic into uniform

strips or fibers, noting the dimensions used in your project.

Sieve Analysis: Perform a sieve analysis on the soil sample to determine its particle size distribution and remove any large impurities.

2. Soil Characterization

Atterberg Limits: Conduct tests to determine the liquid limit, plastic limit, and plasticity index of the soil.

Specific Gravity: Determine the specific gravity of the soil to understand its inherent density.

3. Stabilization Procedure Proportioning:

Prepare different soil-plastic mixtures by adding varying percentages of the prepared plastic waste by weight.

Compaction Test (Modified Proctor Test): Conduct a modified Proctor test on the mixtures to determine the optimum moisture content (OMC) and maximum dry density (MDD) for each percentage of plastic. The modified test is often preferred for applications like road construction.

4. Stability Evaluation

California Bearing Ratio (CBR) Test: Perform an unsoaked CBR test on the stabilized soil samples at their respective MDDs. This test measures the soil's strength and load-bearing capacity. Unconfined Compressive

Strength (UCS) Test (Optional): For a more comprehensive analysis, you can also conduct unconfined compressive strength tests to evaluate the improved shear strength of the stabilized soil.

5. Data Analysis and Conclusion

Analysis: Plot the results, such as the relationship between the plastic content and the CBR value or UCS.

Conclusion: Determine the optimum percentage of plastic waste that provides the maximum improvement in soil strength. Compare the properties of the stabilized soil with the original soil to quantify the effectiveness of the plastic waste as a stabilizer.

III. RESULTS AND ANALYSIS

Sieve Analysis

Determine the grain-size distribution of a soil/aggregate sample (percent passing each sieve). Used to classify coarse-grained soils and design gradation for concrete/roads.

Result

% Gravel=0 % Sand=100-74.4=25.6 %

%Slit and clay=74.4

Specific Gravity

Specific gravity of solid particles (Gs) = ratio of density of soil solids to density of water. Used for converting between mass and volume, calculating void ratio, porosity, percent voids, and degree of saturation.

Result

Specific Gravity of given Soil is=2.76

Moisture content (water content)

Find the mass of water present in a soil as a percentage of the oven-dry mass — fundamental for compaction, Atterberg tests, strength, and volume change calculations.

Result

The moisture Content % = 17.56

Liquid limit (LL)

The liquid limit is the water content at which the soil changes from plastic to liquid behavior. It's a key parameter in consistency and plasticity —used for classification (PI = LL - PL), predicting compressibility and shear strength trends for clays/silts.

Reporting:Liquid Limit = 43%

Plastic limit (PL)

Plastic limit is the water content below which soil no longer behaves plastically (i.e., it crumbles instead of forming plastic threads). Combined with LL, it gives Plasticity Index (PI = LL – PL), a measure of soil plasticity.

Reporting :Plastic Limit = 28.9 %

SPT TEST:

Standard Proctor Test Table (Soil + Plastic Waste) Soil + 2.5% Plastic Waste

Trial No.	Weight of EmptyMould(g)	Weight of Mould + Wet Soil (g)	Weight of Wet Soil (g)	Water Content (%)	Bulk Density(g/cc)	Dry Density (g/cc)
1	2450	4200	1750	6	1.75	1.65
2	2450	4300	1850	8	1.85	1.71
3	2450	4380	1930	10	1.93	1.75
4	2450	4350	1900	12	1.9	1.7
5	2450	4300	1850	14	1.85	1.62

UCS TEST :

Unconfined Compressive Strength (UCS) Test Table Soil Stabilized with 2.5% Plastic Waste

Sample No.	Diameter of Specimen (mm)	Height of Specimen (mm)	Cross-sectional Area (cm ²)	Failure Load (N)	UCS Value (kN/m ²)
1	38	76	11.34	210	185
2	38	76	11.34	225	198
3	38	76	11.34	11.34	240

CBR TEST:

Calculated CBR Values

Plastic Content	Load at 2.5 mm (kg)	Load at 5 mm (kg)	Approx. CBR %
0%	199	345	4
0.50%	120	189	2.5
1%	225	385	4.8
2%	248	400	5.2
2.50%	230	362	4.5

“The optimum plastic content for soil stabilization was found to be approximately 2%, at which maximum CBR value was obtained.



IV. CONCLUSION

This project on soil stabilization using plastic waste successfully demonstrated that waste plastic can be effectively utilized as a stabilizing material to improve the engineering properties of soil. Various laboratory tests such as Atterberg limits, Standard Proctor Test, Unconfined Compressive Strength (UCS) Test, and California Bearing Ratio (CBR) Test were conducted on soil mixed with different percentages of plastic waste. The experimental results showed a noticeable improvement in soil strength and stability after the addition plastic. The CBR and UCS values increased significantly up to the optimum plastic content, indicating enhanced load-bearing capacity and better resistance against deformation. The study also revealed that excessive plastic content may reduce the effectiveness of stabilization, which highlights the importance of selecting an optimum percentage of plastic for practical application. One of the most important achievements of this project is its contribution toward sustainable and eco-friendly construction practices. Plastic waste is one of the major environmental problems worldwide, and its reuse in geotechnical engineering offers a practical solution for reducing pollution while improving soil performance. This method not only minimizes the disposal of plastic waste in landfills but also reduces the requirement of traditional stabilizing materials, making the process economical and environmentally responsible. Overall, the project proves that plastic waste can be successfully used for soil stabilization in road construction, embankments, and other civil engineering works. The study concludes that utilizing waste plastic in soil stabilization is a sustainable, cost-effective, and innovative approach that benefits both the construction industry and the environment. This project highlights how engineering solutions can transform waste materials into valuable resources for future infrastructure development.

V. REFERENCES

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