

**SOIL STABILIZATION USING PLASTIC POWDER****M.Karthikeyan**

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**Abstract:** Soil stabilisation is any process which improves the physical properties of soil, such as increasing shear strength, bearing capacity etc. which can be done by use of controlled compaction or addition of suitable admixtures like cement, lime and waste materials like fly ash, phosphogypsum etc. The cost of introducing these additives has also increased in recent years which opened the door widely for the development of other kinds of soil additives such as plastics, bamboo etc.. Use of plastic products such as polythene bags, bottles etc. is increasing day by day leading to various environmental concerns. Therefore the disposal of the plastic wastes without causing any ecological hazards has become a real challenge. Thus using plastic bottles as a soil stabiliser is an economical utilization since there is scarcity of good quality soil for embankments. This project involves the detailed study on the possible use of waste plastic bottles for soil stabilisation. The analysis was done by conducting plate load tests on soil reinforced with layers of plastic bottles filled with sand and bottles cut to halves placed at middle and one third positions of tank. The comparison of test results showed that cut bottles placed at middle position were the most efficient in increasing strength of soil. The optimum percentage of plastic strips in soil was found out by California Bearing Ratio Test and using this percentage of plastic, plate load test was also performed. The size and content of strips of waste plastic bottles have significant effect on the enhancement of strength of the soil.

**Keywords-** Soil, Plastic, Stabilization.

**I. INTRODUCTION**

Soil stabilisation means the improvement of stability or bearing power of the soil by the use of controlled compaction, proportioning and/or the addition of suitable admixture or stabilisers. The basic principles of soil stabilisation are: x Evaluating the properties of given soil. x Deciding the lacking property of soil and choose effective and economical method of soil stabilisation. x Designing the stabilised soil mix for intended stability and durability values. Stabilisation can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. Stabilisation can be used to treat a wide range of sub-grade materials from expansive clays to granular materials. The most common improvements achieved through stabilisation include better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. In wet weather, stabilisation may also be used to provide a working platform for construction operations. stabilisation may be the existing moisture content, the end use of the soil structure and ultimately the cost benefit provided.

## **II. SIGNIFICANCE**

For many years, road engineers have used additives such as lime, cement and cement kiln dust to improve the qualities of readily available local soils. Laboratory and field performance tests have confirmed that the addition of such additives can increase the strength and stability of such soils. However, the cost of introducing these additives has also increased in recent years. This has opened the door widely for the development and introduction of other kinds of soil additives such as plastics, bamboo, liquid enzyme soil stabilizers etc. Soil stabilisation using raw plastic bottles is an alternative method for the improvement of subgrade soil of pavement. It can significantly enhance the properties of the soil used in the construction of road infrastructure. Results include a better and longer lasting road with increased loading capacity and reduced soil permeability. This new technique of soil stabilisation can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials that lead to the foundation of sustainable society. It can be effectively used in strengthening the soil for road embankments and in preparing a suitable base for the upper pavement structure. Since it increases the bearing capacity of soil considerably, the land use can be increased. It can lower the road construction and maintenance costs while increasing the overall quality of its structure and surface. The promise that soil stabilisation technology can actually improve the mechanical qualities of local road soil so that stronger, more durable roads can be built has prompted national road ministries around the world to conduct extensive testing to verify that this new technology is truly cost-effective. The result is that this new advance in soil stabilisation technology is increasingly being used in both constructing and improving/rehabilitating unsurfaced and paved roads worldwide.

## **III. NEEDS AND ADVANTAGES**

Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil. Hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. It is very expensive to replace the inferior soil entirely soil and hence, soil stabilization is the thing look for in these cases.

- It improves the strength of the soil, thus increasing the soil bearing capacity.
- It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation.
- It is also used to provide more stability to the soil in slopes or other such places.
- Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather
- Stabilization is also done for the soil water proofing, this prevents water from entering into the soil
- It helps in reducing the soil volume change due to change in temperature or moisture content.
- Stabilization improves the workability and the durability of the soil.

### **Reinforcing Materials**

- Plastic Waste

Plastics currently play a massive role in our daily lives. Plastics are utilized in virtually all areas of manufacturing. Tons and tons of plastic products are molded on a daily basis, even as the waste continues to build up.

**Soil Properties**

The soil is obtained from Rajahmundry, East Godavari district, Different tests were conducted in laboratory on the soil sample obtained to estimate various properties of the soil sample and the properties obtained from the tests conducted can be classified into two categories as follows.

- Index Properties
- Engineering Properties

**IV. EXPERIMENTAL INVESTIGATION**

**Material Collection**

Soil The soil used for current study has been taken from kanjikode of East palakkad district. It is collected from a depth of 2m. Tests are conducted to determine the index properties, engineering properties as per Indian standards (IS 2720). The soil properties are given in table 1

**Table 1 Soil properties**

Area	Kanjikode
Depth	2m
<b>Grain Size Analysis</b>	
Gravel	1%
Sand	28%
Fines (silt clay)	71%
<b>Index Properties</b>	
Liquid limit	56%
Plastic limit	33.33%
Plasticity index	22.67%
Specific Gravity	2.73
Free Swell index	40
Soil Classification	CH
<b>Engineering Properties</b>	
Optimum Moisture Content (OMC)	13.4%
Maximum Dry Density (MDD)	1.67 kg/m <sup>3</sup>
Fines (silt clay)	71%

Material Type	Plastic (powder)
Size	4.75mm (passing)
Color	Mixed color
Specific Gravity	1.8



Fig 1 Plastic Material

**Liquid limit test**

**Table 3 Liquid limit test values**

sample number	1	2	3
Mass of empty bottle (M1) in gm.	660	660	660
Mass of bottle+ dry soil (M2) in gm.	860	861	860
Mass of bottle + dry soil + water (M3) in gm.	1544	1542	1539
Mass of bottle + water (M4) in gm.	1417	1417	1416
<b>Avg. specific gravity</b>	<b>2.7</b>		

Liquid limit as obtained = 56%

Plastic Limit

**Table 4 Plastic Limits Values**

Sample	1
Mass of empty can	36
Mass of (can+ wet soil) in gm.	40
Mass of (can + dry soil) in gm.	39
Mass of soil solids	1
Mass of pore water	3
Water content (%)	33.3

**Particle Size Distribution**

**Table 5 Particle size distribution**

Sieve size	Retained (g)	Retained (%)	Cumulative retained (%)	Cumulative finer (%)
4.75mm	0	0	0	100
2mm	114	22.8	22.8	77.2
1mm	82	16.4	39.2	60.8
600microns	47	9.4	48.6	51.4
425microns	44	8.8	57.4	42.6
300microns	50	10	67.4	32.6
150microns	108	21.6	89	11
75microns	33	6.6	95.6	4.4
pan	22	4.4	100	0

- Coefficient of curvature (cc) =6.92

- Coefficient of uniformity (uc) =0.6

**Standard Proctor Compaction Test**

Standard Proctor Compaction Test results variation at different Percentage of adding plastic powder is shown in Table 6

**Table 6 Standard Proctor Compaction Test results variation**

Test	Dry density	OMC
Soil without adding plastic	1.67g/cm	21.34%
Soil adding 0.5% plastic waste	1.73g/cm	21.28%
Soil adding 1% plastic waste	1.7 g/cm	21.3%
Soil adding 1.5% plastic waste	1.65 g/cm	21.76%
Soil adding 2% plastic waste	1.609 g/cm	21.79%

California bearing ratio test (CBR) California bearing ratio test (CBR) results variation at different Percentage of adding plastic powder is shown in Table 7

**Table 7 California bearing ratio test (CBR) results variation**

Test	CBR 2.5mm	CBR 5mm
Soil without adding plastic	4.39	4.04
Soil adding 0.5% plastic waste	3.27	3.67
Soil adding 1% plastic waste	4.94	4.23
Soil adding 1.5% plastic waste	3.869	3.27
Soil adding 2% plastic waste	2.97	2.97

**Unconfined Compressive Strength of Cohesive Soil**

Unconfined Compressive Strength Test results variation at different Percentage of adding plastic powder.

Test	Compressive stress	Shear strength
Soil without adding plastic	25.6 kn/m <sup>2</sup>	12.18 kn/m <sup>2</sup>
Soil adding 0.5% plastic waste	28.1 kn/m <sup>2</sup>	14 kn/m <sup>2</sup>
Soil adding 1% plastic waste	8 kn/m <sup>2</sup>	4.4 kn/m <sup>2</sup>
Soil adding 1.5% plastic waste	8. 8.8 kn/m <sup>2</sup>	4.4 kn/m <sup>2</sup>
Soil adding 2% plastic waste	11.9 kn/m <sup>2</sup>	5.95 kn/m <sup>2</sup>

**V. CONCLUSION**

Use of plastic products such as polythene bags, bottles, containers and packing strips etc. is

increasing day by day. The disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Thus using plastic as a soil stabilizer is an economical and gainful utilization since there is scarcity of good quality soil for embankments and fills. Thus this work is carried out to meet the challenges of society to reduce the quantities of plastic waste, producing useful material from non-useful waste materials.

- Increase in maximum dry density occurs at 0.5% of adding plastic waste and plastic granules.
- Results by CBR test concludes that the bearing capacity of the soil is increased at 1% of adding plastic waste and plastic granules.
- Results by UCS test conclude that the Compression strength of the soil is increased at 0.5% of adding plastic waste and plastic granules.

## **VI. FUTURE SCOPE**

- In future study test can be carried on black cotton soil or on different types of soil. The plastic waste can be replaced by cement, marble polish waste, Fly ash, sand and quarry dust.
- From the above materials, different proportions and combinations can be made which can be used for construction of subgrade and pavements.

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