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Stabilisation of Sandy Soil with the Combination of Fly Ash and Crumb Rubber

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Abstract—*In developing countries like India, due to urbanisation and industrial development, there has been an enormous increase in the production of waste materials like fly ash and crumb rubber. The increase of these waste materials is progressing at an alarming rate, and disposal of such wastes is becoming a major concern. Normally such kind of waste materials are haphazardly dumped or stockpiled and such haphazard dumping causes lot of environmental problems. If such waste materials could be used as an alternative for the virgined natural soil like sand, gravel or clay, it would be rendering lot of cost benefit effect. As such, in our project work, an effort is made to study the impact of such waste materials mixed with locally available sandy soil found in and around Guwahati city. For this purpose different tests like unconfined compressive strength test and compaction test has been conducted on the soil mixed with varying percentages of fly ash and crumb rubber at equal distribution of 15%,25%,35% and 45% respectively. After conducting the tests, it has been observed that inclusion of fly ash and crumb rubber at 35% by the weight of the soil gives the optimized result and increase in the percentage of both fly ash and crumb rubber increases the strength upto 35% after which a significant reduction in strength has been observed. So, from this project work it has been concluded that treating sandy soil with the optimized percentage of 35%, better strength is attained.*

1. INTRODUCTION

Soil is generally defined as a structure composed of minerals, mixed with some organic matter, which differ from its parent materials in terms of its texture, structure, consistency, colour, chemical, biological and other characteristics. The definition of soil varies depending on the person considering it**.**Soil stabilization is the permanent physical and chemical alteration of soils to enhance their engineering properties. Soil stabilization is most important for the construction purpose which is widely used in connection with road pavement and foundation construction because it improves the engineering properties of soil such as strength, volume stability and durability. Benefits of the soil stabilization process can include higher resistance values, reduction in plasticity, lower permeability, reduction of pavement thickness, elimination of excavation materials hauling or handling.

2. OBJECTIVE

I. To find out optimum moisture content and maximum dry density has been determined from Modified Proctor Test.
II. To find out the percentage use feasible for construction.
III. To reduce the impact of waste materials on environment.
IV. To stabilize locally available sandy soil with inclusion of waste materials like fly ash and crumb rubber.

3. SOURCE OF MATERIAL

Fly ash was collected from a local site of **Rajbhagan, Ri-bhoi district, Meghalaya.**

4. METHODOLOGY

The test on the following properties of the material were conducted:

4.1 Particle size distribution

Sieve analysis is carried out as per IS 2386 Sieve analysis helps to determine the particle size distribution of the coarse and fine aggregates..

4.2 Specific Gravity

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Specific gravity was determined by pycnometer method.

4.3. Liquid Limit

For determination purpose the liquid limit is that water content at which the cone of the standard liquid limit apparatus (cone penetration apparatus) penetrates a value from 15mm to 25mm.The liquid limit was determined by cone penetration method.

4.4. Plastic Limit

For determination purposes, the plastic limit is defined as the water content at which a soil just begins to crumble when rolled into a thread of 3 mm in diameter.The soil that we have taken in our project work is found to be non-plastic as the value of plastic limit is zero. Therefore, the type of the soil taken is sandy in nature.

4.5 Standard Proctor Test

Compaction is the process in which soil particles are rearranged in a closer state by impact loading and air is expelled from the voids. The dry density of soil changes with its water content. The water content at which the dry density of soil maximum which is called the optimum water content.

4.6 Unconfined Compressive Strength

.The unconfined compressive strength (q_u) is the load per unit area at which the cylindrical specimen of a cohesive soil fails in compression. (q_u)=P/A

The un-drained shear strength (C_u) of the soil is equal to one-half of the unconfined compressive strength. $C_u= q_u/2$

4.7 Materials Used

The materials used in this project work are waste materials namely fly ash and crumb rubber coming from cement factories and shredding of used tires.

5. EXPERIMENTATION & RESULTS

5.1 Sieve Analysis

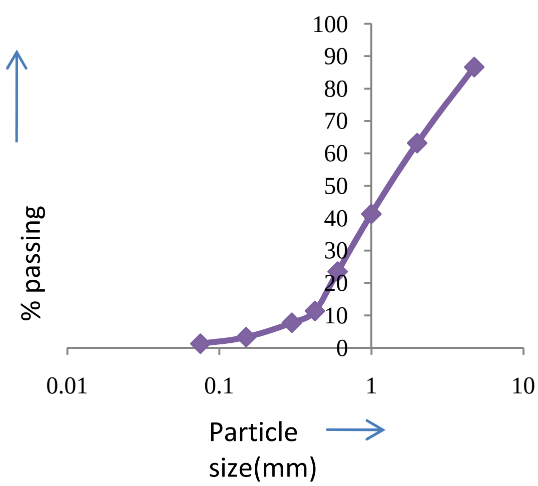

Fig. 1

1. Sieve Analysis Graph

Inference: From the sieve analysis chart, we have gone for finding the Uniformity Coefficient and Coefficient of Curvature, from which we could grade our sand as SW which is well graded sandy soil.

5.2. Specific gravity

Table:1 Observations for Specific Gravity

Sl No.	1	2	3
Weight of empty pycnometer (gm) A	48	48	48
Weight of pycnometer+ soil (gm) B	72	76	76
Weight of dry soil (gm) B-A	24	28	28
Weight of pycnometer+ water+ soil (gm)C	160	162	160
Weight of pycnometer+ water (gm) D	148	148	148
Specific Gravity	2	2	1.75

Result: Specific Gravity by the above test if found out to be 1.91.

5.3 Liquid Limit

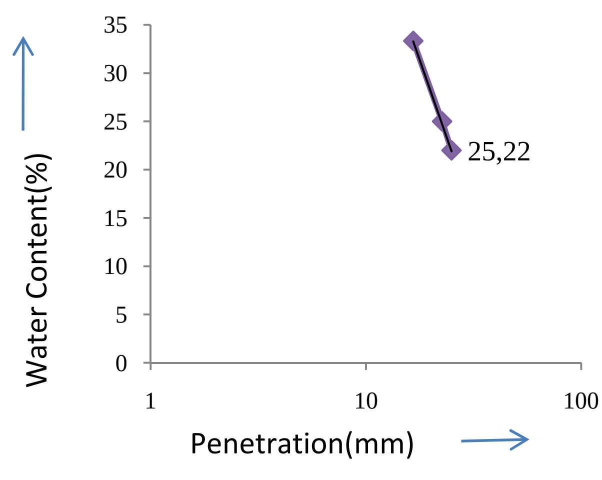

Fig. 2: Liquid Limit Graph

Inference: From the graph we observe that at 25mm penetration, the liquid limit is found to be 22%.

5.4 Standard Proctor Compaction Test

Table 2: Variation of MDD with Percentage increase of waste material

% of waste material added	Maximum dry density(gm/cc)
0	1.55

15	**1.6**
25	**1.69**
35	**1.82**
45	**1.7**

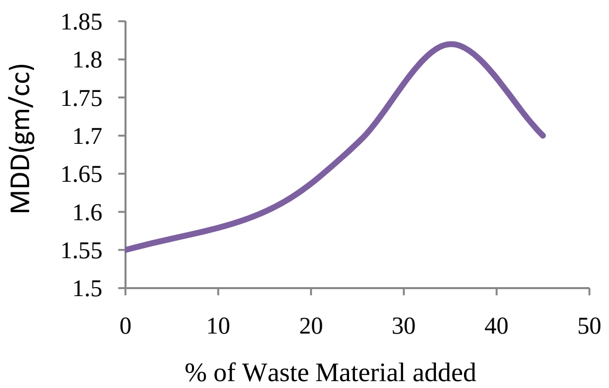

Fig. 3 Compaction curve showing the variation of MDD with % increase of waste material

Inference: With the increase of percentage of waste material, the maximum dry density increases but the increase is significant upto 35% inclusion of waste material by weight of the soil. Further increase leads to a decrease in the maximum dry density value.

Table 3: Variation of OMC with Percentage increase of waste material

% of waste material added	Optimum moisture content (%)
0	**16**
15	**17.6**
25	**20**
35	**21**
45	**18.3**

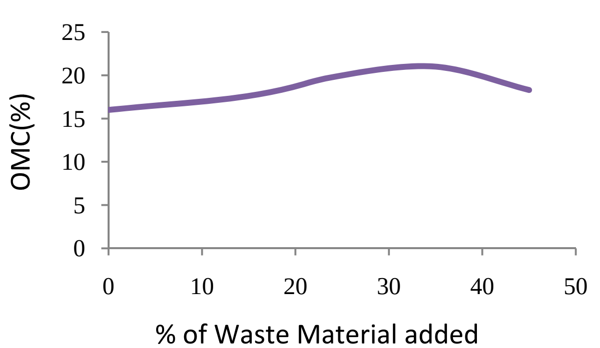

Fig. 4: Compaction curve showing the variation of OMC with % increase of waste material

Inference: Here in this case the optimum moisture content value increases with the increase of waste material. However a good decrease in optimum moisture content is observed at 45% inclusion of waste material by weight of soil.

5.4.1 Conclusion from Compaction test

From the compaction test we observe that with the increase in percentage of waste materials, the maximum dry density increases. But, the increase is prominent up to 35%. At 45% inclusion of waste material by the weight of soil brings in a significant decrease in maximum dry density We see that with the increase in percentage of waste materials, OMC also increases. Although, the OMC decrease with 45% inclusion of waste material to the soil.

5.5 Unconfined Compressive Strength Test

The sample is prepared as per standard specification of UCS. The amount of soil that we take is determined by fixing the maximum dry density that we obtain from the compaction test for both treated and untreated soil samples. Similarly, the amount of water that is added for making the sample is fixed by taking the optimum moisture content value from the compaction curve for both treated and untreated soils.

Fig. 5 Sample Preparation

Table 4: Variation of Undrained Shear Strength with Percentage increase of waste material

% of waste material added	Undrained Shear Strength (KN/mm²)
0	**1.765**
15	**2.98**
25	**3.9**
35	**4.225**
45	**4.125**

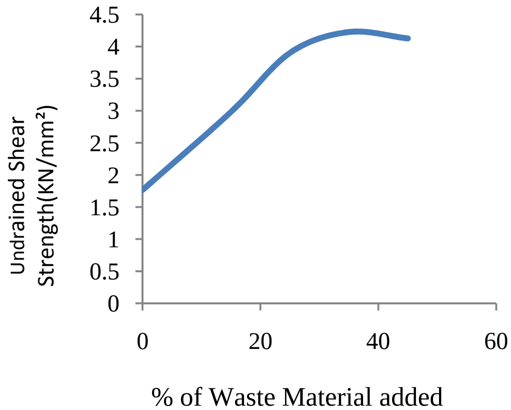

Fig. 6 UCS test curve showing the variation of Undrained shear strength with % increase of waste material

Inference: With the increase of percentage of waste material, the Undrained shear strength increases but the increase is significant upto 35% inclusion of waste material by weight of the soil. Further increase leads to a decrease in the Undrained shear strength value.

5.5.1 Conclusion from Unconfined Compressive Test

From the Unconfined Compressive Test we observe that with the increase in percentage of waste materials, the undrained shear strength increases. But, the increase is prominent upto 35%. At 45% inclusion of waste material by the weight of soil brings in a significant decrease in undrained shear strength.

6. EQUIPMENTS AND APPARATUS USED”

6.1 Sieve Shaker

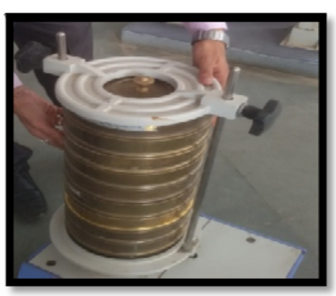

Fig. 7 Sieve Shaker

6.2 Pycnometer

Fig. 8 Pycnometer

6.3 Electronic Weighing Machine

Fig. 9 Electronic Weighing Machine

6.4 Cone Penetrometer

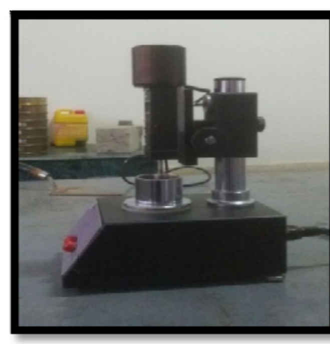

Fig. 10 Cone Penetrometer

6.5 Compaction Test Equipments

Fig. 11 Compaction Test Equipments

6.6 Unconfined Compression Tester

Fig. 12: Unconfined Compression Tester

7. CONCLUSION

Compaction test and UCS test were conducted on locally available sandy soil found in and around Guwahati city by treating the soil with varied percentages of dumped waste materials like fly ash and crumb rubber. The results from the compaction test showed that maximum dry density increases with the increase in the percentage of waste material. But the increase was significant up to an addition of 35% waste material (20% fly ash and 15% crumb rubber). This shows that the soil comes to a closure packing at higher percentage of waste material inclusion with the soil. This can be attributed to the fact that better interlocking property can be achieved with the inclusion of waste material i.e, fly ash and crumb rubber up to 35% by weight of the soil. However, in case of OMC it is observed that the water content value increases with waste material.

From the Unconfined Compressive Test we observe that with the increase in percentage of waste materials, the undrained shear strength increases. But, the increase is prominent upto 35%. At 45% inclusion of waste material by the weight of soil brings in a significant decrease in undrained shear strength.

Hence from our project work we could conclude that by uniform mixing of waste material like fly ash and crumb rubber with sandy soil brings in significant increase in both maximum dry density and unconfined compressive strength value upto a percentage of 35% (20% fly ash and 15% crumb rubber) by weight of the soil.

8. ACKNOWLEDGEMENT

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