ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 7, January 2015

Experimental Investigation on California Bearing Ratio (CBR) For Stabilizing Silty Sand with Fly Ash and Waste Polypropylene

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Abstract: Soil stabilization 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 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, fly ash etc. This new technique of soil stabilization can be effectively used to meet the challenges of society, to reduce the quantities of waste, producing useful material from non-useful waste materials. 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 stabilizer 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 polypropylene and fly ash for soil stabilization. The analysis was done by conducting wet sieve analysis, compaction test and CBR (Soaked and UnSoaked) by replacing the soil with fly ash and polypropylene. The optimum percentage of plastic and fly ash in soil was found out by California Bearing Ratio Test. The amount of waste polypropylene has significant effect on the enhancement of strength of the soil. Many methods exist today, which utilize mainly CBR test values for designing pavement thickness requirement. In order to decrease the thickness of pavement we are going to increase the CBR value by stabilizing the soil with waste materials like fly ash and polypropylene, which decreases the cost of laying of pavements. From the results of this project the dry density and CBR (Soaked and UnSoaked) values are increasing with increase in the replacement of soil with fly ash and polypropylene up to certain limit and there after it will be decreases. The percentage at which the maximum values of dry density and CBR (Soaked and UnSoaked), are obtained is known as Optimum percentage of fly ash and polypropylene. The optimum percentage of fly ash is 15% and the optimum percentage polypropylene is 25%.

Keywords—**silty sand, polypropylene, California Bearing Ratio, optimum moisture content and dry density.**

I. INTRODUCTION

A. GENERAL

Civil engineering includes the conception, analysis, design, construction, operation, and maintenance of a diversity of structures, facilities, and system. All of them are built on, in, or with soil or rock. The behavior of the soil and rock at the location of any project has a major influence on the success, economy, and safety of the work. Civil engineers are also concerned virtually with all aspects of environmental control, including water resources, water pollution control, waste disposal and containment, and the mitigation of such natural disasters as floods, earthquakes, landslides, and volcanoes. Here the soils and their interactions with the environment are major considerations. To properly deal with the earth materials associated with any project requires knowledge, understanding, and appreciation of the importance of formation, materials science and testing, and mechanics. The ultimate support for any structure is provided by the underlying earth or soil material and, therefore, the stability of the structure depends on it. Since soil is usually much weaker than other common materials of construction, such as steel and concrete, a greater area or volume of soil is necessarily involved in order to satisfactorily carry a given loading. The California Bearing Ratio (CBR) is a measure of resistance of material to penetration of standard plunger under controlled density and moisture conditions.This test may be conducted in remoulded or undisturbed specimens in the laboratory. Many methods exist today, which utilize mainly CBR test values for designing pavement thickness requirement. In order to decrease the thickness of pavement we are going to increase the CBR value by stabilizing the soil with waste materials like fly ash and polypropylene, which decreases the cost of laying of pavements.

II. DETAILS OF TESTS CONDUCTED

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In order to meet the objectives of the present investigation a total of three series of tests are conducted on soils as given below.

A. First Series of Tests

The first series of tests are aimed at studying the classification, compaction (Fig 1) and CBR (Soaked and unsoaked) behavior of silty sands in natural conditions. Table 1 gives the various types of tests which are conducted for soil in laboratory.

TABLE 1: Details of 1st series of tests conducted

S.No.	Type of Soil	Tests conducted
1.	Natural Silty Sand	Wet sieve analysis, Light Compaction test and CBR (Soaked and Unsoaked) test.

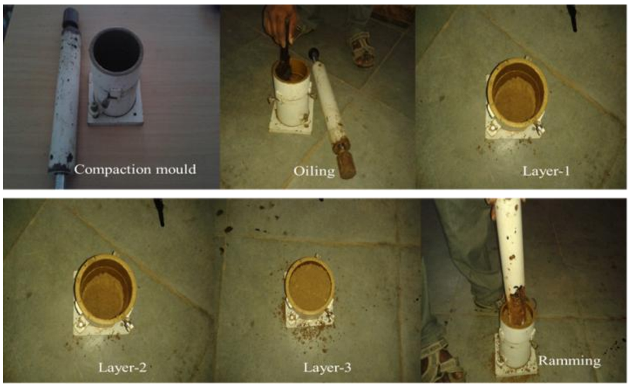

Fig 1. Process of compaction

B. Second Series of Tests (Determination of Optimum Fly ash)

The second series of tests are aimed at determining 'Optimum Fly Ash' from the view point of compaction characteristics and CBR (Soaked and Un soaked) characteristics. Fly ash is mixed with the soil in different proportions and tests are conducted as per the details presented in Table 2.

TABLE 2: Details of 2nd series of tests conducted

S.No.	Soil mixtures	Tests conducted
1.	Silty sand +5%Flyash	Compaction test and CBR (Soaked and Unsoaked) test.
2.	Silty sand +10%Flyash	
3.	Silty sand +15%Flyash	
4.	Silty sand +20%Flyash	
5.	Silty sand +25%Flyash	

C. Third Series of Tests (Influence of optimum Polypropylene)

The third series of tests are aimed at studying the influence of optimum Polypropylene on compaction and CBR (Soaked and Unsoaked) behaviour of sandy soils treated with optimum fly ash. The optimum fly ash obtained from second series of tests is used in this series of tests and the tests are conducted on those soils with various proportions of polypropylene. All the tests were conducted after addition of polypropylene. The details of third series of tests conducted are shown inTable 3.

TABLE 3: Details of 3rd series of tests conducted

S.No	Soil mixture	% Polypropylene added	Tests conducted
1.	Silty Sand + Optimum Fly ash	5	Compaction test, CBR (Soaked and Unsoaked) test.
2.		10	
3.		15	
4.		20	
5.		25	
6.		30	
7.		35	

III. CALIFORNIA BEARING RATIO BEHAVIOUR OF FLY ASH AND POLYPROPYLENE STABILISED SOILS

A. SILTY SAND WITHOUT ADDITION OF ADMIXTURES

Sandy soils in nature may contain coarse fraction in varying proportions. Hence, in order to determine the dry density and pavement thickness, I.S light compaction test (Fig 2) and California bearing ratio test(Fig 3 & 4) were conducted on the soil.

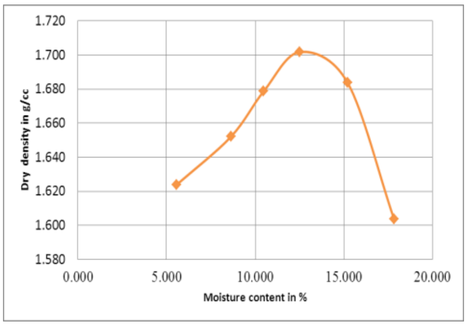

Fig 2. Compaction curve

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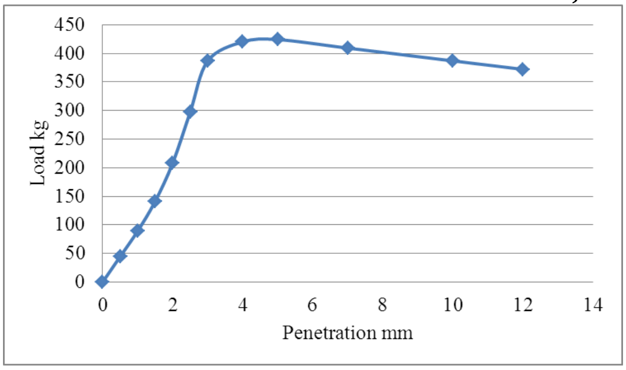

Fig 3. CBR (UnSoaked) behavior curve

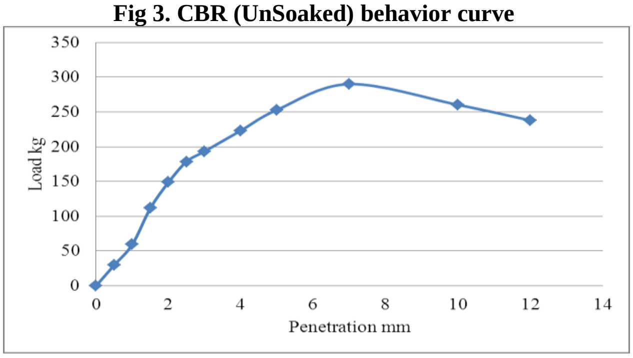

Fig 4. CBR (Soaked) behaviour curve

B. EFFECT OF FLY ASH ON SOIL PROPERTIES

One of the objectives of the present investigation is to study the effect of fly ash on compaction (Fig 5), and CBR characteristics (Fig 6 & 7). The results presented in the previous section reveal that the soil is classified as silty sand and also we obtain the values of OMC and MDD from compaction test. In this series of tests the soil is replaced with the fly ash in various proportions such as 5%, 10%, 15%, 20% and 25% by its dry weight.

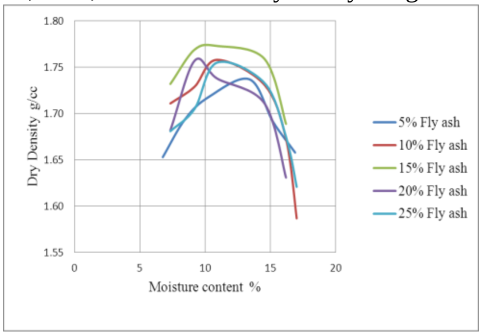

Fig 5. Variation of MDD and OMC with fly ash

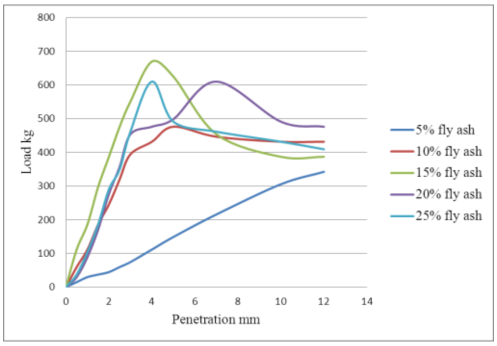

Fig 6. Variation of CBR (Unsoaked) with fly ash

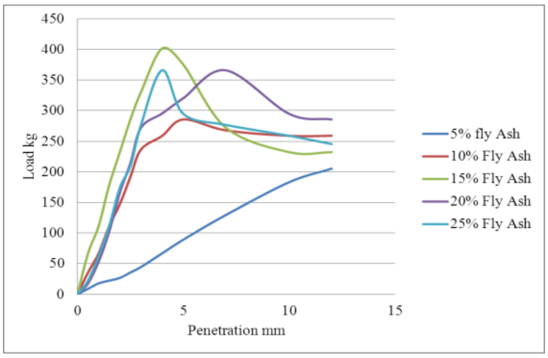

Fig 7. Variation of CBR (Soaked) with Fly Ash

C. EFFECT OF OPTIMUM FLY ASH AND WASTE POLYPROPYLENE ON SOIL PROPERTIES

The objective of the present investigation is to study the effect of optimum fly ash and waste polypropylene on soil properties such as compaction (Fig 8) and CBR characteristics (Fig 9 & 10). The results presented in the previous section reveal that the optimum % of fly ash at which we got the maximum dry density is 15%.In this series of tests the soil is replaced with the optimum fly ash and various proportions polypropylene strips such as 5%,10%,15%,20%,25%,30% and 35% by its dry weight of the sample.

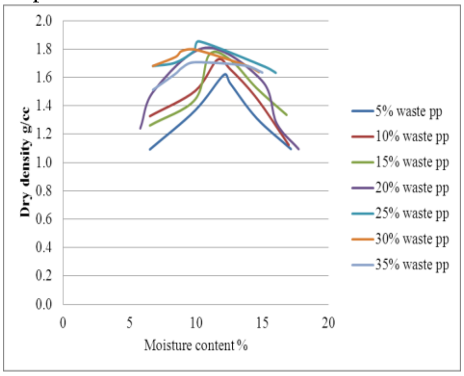

Fig 8. Variation of MDD and OMC with optimum fly ash & polypropylene

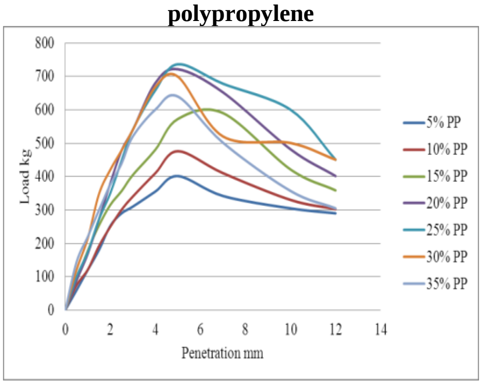

Fig 9. Variation of CBR (Unsoaked) with optimum Fly Ash & Polypropylene

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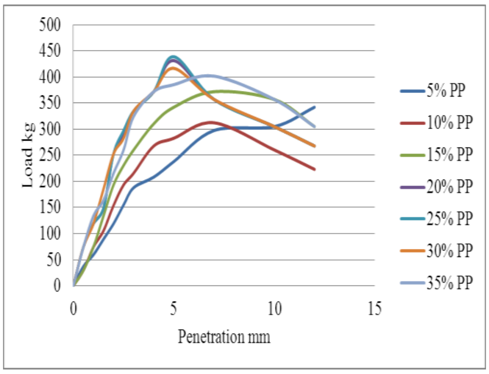

Fig 10. Variation of CBR (Soaked) with optimum Fly Ash & Polypropylene

IV. CONCLUSION

1. Compaction, California bearing ratio characteristics of silty sand are dependent on clay content present in the soil. The MDD and CBR values for thesilty sand are low when compared to the fly ash and polypropylene stabilized silty sands.
2. OMC in general decreases with increasing the replacement of fly ash. MDD increases up to certain % of fly ash called Optimum fly ash and then decreases. Optimum fly ash at which MDD is highest is 15%.
3. Fly ash stabilization increases the CBR (Unsoaked) value by 60% and CBR (Soaked) value by 58.4%, the optimum % of fly ash at which we got this result is 15%.
4. OMC in general decreases with increasing the replacement of polypropylene at optimum fly ash content. MDD increases up to certain % of polypropylene and then decreases.
5. Polypropylene stabilization increases the CBR (Un Soaked) value by 66.52% and CBR (Soaked) Value by about 65% at the optimum replacement of fly ash.
6. The disposal of the plastic wastes without causing any ecological hazards has become a real challenge to the present society. Thus using plastic wastes as a soil stabilizer is an economical and gainful utilization since there is scarcity of good quality soil for embankments, pavements and industrial yards.
7. Thus this project is to meets the challenges of society to reduce the quantities of wastes, producing useful material from non-useful waste materials that lead to the foundation of sustainable society.

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