Subgrade Soil Stabilization using Fines obtained from Demolished Concrete Structures

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Abstract - ***Subgrade soil stabilization is one of the primary and major processes in the construction of any highway. The aim of this paper is to evaluate the utilization of fines (passing 1.18 mm IS sieve) obtained from demolished concrete structures in subgrade soil stabilization. The evaluation involved the determination of the California Bearing Ratio (CBR) value of the clay soil in its natural state as well as when mixed with different proportion of fines. Results showed that the CBR (both Unsoaked and Soaked) value of the clay soil is improved substantially by the addition of fines and the highest CBR value was achieved at 10% fines.***

Key Words: *Stabilization, Clay Soil, Fines, Demolished Concrete, CBR etc…*

1. INTRODUCTION

India has been emerging as one of the world's fastest growing economies and this growth has brought with it a significant boost in construction activities. With the rapid growth in construction activities the amount of construction and demolition (C&D) waste generation is increasing. Due to the large quantities of construction and demolition (C&D) waste which is produced in our country, its disposal in landfills poses a serious environmental problem. The C&D materials have been used in recent years in various civil engineering applications such as roads, embankments, pipe bedding and backfilling. Material engineers are constantly searching for new and innovative engineering methods and techniques to minimize the use of natural resources as well as to protect the environment. Road construction is one of the main fields where researchers are studying the use of waste materials. A number of waste products are currently being used in variety of highway applications. In this study efforts have been made to utilize the fines obtained from the demolished concrete structures as a subgrade soil stabilizer for improving the properties of clayey soil.

2. MATERIAL USED

2.1 Clayey Soil

In the present investigation clayey soil procured from the Chandigarh city was considered for stabilization. The various geotechnical properties of clayey soil observed from experimental investigation are shown in the Table 1.1.

Table 1.1: Geotechnical properties of Virgin Clayey Soil

Sr. No.	Properties	Value
1	Colour	Brown
2	Liquid Limit (%)	36.15
3	Plastic Limit (%)	22.0
4	Plasticity Index (%)	14.15
5	Soil Type as per IS: 1498	CI
6	Optimum Moisture Content (%)	11
7	Maximum Dry Density (g/cc)	2
8	Unsoaked CBR (%)	26.01
9	Soaked CBR (%)	12.35
10	Specific Gravity	2.61

2.2 Stabilizing Material

Fines obtained from demolished waste were procured from NITTTR Chandigarh. The demolished concrete cubes collected from NITTTR Chandigarh were broken into smaller pieces with the help of compression machine. After crushing the material the coarser aggregates were segregated from fines. The finer materials were further ground and sieved through 1.18 mm sieve. The material passing through 1.18 mm sieve was taken for soil stabilization.

3. METHODOLOGY ADOPTED

Laboratory investigations were conducted on untreated (virgin) clayey soil sample and soil samples admixed with fines and their results were analyzed. Fines were mixed independently with the clayey soil at varying percentages of 4 %, 7 %, 10 %, 12 % and 15 % by weight of dry soil. Atterberg limits tests were carried out on material passing through 425 micron for admixed soil samples and soil samples without fines in accordance with IS: 2720 (Part 5). Maximum dry density and optimum water content was determined in accordance with IS: 2720 (Part 8). CBR test was also conducted as per IS: 2720 (Part 16) to determine the strength of clayey soil sample and soil sample admixed with fines.

4. EXPERIMENTAL WORK AND RESULTS

4.1 Compaction Test

To determine the optimum moisture content and the dry density relationship, modified compaction tests (heavy compaction test) were conducted on plain soil and soil admixed with fines. Compaction was done manually. Firstly the tests were conducted on plain soil sample by varying the percentage of water in order to find optimum moisture content and maximum dry density. Later on the tests were conducted on soil admixed with fines obtained from demolished material by varying the percentage of fines as 4%, 7%, 10%, 12% and 15% by weight of dry soil. Individual compaction tests were conducted for each percentage variation of fines to find optimum moisture content and dry density. The results showed that the maximum dry density of the soil admixed with fines increases with the increase in percentage of fines up to 10% with respect to maximum dry density of clayey soil sample. This analysis infers that admixing of fines up to 10% by weight of dry soil with clayey soil reduces the optimum moisture content (OMC) thereby corresponding increase in maximum dry density (MDD) of the soil. As the percentage of fines increases beyond the 10% fines, increase in OMC and corresponding drop in MDD is observed. The increase in OMC is probably due to the effect of hydration of cement. The data and graph showing the variation in OMC and MDD with the addition of fines is shown in the table 1.2 and figure 1.1

Table 1.2: Data of OMC and MDD

Sr. No	Percentage of Fines	OMC (%)	MDD (g/cc)
1	0	11	2.00
2	4	10.7	2.07
3	7	10.5	2.09
4	10	10.2	2.10
5	12	10.6	2.08
6	15	13.2	2.03

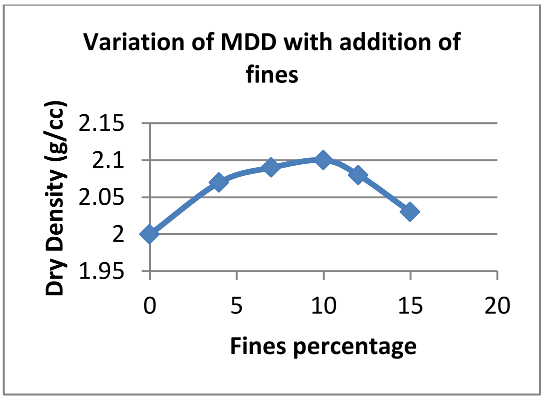

Fig. 1.1: Graph showing Variation of Dry Density with the addition of fines

4.2California Bearing Ratio (CBR)

4.2.1 Unsoaked CBR Test

Unsoaked CBR test was carried out on plain soil samples and soil admixed with fines at different percentages. The results showed that addition of fines improves the Unsoaked CBR value of the soil. The increase in CBR value is attributed to the increase in dry density of the admixed soil samples. Admixing of fines with soil could infill voids and improved the packing density of the soil resulting to better mechanical strength.The graph showing the variation in Unsoaked CBR values of soil mixed with different percentages of fines is shown in figure 1.2. From the graph it can be clearly seen that the Unsoaked CBR value of soil increases with the increase in percentage of fines up to 10%. The maximum percentage variation in Unsoaked CBR value of admixed soil sample with respect to virgin soil is observed as 86.9%.

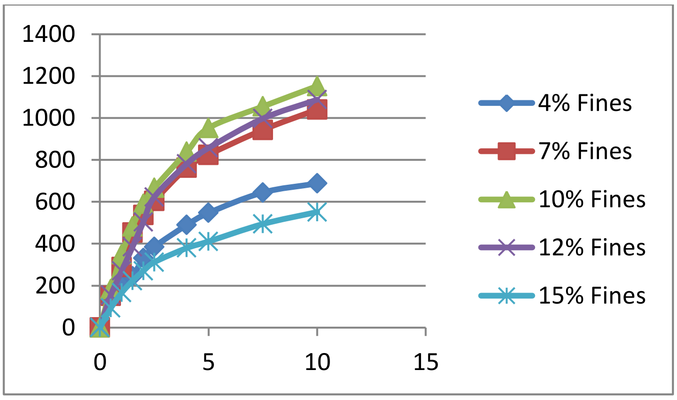

Fig. 1.2: Load Penetration Curve for admixed soil samples

Table 1.3: CBR values

Sr. No.	Fines Percentage	Corresponding CBR value (%)
1	0	26.01
2	4	28.12
3	7	44.15
4	10	48.61
5	12	45.46
6	15	22.77

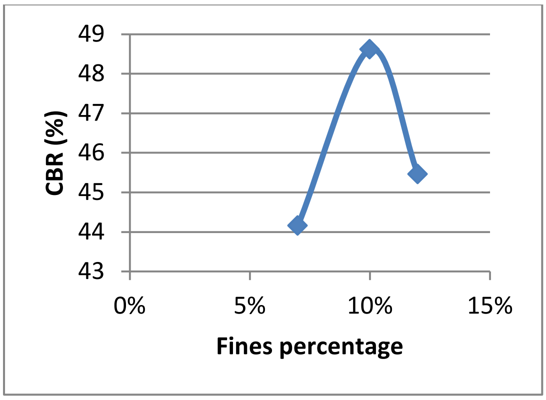

Fig.1.3: CBR values corresponding to fines percentage

4.3 Soaked CBR

Soaked CBR test was conducted on virgin soil sample and soil admixed with 10% fines. Results showed that the increase in soaked CBR value due to addition of fines is more than the Unsoaked CBR value. The percentage variation in the soaked CBR of admixed soil sample with respect to plain soil sample was observed as 276.6%. The increase of CBR value attributed to the hydration of cement. Curing of fines admixed sample during soaked CBR test causes hydration of cement which is responsible for increase in mechanical strength of the admixed samples.

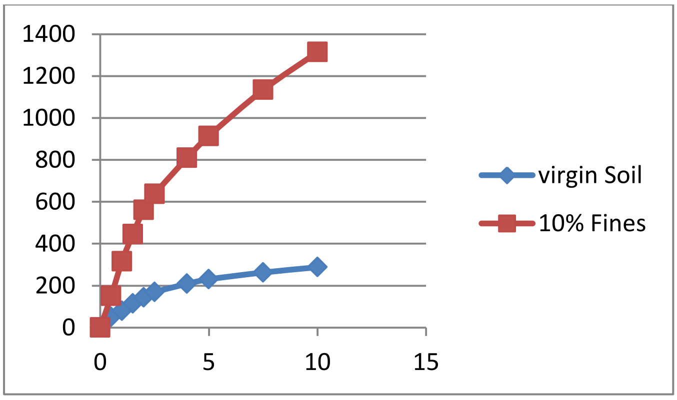

Fig. 1.3 Load penetration curve for virgin and admixed soil samples

Table 1.4: Soaked CBR values

Sr. No.	Fines percentage	Soaked CBR value (%)
1	0	12.35
2	10	46.51

5. CONCLUSION

Admixing of fines up to 10% by weight of dry soil could enhance the CBR value of clayey soil. The percentage variation in Unsoaked and Soaked CBR values with respect to the virgin soil sample were observed as 86.9% and 276.6% respectively. The increase in Unsoaked and soaked CBR value is due to the improvement in the packing density of the soil mass and the curing of admixed soil samples which causes hydration of cement present in the fines resulting in the strength enhancement of the soil.

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