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The Use of Cement Stabilized Granular Soil for Pavement Layer

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ABSTRACT

In recent times as good quality materials have become rarer, use of out-of specification materials in structural parts of road pavement construction have been investigated. This is particularly attractive in developing countries where good quality materials may be prohibitively expensive. This paper describes an investigation into the use of cement stabilized granular soil in the construction of road. The laboratory results indicated that the unconfined compressive strength and compaction characteristic of granular soil cement mixes were acceptable for road pavement layers.

In the present work, laboratory tests have been conducted on granular soil stabilized with different proportions of cement to determine the minimum amount of cement required to achieve targeted compressive strength. The hydrated products of cement binds the soil particles, the strength developed depending on the concentration of cement and the intimacy with which the soil particles are mixed with cement. The laboratory test conducted on different soil samples collected from different part of Jabalpur i.e. from Narmada river sand, Gour river sand and Hiran river sand are sieve analysis, modified proctor test and unconfined compressive test. Test result revealed that there is significant variation of UCS, OMC and MDD of soil samples. The UCS of gravelly soil (Sample-I) is suitable for base layer at 8% cement content and for sub-base layer at 6% cement content similarly for well graded medium sand (Sample-II) is suitable for sub-base layer at 8% cement content and for well graded fine sand (Sample-III) is not suitable for sub-base and base layer however it is suitable for subgrade construction.

Keywords:—*cement stabilization, Granular soil, OMC, MDD, Basic properties, UCS.*

I. INTRODUCTION

Stabilization in a broad sense incorporates the various methods employed for modifying the properties of a soil to improve its engineering performance. Stabilization is being used for a variety of engineering works, the most common application being in the construction of road pavements layer, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials. The improvement of the engineering properties of a soil involves a stabilization process usually through mixing with an additive such as, cement, lime, bitumen, or calcium chloride. These processes are normally named after the additives. Cement stabilization is widely accepted at present time. The purpose is to improve the strength and durability of the structures constructed

with natural soils by the addition of cement to the soils as an additive. It is evident that earth structures such as, roads, highways, airport runways, require soils with sufficiently good engineering properties such as, low plasticity, high bearing capacity, low settlements and high modulus. The main concentration of the research is to determine various sand grain analyses and which of them is perfect for stabilization with cement to use instead of other materials. This research also indicates the stability and durability of the road with perfect soil cement mixing proportions.

II. Experimental Investigation

The soil samples investigated in the study is collected from different part of Jabalpur Madhya Pradesh, those were collected from Narmada river sand, Gour river sand, Hiran river sand Jabalpur district in (M.P), which further designated as Sample-I, Sample-II, Sample-III. The properties of soil samples determined from laboratory study are presented in Table 1. Based on the gradation properties, the three soil samples is classified - Sample-I as well graded gravel (GW) or gravelly soil, Sample-II as well graded medium sand or sandy soil and Sample-III as well graded fine sand or clayey sand as per BIS soil classification system. The heavy compaction test (modified proctor test) is conducted on the soil samples as per IS 2720: Part 8: 1983 to evaluate compaction characteristics.

III. Cement

The cement used in the study is Birla gold 43 Grade Ordinary Portland cement. The properties of cement determined from laboratory tests are presented in Table 2

Table 1: Basic Properties of Soil Samples

S No	Soil Properties Grain seive analysis	Sample 1 Value	Sample 2 Value	Sample 3 Value
1	a.) Gravel (%)	73	0	0
	b.) Sand (%)	17	74	58
	c.) Silt (%)	6	18	22
	d.) Clay (%)	5	8	20
	e.) Uniformity Coefficient	6	7.9	7.6
	f.) Coefficient of Curvature	2.6	1.4	1.4
2	Plasticity Characteristics			
	a) Liquid limit (%)	NP	NP	20.3
	b) Plastic limit (%)	NP	NP	17.6
	c) Plasticity index (%)	NP	NP	2.6
3	Classification of soil	GW	SW	SC
4	Compaction Characteristics			
	a) Optimum Moisture Con-tent (%)	7	8.2	9.8
	b) Maximum Dry Density (g/cc)	2.32	2.11	2.06

Table 2 Basic Properties of Cement

Property		Value
Specific Gravity		3.16
Initial setting time (minutes)		90
Final setting time (minutes)		418
Normal consistency (%)		30
Compressive strength (N/mm^2)		
i)	at 3 Days	32
ii)	at 7 Days	42
iii)	at 28 Days	52.28

4. Compaction Characteristics of Cement Stabilized Soil Samples :

The heavy compaction tests are carried out as per IS 4332 (part 3) -1995 on different soil samples i.e. Sample-I, Sample-II and Sample-III mixed with 2, 4, 6, 8 percent cement content by dry weight of soil for determining compaction characteristics. Care is taken to complete the compaction test within 30 minutes from the instant of mixing of cement to soil. The OMC and MDD values of Cement stabilized different soil samples are presented in Tables.

Table 3 OMC and MDD Value of Cement Stabilized of All Soil Samples

Description of Mix	Sample 1		Sample 2		Sample 3	
	OMC (%)	MDD (gm/cc)	OMC (%)	MDD (gm/cc)	OMC (%)	MDD (gm/cc)
Soil + 0% Cement	7	2.32	8.20	2.11	9.8	2.06
Soil + 2% Cement	7.08	2.35	8.27	2.14	10.16	2.09
Soil + 4% Cement	7.15	2.38	8.57	2.19	10.21	2.13
Soil + 6% Cement	7.23	2.43	8.86	2.22	10.32	2.17
Soil + 8% Cement	7.45	2.47	9.2	2.25	10.46	2.21

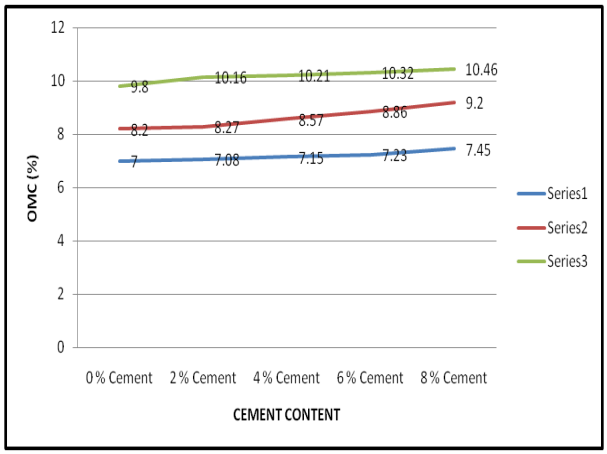

Figure 1: Representation of OMC Vs Cement Content of Soil Samples

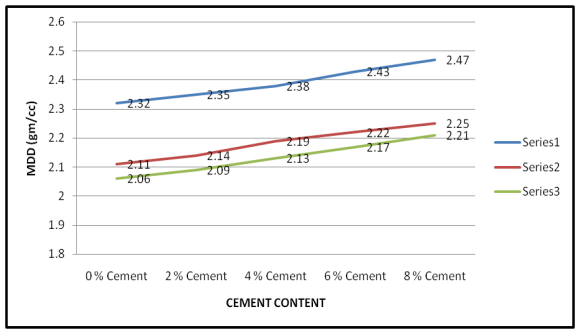

Figure 2: Representation of MDD Vs Cement Content of Soil Samples

It can be seen from above tables that in Sample -I, Sample-II, Sample-III values of M.D.D. values of Cement Stabilized soil samples increased with increase in percentage of cement addition. However, the increment is marginal. The increased MDD values are due to filling up of voids in soil by cement. The optimum moisture content of all soil samples is also increased with increasing cement content under study. It is attributed to increasing the specific surface area of cement content.

V. Unconfined Compressive Strength

Unconfined compressive strength of soil samples are improved with the addition of cement with different proportion as 2%,4%,6%,8%. The UCS results were observed after the 7 days of curing. The graph shows the variation of unconfined compressive strength with different percent of cement content on all three type of soil samples. Comparison of results are tabulated below in graph, Figure 3

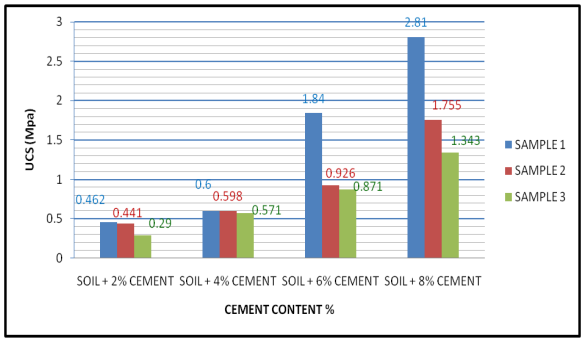

Figure 3. variation of unconfined compressive strength

These bar graphs illustrate the comparison of strength with three types of sand for 7 days. From the diagram, Blue color presents the Sample-I, Red color presents the Sample-II, and Green color presents the Sample-III. In general, the value of 7 days fluctuate very little among the three type of sand Sample-I meets the unconfined compressive strength requirement of base pavement layer and sub-base pavement layer on 7 days is 2.81 MPa and 1.84 MPa similarly Sample-II meets the UCS requirement of sub-base layer on 7 days is 1.75 MPa. On the other hand, Sample III could not satisfy the UCS requirement on 7 days. However, it is satisfy for the subgrade construction.

VI. CONCLUSION

Based on the results of tests conducted on three types of granular soil samples (gravelly, medium sand and fine sand) with different proportion of cement 2%, 4%, 6%, 8%, by dry weight of the soil. Under the study, the following conclusions are drawn.

The maximum dry density of cement stabilized with all soil samples under study increases in proportion of cement.

The optimum moisture content of cement stabilized with all soil samples is also increased with increasing cement content under study.

The UCS results shows that Sample-I is suitable for sub-base at 6% cement content and it is suitable for base at 8% cement content is added to the dry weight of soil similarly Sample-II is suitable for sub-base at 8 % cement content and Sample-III is not suitable for sub-base and base layer of pavement however it is suitable for subgrade construction.

Hence, cement stabilized granular soil (sandy soil/gravelly soil) may be used for the construction of different layer of the pavement.

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