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Study of Geotechnical Properties of Cement Stabilized Gravelly SOIL

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Abstract: ***Pavement generally consists of base and sub-base, which are constructed from suitable materials. When no suitable material is available and it is expensive to bring material from distant sources; an alternative way which is now also practiced in India is to compact the in situ soil mixed with cement. And because of the extensive construction processes the aggregate demand is also so huge that lots of blasting, quarrying, crushing and transportation activities are consuming a lot of energies, but also the aggregate materials are depleting fast and are in short supply. On the other hand among various stabilization techniques, cement stabilization is one of the best options as it suits to any type of soil.***
It is observed that gravel have excellent properties as road aggregates and can be used in the road base and sub-base applications.
In the present work, comprehensive laboratory work is carried out to study the effect on CBR value of well graded gravel stabilized by cement with different cement content i.e. 2% ,4% and 6% of dry weight of gravel soil .The CBR value of cement stabilized gravel is assessed after 96 hours soaking period.
Keywords: Cement Stabilization, Sub grade, Sub base layer, Base layer, Pavements, well graded gravel

I. INTRODUCTION

Stabilized earth is an alternative building material that is significantly cheaper than using conventional Brick and concrete, and is also environmentally sustainable. Earth has been used as a construction material on every continent and in every era .Soil cement is one of the construction materials widely used as foundation for buildings and pavement base due to its relative high strength and its effectiveness in preventing pumping of the sub grade soils. Soil cement especially has been used as a beneficial substitute for conventional base material.
The success of cement stabilization in gravel soils for improving the strength and durability for road, air-field construction, river protection works and building blocks is well established by various researchers (Da Fonseca et al., 2008; Basha et al., 2005; R.S.J. Spence, 1975; Manasseh and Isaac, 2010 ; Ramana Murthy et al.2004) In the present work, laboratory tests have been conducted on gravelly soil stabilized with different proportions of cement to study the CBR value of cement stabilized gravelly soil with cement proportions of 2% ,4% and 6% also determine the compaction characteristics at different cement contents.

II. EXPERIMENTAL INVESTIGATION

A. Materials Used Gravel

The soil investigated in the study is procured from gravel quarry in Gandhi gram Panagar city, Jabalpur district in (M.P), Panagar is located at 23.3°N 79.98°E.
The properties of soil determined from laboratory study are presented in Table 1. The grain size distribution curve of soil is presented in Fig.1. Based on the gradation properties, the soil is classified as well graded gravel (GW) as per BIS soil classification system.
The maximum particle size in the gravel soil collected is below 20mm size.
The heavy compaction test (equivalent to modified proctor test) is conducted on the soil as per IS 2720: Part 8: 1983[1] to evaluate compaction characteristics.
The California Bearing Ratio (CBR) test is carried out as per IS 2720: part 16 (1997) [2] on gravel specimen compacted under IS heavy compaction condition. The Soaked CBR value determined after soaking period of 96 hours is presented in Table 1.

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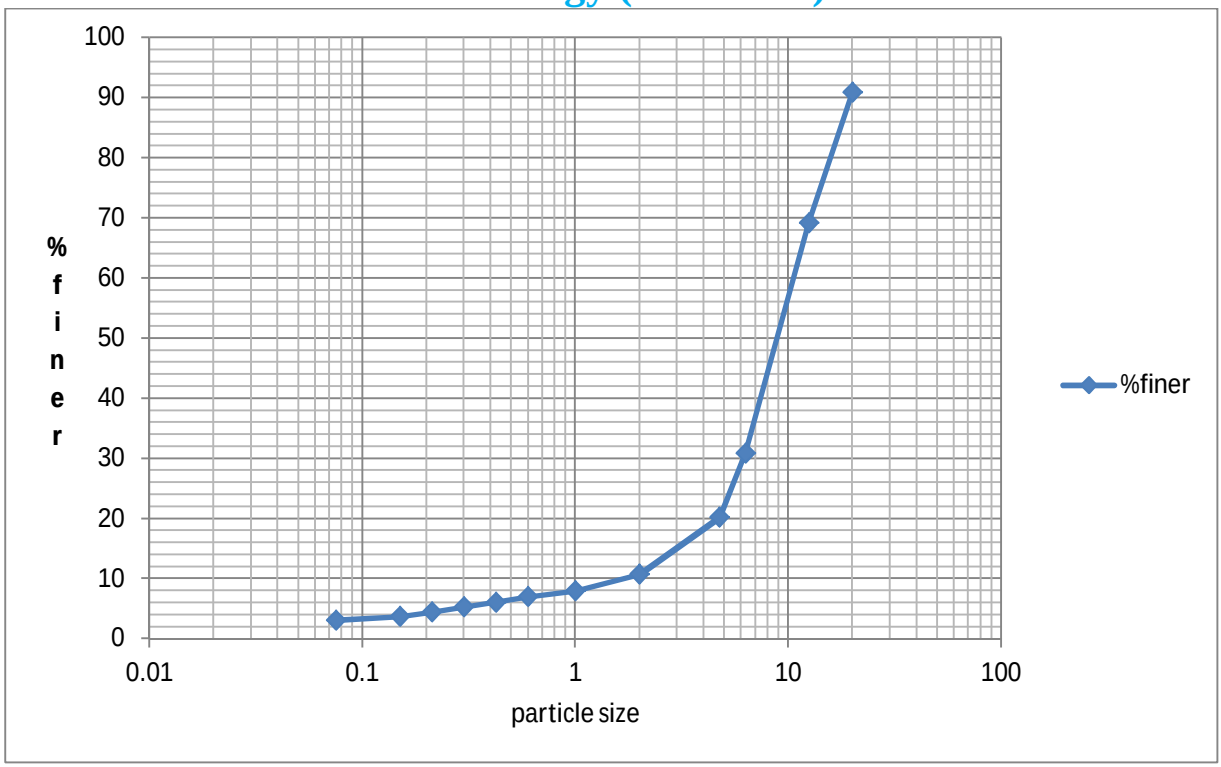

Figure.

Table 1: Properties of Gravel

S. No.	Soil property	Value
1.	Grain Size Analysis	
	a) Gravel (%)	80
	b) Sand (%)	17
	c) Fines (%)	3
	d) Uniformity Coefficient	5.1
	e) Coefficient of Curvature	1.76
2.	Plasticity Characteristics	
	a) Liquid limit (%)	NP
	b) Plastic limit (%)	NP
	c) Plasticity index (%)	NP
3.	Classification of soil	GW
4.	Compaction Characteristics	
	a) Optimum Moisture Content (%)	6.80
	b) Maximum Dry Density (g/cc)	2.10
5.	Soaked C.B.R (%)	30

B. 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: 2 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

III. DETAILS OF LABORATORY STUDIES

A. Compaction tests

Heavy compaction test, according to IS 4332(part3)-1995[6] is used to determine optimum moisture content (OMC) and maximum dry density (MDD) of the gravelly soil. The heavy compaction tests are carried out on gravel soil mixed with varied proportions of cement (0-14 percent by weight in increments of 2 percent) for determining compaction characteristics.

B. California bearing ratio tests

The tests were conducted as per IS: 2720 part 16-1997[7]. CBR specimens were prepared from gravel soil mixed with varying percentages of cement by compacting at respective OMC & MDD values. The CBR values are determined after 96 hours soaking period.

IV. RESULTS AND DISCUSSION

A. Compaction Characteristics

The results of IS heavy compaction tests are presented in Fig 2 and 3. It can be observed that from Fig. 2 that the maximum dry density of gravel soil increased with increase in cement content However, the increment is marginal. The increased MDD values are due to filling up of voids in soil by cement. .Fig. 3 infers that OMC values increased slightly as the cement content is increased.

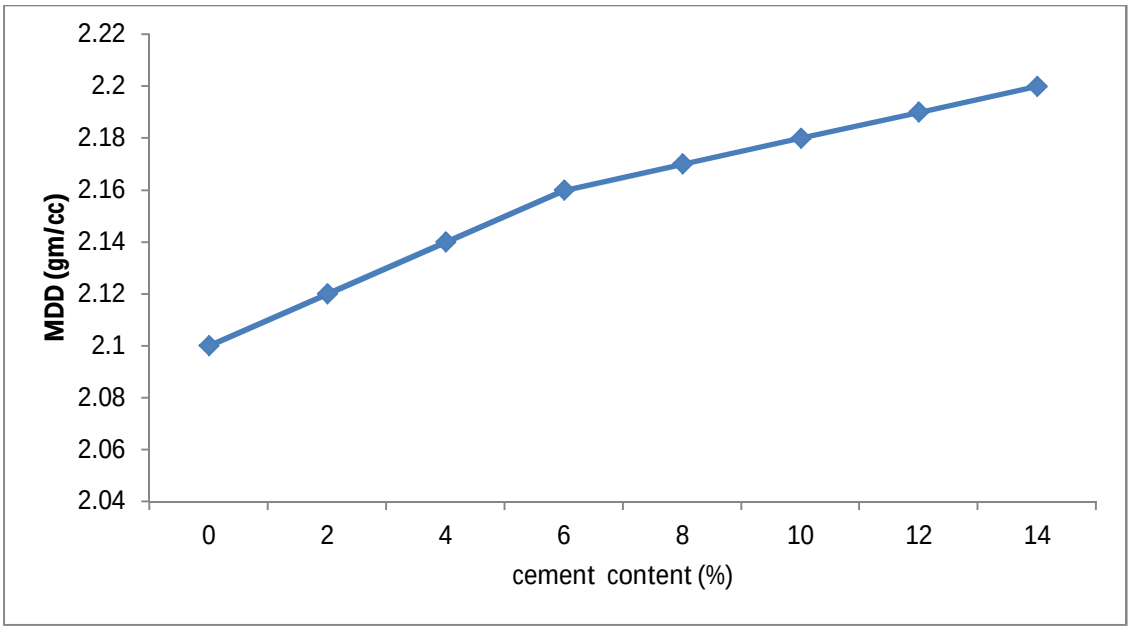

Fig 2 MDD VS CEMENT CONTENT

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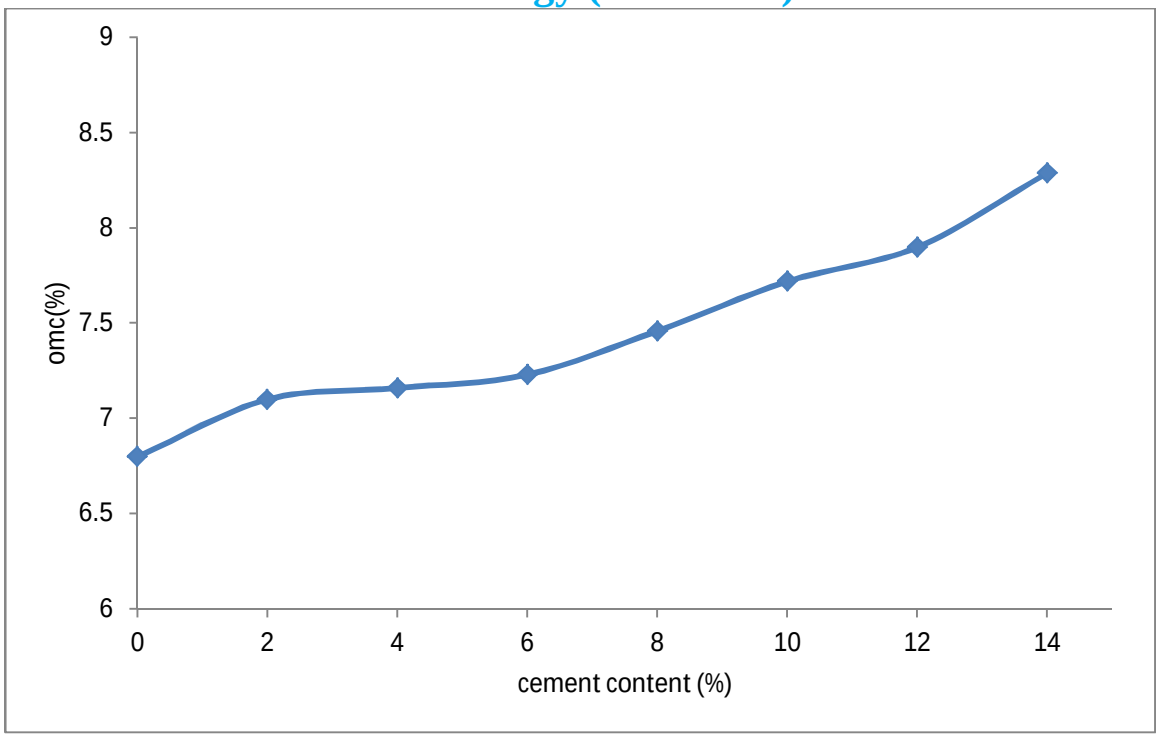

Fig 3 OMC VS CEMENT CONTENT

C. Effect on California bearing ratio

The CBR value of gravel soil stabilized with cement increased significantly with increase in cement content. Cement content for stabilizing gravel soil for making it suitable for use in base courses of pavements is about 6 percent. Variation in CBR value is presented in figure 4.

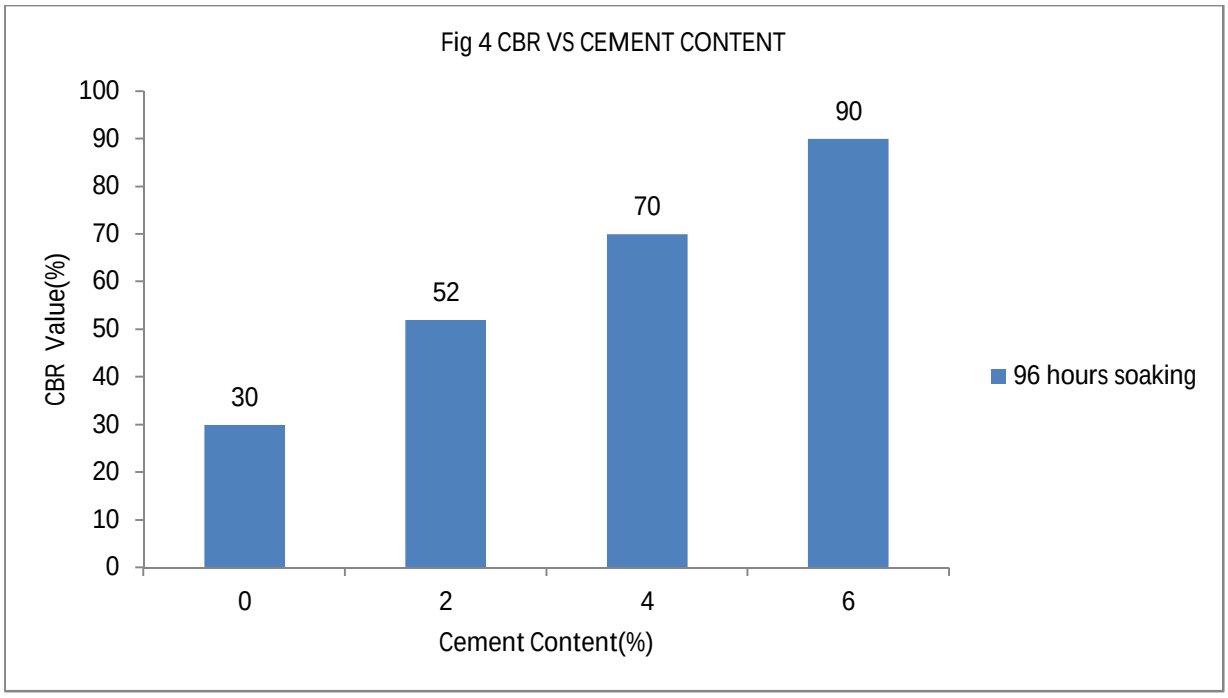

Figure. 4

V. CONCLUSIONS

Based on the results of tests conducted on cement stabilized gravel soil under the study, the following conclusions are made.

The well graded gravel has CBR 30% and hence, it is suitable for use in its original form in sub bases of flexible pavements in rural and urban areas.

The gravel under study can be effectively stabilized by Cement as percentage fines is less than 5% and it is well graded.

The maximum dry density of cement stabilized gravel under study increased with increase in proportion of cement.

The well graded gravel stabilized with cement contents of 6 percent yielded CBR values 90 percent. Hence, cement stabilized well graded gravel may be used in base course of pavements.

Hence, cement stabilized well graded gravel may be used advantageously in preparation of foundation beds, sub base courses of flexible pavements.

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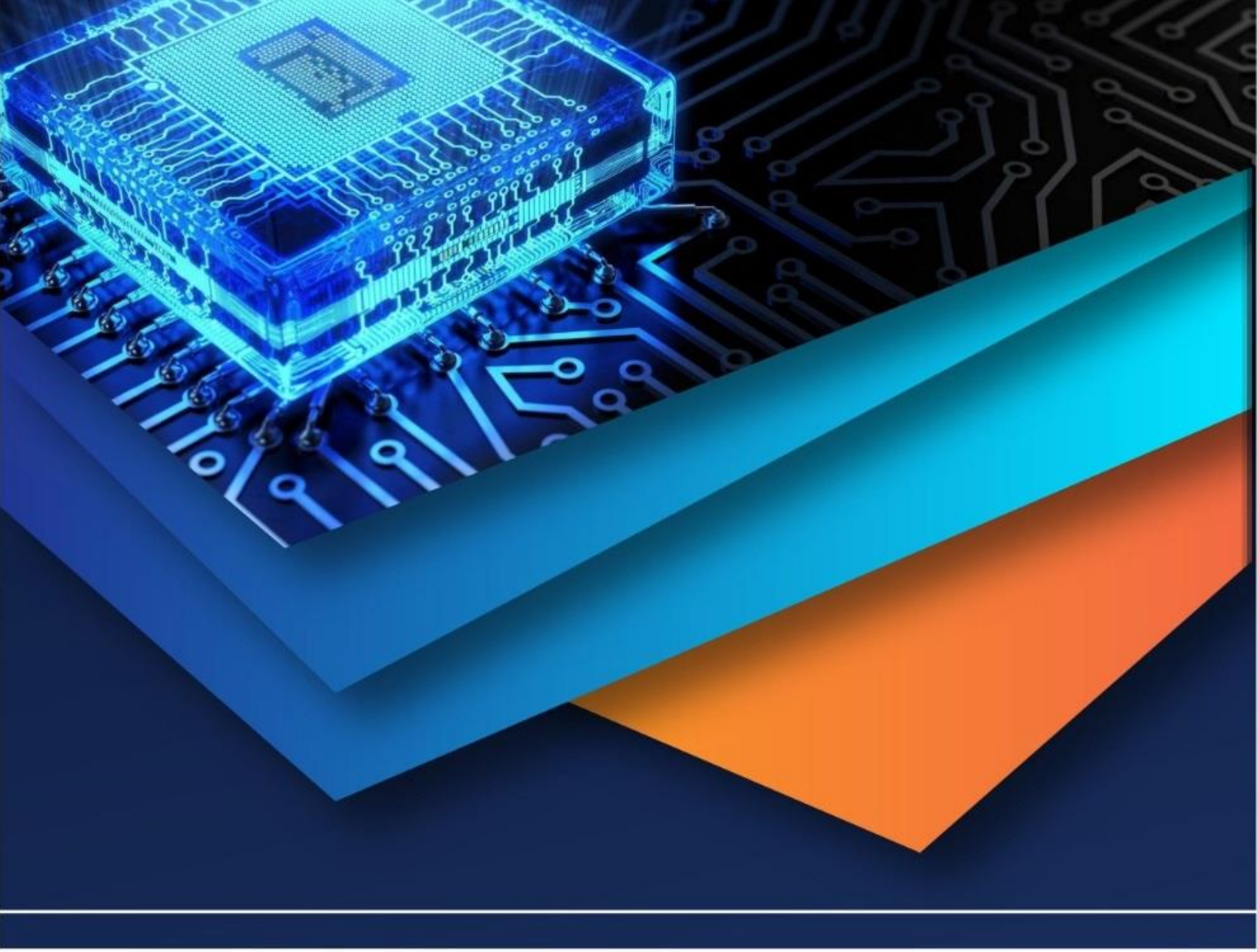

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