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# Soil Stabilisation Using Cement

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**ABSTRACT:** Among the several modes of transportation, the roads have been the most ancient and widely used medium. Since the ancient time for transportation of goods or travelling purpose, we used roads. Heavy loaded trucks running on the roads need special care and attention during construction phase so that they can bear the maximum load. Some of the soil having sufficient load bearing capacity but some of having poor. This research work mainly focuses on soil stabilization using cement to improve geotechnical properties such as plasticity, compaction, and Unconfined Compressive Strength of the studied soil. These properties were determined before as well as after the stabilization of soil. In this work it was found that higher the quantity of cement added to the soil, dry density of soil decreased and optimum moisture content increased. With the addition of cement to the soil, unconfined compressive strength increased, and it was also found higher at higher curing period.

**Key words:** Cement Stabilization, Unconfined Compressive Strength (UCS), Plasticity Index (PI), Compaction.

## I. INTRODUCTION

Road stabilization is the method of providing strength to the natural soil against the heavy load of modern-day traffic and to reduce the damage of roads in a different climate. The methods employed include the use of admixtures, compaction and densification of soil. Admixture can be chemical binders, industrial wastes, cement, and fly ash. Soil Stabilization is a technique used to change different soil properties and to enhance its performance for engineering purpose [9]. Selection of stabilizer for a certain field depends mainly on the type of soil, type of construction to develop, and availability of materials to be used in construction [4]. Cement base pavement has an advantage of great strength and durability.

Also, it is widely available hence becomes the best material for stabilization of soil. The hydrated product of cement binds with soil to form the cement-stabilized base or cement-treated aggregate base. The strength of stabilized soil will mainly depend on the quantity of cement used in the soil. The proportion of cement required in soil decides based on the type of soil. Portland cement widely used as a soil stabilizers, because of its easy handling and quality control properties [8]. With the increase in cement quantity in the strength of the cement stabilized soil increases [1]. Several researchers have found that stabilization using cement is more suitable for granular soil and clay soil having low PI [2]. Based on UCS value, quality of soil used in subgrade classified as soft, medium, stiff, very stiff and hard [3]. UCS value of stabilized soils on curing time increases with the higher quantity of cement added to the soil [6]. The curing period effect the UCS test result of cement stabilized soil, and higher strength obtains for the soil sample cured for 14 days compared to 7 days curing [7].

For different types of soil, a guideline for stabilization has issued specifying the Plasticity Index (PI) of sandy soil to be less than 30. For fine grain soil PI should not be more than 20 and to ensure proper mixing liquid limit (LL) should not be more than 40. For soil having a higher amount of clay two stage stabilization may be adopted i.e. the clay is treated with lime in stage I to reduce the value of plasticity and hence to provide a facility for pulverization, whereas in stage II, the resulting soil stabilized with cement. Physical properties of soil like particle size distribution, clay content, liquid limit and plasticity index play a major deciding factor in any project. Also, the chemical nature of soil has a great impact on deciding the durability of roads. Hence to achieve a solid and stable foundation we need stabilization technique. Factors affecting soil cement stabilization are soil, cement, pulverization and mixing, compaction and curing. Material requirements for stabilization the well-graded soil of LL less than 45%, PI less than 20% and cement quantity based on UCS value.



## II. MATERIAL AND METHODS

The soil used in this research work was local soil situated behind Kalinga University main building, Naya Raipur, Chhattisgarh. Physical properties of the soil determined and presented in Table 1. Test to be performed before soil stabilization are a liquid limit (LL), shrinkage limit (SL), plastic limit (PL), PI, UCS, MDD, OMC and particle size distribution.

**Table 1** Physical Properties of soil studied

| Sl. No. | Properties                                | Local Soil |
|---------|---|------------|
| 1       | Liquid Limit (%)                          | 45         |
| 2       | Plastic Limit (%)                         | 27         |
| 3       | Plasticity Index (%)                      | 18         |
| 4       | Shrinkage Limit (%)                       | 20         |
| 5       | Specific Gravity                          | 2.68       |
| 6       | Gravel (%)                                | 3          |
| 7       | Sand (%)                                  | 52         |
| 8       | Silt (%)                                  | 24         |
| 9       | Clay (%)                                  | 21         |
| 10      | Natural Moisture Content (%)              | 7          |
| 11      | Maximum Dry Density (gm/cm <sup>3</sup> ) | 1.96       |
| 12      | Optimum Moisture Content (%)              | 14         |

Primary methods of soil stabilization used are mechanical stabilization and chemical stabilization. In any road construction, a mechanical method conducted by compacting the soil through rollers, and chemical method includes utilization of fly ash, lime, cement, etc. In chemical method two types of additives used at the time of stabilization of soil. First one is mechanical additives and the second one is chemical additives. As a mechanical additives cement used and its main function is to alter the soil property mechanically by adding an optimum quantity, thereby to improve the soil bearing capacity. In laboratory stabilization using cement was conducted in 3 steps. In step one soil sample was prepared after that left it in the air to dry and then put it in the oven at 100<sup>0</sup>C for one day. Remove the soil from oven and crushed the sample using the crushing machine. In step second optimum quantity of cement required to the soil, stabilization process determines with the help of pH-test [5]. In the third step, cement stabilized sample prepared by compacting it at a maximum dry density (MDD) and optimum moisture content (OMC).MDD and OMC of specimens were obtained using modified Proctor test.

Various physical properties of soil like plasticity, compaction, and UCS were determined before as well as after the stabilization. The pavement performance of a stabilized road largely governed by the gradation and the soil type or granular material used for the purpose of stabilization. The strength of stabilized materials can measure by many ways, of which most popular is the UCS test. The quantity of cement added to the soil based on the type of soil. Soil Cement specimens prepared with various cement contents in constant volume mould. The compressive strength of these specimens tested after 1, 3, 7 and 14 days of curing. A graph plotted between cement content and compressive strength. Soils pulverized more easily when they contain proper moisture content. Pre-wetting helps in pulverization of dry, hard soils. Other issues in soil cement are moisture content during compaction, rolling to be completed within 2 hours of mixing and minimum seven days curing.

## III. CEMENT STABILIZED SUBGRADE CONSTRUCTION PROCEDURE

Construction of cement stabilized subgrade soil follow this procedure-

- Subgrade material was spread on the top of embankment layer (150mm + 25% loose) and lightly compacted.

- Total work area marked with grids of the area required for one bag of cement (2.5m X 2.5m) Figure 1(a).
- Cement spread at the rate of one bag per grid Figure 1(b).
- Soil and Cement mix by mechanical Harrow followed by tractor mounted rotovator Figure 1(c) and (d).
- Moisture added to the soil (+/-1% of OMC).
- Compaction is process completed done with 1(e).
- Quality Control tests conducted as per the frequency.

The methodology for cement stabilised subgrade can describe with the help of pictures taken at the site (Figure 1).



(a)



(b)



(c)



(d)



**Figure 1** Showing cement stabilised subgrade at test site

#### IV. RESULT AND DISCUSSION

Figure 2 shows the effect of quantity of cement added to the soil on consistency limit. From the figure, it was observed that there is an increase in consistency limit of soil with the increase in the quantity of cement added to the soil. However, the rate of increase is very less.

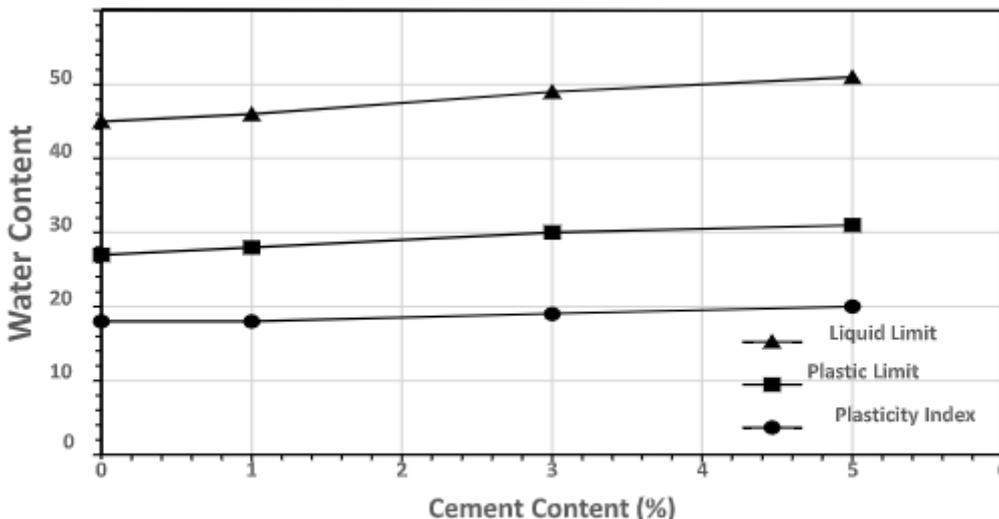


Figure 2 Effect of quantity of cement added to the soil on consistency limit of soil

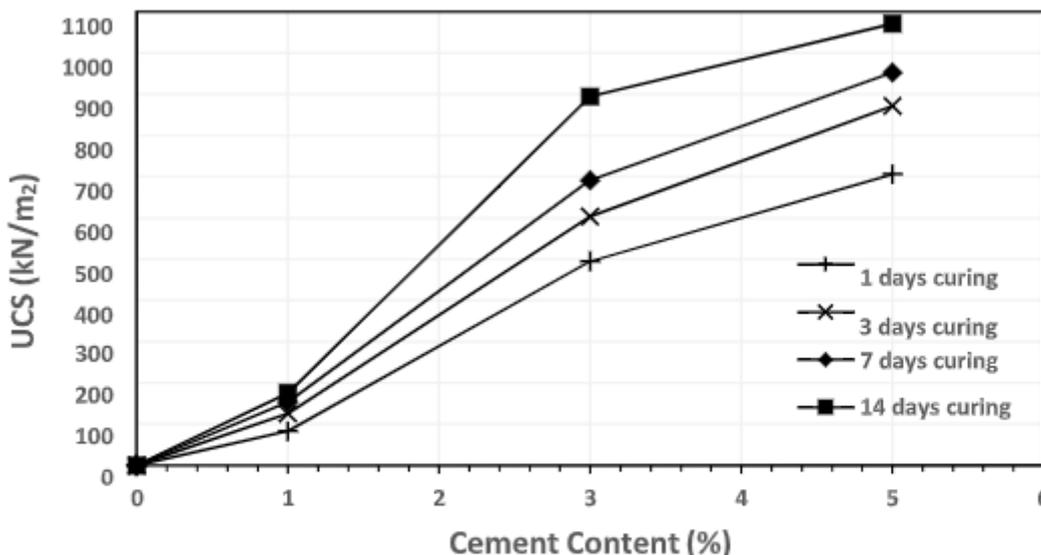


Figure 3 Effect of quantity of cement added to the soil on UCS of soil

Figure 3 shows the effect of quantity of cement added to the soil on unconfined compressive strength (UCS) of soil. The soil was kept for 1, 3, 7 and 14 days curing period. Several specimens were prepared in the laboratory for the compressive strength testing. The specimens were prepared by proportioning soil and cement according to selected ratios then adding the optimum percentage of water. The compression tests were carried out with standard cubes (7x7x7cm) and strength measured by ASTM D 422-63 which involve curing of the soil. With the increase in cement content, it was found that strength of soil increase. The strength of soil also depends on curing period. Figure 4 shows the effect of curing period on UCS of soil. From the figure, it was observed that with the increase in curing period strength of soil increases. So the strength of soil not only depends on cement content, but it also depends on the curing period of soil.

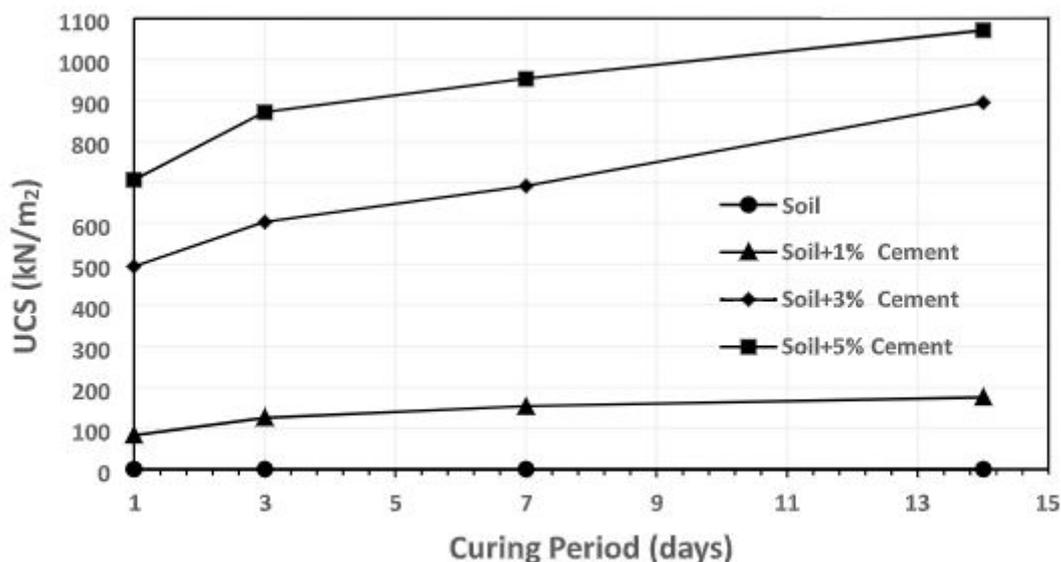


Figure 4 Effect of curing period on unconfined compressive strength (UCS) of soil

### V. CONCLUSIONS

The conclusions obtained from the research work can be summarized as follows:

- Soil cement provided strength and durability which is outstanding value as a base/sub-base material. Also, it is best alternative material for low-cost structure.
- Soil cement benefits the pavement by distributing the load uniformly, eliminate base rutting and reduces deflection as well as moisture problem.
  - The OMC of mixture (soil-cement) increase with increasing of cement content.
  - The UCS of stabilized soil increases with increasing the quantity of cement in a mixture.
  - The UCS of stabilized soil increases with increasing the curing period.

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