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Soil Stabilisation using Cement

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Abstract

Among the several modes of transportation, the roads are the foremost ancient and widely used medium. Since the traditional time for transportation of products or travelling purpose, we used roads. Heavy loaded trucks running on the roads need special care and a spotlight during construction phase in order that they will bear the utmost load. a number of the soil having sufficient load bearing capacity but a number of having poor. This research work mainly focuses on soil stabilisation using cement to enhance geotechnical properties like plasticity, compaction, and Unconfined Compressive Strength of the studied soil. These properties were determined before also as after the stabilisation of soil. during this work it had been found that higher the number 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 had been also found higher at higher curing period.

Cement stabilization of soil is completed by mixing pulverized soil and hydraulic cement with water and compaction the combination to achieve a robust material. the fabric obtained by mixing soil and cement is know as soil-cement. Since 1915 more then 1 lakh miles equivalent 7.5m wide pavement bases has been constructed from cement stabilized soil. Soil Stabilization may be a process of treating a soil to enhance its stability and bearing capacity for using the soil as Construction material. the foremost Important Purpose of Soil Stabilization is that the increase the strength of pavement layers like sub-base, base course etc. and to extend the steadiness of earth add embankment as an entire

The soil to be stabilized is pulverized, water is added and is mixed. The bituminous material is then added and is remixed. The mixture is spread to the specified grade and compacted. The compacted surface cured.

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

1.Introduction :

Road stabilization is that the method of providing strength to the natural soil against the heavy load of recent day traffic and reduced the damage of road during a different climate. The methods employed include the used of admixtures, compaction and densification of soil. Admixture are often chemical binders, industrial wastes, cement, fly ash. Soil Stabilization may be a technique wont to change different soil properties and to reinforce its performance for engineering purpose. Selection of stabiliser for a particular field depends mainly on the sort of soil, sort of construction to develop, and availability of materials to be utilized in construction.Cement base pavement has a plus of great strength and sturdiness . Also, it's widely available hence becomes the simplest material for stabilisation of soil. The hydrated product of cement binds with soil to make the cement-stabilized base or cement-treated aggregate base. The strength of stabilised soil will mainly depend upon the number of cement utilized in the soil. The proportion of cement required in soil decides supported the sort of soil. hydraulic cement widely used as a soil stabilisers, due to its easy handling

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and internal control properties. With the rise in cement quantity within the strength of the cement stabilised soil increases. Several researchers have found that stabilization using cement is more suitable for granular soil and clay soil having low PI. supported UCS value, quality of soil utilized in subgrade classified as soft, medium, stiff, very stiff and hard. UCS value of stabilised soils on curing time increases with the upper quantity of cement added to the soil. The curing period effect the UCS test results of cement stabilisedsoil, and better strength obtains for the soil sample cured for 14 days compared to 7 days curing.
For different sorts of soil, a suggestion for stabilisationhasissued specifying the Plasticity Index (PI) of sandy soil to be but 30. For fine grain soil PI shouldn't be quite 20 and to make sure proper mixing liquid limit (LL) shouldn't be quite 40. For soil having a better amount of clay two stage stabilisation could also be adopted i.e. the clay is treated with lime in stage I to scale back the worth of plasticity and hence to supply a facility for pulverisation, whereas in stage II, the resulting soil stabilises with cement. Physical properties of soil like particle size distribution, clay content, liquid limit and plasticity index play a serious deciding think about any project. Also, the chemical nature of soil features a great impact on deciding the sturdiness of roads. Hence to realize a solid and stable foundation we'd like stabilization technique. Factors affecting soil cement stabilisation are soil, cement, pulverisation and mixing, compaction and curing. Material requirements for stabilisationare the well-graded soil of LL but 45%, PI but 20% and cement quantity supported 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 stabilisation are a liquid limit (LL), shrinkage limit (SL), plastic limit (PL), PI, UCS, MDD, OMC and particle size

distribution. Primary methods of soil stabilisation used are mechanical stabilisation and chemical stabilisation. In any road construction, amechanical method conducted by compacting the soil through rollers, and chemical method includes utilisation of fly ash, lime, cement, etc. In chemical method two types of additives used at the time of stabilisation 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 1000C 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, stabilisationprocess determines with the help of pH-test [5]. In the third step,cementstabilised 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.

Table 1 : physical properties of soil study

Sr.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/cm3]	1.96
12	Optimum moisture content [%]	14

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Various physical properties of soil like plasticity, compaction, and UCS were determined before as well as after the stabilisation. The pavement performance of a stabilised road largely governed by the gradation and the soil type or granular material used for the purpose of stabilisation. The strength of stabilised 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 pulverisation 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 stabilised 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)

• Cement spread at the rate of one bag per grid

• Soil and Cement mix by mechanical Harrow followed by tractor mounted rotovator

• Moisture added to the soil (+/-1% of OMC).

• Compaction isprocess 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 (fig. 1). Soil Stabilization Using Cement

IV. Result And Discussion

1 Liquid Limit Test

The liquid limit is the moisture content at which the groove, formed by a standard tool into the sample of soil taken in the standard cup, closes for 10mm on being given 25 blows in a standard manner. This is the limiting moisture content at which the cohesive soil passes from liquid state to plastic state.

Table 2 : Liquid limit test and values

s.no	Sample	Liquid limit values
1	Soil sample	0.138
2	Soil +3% cement	0.19
3	Soil + 6% cement	0.27
4	Soil + 9% cement	0.32

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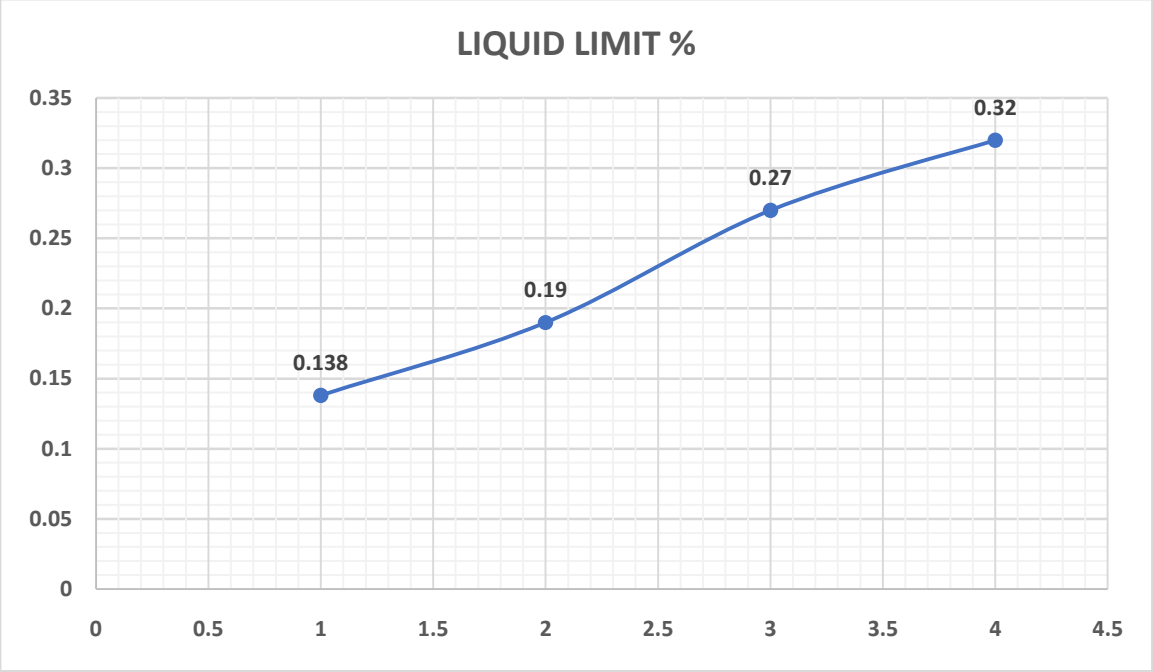

Liquid limit test graph

2 Plastic Limit Test

The plastic limit is the constant defined as the lowest moisture content and expressed as a percentage of the weight of the oven dried soil at which the soil can be rolled into threads one-eighth inch in diameter without the soil breaking into pieces.

2. Plastic limit Test Values

S.NO	**SAMPLE**	**Plastic limit %**
1	**Soil sample**	**62.80 %**
2	**Soil +3% cement**	**71.30 %**
3	**Soil +6% cement**	**83.50 %**
4	**Soil +9 % cement**	**92.70 %**

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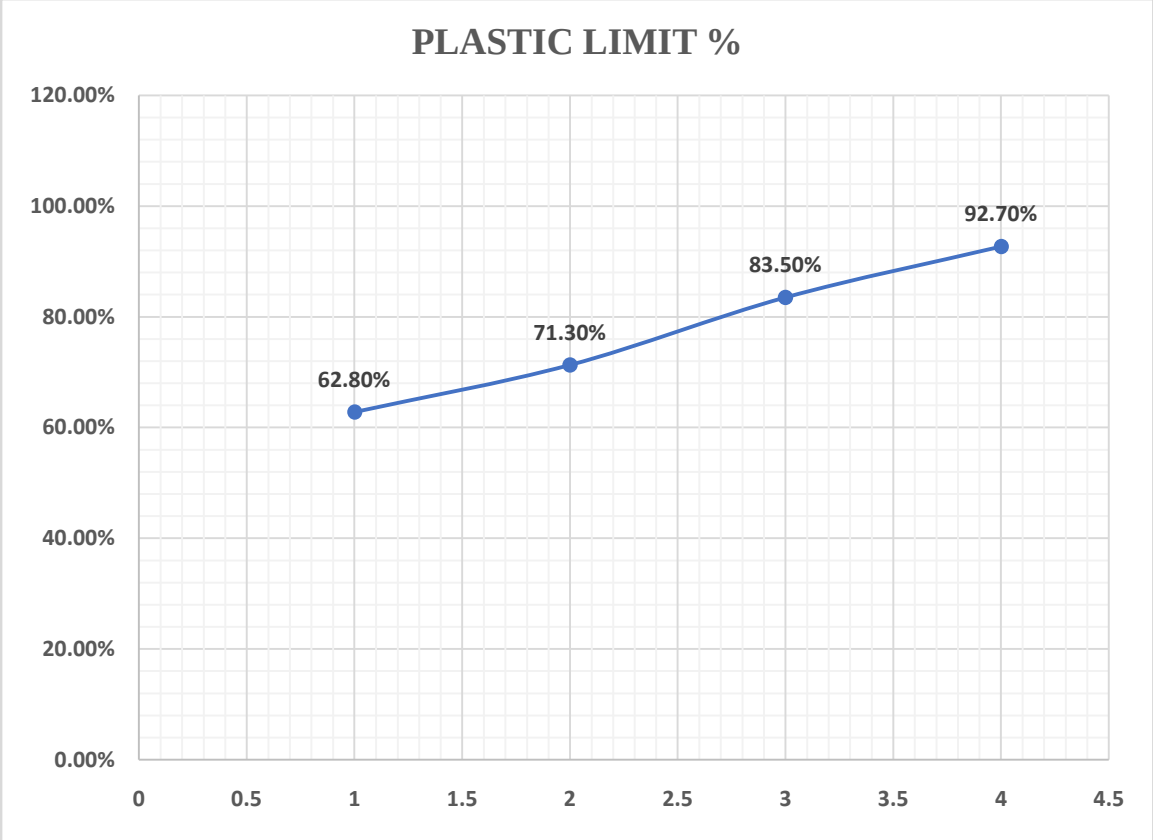

P LASTIC LIMIT TEST GRAPH

3 Specific Gravity Test

Specific gravity is the ratio of the density of a substance to the density of a substance, it is the ratio of the mass of a substance to the mass of a reference substance for the same given volume. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance.

Specific Gravity Test values

S.NO	SAMPLE	SPECIFIC GRAVITY
1	SOIL SAMPLE	1.93
2	SOIL + 3% CEMENT	2.062
3	SOIL + 6% CEMENT	2.173
4	SOIL +9% CEMENT	2.241

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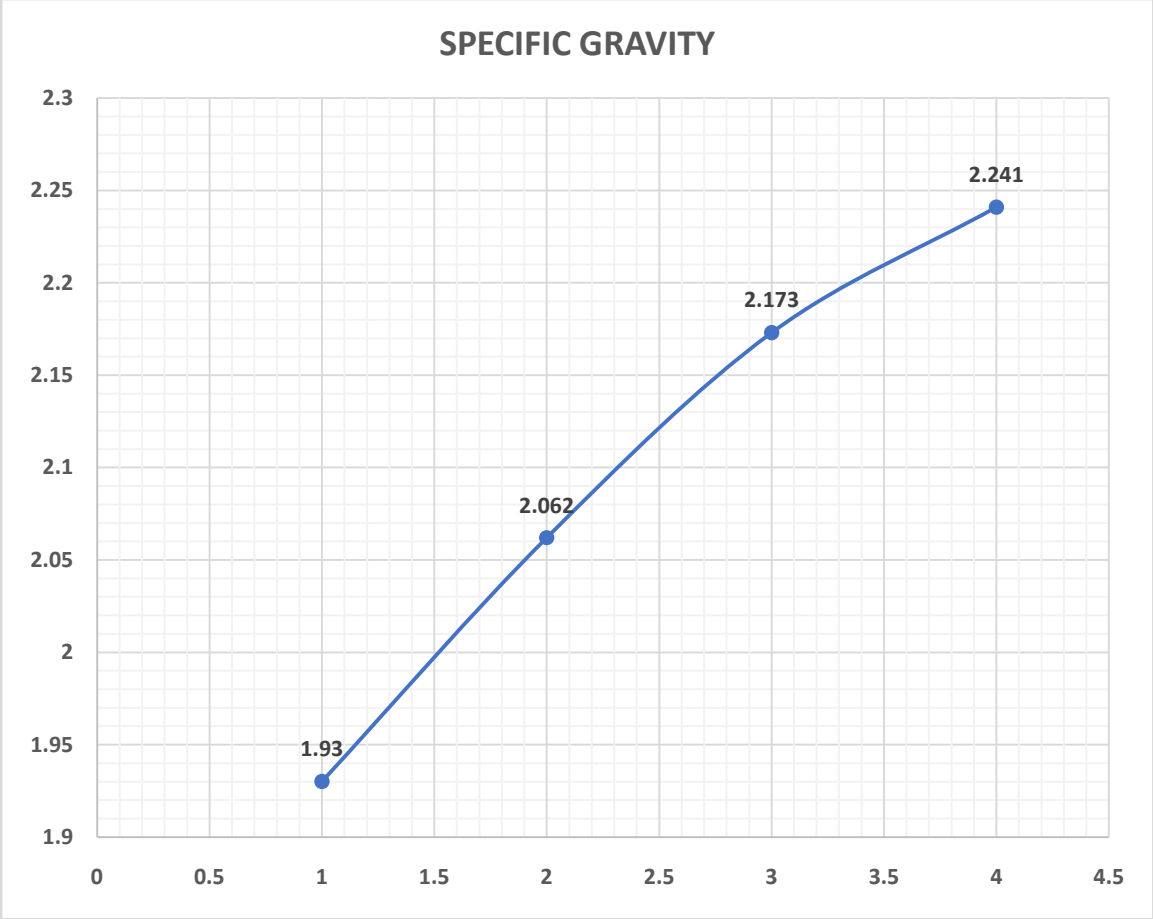

SPECIFIC GRAVITY GRAPHS

4. **Standard Procter compaction**

The proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. The dry density of a soil for a given compactive effort depends on the amount of water the soil contains during soil compaction.

Standard Procter Compaction Test Values

S.NO	SAMPLES	S P C
1	SOLI SAMPLES	1.88
2	SOIL +3% CEMENT	1.9
3	SOLI +6% CEMENT	1.93
4	SOIL +9% CEMENT	1.95

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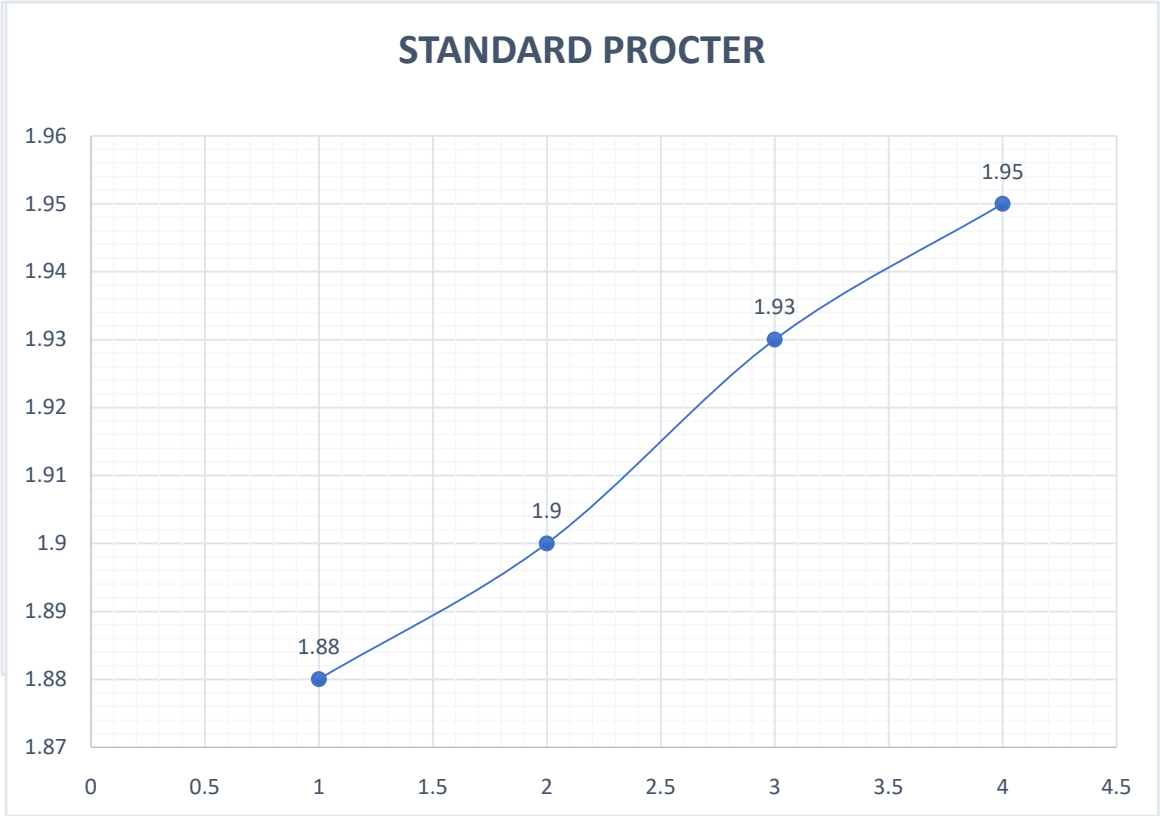

STANDRD PROCTER COMPCTION

5. Moisture content

The moisture content of soil also referred to as water content is an indicator of the amount of water present in soil. By definition moisture content is the ratio of the mass of water in a sample to the mass of solids in the sample, expressed as a percentage.

Moisture Content Test Values

S.NO	SAMPLE	MOISTURE CONTENT
1	SOIL SAMPLE	7.90%
2	SOIL +3% CEMENT	8.40 %
3	SOIL +6% CEMENT	8.90 %
4	SOIL +9% CEMENT	9.80 %

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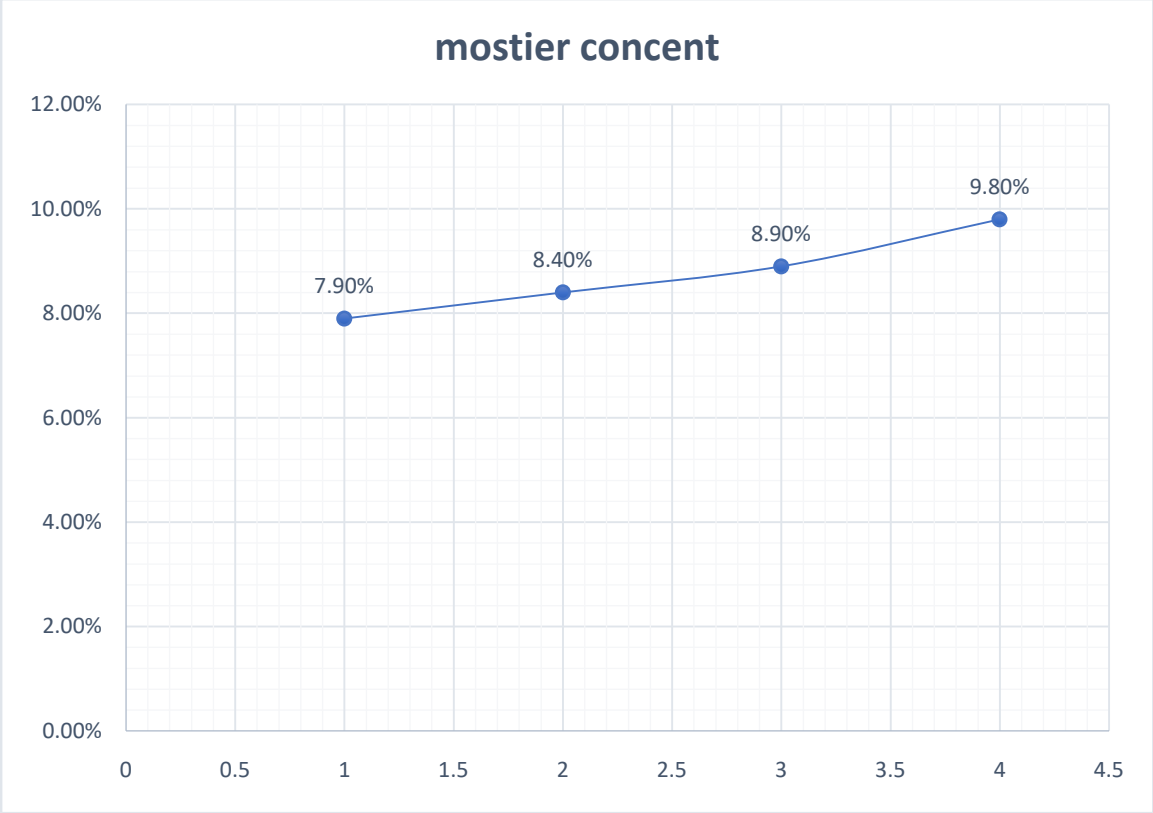

Moisture Content Test Values

6. Unconfined compressive strength

The unconfined compression test is by far the most popular of soil shear testing because it is one of the fastest and cheapest methods of measuring shear strength. The method is used primarily for saturated, cohesive soils recovered from thin-walled sampling tubes. The unconfined compression test is inappropriate for dry sands or crumbly clays because the materials would fall apart without some land of lateral confinement.

Unconfined Compressive Strength test values

S.NO	Samples	Unconfined compressive strenght
1	Soil sample	123
2	Soil+3% cement	256
3	Soil+6% cement	654
4	Soil +9% cement	1059

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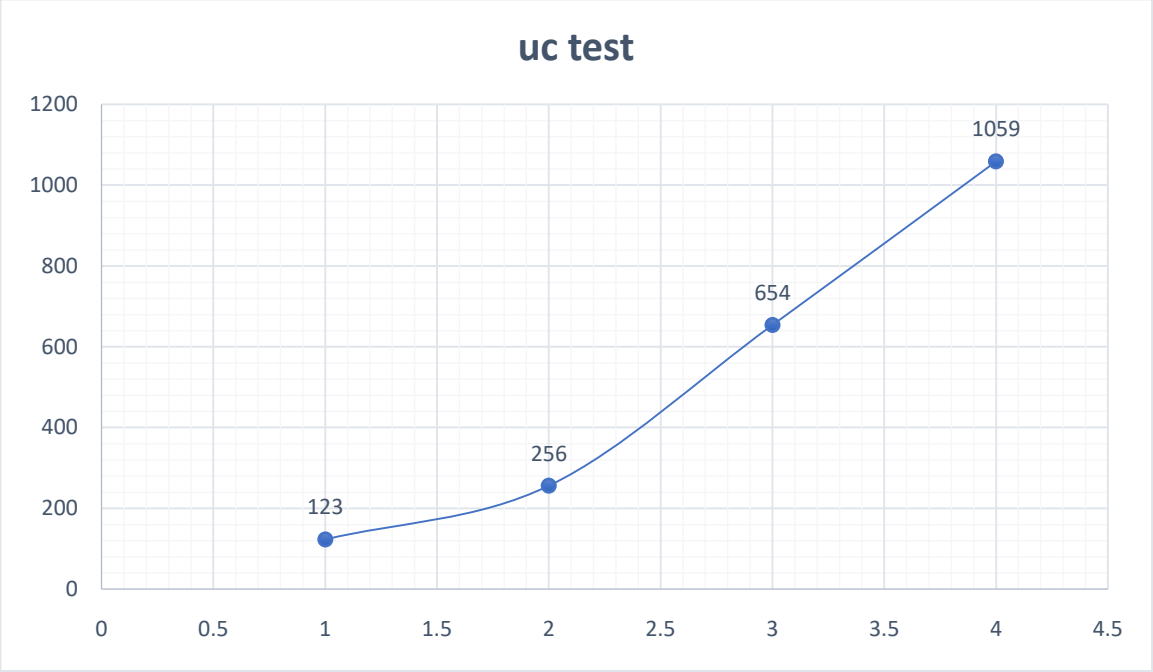

Conclusion

The conclusions obtained from the research work can be summarised 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 stabilised soil increases with increasing the quantity of cement in a mixture.
- The UCS of stabilised soil increases with increasing the curing period.

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