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Soil stabilization using biomedical waste – Syringe

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ABSTRACT

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.

Keywords: *Soil stabilization, Black cotton soil, Biomedical Waste, Syringe.*

1. INTRODUCTION

1.1 General

Black cotton soils are nothing but a fine grain of inorganic disintegrated rocks, which possesses medium to high compressibility. They also contain high shrinkage and swelling properties.

Black cotton soils occur mostly in the central and western parts of India and which covers approximately 22% of the total area. Because of its high swelling and shrinkage characteristics, the Black cotton soils have been a challenge to the civil engineers. The Black cotton soils are very hard when dried, but loses its strength completely when in wet condition.

Civil engineers have always faced problems with constructing facilities on or with black cotton soils, which do not hold sufficient strength to support the imposed loads upon them on or during the service life of the structure. Many areas of India have soils with high silt contents, low strengths, and poor bearing capacities. The penurious engineering performance of such soils has forced Engineers to make an effort to improve the engineering properties of black cotton soils. There are various techniques that could be used to improve the performance of black cotton soils the choice of a particular soil stabilization method depends mainly on the type of soil to be improved, its characteristics and the type and degree of improvement which is required in a particular application. Stabilization of soils is an effective method for improving the properties of soil and pavement system performance.

The objective of any stabilization technique is to improve the durability, erosion control, increase workability and constructability of the soil. For any given soil stabilization technique to work effectively is to improve present soil conditions rather than removing and replacing the whole material. Availability of funds and the resources would also be a determining factor in which a stabilizing agent is selected.

1.2 Aim and objective of study

The main purpose of the research is to improve the physical properties of black cotton soil. The behavior of black cotton soils is very uncertain when they are subjected to moisture content. These changes pose a considerable challenge for the civil engineers during construction activities especially while constructing foundations. The withstanding strength of soil changes when moisture occupies large spaces in the voids of the soil. The most usual noticeable features when water comes in contact with this type of soils are excessive compression of soil, collapsing behavior, high permeability, high swelling capacity and low shear strength. These poor characteristics make the black cotton soil undesirable for construction purposes, hence they need to be stabilized before they can be put to use. Though black cotton has unfavorable characteristics for infrastructural developments, they are used as agents of environmental protection and waste disposal**.**

2. MATERIALS USED

2.1 Black cotton soil

These soils have been formed from basalt or trap and contain the clay mineral montmorillonite, which is responsible for the excessive swelling and shrinkage characteristics of the soil. These soils have high clay content. They are rich in minerals like iron, lime, calcium, and alumina. Lightly loaded structures are most susceptible to damage as a result of the volume changes in the soil. Black Cotton Soils are made of varying proportions of minerals like Montmorillonite, illite and Kaolinite, Chemicals, like Iron oxide and Calcium Carbonate and organic matter like hummus. Montmorillonite is a Predominant mineral of black cotton soils. The swelling and shrinkage behavior of black cotton soils originate mainly from this mineral. Clay minerals are hydra silicates of aluminum and magnesium. They are made of sheets of silica and alumina stacked one above the other forming sheet-like structure with expanding lattice. The structure of some aluminum is of magnesium ions and the mineral becomes chemically active. They attract water molecules (dipoles) and various types of hydrated cations to the surface causing the soil to increase the volume. An abundance of calcium in black cotton soils to yet another feature. It may be present in the form of saturating ions. Treatment with the Sodium about the Base Exchange and the soils become softer and more plastic. Organic matter in the form of humus makes these soils more plastic and compressible. The dark color of the black cotton soils is believed to be either due to hummus or titanium oxide.

Chart -1 black cotton soil sample

Chart -2 black cotton soil sample

Table-1: **characteristics of black cotton soil**

S. No.	Properties	values
1	Dry density	1300 to 1800 kg/m3
2	Liquid limit %	40 to 60 %
3	Plastic limit %	20 to 60 %
4	Soil classification	CH or MH
5	Free swell index	40 to 180 %

Table-2: chemical composition of black cotton soil

S. No.	Property	range
1	pH value	>7(Alkaline)
2	Organic content	0.4 to 204%
3	CaCO3	5 to 15 %
4	SiO2	50 to 55 %
5	Al2O3	3 to 5 %
6	Montmorrilonite mineral	30 to 50 %

2.1 Biomedical waste Syringes

A syringe is a tool which is used in hospitals and laboratories to extract blood from the human body. Syringes are also frequently used in clinical medicine to administer injections, infuse intravenous therapy into the bloodstream, apply compounds such as glue or lubricant, and draw/measure liquids, which may also be used to do the same for animals. It is made of virgin or clear plastic. After removing the needle from the syringe it is then further sterilized to kill all the bacteria's and germs so, that it can be used as a stabilizing material. It is light in weight approximately 2gm for 5ml size syringe. So it gives the ease to transport it anywhere. Syringes are then crushed into powder form so that it can be mixed in the black cotton soil. Chart (3) shows used or waste syringe. And chart (4) shows the powdered form of the syringe.

Chart -3: waste syringe

Chart -4: waste syringe powder

3. METHODOLOGY

Syringe powder is mixed at different percentages i.e. 2%, 4%, 6% and 8% to the dry weight of soil. Unconfined compression strength test and California bearing ratio test conducted to determine the strength and CBR values of soil. Mixing of syringe powder in the black cotton soil have been carefully such the powder mixes uniformly in the soil. The mixing is done manually and proper care is taken to prepare a homogenous mixture.

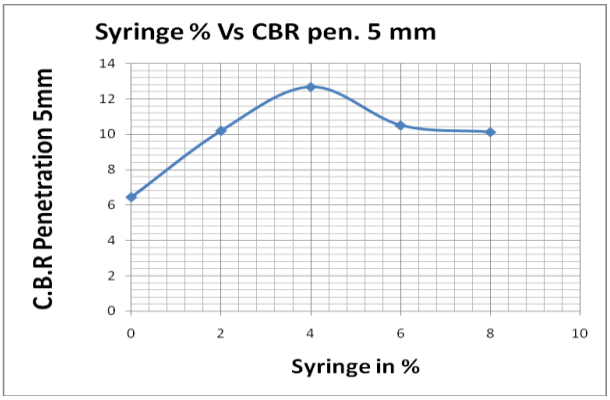
3.1 California bearing ratio test

California bearing ratio test was conducted to determine the amount of penetration in soil under the standard loading condition. The specimens are prepared by mixing different percentage of powdered syringe and then conducting CBR test.

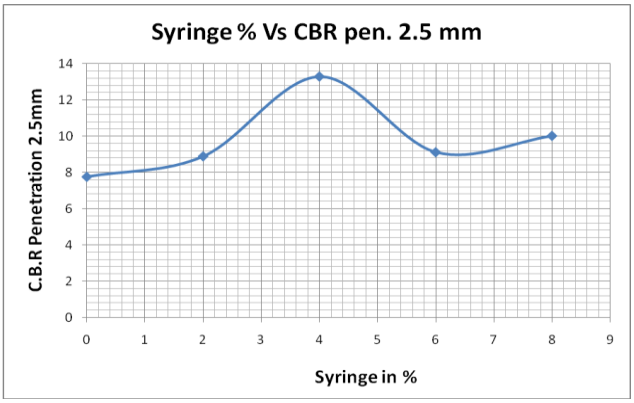
Chart -5: waste syringe powder

Table-3: **CBR value comparison**

CBR value	0%	2%	4%	6%	8%
2.5mm	7.760	8.886	13.273	9.111	10.011
5mm	6.448	10.198	12.673	10.498	10.123



Graph -1: 5mm penetration



Graph -2: 2.5mm penetration

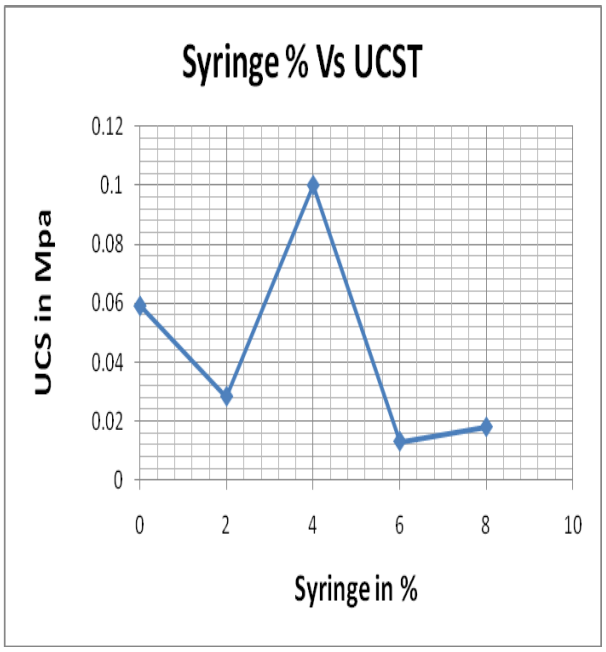
3.2 Unconfined compressive Strength test

Unconfined compressive strength test on soil is used to find the unconsolidated strength of soil. A cylinder of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen is called unconfined compressive strength of the soil. Syringe powder are added in the soil and thoroughly mixed. UCS moulds are prepared as shown below and a plot is made.

Table-4: **UCS value comparison**

syringe powder	0	2	4	6	8
UCS reading(Mpa)	0.0590	0.0283	0.1000	0.0130	0.0179

Chart -6: UCS soil sample



Graph -3: UCS value comparison

4. RESULTS AND DISCUSSION

It is observed that after performing CBR test the penetration percentage of the black cotton soil without syringe powder was at 6.448, so by adding 2 % syringe powder the penetration value was increased by 3.75. It was seen from (graph-2) that the peak CBR value was reached when 4% syringe powder was added which was 12.673. On the other hand, the CBR values declined to around 10 when 6% and 8% syringe powder were added. Furthermore, the maximum compressive strength of black cotton soil was attained when 4% syringe powder was added which was 0.100mpa. While by addition of 6% and 8% syringe powder and

compared to soil with 0% syringe powder the compression strength of the soil did not show much improvement. The values hovered between 0.500mpa to 0.010mpa.

5. CONCLUSION

There are many hazardous wastes being thrown away in the environment and biomedical waste comes under one of the most hazardous type of waste. If it is not disposed with care it can cause a spread of an epidemic disease which can take thousands of lives. So by using this type of waste as a stabilization material, it will not only reduce the need to dispose it in the surrounding, but also help to increase the engineering properties of black cotton soil. However the application restricts to minor projects only.

After performing Californian bearing ratio test and unconfined compressive test it was observed that the optimum percentage of syringe powder which is to be added in the black cotton soil comes out to be 4% of the dry weight of soil. Both CBR valve and UCS value were peaked when 4% syringe powder was added.

6. REFERENCES

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