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ENHANCEMENT OF SOIL PROPERTIES BY USING BONE ASH & SODIUM CHLORIDE.

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ABSTRACT:- As per agricultural purposes, soil can be defined as the uppermost layer of earth's surface on which many types of plant grow, we also cultivate these crops. A black or dark brown material typically consisting of a mixture of organic remains, clay and rock particles are called soil. The lower portion of earth's crust which supports the foundations and carries various loads is called hard rock or strata. As far as engineering purposes is concerned, soil may be defined as the mixture of minerals, aggregates, organic matter etc. It may be loose or cohesive. Soil stabilization is the technique of varying the properties of soil by changing the gradation through mixing with chemicals to increase its strength & durability. Generally, various soil failures occurs due to poor shear strength. Hence to overcome such type of failures, cattle bone ash & sodium chloride are used as stabilizer to improve the shear strength of soils. The important tests which are performed are Standard Proctor Test (S.P.T) and Direct Shear Test (D.S.T). The Standard Proctor Test (S.P.T) is performed so as to obtain a graph between Optimum Moisture Content (O.M.C) and Maximum Dry Density (M.D.D). After getting the Maximum Dry Density (M.D.D), Direct Shear Test & Permeability Test are performed to get the required strength so as to bear various loads.

Key Words: Clayey soil, Bone Ash, Sodium Chloride.

1. INTRODUCTION

Soil stabilization is the technique of varying the properties of soil by changing the gradation through mixing with chemical to increase strength and durability. Mechanical stabilization and chemical stabilization are the main two method used in stabilization. There are three resolution for soil stabilization these includes permeability upgrading, the increase in strength of an existing soil to improve its load-bearing capacity, and improvement of soil resistance to the process of traffic usage, and weathering among others. In other words, soil stabilization is the phenomenon by which certain properties of soil-are upgraded in order to make the soil serves good as a foundation or construction material. To adjust soil properties such as strength, compressibility, hydraulic conductivity, swelling potential and volume change properties, the chemical process such as mixing with cement, fly-ash, lime, lime by-products & blends of any one of these materials can be used. The chemical techniques are reliant on reaction between chemical additives and soil properties which then yield a strong network that bind the soil grains.

II. EXPERIMENTAL INVESTIGATIONS

2.1 Materials used

2.1.1 Soil

The soil which is used to study was the locally available clayey soil. Various tests have been performed to determine the index as well as the engineering properties of the parent soil by IS specifications.

2.1.2 Bone Ash

Bone ash is the white material which is formed by the calcinations of bones. It is mainly composed of calcium phosphate. It is generally used in fertilizers, polishing compounds and in making ceramics such as bone china.

TABLE 1 PHYSICAL PROPERTIES OF BONE ASH

S.NO	PROPERTIES	VALUES
1.	Specific gravity	1.493
2.	Color	White
3.	Shrinkage	9.5% to 12%
4.	Bulk density	2.34 to 2.55 gm/cm3
5.	Modulus of rupture	400 to 700 Kg/cm2

2.1.3 Sodium Chloride

Stabilization with sodium chloride is best suited to black cotton soils. Such kind of stabilization is achieved with calcium chloride. Maximum strength occurs when soil is stabilized with predetermined sodium chloride.

TABLE 2 VARIOUS PROPERTIES OF SODIUM CHLORIDE.

S.NO	PROPERTIES	%BY WEIGHT
1.	Molar mass	58.44 g/mol.
2.	Color	White
3.	Density	2.16 g/ml
4.	Melting point	801 ‘C

III. **METHODOLOGY**

The main tests which were performed as below:-

1. *Standard Proctor Test.*
   Two types of compaction tests are regularly performed: (1) The Standard Proctor Test, and (2) The Modified Proctor Test. Each of these tests can be performed in three different methods.. In the Standard Proctor Test, the soil is compacted by a hammer of weight 5.5 lb falling a distance of one foot into a soil filled mold. The mold is filled with three equal layers of soil, and each layer is subjected to 25 blows of the hammer. The Modified Proctor Test is identical to the Standard Proctor Test except it employs, the weight of hammer is 10 lb falling a distance of 18 inches, and uses five equal layers of soil instead of three. The samples are mixed at optimum moisture content and maximum dry density is obtained as per IS: 20 (Part7)1974. To get the required consistency, a specified amount of water is added. Then all the ingredients are thoroughly mixed with a spatula thoroughly.
2. *Direct Shear Test.*
   To determine the consolidated-drained shear strength of a sandy to silty soil, direct shear test (DST) is used.
   The shear strength parameters such as cohesion (c) and the angle of internal friction (φ) of the soil, is determined by this test. The shear strength is one of the most important soil properties and it is required whenever any structure depends on the soil shearing resistance. The test is conducted by putting the soil at OMC and MDD inside the shear box which is made up of two independent parts. A constant normal load (ς) is applied to obtain one value of c and φ. At a constant rate, the horizontal load (shearing load) is increased and is applied till the failure point is reached. This load when divided with the area gives the shear strength ‘τ’ for that particular normal load. After repeating the experiment for different normal loads (ς) we obtain a plot which is a straight line with slope equal to angle of internal friction (φ) and intercept equal to the cohesion (c). The easiest and the quickest way to determine the shear strength parameters of a soil sample is by direct shear test.
   The two components are combined in Coulomb’s shear strength equation,

$$\tau = c + \sigma \tan ø$$

   Where τ = shearing resistance of soil at failure
   c = apparent cohesion of soil.
   σ = total normal stress on failure plane.
   ø = angle of shearing resistance of soil (angle of internal friction).

IV. RESULTS AND DISCUSSIONS

Standard Proctor Test

In this chapter, on locally available clayey soil (CI), the results of the test which have been conducted are studied which has been stabilized by using different chemicals such as bone ash & sodium chloride in geotechnical lab.

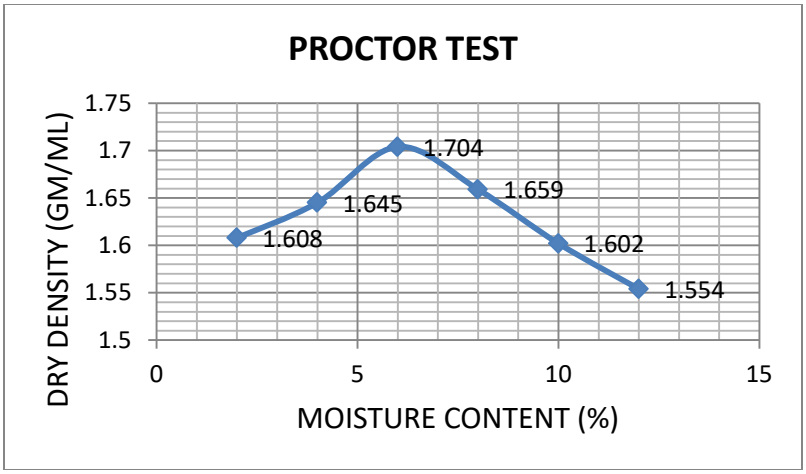

Fig-1**: Standard Proctor Test Graph**
OMC = 8% & Maximum Dry Density (M.D.D.) = 1.704

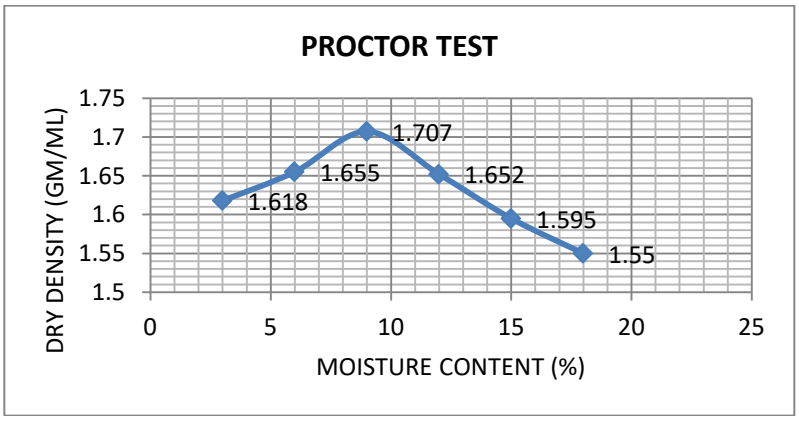

Fig-2: **SPT Graph using Sodium chloride**
OMC = 12% & Maximum Dry Density (M.D.D.) = 1.707

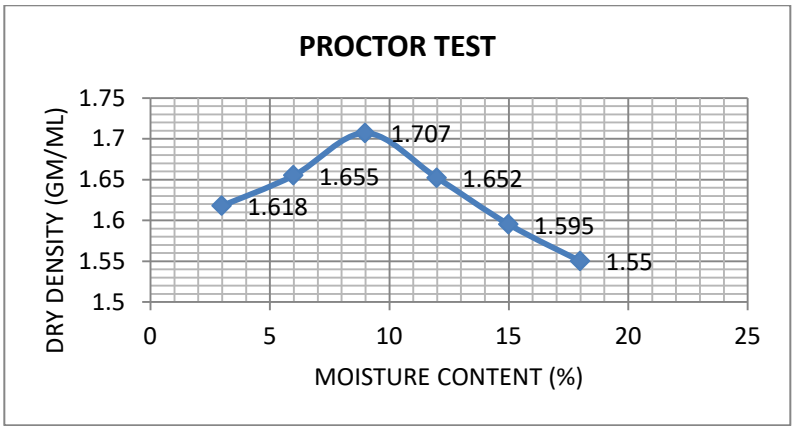

FIG-3: **SPT Graph using Bone Ash**
OMC = 12% & Maximum Dry Density (M.D.D.) = 1.726

Direct Shear test:-

Direct shear test of clayey soil is shown in the graph below. In order to attain the required strength so as to sustain load on it, various samples are tested. The shear resistance of a structure is dependent on shear strength of soil which is one of the most vital engineering properties of a soil.

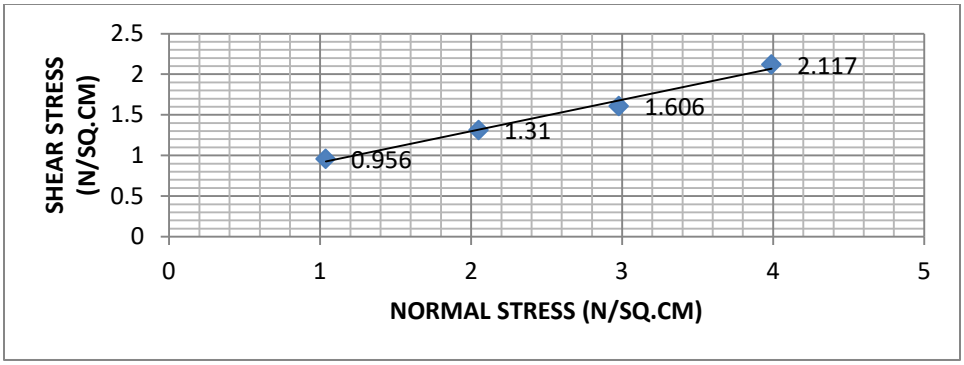

Fig-4: **Graph for 2% Bone Ash & 1% Sodium Chloride**

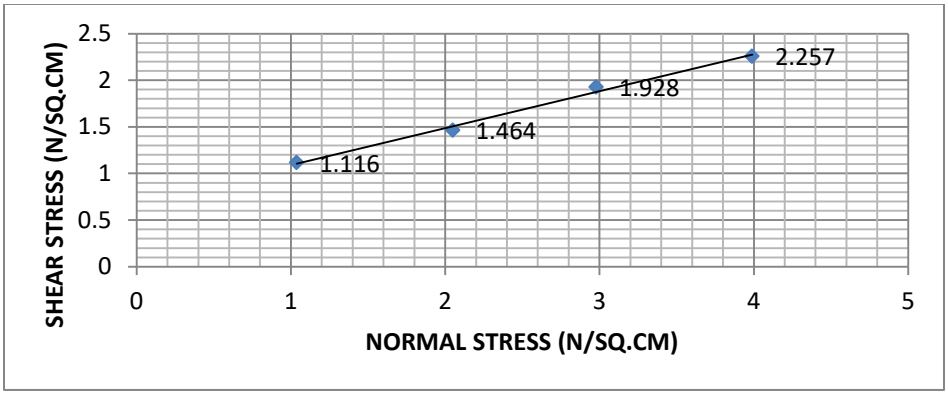

Fig-5: **Graph for 4% Bone Ash & 2% Sodium Chloride**

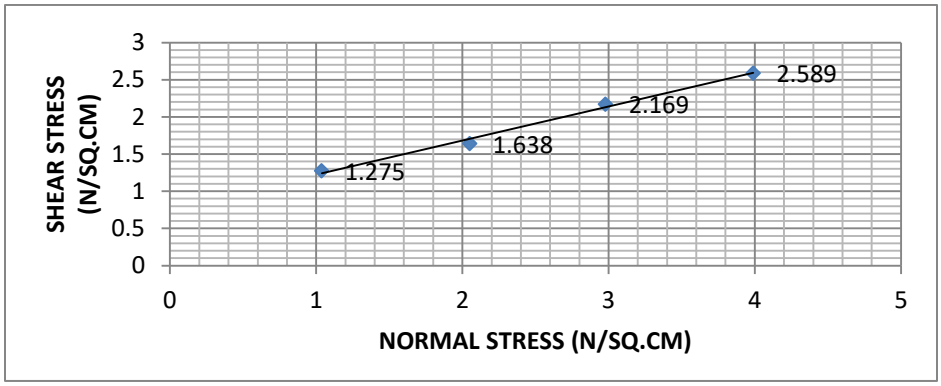

Fig-6: **Graph for 6% Bone Ash 3% Sodium chloride**

V. CONCLUSION

- In my research work, Bone Ash & Sodium Chloride were used to treat the locally available clayey soil , which results in the improvement of engineering properties of soil.
- Based on direct shear test on soil with bone ash and sodium chloride of 2%, 4%, 6%, 8%, 10% and 1%, 2%, 3%, 4%, 5% respectively, the increase in cohesion was found to be 60.14%, 47.34%, 12.44%, 11.36%,and 44.20%,respectively, with no order in the angle of internal friction.
- Based on direct shear test on soil with bone ash and sodium chloride 10% and 1%, 2%, 3%, 4%, respectively, the increase in cohesion was found to be 0%, 1.8%, 3.03%, and 5.88 % respectively, with no order in the angle of internal friction.

- Based on direct shear test on soil with bone ash and sodium chloride of 2%, 4%, 6%, 8%, and 5%respectively, the increase in cohesion was found to be 0%, 5.6%, 19.92%, and 6.43% respectively, with no order in the angle of internal friction.

- The decrease in the shear strength values after the addition of 10% bone ash and 6% sodium chloride is attributed due to excess bone ash and sodium chloride that occupies spaces within the soil pore and form weak bonds between the soil and the cementitious compounds-formed by reactions, thus having a negative effect on the cohesive nature of the soil.

- Based on permeability test on soil with bone ash and sodium chloride of 2%, 4%, 6%, 8%, 10% and 1%, 2%, 3%, 4%, 5% the decrease in permeability was found to be 11.11%, 22.12%, 17.54%, 31.45%, 48.32% and 10% respectively.

- Based on permeability test on soil with bone ash and sodium chloride of 10% and 1%, 2%, 3%, 4%, the decrease in permeability was found to be 0%, 7.196%, 10%, and 6.43% respectively.

- Based on permeability test on soil with bone ash and sodium chloride of 2%, 4%, 6%, 8%, and 5% the decrease in permeability was found to be 0%, 14.40%, 17.20%, and 22.20% respectively.

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