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STABILIZATION OF BLACK COTTON SOIL USING SUGARCANE BAGASSE ASH-A REVIEW

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ABSTRACT

Expansive soils (Black cotton soil) cover a large part of country (as Madhya Pradesh, Maharashtra, Andhra Pradesh) and does not have sufficient geotechnical properties and resulting failure of structure occurs in the form of settlement, cracks etc. Hence it is required to use economical, effective and locally available materials from industrial and agricultural wastes as a stabilizer to improve the property of deficient soils and also to minimize the cost of construction. Sugarcane bagasse is a solid waste material which is generated as a by-product from sugar mills. This waste when burnt results in bagasse ash. It is a fibrous material with presence of silica (SiO_2) and can be used to improve the existing properties of black cotton soil.

This study aims to investigate feasibility of using sugarcane bagasse ash to improve the geotechnical properties of the soil. Clayey soil is used with different percentage of bagasse ash i.e. (0%, 4%, 8%, 12%, 16%, 20%, 24% and 28%). Different tests (Atterberg's limits. Standard Proctor Test and CBR Test) have been performed to find out its effect on strength parameters.

Keywords- Black cotton soil, CBR test, Standard proctor test)

INTRODUCTION

Long term performance of pavement structures is significantly impacted by the stability of the underlying soil. In situ subgrade soils often do not provide the support required to achieve acceptable performances under traffic loading and environmental demands. A major cost would be incurred by borrowing soil material which is involved in hauling the material from the borrowing site to the construction site. This cost, in terms of finance, resources and time could however be avoided by simply improving the characteristics of the underlying soil.

The pavement design is based on the premise that specified levels of quality will be achieved for each soil layer in the pavement system. As the quality of a soil layer is increased, the ability of that layer to distribute the load over a greater area is also increased.

As in some cases, the properties of the soils in the immediate vicinity of the construction work may not meet to the required specifications. Hence it is required to improve the characteristics of the soil at the site.

Expansive soils cover a large part of country and do not have sufficient geotechnical properties. Resulting failure of structure occurs in the form of settlement, cracks etc. Hence it is required to use potentially cost effective and locally available materials from industrial and agriculture waste as a stabilizer to improve the property of deficient soils and also to minimize the cost of construction.

Soil improvement is a technique in which the existing properties of the soils are improved by means of addition of cementing materials or chemicals. Improvement of soils can be carried out by any of the stabilization methods i.e., mechanical stabilization, cementing stabilization and chemical stabilization. Rearrangement of soil particles by means of mechanical compaction is referred as 'Mechanical Stabilization', Cementing material such as cement, lime, bitumen etc. is added to soil is 'Cementing Stabilization' and use of chemicals in soils such as calcium chloride, sodium chloride etc. in 'Chemical Stabilization'. Developments in the country have awakened the sense of economical resources management in the populace. Now the researchers have focused more on the use of potentially cost effective and locally available materials from industrial and agriculture waste so as to improve the properties

of deficient soils. Sugarcane Bagasse Ash is a solid waste material which is generated as a by-product from sugar mills and alcohol factories. These industries produce large amount of bagasse ash, Disposal of this sugarcane bagasse ash becomes a serious problem, which also affects the environmental health.

Bagasse is a cellular fibrous waste product after the extraction of the sugar juice from the cane mills. For every ten tons of sugarcane crushing, a sugar factory produces nearly three tons of wet bagasse which is a by-product of sugarcane industry. When this bagasse is used as burner in various industrial processes, the resulting ash is known as Bagasse Ash. Bagasse shows the presence of amorphous silica, which is an indication of pozzolanic properties, responsible for holding the soil grains together for better strength. The use of bagasse ash as stabilizing material for clayey soil is checked under various tests such as Standard Proctor Test, California Bearing Ratio and Atterberg's limit etc.

VARIOUS METHODS OF SOIL IMPROVEMENT

1) Compaction

(a) Static compaction including compaction piles.

(b) Dynamic

2) Consolidation

a) Preloading

b) By surcharge (Embankment)

c) By water

d) Drainage

3) Sand drains

a) Sand wicks

b) Rope drains

c) Cardboard drains

4) Soil Stabilization

a) Remove and Replace

b) Mechanical Stabilization

c) Admixture Stabilization

d) Lime piles

5) Soil Reinforcement

a) Granular pile

b) Stone Columns

c) Soil nailing

d) Root Piles micro piles

e) Reinforced Earth

The Physical properties of soils can often be economically improved by the use of admixtures. The process of soil stabilization involves first mixing with the soil a suitable additive, which change its properties and then compacting soil-admixture suitably.

LITERATURE REVIEW

GENERAL

The stabilization of soils has been recognized before the Christian era began and performed for millennia. Many ancient cultures including the Chinese, Romans and Incas utilized various techniques to improve soil suitability some of which were so effective that many of the buildings and roadways they constructed still exist and some are still in use.

The Mesopotamians and Romans separately discovered that it was possible to improve the ability of pathways to carry traffic by mixing the weak soils with a stabilizing agent like pulverized limestone or calcium. This was the first chemical stabilization of weak soils to improve their load carrying capacity.

Jump forward a few years to the war in Vietnam, the US military were looking for methods for rapid stabilization of weak soils for support of its missions worldwide. Over the past 60 years they had used cement and lime, these being the most effective stabilizers for road and airfield applications.

But efforts were being made to find a stabilizer that could be used quickly without having to carry out extensive site tests that would increase the strength of the prevalent soft clay type local soils rapidly to support the landing and take-off of air traffic on their temporary airfields.

The beginning of modem soil stabilization started in the United States in 1920s, a time in which regulations were being imposed on many businesses during the expanding industrial era. Paper Mills that once discarded their by-products into their neighbourhood rivers had to discover a creative way of disposing of their highly toxic, liquid waste. One solution was to promote the use of their waste as a dust palliative on dirt roads. Surprisingly, some of the treated roads developed a hardened surface. Other roads did not; it was only decades later after significant private and government researches, and the development of better technology during the 1940s-1960s that the reason for this change had begun to be understood as being caused by a chemical reaction between the waste solution and the clay particles within the soil.

Efforts have been made to find an amalgam by adding various combinations of different materials that could cope up with the varying levels of moisture andprevailing air temperature. Out of these, significant advances have been made by using industrial wastes like bagasse ash, granulated blast furnace slag, copper slag, steel slag etc. for improving the soil properties in many investigative studies. Listed below are some of the investigative studies and their outcomes.

STABILIZATION USING ADDITIVES

Purbi Sen, Mukesh

A number of stabilization methods are being used to improve soil properties since ancient times. In present study, effects of various locally available stabilizing agents like Ordinary Portland Cement, Lime, and Fly ash have been studied for strength improvement and plasticity behaviour Specimens were prepared by mixing with varying proportion of lime, cement and fly ash with clayey soil separately. The Unconfined Compression Test (UCC) and Atterberg's limit of the soil with different percentage of additives were determined separately after curing specimens for 7 days. 7.5 to 8% of Portland cement gave UCC strength around 28 kg/cm^2, which is satisfactory for road use under Indian climate conditions. The 7 days peak strength of soil lime specimens was found at 7.5 % lime content, although addition of 6-12 % of lime was suitable. The 7 days strength of specimens mix with fly ash was found significantly more than that of specimen without fly ash.

Syed Abolhassan Naeini, Bahman Naderinia

Improvement and stabilization of soils are widely used as an alternative to substitute the lacking of suitable material on site. Soils may be stabilized to increase strength and durability or to prevent erosion and dust generation. The use of non-traditional chemical stabilizers in soil improvement is growing each passing day. A new stabilizing agent was developed to improve the mechanical performance and applicability of clayey soils. In this study a laboratory experiment is conducted to evaluate the effects of plasticity index and waterborne polymer on the Unconfined Compression Strength (UCS) of clayey soils. The laboratory test includes Sieve Analysis, Hydrometer, Atterberg's limits, Modified Compaction and Unconfined Compression Tests. Three clayey soils with different plasticity indexes were mixed with various amounts of polymer (2, 3, 4 and 5%) and compacted at the optimum water content and maximum dry density.

Y.I Murthy

Presented that the expansive soil can be stabilized by using the mill waste. In this research, it has been seen that the physical and mechanical properties of soil can be changed by using the mill waste as an addition to the expansive soil. It has been seen that the bearing capacity of soil can be increased up to a certain amount of mill waste added in the soil. According to the study it shows that permeability of soil increases but the plasticity of soil decreases by increasing the amount of mill waste. He concluded that the CBR value of black cotton soil mixed with 15% mill scale increased three times that of plain black cotton soil. Permeability value of black cotton soil increased manifolds by increasing the percentage of mill scale and the plasticity of the black cotton soil decreased from 35.71% to 30.60% by adding 12% of mill scale.

STABILIZATION USING SUGARCANE BAGASSE ASH

M. Chittaranjan, M. Vijay, D. Keerthi

studied the 'Agriculture waste as soil stabilizer'. This study presented the scope of agriculture waste like sugarcane bagasse Ash, groundnut shell and rice husk in stabilization, to enhance the properties of soil. The

soil is treated with these agricultural wastes with the replacement of 0%, 3%, 9%, 12% and 15%. The result of CBR shows that the CBR value increases with the percentage of waste.

K.S. Gandhi

Expansive clay soils that change significantly in volume with change in water content are the cause of distortions to structures that cost taxpayers several billion dollars annually in India. This paper is based on some of the key advances developed over the past 60 years in improving our understanding of the nature and methods of modifying and stabilizing expansive clay soils. Hence to improve the strength of expansive soil of Surat region, bagasse ash was used as additive which increased the stability of soil and decreased the swelling of soil. As bagasse ash is high in silica, calcium and other minerals, it provides the necessary homogenous mass for performing the required test. Different tests are carried out with varying percentage of bagasse ash to check the effect on swelling pressure and basic properties.

Alavez- Ramirez et al.

Presented 'The use of sugarcane bagasse ash and lime to improve the durability and mechanical properties of compacted soil blocks' This study analyses the use of lime and sugar cane bagasse ash (SCBA) as chemical stabilizers in compacted soil blocks. The blocks were tested for flexure and compression in a dry and saturated state. The tests were performed at 7, 14 and 28 days of age in order to evaluate the effects of the addition of lime and SCBA on the mechanical properties of the compacted soil blocks. The results indicate that blocks manufactured with 10% of lime in combination with 10% of SCBA showed better performance than those containing only lime. Nevertheless, the addition of lime improved the strength of the blocks when compared with blocks fabricated with plain soil. According to SEM and DRX analyses, considerable improvement of the matrix was observed due to the formationof strong phases, such as CSH and CAH for the mixtures with additives. It was also concluded that the combination of SCBA and lime as a replacement for cement in the stabilization of compacted soil blocks seems to be a promising alternative when considering issues of energy consumption and pollution. They used the sugarcane bagasse ash and lime to improve the mechanical properties and durability of bagasse ash.

They concluded that with an addition of 10% Lime and 10% Sugarcane Bagasse Ash significantly improves the mechanical properties and durability of compacted soil blocks.

Prakash Chavan and Dr. M, S. Nagakumar

Presented 'Study of soil stabilization by using bagasse ash' In the study the soil sampling was done on Kavadimatti village Bagalkote district as per IRC recommendations. This soil was classified as CH as per Indian Standard Classification System (ISCS). Different dosages of blast furnace slag i.e., 3%, 6%, 9% and 12% were used to stabilize the expansive soil. The performance of Bagasse Ash stabilized soil was evaluated using physical and strength performance tests namely; plasticity index, specific gravity, compaction, California Bearing Ratio (CBR) and Unconfined Compressive Strength 1/1 Test (UCS). These tests were conducted in order to evaluate the improvement in strength characteristics of the sub grade soil. Hence, use of such advanced materials in road construction can prove efficient in increasing the strength of soil which in turn reduces the project cost. From the results, it was observed that the basic tests carried out proved significant after the addition of Bagasse Ash. Furthermore, California Bearing Ratio value improved from 1.16% to 6.8 %. And the unconfined compressivestrength of specimens increased from 93kN/m^2 to 429 kN/m^2.

Kiran R. G. Kiran L

Had studied 'The analysis of Strength Characteristics of Black Cotton Soil Using Bagasse Ash and Additives as Stabilizer'. In this study the black cotton soil is taken from Harihara, Devanagari district of Karnataka. Under this study laboratory experiments are carried out for different percentages (4%, 8% and 12%) of bagasse ash and additive mix proportions. The strength parameters like CBR, UCS are determined and it is observed that, the blend results of bagasse ash with different percentage of cement for black cotton soil gave change in density, CBR and UCS value. The density values got increased from 15.16 kN/m^2 to 16.5kN/m^2 for addition of 8% bagasse ash with 8%

cement, then CBR values got increased from 2.12 to 5.43 for addition of 4% bagasse ash with 8% cement and UCS values got increased to 174.91 kN/m^2 from 84.92 kN/m^2 for addition of 8% bagasse ash with 8% cement. The MDD value increases up to 8% replacement and CBR, UCS values also increases maximum on optimum percentage i.e., 8%, beyond which it decreases.

METHODOLOGY

It is most important part of the whole process. Different samples are prepared with varying proportion of soil and bagasse ash. Efforts have been made to find out the optimum value for the mixed samples by conducting a series of tests. The field tests would be an ideal method for simulation of any experimental study. It has been generally averted because it is expansive as well as time consuming. So as the substitute, carefully conducted model tests can be employed advantageously in order to obtain useful qualitative and sometimes quantitative results. With modem technique measuring instruments and other facilities it is now possible to conduct a testing in near field conditions. Moreover, the laboratory testing has the advantage of better control over various parameters which may influence the problem under consideration. For example, it is possible in a model to undertake parametric study by keeping all other the variables as constant while the effect of one particular parameter is being studied.

EXPERIMENTAL PROCEDURE

Following are the tests which have been carried out in laboratory:

A. Characterisation Tests

1. Moisture Content Determination

2. Atterberg's Limits Determination

3. Specific Gravity Test by Pycnometer

B. Strength Tests

1. Standard Proctor Test

2. California Bearing Ratio Test

For parent soil 3 kg of oven dried soil sample is taken on tray and thoroughly mixed with water. For the blended mixtures the quantity of soil depends upon the ratio at which it is desired to be mixed with other additives. The amount of water mixed at first trial may vary according to the soil sample composition. 1) The stabilization of clayey soil with bagasse ash is carried out by blending the soil with different percentage of bagasse ash (0%, 4%, 8%, 12%, 16%, 20%, 24% and 28%). 2) The strength tests are carried out on each percentage of blends. By getting the result of all these blends the comparison of the best suitable additive mix will be carried out.

CONCLUSION

The present experimental studies were carried out to find out the stabilization of clayey soil by using sugarcane bagasse ash. The following conclusions have been drawn based on the laboratory investigations carried out in this study.

1. Consumption of sugarcane bagasse ash in bulk quantity in construction of road project can be made with reducing the accumulation hazard and environmental pollution of this waste.

2. Maximum dry density of treated soil is decreased with the increasing percentage of sugarcane bagasse ash and the optimum moisture content is increasing up to an optimum value of sugarcane bagasse ash and then decreases.

3. It has been observed that the CBR value increased w.r.t increasing percentage of sugarcane bagasse ash up to an optimum percentage i.e., 20%.

4. Use of sugarcane bagasse ash as a stabilizer for improving soil characteristics is an economical and effective solution for the region having large number of sugar mills and other related industries. The proposed method of soil stabilization can be used mainly in the field of stabilization and application for roads etc. The present method is more economical and environmental friendly as well, and is an alternate to other expensive techniques.

5. On addition of bagasse ash improve the properties of clayey soil, so it is used with limits.

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