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REDUCTION OF SWELLING AND SHRINKAGE CAPACITY OF EXPANSIVE SOIL USING BRICK DUST.

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ABSTRACT

This Research Paper express the project documents of general framework for the major areas of various government and non-government departments regarding the stabilization of expensive soil. The theme of this research paper is to determine that either soil stabilization technique by local stabilizer is feasible within Pakistan or not, the project provides information related to many parameters. The result of this research paper is the concept which is feasible. By performing test on expansive soil of Mardan by adding the Brick Dust the result shows us that by using 10% of Brick dust in expansive soil it improves result by decreasing the shrinkage and swelling of soil by adding more brick dust in expansive soil the efficiency of brick dust are going to decrease. The expensive soil of Mardan has clayey soil which comes under the category of A6 class of AASHTO soil classification. The average natural moisture content of the soil is more than 25% which makes them water logged and create problem for pavement and building construction. These soil samples were tested by adding brick dust into it. Laboratory tests were conducted for determining finer sieve #200 passing (for finesse modulus), Atterberg's limits, modified proctor test (for OMC and maximum dry density),unconfined compression test (UCT) and California Bearing Ratio (CBR). Data was collected and analyzed for feasibility. The performance of stabilizers/Additives was compared with the performance of virgin soil. This comparison allowed for fundamental conclusions and recommendations to be made for soil stabilizers and their abilities to be used for new roads, buildings and rehabilitation purposes.

1. INTRODUCTION

1.1. Expensive Soil& Their Occurrence:

The Potential of Expansive soil shows shrinking or swelling under changing moisture conditions. The shrinkage of expensive soil is due to montmorillonite mineral, which expands when comes in contact with water and shrinks when the water evaporates. Expansive clay is a type of clay that is known as a lightweight aggregate with a rounded structure, with a porous inner, and a resistant and hard outer layer.

Soils with a high content of expansive minerals can form deep cracks in dry seasons or years; such soil are called vertisol. Soil with smectite clay including montmorillonite and bentonite, have the most dramatic shrink-swell capacity.

Clayey soil or Black cotton soil is an expansive soil, which swells or shrinks excessively due to change in moisture content. When an engineering structure is associated with black cotton soil, it experiences either settlement or heave, depending on the stress level and the soil swelling pressure. Design and construction of civil engineering structures on and with expansive soils is a challenging task for geotechnical engineers [1].

Expansive soils contain the clay mineral montinorillonite with claystones, shales, sedimentary and residual soils. Clay exists in the moisture deficient, unsaturated conditions. [2]

Saudi Arabia, USA, South America, Canada, Africa, Australia, Europe, India, Pakistan, Oman and China are the Countries where the expansive soil covers wide areas. Arid climate, geology and severe weathering condition are major causes of such widespread of expansive soils. Basic mineralogy is associated with the volume change property of these expansive soils. The swelling characteristics are primarily associated to some specific clay minerals.

In Pakistan these soils occur in:

D.G Khan, Punjab

Khushab, Punjab

Qaid Abad, Punjab

Gujjar Khan, Punjab

Sialkot, Punjab

Kohat,Mardan,Swabi, KPK

Mianwali, Punjab

1.2. Damages Related with Expansive Soil:

Due to Change of Water Ratio the structure founded on expensive soil shows settlement with a light loaded structure such as pavements, walkways, railways, roadways, foundations, channel linings, lifting of water supply pipeline and sewerage lines etc because of swelling and shrinkages in soil.

The annual damage to civil engineering structures due to expansive soil is huge

USA $1000 Million

UK $150 Million

Expansive soils in many parts of the United States pose a significant hazard to foundations for light buildings. Swelling clays derived from residual soils can exert uplift pressures of as much as 5,500 PSF, which can do considerable damage to lightly-loaded wood-frame structures. Insurance companies pay out millions of dollars yearly to repair homes distressed by expansive soils.

Expansive soils owe their characteristics to the presence of swelling clay minerals. As they get wet, the clay minerals absorb water molecules and expand; conversely, as they dry they shrink, leaving large voids in the soil. Swelling clays can control the behavior of virtually any type of soil if the percentage of clay is more than about 5 percent by weight. Soils with steatite clay minerals, such as montmorillonite, exhibit the most profound swelling properties.

Potentially expansive soils can typically be recognized in the lab by their plastic properties. Inorganic clays of high plasticity, generally those with liquid limits exceeding 50 percent and plasticity index over 30; usually have high inherent swelling capacity. Expansion of soils can also be measured in the lab directly, by immersing a remolded soil sample and measuring its volume change.

In the field, expansive clay soils can be easily recognized in the dry season by the deep cracks, in roughly polygonal patterns, in the ground surface. The zone of seasonal moisture content fluctuation can extend from three to forty feet deep. This creates cyclic shrink/swell behavior in the upper portion of the soil column, and cracks can extend too much greater depths than imagined by most engineers.

1.3. Treatment of Expensive Soil:

Different technique of Physical and chemical alteration of expansive soil using solid wastes like fly ash rice husk ash, marble dust, phosphor gypsum, granulated blast furnace slag, red mud, waste tyre etc.

- Remove and Replacement of Expensive material with non-expensive fill where need.
- Surcharge of the material to limit its swelling potential.
- By using moisture barriers Control moisture changes in the material after construction.
- Control soil placement during construction so that the moisture content is unlikely to change after the pavement is placed. This usually requires placing the soil at moisture contents above the laboratory determined optimum values and many also include placement to lower density and use of a sheep foot roller to obtain a more dispersed particle distribution.

2. LITERATURE REVIEW

2.1. Review on Expansive Soil:

Expansive soils, which usually contain the clay mineral montmorilonite, include sedimentary and residual soils, claystones, and shales. In arid and semiarid climates, they exist in a moisture-deficient, unsaturated condition. The expansive nature of soil is most obvious near ground surface where the profile is subject to seasonal, environmental changes (Terzaghi, Peck and Mesri, 1996; Fredlund and Rahardjo, 1993). There are many correlations that are useful in identifying potentially expansive soils. It may also be possible to identify them visually.

Figure 1. Expansive Soil Crack

2.2. Expansive Soil Identification:

For appropriate Foundation the Identification of potential swelling or shrinking subsoil problems is an important tool (Hamilton, 1977 and Van Der Merwe, 1964).

For Direct and Indirect measurement many tests and methods have been developed or modified for estimating shrink-swell potential. Direct methods provide actual physical measurements of swelling whereas indirect methods involve the use of soil properties and classification schemes to estimate shrink-swell potential.

In the field the nature of earth may be simply deduced by the examination of exposures of the material by simple field test. The accurate identification and study of clay minerals and their expandable properties should be accomplished in the laboratory. There are many correlations that are useful for identifying potentially expansive soils. It is also possible to identify them visually. Visual indications may be (Wayne et al., 1984);

- Wide and deep shrinkage cracks occurring during dry periods.
- Soil is rock-hard when dry, but very stiff and sticky when wet.
- Damages on the surrounding structures due to expansion of soil.

2.3. Damaged and Control of Expansive soil:

Masoumeh Mokhtari & Masoud Dehghani. The paper gives detail information about the identifying of black cotton soil, about its swell – shrink behavior, their factors affecting and reasons of swell – shrink behavior and the controlling measures. The author has listed three methods to resolve this problem of swelling and shrinkage of clayey soil. They also described their conclusion that Control of the swell-shrink behavior can be accomplished in several ways, for example by Replace existing expansive soil with non-expansive soil, maintain constant moisture content and Improve the expansive soils by stabilization from which stabilization is a better option to choose as per economic and improvisational consideration [3].

2.4. Effect of Locus Bean Waste Ash on Lime Modified Black Cotton Soil:

With Particle size distribution the effect of LBWA on the lime modified soil was studied, Atterberg limits, compaction characteristics and shear strength parameters using three compactive efforts of British Standard light (BSL), West African Standard (WAS),and British Standard heavy (BSH). Statistical analysis was carried out on results obtained from the tests conducted to determine significant difference (i.e.$p<0.05$) on the various soil-lime-LBWA mixtures using a two-way Analysis of Variance with the Microsoft Excel Analysis Tool Pak Software Package. Analysis of the results of the soil-lime mixtures considered showed increase in percentage of fine fraction, improvement in the plasticity index, decrease in maximum dry density (MDD), with increase in optimum moisture content (OMC), as well as a decrease in cohesion with increasing angle of internal friction all with higher locust bean waste ash contents. The results also showed that the modified soil met their requirements of the Nigerian General Specifications of not more than 35% passingsieve No.200, maximum plasticity (PI) index of 12%, and liquid limits (LL) of a maximum of 50% when used as a subgrade material in road construction. An optimal blend of 4% lime 8%LBWA is recommended for the modification of black cotton soil. [4]

When clayey soils with high plasticity are treated with lime, the plasticity index is decreased and soil becomes friable and easy to be pulverized, having less affinity with water. Lime also imports some binding action [5].

2.5. Fly Ash:

Based on chemical composition the FA is classified into F& C Classes. FA is a pozzolanic material. Class F fly ash is produced by burning anthracite and bituminous coal, and class C fly ash is produced by burning lignite and sub-bituminous coal. The major difference between class F and class C fly ash is in the amount of calcium and the silica, alumina, and iron content in the ash. Class C fly ash, in addition to having pozzolanic properties, also has some cementitious properties and it has been successfully used as part of the binder in stabilized base applications [6].

2.6. Brick Dust:

Brick dust Burnt brick powder is a waste powder generated from the burning of bricks with the soil covered by surroundings. Due to burning of soil bricks it hardened and at the time of removal the set-up we get the powder form of brick. It has red colour and fine in nature. It has great ability to reduce the swelling potential of black cotton soil. [7]

3. <u>MEHODOLOGY:</u>

3.1. Soil Identification/Sample Collection:

We collected the sample from katling Babuzai (Mardan) KPK. According to AASHTOclassification this soil sample was clayey soil and was expected to lie under the category of A-6 or A-7 soil.After taking the soil sample we performed the following test in soil and highway engineeringlab Iqra Natonal University Peshawar.

The Test performed in Iqra National University Peshawar is under

1. Moisture Content

First of all we find the moisture content of each soil sample taken from site and then small amount of soil was taken from each soil sample. The soil was taken from the center of the sample which was expected to be in the in-situ form. Weight of the soil was measured by balance and then noted. After this we place the soil in oven for 24 hours for complete drying at 100°c, the dried weight of the sample was noted and the moisture content was calculated by the formula given below. Moisture content= (weight of wet soil-weight of dry soil)/weight of dry soil*100

2. Atterberg's Limits (Liquid limit, plastic limit, shrinkage limit)

The Atterberg's limits are a basic measure of the critical water contents of a fine-grained soil, such as its shrinkage limit, plastic limit, and liquid limit. As a dry, clayey soil takes on increasing amounts of water, it undergoes dramatic and distinct changes in behavior and consistency.

3. Standard proctor test

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

4. California bearing ratio test

The California Bearing Ratio (CBR) test is a simple strength test that compares the bearing capacity of a material with that of a well-graded crushed stone (thus, a high quality crushed stone material should have a CBR 100%). The test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material.

5. Unconfined compression test

Unconfined Compression Test (UCT) is a simple laboratory testing method to assess the mechanical properties of rocks and fine-grained soils. It provides measures of the undrained strength and the stress-strain characteristics of the rock or soil. The unconfined compression test is often included in the laboratory testing program of geotechnical investigations, specially when dealing with rocks.

4. RESULT AND CONCLUSION:

The Result obtains for to rectify the Black cotton soil and expansive soil of Mardan KPk Pakistan.

Results of tests performed on Mardan soil sample		
Tests performed	**Virgin Soil Sample**	**10% brick dust as additive**
Fineness modulus(%)	92.46	92.46
Plasticity Index(P.I=L.L –P.L)	9.9	9.9
MDD(psf)	118	117
OMC(%)	15.8	16.1
bearing capacity(TSF)	0.45	0.94
shearing strength(psf)	497.8	1030.85

Safe bearing capacity(TSF)	----	2.55
shearing strength(psf)	----	2813.95
% swell value	2.03	1.37
CBR	11.8	54.7

CONCLUSION

From the contrast analysis we concluded that the brick dust greatly improve the engineering properties of the poor expensive soil at 10% proportion by weight.by increasing the percentage of brick dust it will directly no proper effect on the properties effect of expansive soil.

5. RECOMMENDATION:

This project thoroughly investigated the behavior of brick dust as additive used in expensive soil which are having poor properties. From the analysis we recommend that expensive soil can be improved sufficiently by adding 10% brick dust as additive and its shear strength was seen getting improved very much.

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