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Study on Characteristics of Expansive Soil By Using Stabilizer Topken Micro Silica

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Abstract – Expansive soils are highly problematic because o f their nature of soils to undergo large volumetric change due to variations in the moisture content. Changes in volume resulting from variations in moisture in expansive soils and expansive soil sub grades cause damage to structures, highway pavements and other civil engineering infrastructure. Cores were brought to the laboratory from a piece of roadwork. Remolded samples were taken from subgrade of a deteriorated road. The following involves describing the behavioral characteristics of expansive soil as it relates to flexible pavements. Soils are generally classified using the X-ray diffraction [XRD]. The study is based upon simulating the vertical subgrade soil displacement during traffic load, and its influence on load-settlement on flexible pavement behavior. The paper presents a summary of technologies used to identify, test and treat expansive soils. The paper also discusses geological, mineralogical and physical properties of expansive soils along with categorization of technologies and testing methods with respect to applicability in highway engineering.

Index Terms – Expansion Soil, silica fume, plaxis, sub grade, X-ray diffraction, settlement.

1. INTRODUCTION

Several pieces of pavements can be found on expansive soils in many parts of the world, particularly in semi-arid regions. Such soils are generally unsaturated and contain a large amount of clay. Expansion of the clayey soils, containing illites in varying quantities, is the root cause of numerous distresses in buildings and large structures. In the presence of water after a dry state, these soils undergo a significant volume change. The volume change of expansive soils is primarily due to the hydration of the clay minerals or more precisely, the adsorption of water molecules to the exterior and interior surfaces of clay mineral to balance the inherent change deficiency of the particle. Contrary, if the soil is parched, it undergoes a reduction in volume, i.e. shrinkage takes place, which leads to the development of network cracks of polygonal shapes. They are manifested by intense degradation of pavements and surrounding grounds. The losses due to extensive damage to highways running over expansive soil.

The problem is further exacerbated when the subgrade is expansible. Even if the pavement is correctly designed, the swelling character of the subgrade goes to distort all predictions. Soil characteristics play a vital role for any construction. Expansive soils are problematic in nature due to their tendency to swell in presence of moisture and to shrink in moisture absence. It is well known that larger stresses can be created when volume change of a material occurs. The stresses reflect in the form of cracking, heaving and settlement of highway pavements. Therefore, a significant increase in the costs of routine maintenance, rehabilitation and even reconstruction of the deteriorated pavements will be forced to the road authorities. The cracking phenomenon can occur through volumetric changes under changing moisture conditions in expansive subgrade describes expansive soils as soils which swell or increase their volume when they imbibe water. An underestimation of these features may lead to a situation where in the measures proposed prove inadequate or totally ineffective. The expansion of soils leads to structural damages which include damage in pavements, canal linings, bridge abutment and rupturing of pipelines. Cracks in beams, columns and flooring in buildings are very often found. These volumetric deformations usually result in differential movements of flexible pavements resting on the expansive sub grade. Consequently, structural damages could happen if no special measures have already been taken during the design process. The method used for pavement design in Algeria is known as the catalog structure and is based on the French Method that uses the elastic Burmister's model for a multi-layer, semi-infinite structure. It assumes a semi-analytical stress-based field where deformations are calculated for when pavement is subjected to very heavy traffic. However, in the case of flexible pavement over expansive soils, subjected to high gradients of volume change, the method does not take into account such an effect in predicting pavement behaviour. Literature reveals that several locations in Edulabad, are made of expansive soils causing pavement deteriorations. As a part of road network maintenance, rehabilitation methods have been developed specifically for the flexible pavements of a Edulabad Main Road, which has suffered from severe degradation in its structural integrity. The geotechnical records of N10 show that it was constructed on expansive subgrades. Totally, 31 soil samples were taken, 10 of which were core samples and 21 were from wells. The results of laboratory test classified these soils of having medium to high expansion potential. Further soil data were obtained using the Principal Component Analysis [PCA].

2. METHODS FOR CLASSIFICATION AND SOIL PROFILE EXPANSIVE SOILS.

For identification of soils, the most common method includes subsurface exploration which further includes preliminary exploration and detailed exploration. This provides an idea of soil classification. A soil testing program was set up to test 10 trials of the samples cored 6 m deep and 21 wells of 2 to 3 m deep using a shovel. The purpose was to establish the geological profile of the site and to ensure there were enough intact and disturbed samples for laboratory testing. The process is carried out based on color, texture and observations made at the field. The field identification of expansive soils can be done by observing the cracking pattern of the surface of the soil in summer seasons but in other seasons detailed study is required. Visual analyses of wells and core samples revealed the presence of marly clay, clayey silt and marl. In addition to the routine characterization testing, the X-ray diffraction [XRD] technique was used to obtain semi-quantitative mineralogical composition and chemical analysis. Presence of expansive soil increases cost and time for many civil engineering construction projects. Identification of the expansive soils and rocks using remote sensing, which involves less ground visits, should be useful. The identification of a few training samples is the first phase of remote sensing investigation. Then a signature is developed which can represent the training samples. Identification of expansive soils is thereafter tried using the supervised classification technique, following the maximum likelihood decision rule. Success and applicability of one or the other of the methods depends upon the nature of data structure, uniqueness of the signature, statistical distances between the signatures, nature of information class being sought, spectral bands used etc. All the three groups of spectral bands - visual, infra-red and microwave- have been applied for the investigation. The final result of classification appears in the form of a classified map.

3. EXPANSION SOIL TREATMENT TECHNIQUES

According to Perry and Little (2002), the majority of treatment methods currently employed in the field has been around since 1960.One-dimensional tests are instrumentals for predicting the compressibility, collapse and expansion potential of soils. A geotechnical investigation company issued the permission of extracting undisturbed samples from the depths of 0.3 – 3.0 m and 3.0 – 6.0 m for oedometer test for free swell. Top priority to replacement of expansive soil with a less expansive material during the construction of foundation, while the current researchers rate replacement as the last option. However in the presence of ample depth, preference is still given to replacement method. The concept of bulking of aggregate is utilized in this method. The entire depth of expansive clay stratum or a part of it, depending on thickness, is replaced by sand. Then it is compacted to desired density and thickness. It is known that swelling pressure varies directly to density of sand layer and inversely to thickness. Hence sand cushions are formed in their loosest state to avoid excessive increase in swell pressure. Find that cohesive forces are developed up to a depth of about 1-1.2m, with saturation of expansive soil. This cohesive force helps to counter heave in soil beneath, even though the soil within the zone itself swells. The present trend of replacement has been shifted to cohesive non swelling material. The experiment results for various methods of minimizing damage by encapsulating clay with impermeable fabric suggests that vertical moisture barrier proves to be successful method, when installed in the shoulder of the pavement. The replacement of certain percentage of expansive soil with Ordinary Portland Cement (OPC) shows astonishing results. The percentage of soil removed could be 8%, 10% or 20% depending on various physical and geotechnical factors at the site. The use of GGBS (eco-cement) in expansive soil stabilization is a new process in geotechnical field. The laboratory tests report that the replacement of expansive soil with cement and GGBS in the ratio of 1:2 improves the shear strength and decrease in compressibility will be noticed. For practical implications, this technique requires high cost input.

4. MATERIALS AND METHODOLOGY

The stabilizer materials used in this study was Topken Micro silica Grade 96OU is a dry silica fume powder. The composition of SF is presented in table 1.

Table 1. Chemical and Physical Properties

Property	**Specified Value (ASTM C1240-14)**	**Analysis**
SiO2	Minimum 85%	86.60
H2O	Maximum 3%	1.48
Loss of ignition	Maximum 6%	2.50
Specific Surface Area	Minimum 15 m2/g	16.5
Pozzolanic Activity Index,7 days	Minimum 105 % of control	134
Retained on 45 micron sieve	Maximum 10%	0.68
Bulk Density	500-700 Kg/m3	575

The black cotton soil has been used as a base material in this study. It has been replaced partially by silica fume by weight of dry soil. The soil sample was disturbed. The soil is classified as clay of high plasticity
(Gs = 2.69 with 90% fines) with expansive behavior. The engineering characteristics of clay sample are presented in Table-2 & Figure-2.

Table-2 Properties of black cotton soil

S.No.	Particulars	Test Results
1.	Grain Size distribution: Sand (%) Silt + clay(%)	 09% 86%
2.	Liquid Limit (%)	66.5%
3.	Plastic Limit (%)	29%
4.	Plasticity Index (%)	37.5%
5.	Shrinkage Limit (%)	10.44 %

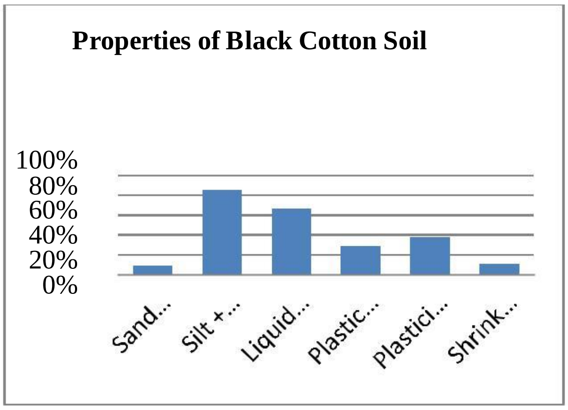

Figure 2. Properties of Black Cotton Soil

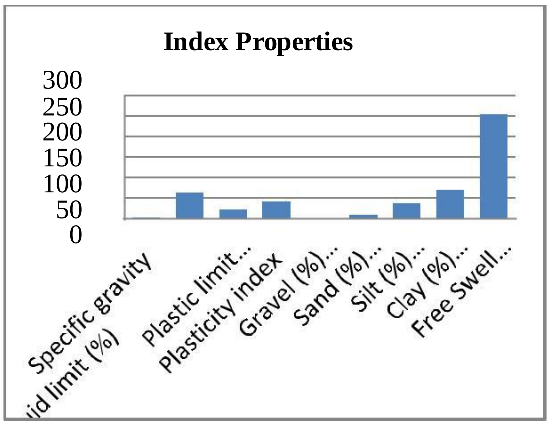

Figure 3. Index Properties

Expansive clay stabilization with chemicals has been found to reduce swelling and influence Free Swell Index FSI, swelling pressure and swell potential. Among all additives, lime is one of the economical and effective additives. It reduces swell potential meanwhile increases workability and strength.

Find the stabilization methods to overcome the cycling variations of expansive subgrade. Plaxis version 8.6 was used to model the behavior. Pavement structures have rarely been analyzed with finite element programs under dynamic loading. One reason for this is the fact that traffic loading is much more complicated than static loading normally applied in geotechnical problems

5. ANALYSIS OF RESULTS AND DISCUSSION

The test results obtained from the experimental work are briefly discussed below. The variation of Liquid Limit, Plasticity Index, Shrinkage limit, specific gravity, standard proctor test (OMC, MDD) and differential free swell. as compare to the initial values. The swelling behavior of the soil is also checked to a great extent. The Liquid limit decreased from 66.5% to 63% as silica fume content is increased from 0% to 15%.Similarly the plasticity index of BC soil increases from 37.5% to 41.67% with the increase of silica fume content in the black cotton soil. The shrinkage limit increases from 10.44% to 13.01% and specific gravity decreases from 2.69 to 2.59 with the increase of micro silica. The only way is chemical alteration done using cement, lime, fly ash or other material depending upon the use. The technique of fly ash uses the waste materials and hence it is environmentally friendly too. As this paper focuses on road construction on expansive soil, the latest trend has been discussed in this topic. Currently, the use of additives is considered to be most effective way of achieving a variety of outcomes. The main reason behind this includes availability of a variety of additives with specific material properties.

6. CONCLUSIONS

The waste materials such as Micro Silica Fume (SF) can also be used as non-traditional stabilizer for black cotton soils. This paper examines the effect of adding Silica Fume (SF) on the index properties of BC soils. From the series of laboratory experiments have been conducted on varieties of samples containing: 0%, 5%, 10% and 15% for Silica Fume, it is found that the index properties of soil have been improved by adding different percentage of Silica Fume. The swelling properties of BC Soil have also improved. Thus, expansive soil stabilized with micro silica fume can be used as a sub-grade material for construction of flexible pavements in rural roads with low traffic volume. The
stated outcomes from the present review paper indicates that further research could be undertaken in the following areas (with respect to clays) for construction of pavements on expansive soil longer

term testing of stabilization process..Advantages of performance based testing over traditional testing. Deformations are confirmed by plastic points where the cup points are manifested in the sub-grade along the shoulders and in the middle of the pavement, which indicate that the stress state in these points is equivalent to the pre-consolidation stress or they are highly loaded to the maximum stress level that has previously been reached. Hence, the pavement is solicited by both sides; traffic which transmits a high pressure to sub- grade and to groundwater, concentration of tension cut-off points. The points are in failure state under tensile stress, which explains the appearance of crack networks along the shoulders. The cracks promote water penetration to the pavement structure creating a zone of saturation that will reduce the bearing capacity of the soil, decrease the stability of the shoulder slope, and produce settlement and lateral displacement of shoulder.

REFERENCES

[1] "Fly Ash for Soil Improvement", Geotechnical Special Publication No.36, America Society of Civil Engineers, New York, New York,1993.
[2] "Soil and Pavement Base Stabilization with Self Cementing Coal Fly Ash", American Coal Ash.
[3] Biswas, etal. (2012). "Utilization of Rice husk wit h Lime in Subgrade Soil for a Rural Road."International Conference on Emerging Frontier in Technology for Rural Area.
[4] Phanikumar, B.R. (2009).Effect of lime and fly ash on swell consolidation and shear strength characteristics of expansive clays: A comparative study‖, Jrl. of Geomechanics and Geoengineering: An international journal, Vol.4, Issue 2, pp. 175-181.
[5] Dakshanamanthy, V. and Raman, V. (1973) "A Simple Method of Identifying an Expansive soil", Soils and Foundations, Japanese Society of Soil Mechanics and Foundation Engineering, 13 [1], pp 97–104.
[6] BLACK COTTON SOILS OF INDIA A review of engineering properties and Construction Techniques. U.G. Project report submitted by A.M. Patankar, D.M. Mukewar and S.L. Khankhoje Final Year B.E Students of Vishveshvarayya Regional College of Engineering Nagpur.
[7] Bhuvaneshwari, S., Robinson, R.G. and Gandhi, S.R., "Stabilization of expansive soils using fly a sh, "Fly Ash India, 2005, Fly Ash Utilization Program (FAUP), TIFAC, DST, New Delhi.
[8] Suri, S., Adhikari, R. and Phanikumar, B. R. (2013). ―Free swell index of an expansive soil blended with limeand fly ash‖, A Research Report submitted to VIT University, India.

and deformations caused by theexpansion of sub-grade. Along th