ENHANCEMENT OF SHEAR STRENGTH OF SOIL USING CEMENT AND BITUMEN EMULSION

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Abstract: The development of any country depends on the transportation facilities and the construction projects. For the projects to be successful, the soil used for the foundation beds must be strong which requires better soil properties. Expansive soils have the tendency to swell when they come in contact with moisture and to shrink if moisture is removed from them. These volume changes in swelling soils are the cause of many problems in structures that come into their contact or constructed out of them. An attempt has been made to use emulsion for improving the strength and geotechnical properties of gravel soil. Very mostly, use of use of bitumen emulsion is environmentally accepted. To achieve the whole project some experimental investigation is needed in laboratory. The experiments which to be conducted are Specific Gravity of the soil sample, Grain size Distribution of soil sample and liquid limit plastic limit test to identify the material and Standard Proctor test to obtain maximum dry density and optimum moisture content of soil sample, Unconfined shear strength test of soil sample mixing with emulsion. The different values adopted in the present study for the percentage of cement (12 %) and Bitumen emulsions are 6, 12, 18 and 24 %.

1.1 INTRODUCTION

Soil stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil thereby controlling the shrink-swell properties of a soil and, improving the load bearing capacity of a sub-grade. Stabilization can be used to treat a wide range of sub-grade materials from expansive clays to granular materials. The necessity of improving the engineering properties of soil has been recognized for as long as construction has existed. 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 today. The modern era of soil stabilisation began during the 1960's and 70's when general shortages of aggregates and fuel resources forced engineers to consider alternatives to the conventional techniques of replacing poor soils at building sites with shipped-in aggregates that possessed more favorable engineering characteristics. Soil stabilisation then fell out of favor, mainly due to faulty application techniques and misunderstandings. More recently, soil stabilisation has once again become a popular trend as global demand for raw materials, fuel and infrastructure has increased. This time, however, soil stabilisation is benefiting from better research, materials and equipment.

1.2 LITERATURE REVIEW ON STABLIZATION

Olugbenga Oludolapo Amu et al studied the Suitability and Lime Stabilization Requirement of Some Lateritic Soil Samples as Pavement. In this work, Soil samples A, B, and C collected from a dam site and stabilized with 0, 2, 4, 6, 8, and 10% of lime were subjected to preliminary tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits) and strength tests (compaction, California bearing ratio (CBR), unconfined compression and undrained triaxial). Results of the preliminary tests classified the samples as fair to poor pavement construction materials. The suitability of samples A, B and C was improved by optimum lime stabilization at 8, 6, and 6% respectively.

Simarpreet Singh Batra et al studied the effect of cationic bitumen emulsion on shear strength parameters of soil. Many attempts have been made by numerous scholars in the history to increase the strength of soil by different methods including addition of lime, cement etc. Recent research is being carried to use non-traditional materials like Bitumen Emulsions etc. for improving the properties of soil. Bitumen Emulsions are usually dispersions of minute droplets of bitumen in water i.e. oil in water emulsions and are used to improve the cohesive strength of granular, low cohesion, low plasticity materials. They can also improve the integrity of road base, sub-base or sub-grade materials by resisting the damage caused by water. In this paper, the Direct Shear Test was conducted on soil with varying amount of Cationic Bitumen Emulsion (0%, 2%, 5%, 6% and 7%) to study the effect on Shear Strength parameters of the soil. The maximum shear strength of the soil was observed at 6% Bitumen Emulsion from the laboratory tests performed on the soil i.e. approximately 65% more shear strength by increasing Angle of Internal Friction but reduced Cohesion than the soil without any Emulsion.

Avinash P et al studied the Stabilization of Soil in the Capital Region of Andhra Pradesh using Cutback Asphalt. A Laboratory investigation is carried out to study the effect of cutback Asphalt on engineering and index properties of the Black Cotton Soil. The soil used in the study is brought from Thullur mandal, Andhra Pradesh, a major extent of this region is covered by black cotton soil. A series of laboratory tests are conducted, namely, USCS soil classification, specific gravity, optimum moisture content, maximum dry density, liquid limit, plastic limit, swell pressure, free swell index, California bearing ratio are conducted on soil samples with varied bitumen content ranging from 0% - 13% leaving intervals at 1, 5, 9, and 13 %, and tested thereafter. The results stand out the increase in liquid limit and plastic limit, and the fall in the swell pressure, free swell index on addition of optimum cutback asphalt. However, in case of stability case there is increase in California bearing ratio in soaked and unsoaked condition with increase in stabilizer (cutback bitumen).

A. Ghosh directed the Stability of Soil Block using Bitumen Emulsion. The prime objective of soil stabilization is to improve the California Bearing Ratio of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base

courses. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being used to construct the entire road. There are numerous stabilizers used for stabilizing the soil such as lime, cement, bitumen, fly ash etc. In this study, Bitumen emulsion is used as a stabilizer. From this study it is clear that there is a considerable improvement in California Bearing Ratio (CBR) of sub-grade due to use of MS bitumen emulsion if proper mixing is done.

Sabat assessed the appropriateness of utilizing sugarcane bagasse fiery remains and lime slop as settling operators for soil adjustment of asphalt subgrade. The goal of the work was to examine the consolidated impacts of baggase cinder and lime slime on the geotechnical properties of the soil. Lime slime and bagasse powder were included augmentations of 4% upto 20% and 16% individually. The test program lead the analyst to presume that the expansion of bagasse fiery debris and lime ooze both brought about a lessening in the greatest dry thickness of the soil and expanded the ideal dampness content. 8% bagasse powder with 16% lime slop was observed to be the ideal measurement as it created the most extreme CBR and unconfined compressive quality of the balanced out soil. A monetary investigation of asphalt built on the settled asphalt brought about base reserve funds of 13.9% in expense of the asphalt when contrasted with the untreated soil.

Marandi et al dealt with Base Course Modification through Stabilization utilizing concrete and bitumen. The primary goal of this exploration was to examine the utilization of bitumen emulsion in base course adjustment. So it was analyzed as supplanting with customary asphalt in locales with low quality materials. Adjustment of soils and totals with bitumen indicates it contrasts incredibly from concrete adjustment. The fundamental system engaged with bitumen adjustment was a waterproofing marvel.

1.3 STANDARD PROCTOR TEST

Proctor Test is mainly for knowing the re1ationship between the dry density of soils and moisture substance compacted in a mou1d of a particular size with a 2.5 kg rammer dropped from a stature of 30 cm. This test is conducted by research centers to decide the experimental Optimum Moisture Content (OMC) which makes the soil thick and achieve the maximum dry density (Yd).

Tab1e 1: Maximum Dry density of soil samples

Sr. No	Sample	Maximum dry density(g/cc)
1.	Normal Soi1 Sample	1.45
2.	Soi1with 6 % bitumen emulsion with 12 % Cement	1.60

3.	Soil with 12 % bitumen emulsion with 12 % Cement	1.73
4.	Soil with 18 % bitumen emulsion with 12 % Cement	1.89
5.	Soil with 24 % bitumen emulsion with 12 % Cement	1.78

1.4 UNCONFINED COMPRESSION TEST

The unconfined compressive strength is defined as the 1oad per unit area where the cy1indrical specimen of a cohesive soi1 falls in compression and by plotting the axial stress and strain in the graph, following unconfined strengths are computed as per reinforcement. This test was also conducted on test soi1 with different percentage of cutback bitumen content. As, it is well known that the unconfined compressive strength of sandy soi1 specimen is negligible or practically zero.

Tab1e 2: Unconfined Compression Strength of soi1 samp1es

Sr. No	Samp1e	Unconfined Compression Strength
1.	Normal Soil Sample	0.0845
2.	Soil with 6 % bitumen emulsion with 12 % Cement	0.0864
3.	Soil with 12 % bitumen emulsion with 12 % Cement	0.0954
4.	Soil with 18 % bitumen emulsion with 12 % Cement	0.1058
5.	Soil with 24 % bitumen emulsion with 12 % Cement	0.1024

1.5 DIRECT SHEAR TEST

An immediate shear check is a 1aboratory or maybe field check employed by geotechnical engineers to calculate the shear strength properties of soil or maybe rock materia1, or maybe of discontinuities in soil or even rock masses. The density of the soil sample is estimated out of the mass of soil and also the amount of the shear package. The dial readings are changed to the correct displacement and stuff products by multiplying with respective very least matters. Shear stresses are estimated by dividing horizontal displacements together with the sample duration, as well shear stresses are acquired by dividing horizontal shear forces with the shear region. The shear anxiety compared to horizontal displacement is plotted. The optimum worth of shear emphasize is read in case disappointment has transpired, normally look at shear strain at twenty % shear stress. The optimum shear anxiety compared to the corresponding stress that is normal is plotted for every check, the angle and the cohesion of shearing opposition of the soil is set out of the graph.

Table 3: Cohesion and ang1e of friction

Sr. No	Sample	Cohesion (kg/cm2)	Ang1e of internal friction (0)	Maximum shear stress(kg/cm2)
1.	Normal Soil Sample	0.093	20.126	0.470
2.	Soil with 6 % bitumen emulsion with 12 % Cement	0.072	22.392	0.527
3.	Soil with 12 % bitumen emulsion with 12 % Cement	0.067	23.227	0.562
4.	Soil with 18 % bitumen emulsion with 12 % Cement	0.063	28.140	0.706
5.	Soil with 24 % bitumen emulsion with 12 % Cement	0.056	25.390	0.643

CONCLUSION

Different conclusions can be drawn from this study:

1. The price of Bitumen Emulsion is much more than different standard materials for the Soil Stabilization though it may be utilized in locations owning very poor soil as a result of the Shear Strength of its improving property
2. Unstabilized soil sample has a high Atterberg's limits and swelling percentage.
3. The results indicate that with the increase of bitumen emulsion in the soil sample at 21 % proportion ratio the soil strength is increased and after certain percentages it's getting decrease.
4. Liquid Limit increases, as the percentage of bitumen emulsion increases.
5. Addition of bitumen emulsion with soil reduces their plastic indices.
6. Observing the economic cost of its as well as quality of stabilization enhancement, it's apparent this kind of stabilization might be appropriate in gravel soil or perhaps in shoulder part of highways.
7. At 7 % Bitumen Emulsion, the cohesion value between the soil particles was reduced down to 0.07 N/mm^2 but also at the same moment the ang1e of Interna1 Friction was suddenly increased to 21.74^ocausing in approx. 65% increase in particularly the Shear Strength of soil due to sticking property of Bitumen partic1es that binds the soi1 partic1es resulting in increased friction between the soil particles.
8. The use of bitumen emulsion to stabilize uniform grained soil can create improved ground layer but also a surface base.
9. Use of bitumen emulsion as being an admixture for enhancing engineering qualities of the soils is an affordable resolution to make use of the locally offered very poor earth.
10. In proctor test (low compactive effort), Maximum dry density of 1.85 g/cm^3 was achieved at a moisture content of 12.24%. Additionally, increase in moisture content decreases the dry density of the specimen.

REFERENCES

1. Simarpreet Singh Batra, "Effect of Cationic Bitumen Emulsion on Shear Strength Parameters of Soil", International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
2. N. Vijay Kumar, "study on strength of Laterite soil using bitumen emulsion and ESP, CSA", International Journal of Current Engineering and Scientific Research (IJCESR), ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-7, 2017.
3. KOTA PRUDHVI TEJA, "Improvement Of Silty Soil As Subgrade Material By Stabilizing With Bituminous Emulsion", International J. of Engg. Research & Indu. Appls. ISSN 0974-1518, Vol.8, No. III (August 2015), pp.81-95.

4. K. Mounika, B. Satya Narayana Reddy, D. Manohar, "Influence of sea shells powder on black cotton soil during stabilization", International Journal of Advances in Engineering & Technology, Vol.7, Issue 5, pp 1476-1482, 2014.
5. Olumide Moses and Ogundipe, "Strength and compaction characteristics of bitumen-stabilized granular soil", International journal of scientific & technology research, Vol.3, Issue 9, pp 2277-8616, 2014.
6. S. Bhuvaneshwari, R.G. Robinson, S.R. Gandhi, "Stabilization of Expansive Soils Using Flyash" Flyash Utilization Programme, TIFAC, DST, New Delhi VIII 5.1 to 5.10, 2005
7. Dr. AfafGhais Abadi Ahmed, "Flyash Utilization in Soil Stabilization", in Proc. of Int. Conf. on Civil, Biological and Environmental Engineering (CBEE), Istanbul, Turkey, pp. 76 – 78,May2014
8. S. Bhuvaneswari, R. G. Robinson and S. R. Gandhi, "Stabilization of Expansive Soil Using Fly Ash", Fly Ash Utilization Programme (FAUP), TIFAC, DST, New Delhi. 2005.
9. M.Arabani and M.Veis Karami, "Geo Mechanical Properties of Lime Stabilized Clayey Sands", the Arabian Journal for Science and Engineering, Vol.32, Isssue No.1B, pp 1-25, 2007.
10. D. Neeraja, "Influence of Lime and Plastic Jute on Strength & CBR Characteristics of Soft Clayey (Expansive) Soil", Global Journal of Researches in Engineering,Vol.10, Issue 1, pp 16-24(Ver, 1.0), 2010.
11. Oriola, Folagbade and Moses, George, "Agricultural Wastes As Soil Stabilizers in Black Cotton Soil", International Journal of Earth Sciences and Engineering,ISSN 0974-5904, Vol.4, Issue6 SPL, pp 50-51, 2011.
12. Maheshwari G.Bisanal, "Study on Stabilization of Soil Using Sea Shell and Bitumen Emulsion", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 7, July 2015.
13. Elifas Bunga, H. Muh, Saleh Pallu, Mary Selintung, Arsyad M, and Thaha, "Stabilization Of Sandy Clay With Emulsified Asp halt", International Journal of Civil& Environmental Engineering, Vol.11, Issue 5, pp 52-58, 2011.
14. Laxmikant Yadu, Rajesh Kumar Tripathi and Dharamveer Singh, "Comparison of Fly Ash and Rice Husk Ash Stabilized Black Cotton Soil", International Journalof Earth Sciences and Engineering, ISSN 0974-5904, Vol.4, Issue 6 SPL, pp 42-45, 2011.
15. Dr. Akshaya Kumar Sabat, "A Study on Geotechnical Properties of Lime Stabilized Expansive Soil-Quarry Dust Mixes", International Journal of Emerging TrendsIn Engineering & Development, Vol.2, Issue 2, 2012.
16. K. Jayaganesh, S. Yuvaraj, D. Yuvaraj, C. Nithesh and G. Karthik,"Effect of bitumen emulsion and sea shell powder in the unconfined compressive strength ofblack cotton soil", International Journal of Engineering Research and Applications (IJERA), Vol.2, Issue 3,pp 242-245, 2012.

17. Janathan Q. Addo, Sanders, T. G. & Chenard, M. (2004), Road dust suppression: "Effect on unpaved Road Stabilization".
18. Sherwood, P. (1993). Soil stabilization with cement and lime. State of the Art Review. London: Transport Research Laboratory, HMSO.
19. Pousette, K., Macsik, J. and Jacobsson, A. (1999). Peat Soil Samples Stabilized in Laboratory-Experiences from Manufacturing and Testing. Proceeding of Dry Mix Methods for Deep Stabilization (pp. 85-92). Stockholm: Balkema, Rotterdam.
20. Maheshwari g. Bismal and Ravi Kumar badiger (July 2015) Study on Stabilization of Soil Using sea and Bitumen Emulsion.