

Analysis of Stabilization of Soil Cement for Base of Railway Track & Sub grade

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Abstract—“Soil Stabilization is the alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations. The changes in the soil properties are brought about earlier by the incorporation of additives or by mechanical blending of different soil types. The aim of the study is to review on stabilization of soil using cement. In this report soil has been taken from several laboratory test is done on that soil sample and soil mixed with cement. The experiments done on the treated and untreated soil are Shrinkage limit, plastic limit, and liquid limit), Standard Proctor test, Water content, Direct Shear test and California bearing ratio (CBR) test by adding 2%, 4% and 6% of cement on the soil sample. Construction of rail tracks requires appropriate improvement techniques for ballast and underlying soft formation soil, both of which deform and degrade progressively under heavy train loads. This paper aims to demonstrate and discuss some major aspects in relation to stabilization of ballasted rail tracks overlaying soft formation soils. The use of geocomposites (i.e. bonded geogrid-geotextile layers) for enhancing the performance of rail tracks is described, with the aim of achieving reduced track settlement, increased resilient modulus and decreased ballast degradation. The effects of increasing the confining pressure on rail tracks in regard to particle breakage are studied using laboratory.

Key words: Cement, Direct Shear Test, California Bearing Ratio, shrinkage limit, plastic limit, liquid limit and ballast.

1. INTRODUCTION

A proper understanding of the geotechnical properties of soils is a pre-requisite for its use in engineering construction works. Studies on the engineering properties of these materials have made geologists and engineers aware of a wide range of properties. However the relative abundance of soil notwithstanding, its suitability for various purposes can be enhanced through the modification of its properties by stabilization. Long term performance of railway track structures often depends on the stability of the underlying soils. Engineering design of these constructed facilities relies on the assumption that each layer in the railway track has the minimum specified structural quality to support and distribute the super imposed loads. These layers must resist excessive permanent deformation, resist shear and avoid excessive deflection that may result in fatigue cracking in overlying layers. Available earth materials do not always meet these requirements and may require improvements to their engineering properties in order to transform these inexpensive earth materials into effective construction materials. This is often accomplished by physical or chemical stabilization or modification of these problematic soils. Although the solution appears simple and straight forward, engineering properties of individual soils may vary widely due to heterogeneity in soil composition, difference in micro and macro structure among soils, variability and heterogeneity of geologic deposits and due to differences in physical and chemical interactions of air/water with soil particles. These differences necessitate the use of site-specific treatment options for stabilization.

1.1 PURPOSE

This manual establishes criteria for improving the engineering properties of soils used for railway track base courses, sub base courses, and sub grades by the use of additives which are mixed into the soil to effect the desired improvement. These criteria are also applicable to roads and airfields having a stabilized surface layer.

1.2 USE OF SOIL-CEMENT STABILIZATION

The use of soil-cement can be of great benefit to both owners and users of commercial facilities. Its cost compares favourably with that of granular-base railway track. When built for equal load carrying capacity, soil-cement is almost always less expensive than other low-cost site treatment or railway track methods. The use or reuse of in-place or nearby borrow materials eliminates the need for hauling of expensive, granular-base materials; thus both energy and materials are conserved.

1.3 MECHANISMS OF STABILIZATION

The stabilization mechanism may vary widely from the formation of new compounds binding the finer soil particles to coating particle surfaces by the additive to limit the moisture sensitivity. Therefore, a basic understanding of the stabilization mechanisms involved with each additive is required before selecting an effective stabilizer suited for a specific application. Chemical stabilization involves mixing or injecting the soil with chemically active compounds such as Portland cement, lime, fly ash, calcium or sodium chloride or with viscoelastic materials such as bitumen. Chemical stabilizers can be broadly divided in to three groups: Traditional stabilizers such as hydrated lime, Portland cement and Fly ash; Non-traditional

stabilizers comprised of sulfonated oils, ammonium chloride, enzymes, polymers, and potassium compounds; and By-product stabilizers which include cement kiln dust, lime kiln dust etc. Among these, the most widely used chemical additives are lime, Portland cement and fly ash. Although stabilization with fly ash may be more economical when compared to the other two, the composition of fly ash can be highly variable

1.4 DIFFERENT TYPE OF STABILIZATION

i. Mechanical stabilization ii. Geosynthetic stabilization iii. Chemical stabilization

I. MECHANICAL STABILIZATION– This is the process of altering soil properties by changing the gradation through mixing with other soils, densifying the soils using compaction efforts, or undercutting the existing soils and replacing them with granular material. A common remedial procedure for wet and soft sub grade is to cover it with granular material or to partially remove and replace the wet sub grade with a granular material to a pre-determined depth below the grade lines. The compacted granular layer distributes the wheel loads over a wider area and serves as a working platform.

II. GEOSYNTHETIC STABILIZATION- Geogrid has been used to reinforce road sections. The inclusion of geogrid in sub grades changes the performance of the roadway in many ways. Tensile reinforcement, confinement, lateral spreading reduction, separation, construction uniformity and reduction in strain have been identified as primary reinforcement mechanisms. Empirical design and post-construction evaluation have lumped the above described benefits into better railway track performance during the design life

III. CHEMICAL STABILIZATION – The transformation of soil index properties by adding chemicals such as cement, fly ash, lime, or a combination of these, often alters the physical and chemical properties of the soil including the cementation of the soil particles.

3. METHODOLOGY

The use of stabilization to improve the properties of a material is becoming more widespread due to the increased strength and load spreading ability that these materials can offer. A collective experience has demonstrated that cement can be mixed to increase the strength of soil in different ways. However, the basics always remain the same: treated soil is the simple product of cement with soil. There is no secret ingredient or proprietary formula that makes treated soil mixed with cement. Stabilization is the process of mixing a stabiliser, for example cement, with a soil or imported aggregate to produce a material whose strength is greater than that of the original unbound material. In this report soil has been taken from ABU PUR Muradnagar U.P, and several laboratory tests are done on that soil sample and soil mixed with cement. The experiments done on the treated and untreated soil are Shrinkage limit, plastic limit, and liquid limit (liquid limit and plastic limit), Standard proctor test, Direct shear test and California bearing ratio (CBR) test by adding 2%, 4%, and 6% cement on the soil sample.

4. EXPERIMENTAL INVESTIGATION

This provides detail of materials used in the experimental work. A laboratory investigation program was carried out to evaluate the mechanical properties of the untreated soil and soil stabilized with waste tyre rubber. The soil was stabilized with cement contents by weight of soil. The test which carried out on the samples of untreated and stabilized soil are as follows:

1. Grain Size Analysis
2. Atterberg's Limits
3. Proctor Compaction Test
4. Direct Shear test
5. California Bearing Ratio Test
5. TEST RESULT –

5.1 GRAIN SIZE ANALYSIS - Unified classification of Soil = SC/SM The result obtained from the above test indicates that according to Unified Soil Classification System (USCS) the soil sample is SC (Silty Sands)/SM (Clayey Sands). Measured by standard available means with reference to the Standard Liquid Limit Device. It is defined as the minimum water content at which a part of soil cut by a groove of standard dimensions will flow together for a distance of 12mm (1/2 inch) under an impact of 25 blows in the device.

5.2 ATTERBERG LIMIT -The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil: its shrinkage limit, plastic limit, and liquid limit. As a dry, clayey soil takes on increasing amounts of water, it undergoes distinct changes in behavior and consistency. Depending on the water content of the soil, it may appear in four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil is different and consequently so are its engineering properties. Thus, the boundary between each state can be defined based on a change in the soil's behavior. The Atterberg limits can be used to distinguish between silt and clay, and it can distinguish between different types of silts and clays. These limits were created by Albert Atterberg, a Swedish agriculturist

5.3 MOISTURE-density relation The moisture-density relation of the samples are shown in fig 5.3 from the plots shown in fig. 5.3, the maximum dry density (γ_{max}) increase while w_{opt} decrease when 2%, 4%, and 6% cement added to soil sample as compared with the untreated sample, the value of γ_{max} increase up to 1.06 while w_{opt} reduced up to about 0.89 for the sample stabilized with 6% cement content,

5.4 DIRECT SHEAR TEST- Test result of direct shear test indicates with increase in cement content the value of cohesion „c“ decreases and the value of angle of internal friction „ Φ “ increases with every interval of increment of cement. For Untreated Soil From the curve $c = 1.6$ $\Phi = 380$ For 2% cement addition From the curve $c = 1.1$ $\Phi = 400$ For 4% cement addition From the curve $c = 0.6$ $\Phi = 410$ For 6% cement addition From the curve $c = 0.6$ $\Phi = 400$

5.5 California Bearing Ratio For untreated soil sample

Maximum value of CBR for sub grade = 5.07 % For 2% cement added to soil sample Maximum value of CBR for sub grade = 6.62 % For 4% cement added to soil sample Maximum value of CBR for sub grade = 8.23 % For 6% cement added to soil sample Maximum value of CBR for sub grade = 10.15 %

CONCLUSION

This study made a comprehensive examination of the effectiveness of cement treatment on geotechnical properties of soils taken from ABU PUR, Modinagar U.P. 1. Test result indicate that with the increase in cement content liquid limit, plastic limit and plasticity index decreases as compared to untreated sample. 2. Maximum dry density increases while optimum moisture content reduced with increasing 2%, 4%, and 6% cement with respect to untreated soil sample. 3. Test result of direct shear test indicates with increase in cement content the value of cohesion „c” decreases and the value of angle of internal friction „ Φ ” increases with every interval of increment of cement. 4. California bearing ratio (CBR) of stabilized samples increases sharply with increases cement content. CBR of sample stabilized with 6% cement and compacted of 5 layers with heavy energy of 55 blown in each layers fulfil the criteria proposed by AASHTO soil classification.

REFERENCES

1. Abu siddique and Bipradas rajbongshi, ““Mechanical properties of a cement stabilized coastal soil for use in road construction”, Journal of civil engineering The institution of Engineers” Vol. CE 30, NO. 1, 2002
2. Anil Misra, Debabrata Biswas and Sushant Upadhyaya (13 Decemeber 2004), “Physio- mechanical behavior of self-cementing class C flyash-clay mixtures,” www.sciencedirect.com
3. Azm S. Al-Homoud, Taisir Khedaywi and Abdullah M. Al. Ajlouni (1999), “Comparison of effectiveness and economic feasibility of bitumen, lime and cement as stabilizing agents for reduction of swell potential of a clayey soil,” Indian Highways, January 1999, pp.51–58.
4. Costas A. Anagnostopoulos (2004), “Physical and Engineering Properties of a cement stabilized soft soil treated with Acrylic Resin additive,” www.ejge.com
- 5-zoubi, Mohammed Shukri (2008), “Undrained Shear Strength and Swelling Characteristic of Cement Treated Soil”, Jordan Journal of Civil Engineering, Vol. 2, pp 53-61
- 6-Shelke, A.P and Murty, D.S (2010), “Reduction of Swelling Pressure of Expansive Soils Using EPS Geofoam” Indian Geotechnical Conference, GEO trendz.
- 7-Neva Elias(2015), “Strength Development of Soft Soil Stabilize with Waste Paper Sludge”, International Journal of Advanced Technology in Engineering and Science, Vol. 3, pp 141-149.
- 8-N.B.O (1962). “N.B.O 15- First Report On Building Foundation in Shrinkable Soil (Second Edition)”, National Buildings Organization, Ministry of works, Housing & Supply, Govt. of India, New Delhi