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Strength and Properties of Subgrade Cohesive Soil Treated with Stone Slurry and Lime: A Review

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Abstract

The foundation is indeed the most essential part of any built up structure, be it a superstructure or a substructure. The stability of soil is the requirement to stabilize the upper surface. Clay being the most unwanted subgrade material cannot always be avoided completely because it is not always economically feasible to replace the part of foundation with a more stable granular soil. Hence, the role of stabilization comes into play. This study aims to investigate the potential utilization of stone slurry waste and stabilization of cohesive soil. The stone slurry waste is usually disposed indiscriminately in open area and sewage network causing health and environmental problems. Every year death of humans and animals are reported due to drowning in open slurry waste site. This water carries large amounts of stone powder, which leads to complex nature of environmental problem so these waste material needs to be utilized meaningfully in economic way. The stone slurry waste taken from the stone cutting plant was dried, grind to fine particle and then mixed with specific amount of clayey soil and Lime. The stone cutting industry consume large amounts of fresh water and produces even larger amount of viscous liquid waste known as stone slurry waste. Calcium Carbonate ($CaCO_3$) is the main constituent of slurry waste in addition to other minerals from parent rock. Stone slurry waste and Lime were mixed in different percentage with parent soil and various geotechnical characteristics were investigated through standard proctor test (SPT) and unconfined compression test (UCS)

Keywords: Subgrade; Soil Stabilization; Waste Utilization; Stabilized Earth

1. Introduction

The one of the most conventional methods of soil stabilization is to remove the weak soil and replace with stronger material. The stabilization process aims to increasing the soil strength and reducing its permeability and compressibility. The stabilization process may include mechanical, chemical, electrical or thermal processes. The processes used depend on the type of soil at site, the time available to execute the project and the stabilization cost compared to the overall cost of the project. The main problem occurs when we have to deal with the cohesive soil altogether, Expansive soil possesses great threat for the construction of buildings due to its less characteristic shear strength and high swelling and shrinkage characteristics. A wide range of soil improvement methods has been used, including soil replacement, dynamic compaction, lime columns, stone columns, and soil reinforcements with fibrous materials. The selection of an appropriate method depends on ground characteristics, effectiveness, and practicality of the preferred technique and associated costs.

1.1 Need for Soil Stabilization

In the broad sense, stabilization includes compaction, pre-consolidation, drainage and many other such processes. Stabilization is the process of blending and mixing materials with a soil to improve certain properties of the soil. The process may include the blending of soils to achieve a desired gradation by the mixing of commercially available additives that may alter the gradation, texture or plasticity, or act as a binder for cementation of the soil. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures, to reduce the swell in case of expansive soils and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils. If weak soils exist, stabilization and improvement of their properties is necessary. Urbanization and industrial development to be concentrate on construction techniques of highways, railways airports and residential building in India. For these constructions should need good soil conditions for foundation techniques and embankments and pavements. Cohesive soils are most commonly available in most of the place of India.

1.2. Waste Utilization

Over the last few years, utilization of by-product of industrial solid waste has been focus of many researchers. Quarrying and stone cutting is the main extractive industry which produce huge amount of stone slurry waste during extraction, cutting and processing of rocks. Disposal of this Stone Slurry Waste becomes a serious problem, which also affects the environmental health. Stone slurry waste shows the presence of CaO, which is indication of pozzolanic properties. The study aims to investigate using of the stone slurry waste and using specific amount of Lime to stabilizing the clayey soils. The stone slurry waste taken from stone cutting plant was dried, grinded to fine particle and then mixed with specific amount of Lime and cohesive soil. The use of Stone Slurry Waste and Lime with clayey soil is checked under the various tests such as Standard Proctor test, Unconfined Compressive Strength, Atterberg's limit etc.

2. Advantage and Scope of Cohesive Soil Treatment

In India, the area covered by clayey soils is nearly 20 percent of the total area and includes almost the entire Deccan Plateau, Western Madhya Pradesh, parts of Rajasthan, Bundelkhand region in Uttar Pradesh and parts of Andhra Pradesh and Karnataka. India is a developing country in which urbanization and industrial development mainly concentrate on construction techniques of highway, airports, residential building, railway, and many more construction work. Many times, the soils in natural states do not present adequate geotechnical properties to be used for these civil engineering projects. For all construction work we need good soil having good strength for foundation, pavement, embankment etc. Clayey soils are normally associated with volumetric changes when they are subjected to change in water content because of seasonal water fluctuations.

Cohesive soil under goes much expansion and shrinkage due to wetting and drying conditions which is one of the most undesirable feature. Construction activities on expansive soil require the stabilization of soil prior to the start of wlork. Some of the stabilization methods using include soil replacement, dynamic compaction, lime/cement columns, stone columns, soil reinforcements with fibrous materials and using conventional material like lime, bitumen, cement, ash etc. But the availability of these conventional materials has not been sufficient to meet the demand of growing population or they prove too expansive as fund limited to a particular construction works limited especially in the newly developing country like India. So, it becomes the need of time to find some alternative material which can successfully replace the conventional material without compromising the engineering properties of the structure. In our study an attempt is made for stabilizing clayey soils with addition of stone slurry waste. The geotechnical properties like unconfined compressive strength, the maximum dry density and optimum moisture content are determined to know the suitability of material.

3. Previous Investigation

The beginning of modern 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. Since then a lot of improvement has been done in this field and researchers are doing their bit to provide solution to this problem. Stone slurry waste is a one of the newest additives and many studies about using stone dust in soil improvement have been done. The use of stone slurry in some talented fields such as soil improvement, seepage and grouting will offer great advantages in geotechnical properties of soil. Stone slurry is the by-product material generated by cutting and shaping of building stones in cutting plants the water used for cooling up the cutting saw flows out carrying very fine suspended particles as high viscous liquid known as stone slurry. For stabilization, we use stone slurry with Lime because Lime increases its strength properties of soil.

Nabil Al-Joulani, in the year 2012 has done some experiment with the direct shear, compaction and CBR tests directly without curing or soaking of the specimens. The two additives were mixed with the soil at percentages of 10%, 20% and 30% by weight. Using the 30% of stone powder has been increased the angle internal friction by about 50% and reduced cohesion by about 64%. When they added the lime then decreased the friction angle and cohesion by 57% and 28% respectively. The addition of 30% stone powder and lime has increased the CBR value from 5.2% to 16% and 18% respectively. The increase in CBR value due to stone powder and lime caused a reduction in the flexible pavement thickness by 47% and 55% respectively. This main substantial saving in the material needed for construction of roads. Similarly, a study by Osman Sivrikaya, Zeki Karaca, in the year 2014 has found that natural stone processing waste used as a stabilized material, however, the waste dolomite marble powder was found to be more effective stabilizer due chemical composition. After some years in 2015 a study by , M. Adamas Joe, conducted a project to utilize the industrial waste products in the process of stabilizing the cohesive soil. From the study it was observed that there was an appreciable improvement in the optimum moisture content and maximum dry density for the soil treated with industrial waste. After performing various experiments, it revealed that lime and industry waste was best stabilizing agent.

4. Current Study

The investigation mainly has been following the major objective of utilizing the stone slurry waste and lime for the improvement of cohesive soil properties. The two additives used in this project (Stone Slurry and Lime) which are one of the cheapest and available in commercial quantities to a large scale. It is expected that, the cohesive soil will induce a cohesion effect in the mixture and the Lime will induce bonding between particles.

This research will help dispose large quantities of stone slurry waste by utilizing them in the construction of roads, foundations etc. The stabilization and utilization of stone slurry waste as construction materials, and will help mitigate its environmental and health impacts.

There are different tests conducted on soil samples and sample prepared by mixing of stone slurry waste and Lime. There are two types of soil samples prepared one is combination of soil, SSW and lime and second is the combination of soil and SSW only. Though field test is consider to be best but it is not possible to conduct field test all the time as they prove to be expansive and time consuming so model test employed to obtain the useful result as now-a-days with modern technology and instrument it is possible to maintain condition similar to that of field. Moreover, laboratory test has advantage of better control over the conditions

To investigate the compaction characteristics and strength characteristics of the clayey soil treated with different combination of SSW with Lime and without Lime is the main objective of present study. It is done to make the soil suitable for desired engineering purpose by modifying its geotechnical characteristics.

Firstly, a series of standard compaction test confirming to IS 2720 – part 7- 1980 was conducted on all the samples to determine the OMC and MDD for parent clayey soil and clayey soil in combination of SSW with Lime and without Lime than a series of UCS test confirming to IS 2720 – part 10 was conducted on clayey soil alone and with combination of SSW with Lime and without Lime.

5. Conclusion

The following conclusion are concluded that Stone slurry waste (SSW) can be used in bulk quantity for stabilization of clayey soil which will solve the problem of their disposal and will reduce the environmental pollution. In addition to this, if the use of clayey soil and stone slurry waste only for stabilization then there is decrease in OMC and increase in MDD with an increase in the total stabilizer content. Furthermore, the use of SSW and Lime as a stabilizer for improving the geotechnical properties of clayey soil is an economical and effective solution especially for the region which has large number of stone cutting industries.

So, the purposed method of stabilization can be used for improving properties of clayey soil in field and make it suitable to required engineering purpose. Also, present method is simple, economic and environmental friendly so can be used as an alternative to other expansive techniques used for stabilization of clayey soil.

6. Future Scope

There is always a scope to do something which has not been done and continuing with this there is a lot of scope of this kind of investigations. Effect of SSW and Lime on other engineering properties of clayey soil can be studied. Likewise, the effects of SSW on expansive soils can be studied.

Similarly, the effects of SSW and Lime on some other properties like water absorption, permeability, modulus of elasticity and shrinkage can be studied. In addition to this, the percentage of stabilizer (between 0 - 28%) other than combination made in present study can be studied.

REFERENCES

[1] Nabil Al–Joulani, “Stabilization of Stone Slurry Waste with Cement and Cohesive Soils” *International journal of applied engineering research* ISSN 0973-4562 volume 11, Number 9 (2016) pp 6236-6243.

[2] R Barani Dharan, (2016)” effect of waste paper sludge ash on engineering behaviors of black cotton soils” *International journal of earth sciences and engineering* ISSN 0974-5904, Volume 09, No. 03.

[3] Rajni Lakhani, Rajesh Kumar and Priyanka Tomar (2014), 'Utilization of Stone Waste in the Development of Value Added Products: A State of the Art Review.

[4] Anupam, Praveen Kumar and Ransinchung (2013), 'Use of agricultural and industrial waste materials in road construction,' *Procedia – Social and Behavioral Sciences*, Vol. No: 104, pp: 264-273.

[5] Nabil Al Joulani, (2012), "Effect of Powder and Lime on Strength, Compaction and CBR Properties of Fine Soils" *Jordan Journal of Civil Engineering* Volume 6, No. 1,2012

[6] Purbi Sen, Mukesh and Mahabir Dixit (2011), "Evaluation of strength characteristics of clayey soil by adding soil stabilizing additives*", International Journal of Earth Sciences and Engineering*, 4, 1060-1061

[7] Mousa F, atom & Magdi El-Emam, (2011), "Soil Stabilization Using Stone Slurry Waste Recovered from Cutting Stone Process in Rock Quarries", *Journal of Solid Waste Technology and Management*, V. 37, No. 2

[8] A. Seco, F. Ramirez, L. Miqueleiz, B. Garcia (2010), "Stabilization of Expansive soils for use in Construction", *Applied Clay Science* 51 (2011) 348-352.

[9] Mirsa, A., Mathur, R., Rao, Y., Singh, A. and Pankaj, Goel. 2010. A new technology of Marble Slurry Waste Utilization in roads, *Journal of scientific and industrial research*, 69; 67-72.

[10] Almeida N., Branco F. De Brito J. And Santos J.R. (2007). "High-performance concrete with recycled stone slurry" *Cement and Concrete Research* No. 37, Pp. 210-220.