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MUROOM STABILIZATION USING FLY-ASH AND GYPSUM – A REVIEW

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Abstract: **Muroom soil found locally finds application in majorly all the sites of construction. The soil in its natural state is stiff, hard and presents a very durable sub-surface for the overlying pavements or any other structure. However, the soil loses a lot of its strength when soaked or in damp and wet conditions. The cost of procurement and transportation also poses serious economic problems when the soil is required in large quantity. The review paper focuses on the studies conducted earlier on stabilization of existing soil using Fly-ash and Gypsum. The reuse of Fly-Ash which is a major industrial waste for strengthening and improving the properties of the soil would solve the major problems of disposal of Fly-Ash and the degrading air quality index due to Fly-Ash fumes. The use of Fly-Ash would make construction as well as soil stabilization more effective in terms of economy and the ease with which the materials can be procured. Gypsum majorly obtained from mining also finds use in soil stabilization. Various other forms and by-products of Gypsum such as Phosphogypsum, Marine-gypsum, FGD (Flue Gas Desulphurization) gypsum, Citro-gypsum etc. find major use in a wide variety of Industries as well as in Geo-Technical operations for the improvement in soil properties. The paper discuses about the tests and conclusions laid down by the works done previously on the process of soil stabilization using Fly-Ash and Gypsum. It also sheds some light on how muroom can be partially replaced by other industrial wastes as the cost of procurement of muroom is very high as compared to that of Gypsum which is easily available and cheap. The Pozzolanic actions of Fly-Ash, as well as the improvement in Soil Permeability due to Gypsum addition are the areas of interest in particular.**

Keywords: Muroom, Fly-Ash, Gypsum, Soil stabilization, Permeability, Pozzolanic action.

1. INTRODUCTION

Soil stabilization being the need of the hour is becoming a frequent phenomenon in improving the mechanical properties of the existing soil. Stabilization is essentially a process of improving the mechanical properties of the soil by the use of physical or chemical methods. The sole reason of treating the soil with industrial as well as agricultural waste is to increase strength, control deformation, improve permeability and make it durable for use in practical conditions [6].

The underlying or the sub-surface soil finds the basis or lays the foundation for the overlying structure or pavement. Soil a heterogeneous medium is composed of a variety of coarse and fine grained particles which largely affect its load bearing capacity and also modify the properties of the soil in its wet or soaked state.

Muroom mainly a form of lateritic soil is reddish brown in colour and has a very small percentage of fines. Sand and muroom mix are found to be durable but in the long run the muroom-sand mix loses its durability and the mix can no longer be used as a pavement sub-grade layer due upheaval and loss in shear strength due to water percolating into the soil [7]. Muroom soil constitutes majorly of coarse grained particles greater than 4.75mm in size and a very small amount of fines. The soil finds major use as sub-grade of pavement as it forms a very hard and durable strata for bearing the overburden pressure. But, a major drawback lies in the high cost of procurement as well as transportation of muroom which makes the use of this soil a little costly. Hence, it becomes necessary to replace the weaker material or stabilize the soil using the necessary stabilizers and additive to make the construction process cost-effective. Industrial wastes such as Fly-Ash in particular find application in such circumstances as a partial replacement for muroom in an attempt to stabilize highway pavements and embankments [1].

As per the reports of the Central Electricity Authority (CEA) the Fly-Ash generation in the country for the year 2019-20 was found to be 226.13 million tonnes against 678.68 million tonnes of coal consumed. The Fly-Ash utilization stood at 187.81

million tonnes recording a utilization of around 83.05%. Indian coal which is generally of low grade possesses ash content ranging from 30 to 45% as against the imported coals having ash content of the order of 2% to 15%. Coal/Lignite based thermal power plants are the largest consumers of coal and hence are majorly contributing to the production of Fly-Ash which requires a large piece of land for its disposal. Fly-Ash disposal remains an issue of concern as it takes up useful land and also pollutes the water and degrades the Air Quality Index (AQI) [2].

Industrial wastes such as Slag and Fly-Ash finds use in a variety of industries but still the rate of production of such wastes is higher than its consumption. The pozzolanic property of Fly-Ash can be used very effectively for the stabilization of in-situ weaker soil [3]. The Pozzolanic properties of Fly-Ash are influenced by the presence of free lime in it thus, by treating Fly-Ash with optimum quantities of Lime or Gypsum its self hardening properties can be enhanced [4].

One of the most problematic soils being highly compressible and having low shear and load bearing strength is black cotton soil which necessarily needs stabilization for it to be fit for use. The use of agricultural waste such as rice husk and Fly-Ash find use in soil stabilization and yields results which are comparable to muroom in its natural state [6].

Gypsum or Hydrated calcium sulphate is a rich source of calcium and finds major use in various geotechnical stabilization methods. As per the Indian Mineral Yearbook 2015 the total Gypsum resource has been estimated as 1,330 million tonnes out of which 37 million tonnes have been placed under the reserve category 1.293 million tonnes under the remaining reserves category [8]. Gypsum and its various other forms including by-products find application in a lot of industries such as cement, fertilizers, pottery, ceramics, chemicals etc. however, the chemical has also been used very effectively in soil stabilization.

Gypsum has a very unique property of enhancing or improving the pozzolanic activity and hence finds use in improving the index as well as engineering properties of the soil and other materials as well [9].

A thorough understanding of the physical, chemical and mechanical properties of the major industrial wastes helps in better interpretation of the chemical changes taking place during the soil-industrial waste interaction [10]. The use of locally available material not only increases the pace of the project but also makes it cost efficient. Chemical additives improve the bonding in the soil but, the rate at which this bonding takes place and the bond depends on the type of chemical additive used [11].

A wide variety of tests such as California Bearing Ratio (CBR) test, Unconfined Compressive Strength (UCS) test, Standard and Modified Proctor tests, Atterberg's Limit and Sieve Analysis tests have been performed and the test results have been tabulated and studied thoroughly.

2. LITERATURE REVIEW

a. Stabilization using Fly-Ash

Sagar D. Turkane et al (2021) the study investigates the slope stability analysis and geotechnical properties of Muroom mixed with Fly-Ash for the construction of embankment. Mix were prepared by varying the percentage of Fly-Ash as 15%, 20%, 25% and 30% respectively by the dry weight of the sample of Muroom. The index properties and strength characteristics of the soil were evaluated by conducting the required tests. A maximum factor of safety of 1.55 is reached at an optimum Fly-Ash percentage of 30% with 6m height of embankment. On addition of Fly-Ash the soil becomes non-plastic and the dry density decreases with percentage increase in the Fly-Ash content thereby giving optimum results at 3m height of embankment.

H. N. Ramesh et al (2016) studied the effect of Fly-Ash on lithomargic soil treated with lime and sodium salts. Lithomargic soil is non-expansive clay mainly consisting of kaolinite clay mineral structure. The Fly-Ash percentage ranged from 10% to 50%. The compaction characteristics were found to reduce and further the soil was treated with lime and sodium salts ranging from 1% to 6% which resulted in the formation of cementatious compounds due to enhanced Pozzolanic action and increased the strength 2 to 4 times as per the results of the Unconfined Compression Strength (UCS) tests.

Manjul Chandravanshi et al (2014) the paper reflects the stabilization of silty sand using a combination of Fly-Ash and Gypsum. Fly-Ash in varying proportions of 0%, 10%, 15% and 20% along with Gypsum in percentages of 2% to 4% were added to the soil and the compaction characteristics which included the Maximum Dry Density (MDD) and the Optimum Moisture Content (OMC) of the soil were studied. The paper concluded that the soil showed better behavior when treated with a mix of Fly-Ash and Gypsum relative to the soil being treated with Fly-Ash alone.

M. R. Vaidya et al (2018) compared the test results of Muroom with Black Cotton Soil stabilized using Fly-Ash and Rice-husk. A mixing ratio of 15% was adopted and the Atterberg's Limit, California Bearing ratio and the Unconfined Compressive Strength (UCS) test results were observed. The study concluded that Muroom and stabilized Black Cotton Soil showed almost similar test results and hence, it was concluded that Fly-Ash and Rice Husk prove to be effective soil stabilizers.

Amarabati Paul et al (2020) the research paper focuses on improving the sub-grade material performance by the use of different soil mix along with Lime and Gypsum as stabilizers. Fly-Ash as the main additive varied from 9.7% to 30%. Lime and Gypsum proportions varied from 2% to 3%. Muroom and Silver sand were used as the main sub-grade material. The results of California Bearing Ratio (CBR) test, Unconfined Compressive strength (UCS) and Proctor tests showed that the Muroom Fly-Ash mix was a better replacement to the conventional graded Coarse aggregate for use in sub-soil pavement layers.

Sona Adeep et al (2016) the technical paper focuses on the use two major industrial wastes that is Fly-Ash and Gypsum along with chemical additives such as Calcium Chloride and Sodium Silicate for soil stabilization. The soil obtained from quarry site was treated and the optimum percentage of the mix was obtained based on strength tests. There was a significant improvement in CBR (California Bearing Ratio) value and the strength of the soil.

b. Stabilization using Gypsum

K. Sarath Chandra et al (2021) red mud a waste obtained while extracting Alumina from Bauxite in the Bayer's process was stabilized using Gypsum. The Gypsum proportion varied as 2%, 4%, 6%, 8% and 10% by dry weight of red mud. The mix was stabilized and strength tests were performed. The treated and un-treated red mud samples were compared based on the results of Unconfined Compressive strength (UCS) test and the California Bearing Ratio (CBR) test. The paper concluded that treated red mud can be used effectively as a construction material as Gypsum increases strength by enhancing the Pozzolanic Action.

P. K. Kolay et al (2010) peat a high compressibility and low shear strength soil was stabilized using Fly-Ash and Gypsum. Gypsum varied as 2%, 4%, 6% and 8% while Fly-Ash content varied from 5% to 25%. The results of Proctor and Unconfined Compressive Strength (UCS) Tests were analyzed which showed that the strength of the soil increased with increased curing periods.

B. Ganesh et al (2016) the paper investigates the effect on the engineering properties of silty clayey soil by using compounds such as sodium chloride and Gypsum. The salts varied in proportion as 15%, 20% and 25%. The affect of the stabilizing agents on the properties of the soil were observed. The strength parameters were found to increase along with a decrease in the values of the Atterberg's Limits on increasing the proportion of the various salts. Hence, the soil was chemically stabilized by altering the soil structure and binding the organic contents more strongly to the clay particles.

Herri Purwanto et al (2020) the paper deals with stabilizing soft clay using Gypsum Plafond waste. The Gypsum Plafond Waste varied as 5%, 10%, 15%, 20% and 25%. California Bearing Ratio (CBR) tests for both soaked and Un-soaked conditions were performed. A highest CBR value of 11.44% was obtained for the soaked condition whereas a value of 15.45% was obtained in the Un-soaked condition. There was a significant improvement in the soil properties.

3. CONCLUSIONS

The above studies have thoroughly analyzed the various mixes and the tests results have been tabulated and reported to the best of the proficiency. Following conclusions and inferences are noted-

- The use of major industrial waste such as Fly-Ash and Gypsum solves the problem of waste disposal and health hazards posed by these wastes.
- A cost effective and efficient method of soil stabilization has been the prime focus of most of the research work.
- An attempt has also been made to partially replace soil by industrial waste such as Fly-Ash.
- The use of locally available and cheaper alternative materials has been worked upon effectively.
- A range of tests such as Atterberg's limit, Proctor tests, Unconfined Compressive strength (UCS) test, California bearing Ratio (CBR) test, shear and stability analysis reflect that the properties of the soil are improved and enhanced for different soaking conditions as well.
- Environmental impacts and the Economics of the project have been taken into due consideration.
- The use of Industrial waste in the Soil Engineering area has been encouraged significantly.

REFERENCES

[1] Sagar D Turkane and Sandeep K Chouksey (2019), "Partial Replacement of Moorum with Fly-Ash in Embankment", Lecture Notes in Civil Engineering, 2019, Volume-77, select proceedings of ICRTICE, 2019, SPRINGER. ISSN: 2366-2557, ISSN: 2366-2565(electronic).

[2] Report on Fly Ash generation at coal/lignite based thermal power plant and its utilization in the country for the year 2019-20. Central Electricity Authority (CEA), Thermal civil design division, New Delhi, November 2020.

[3] H.N Ramesh, Nanda H.S, Phalachandra H.M (2016), "Effect of Fly-Ash on the strength characteristics of Lithomargic soil treated with Lime and Sodium salts", International Journal of Innovative Research in Science, Engineering and Technology, volume-5, issue 12 , December 2016, ISSN (online) : 2319-8753, ISSN (Print) : 2347-6710.

[4] Manjul Chandravanshi (2014), "A laboratory investigation on the compaction properties of soil mixed with Fly-Ash and Gypsum", International Journal of Scientific and Research Publications, Volume 4, Issue 10, October 2014. ISSN: 2250-3153.

[5] Jitesh Rana (2016),"Effect of Fly-Ash and Agricultural Gypsum on Engineering properties of Clayey soil", Indian Geotechnical Conference, 2016.

[6] M.R. Vaidya and Dr. H.H. Shinde (2018), "Comparative study of Moorum and Stabilized Black Cotton Soil by 15% addition of Fly-Ash and Rice Husk Ash", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 7, Issue 11, 2018, ISSN(online): 2319-8753, ISSN(print): 2347-6710.

[7] Pinak Ray, Amarabati Paul, Sourav Ghosh, Kanishka Sarkar and Ranendra Narayan Sen (2020), "An Experimental study on Fly-Ash with Lime and Gypsum for quality improvement in pavement sub-grade material", Springer Nature Switzerland AG 2020, doi/10.1007/s42452-020-03852-2.

[8] Indian Minerals Year Book 2020, PART-III, mineral reviews, 59th edition. Release date – July, 2021.

[9] K Sarath Chandra and S Krishnaiah (2019), "Evaluation of Strength Development of Untreated and Treated Red Mud with Gypsum as a road Construction Material", Lecture Notes in Civil Engineering, 2019, Volume-77, select proceedings of ICRTICE, 2019, SPRINGER. ISSN: 2366-2557, ISSN: 2366-2565(electronic).

[10] Dr. N Srinivasa Reddy and Sona Adeep (2016), "Stabilization Techniques for local soils using Fly-Ash, Gypsum and Chemical additives in Rural Housing and Infrastructure", International Journal of Innovation in Engineering and Technology (IJIET), Volume 6 Issue 3 February 2016, ISSN: 2319-1058.

[11] Kolay P K and Pui M P (2010), "Peat Stabilization using Gypsum and Fly-Ash", UNIMAS E- Journal of Civil Engineering, vol. 1: issue 2 / April 2010.

[12] GVLN Murthy, K.B.V. Siva kavya, A. Venkata Krishna, B Ganesh (2016), "Chemical Stabilization of Sub-grade soil with Gypsum and NaCl" International Journal of Advances in Engineering & Technology (IJAET), ISSN: 22311963.

[13] Herri Purwanto, Agus Setiobudi, Reffanda kurniawan Rustam (2020), "Stabilization of soft clay using a Gypsum Plafond Waste based on CBR testing", International Journal of Scientific and Technology Research volume-9, issue 02, February 2020.