6th International Conference on Recent Development in Engineering Science, Humanities and Management
National Institute of Technical Teachers Training & Research, Chandigarh, India (ESHM-17)
14th May 2017, www.conferenceworld.in ISBN: 978-93-86171-36-8

STABILIZATION OF CLAYEY SOIL BY USING STONE SLURRY WASTE AND CEMENT

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ABSTRACT

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 (CaCO3) is the main constituent of slurry waste in addition to other minerals from parent rock. 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.

This study aims to investigate the potential utilization of stone slurry waste and stabilization of clayey soil. 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 Portland cement. Appropriate amount of water added and mixed. Treatment of clayey soil using stone slurry waste and cement is very simple, economical and pollution controlling. Stone slurry waste and cement were mixed in different percentage with parent soil and various geotechnical characteristics were investigated through standard proctor test (SPT) and unconfined compression test (UCS). Result shows that there is significant effect on geotechnical characteristics of clayey soil due to additions of stone slurry waste and cement which shows effectiveness in stabilizing the clayey soil and encourages their utilization.

keyword: Stone slurry waste, cement, clayey soil, soil stabilization, SPT, UCS.

I. INTRODUCTION

If weak soils exist, stabilization and improvement of their properties is necessary. The stabilizing process aim to increase the soil strength and reduce 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. Expansive soil possesses great threat for the construction of buildings due to its less characteristic shear strength, high swelling and shrinkage characteristics. During the last few decades, damage due to swelling action has been observed clearly in the semi-arid regions in the form of cracking and breakup of pavements, roadways, building foundations, slab-on-grade members, channel, reservoir linings, irrigation systems, water lines, and sewer lines. In order to control this behavior, the expansive soils have to be suitably treated with

ISBN: 978-93-86171-36-8

industrial solid waste (stone slurry waste) or any other available materials which can alter its engineering behavior.

Hence appropriate measures are to be taken for the improvement of properties of soils, preferably before conducting construction work. A wide range of soil improvement methods has been used, including soil replacement, dynamic compaction, lime/cement 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.Soil stabilization is one of the oldest ground improvement techniques. Soil stabilization is the process of improving the engineering properties of soil and thus making it more stable. It is required, when the soil available for construction is not suitable for the intended purpose. Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength and bearing capacity of foundation soils. The main objective of soil stabilization is to increase the strength of soil and to reduce the construction cost by making best use of the locally available materials. 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. The study aims to investigate using of the stone slurry waste and using specific amount of Portland cement to stabilizing the cohesive soil. The stone slurry waste taken from stone cutting plant was dried, grinded to fine particle and then mixed with specific amount of Portland cement and cohesive soil.

II. NEED OF STUDY AND SCOPE

The main objective of this research is to utilize stone slurry and cement in the improvement of clayey soil properties. The two additives are cheap and available in commercial quantities. It is expected that, the cohesive soil will induce a cohesion effect in the mixture and the Portland cement will induce bonding between particles. This research will help dispose large quantities of stone slurry waste. The stabilization and utilization of stone slurry waste as construction materials, and will help mitigate its environmental and health impacts.

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. Construction activities on expansive soil require the stabilization of soil prior to the start of work. 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. 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. Clayey soil under goes much expansion and shrinkage due to wetting and drying conditions which is one of the most undesirable feature. 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

ISBN: 978-93-86171-36-8

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.

The main objective of this paper is to utilization of industrial solid waste in field of geotechnical engineering. A lot of research has been done for the stabilization of clay soil using conventional materials but using stone slurry waste in new one.

II. MATERIAL USED

Soil: Clayey soil was collected from the field of Dayalpur village district Kurukshetra from the depth of 0.3 to 0.5m below the ground surface and thoroughly hand sorted to eliminate vegetative matter and pebbles. Soil was oven dried for 24 hours before investigation its properties as per various IS codes. Soil sample was sieved through 4.75 mm IS sieve for the removal of gravel fraction. Engineering properties investigated are shown in table 1.

S. NO.	Property	Typical value
1	I.S. Classification	CI
2	Plastic limit	23
3	Liquid limit	56
4	Plasticity index	33
5	MDD, gm/cc	1.6
6	OMC %	26.32
7	Specific gravity	2.55

Table- 1

Stone slurry waste: It is the by product material generated by cutting and shaping of building stones in the stone 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. The chemical composition of stone slurry powder may vary depending on the origin of parent rocks. Basically, the stone slurry powder is composed of calcite, as denoted by high content of CaO and loss of ignition.

The physical and chemical properties of stone slurry waste has been reported in several studies [Miesa et al. (2008); Gupta R. C. 2002 and CBRI, (1997)].in table 2 and table 3 presents the properties of stone slurry waste from this research and other researches

Physical properties of stone slurry waste:-

S. NO.	Properties	Values By Author	Values (Mirsa et al. 2008)	Range (CBRI,1997)
1	Specific gravity	2.45	2.67	2.5-2.8
2	Liquid limit	23%	18.05%	12.0-21.0%

ISBN: 978-93-86171-36-8

3	Plastic limit	N.P.	N.P.	N.P.
4	Shrinkage limit	26%	23%	15.0-33.0%

Table-2

Chemical properties of stone slurry waste:-

S. No.	Properties	Values (By Author)	Values (Mirsa et al. 2008)	Values (CBRI,1997)
1	SiO2	3.14%	2.76%	2.5-2.8%
2	Fe2O3	2.43%	0.40%	0.3-3.5%
3	Al2O3	4.72%	0.98%	0.8-6.0%
4	CaO	43.80%	34.90%	20.0-45.0%
5	MgO	5.64%	18.96%	0.2-20.0%
6	L.O.I	40.50%	41.92%	15.0-45.0%

Table-3

Cement: Cement is a very fine material used in many construction applications. Cement is obtained by pulverizing clinker formed by calcinating raw materials primarily consisting of lime(cao), silica(sio2), alumina (al2o3), and iron oxide (Fe2O3).there are many type of cement depending on its chemical composition and contents of calcium and magnesium. There are several studies which addressed the importance of using lime as a construction material and for soil stabilization in particular. Cement improves the strength of fine soil by three mechanisms: hydration, flocculation and cementation. The first and second mechanisms occur almost immediately upon introducing cement. In our case we use Portland cement.

III. SAMPLING AND METHODOLOGY

SAMPLE: Total 4 sample were made with the combination of stone slurry waste and cement with parent soil which are shown in table 4

Sample No.	Description
1	Soil = 100%, SSW = 0%, Cement = 0%
2	Soil = 70%, SSW = 25%, Cement = 5%
3	Soil = 60%, SSW = 33%, Cement = 7%
4	Soil = 50%, SSW = 40%, Cement = 10%

Table- 4

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SSW – Stone Slurry Waste

A. Compaction studies:

The objective of this test is to determine the maximum dry density and optimum moisture content at different percentage of additives and on the parent soil to use these results in the preparation of UCS specimen. Table 5 presents the standard proctor test results and figure 1 shows the variation of dry density values with moisture content for all soil samples with different percentages of additives. Figure 2 presents the variation of dry density with percentage of additive (SSW).

B. Summary of proctor tests on soils with additives:

Sample no.	% additive (SSW)	OMC %	MDD (gm/cc)
1	0%	21.00%	1.65
2	25%	19.00%	1.77
3	33%	16.51%	1.86
4	40%	14.84%	1.95

Table- 5

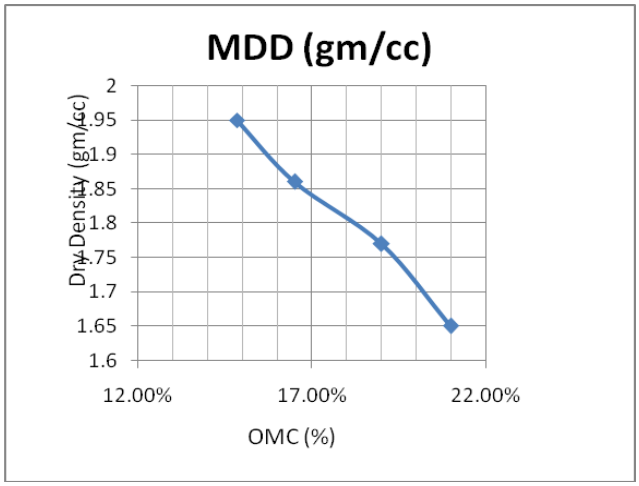

Figure- 1

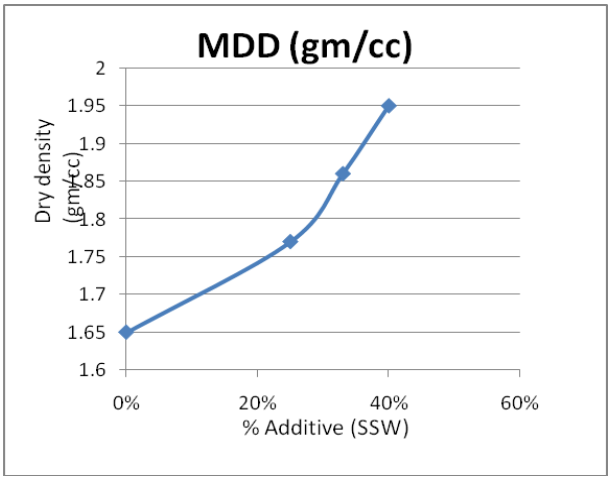

Figure- 2

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C. Unconfined Compressive Strength

The unconfined compressive strength tests were conducted on the optimum from standard proctor tests. The size of the samples prepared was 38 mm diameter and 76 mm length. The variations of UCS for all samples are presented in figure 3. It has been seen that the UCS of the clay samples have been increased with the percentage of SSW.

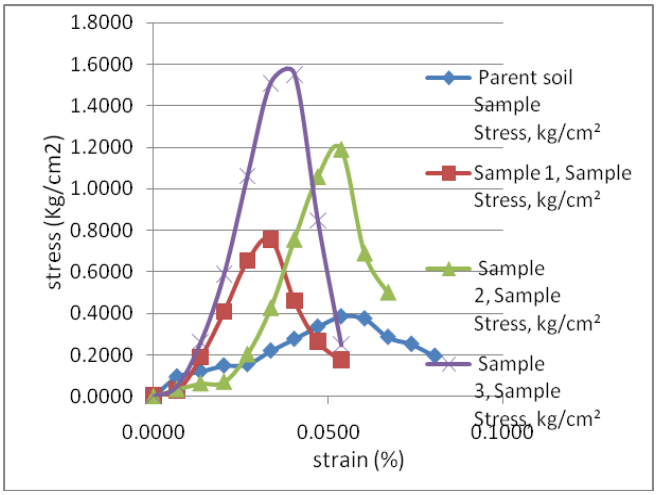

Figure 3

IV. CONCLUSION

The following conclusions were can be drawn from the experimental work carried out investigation on soil samples:

1. There was increase in MDD and decrease in OMC as there was increase in total stabilizer content.
2. There was considerable increase in UCS as stabilizer content is increased when stabilizer content is increased from 0% to 40 %.
3. By this investigation we find that SSW proves to be effective in stabilization of clayey soil and its utilizatilization also solves the problem of its disposal and environmental.

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