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Evaluating the Effect of Saw Dust Ash, Egg Shell Powder and Polypropylene on Geotechnical Properties of Expansive Soil

Irfan Yousuf Wani¹, Er. Neeraj Sharma², Mir Tariq Khurshid³

P.G. Student, Department of Civil Engineering, SSCET, Pathankot Punjab, India^{1,3}

Asst. Professor, Department of Civil Engineering, SSCET, Pathankot Punjab, India²

ABSTRACT: Soil is one of the most important and dynamic material used in various construction projects including multi storied buildings, earth canals etc. The fact that soil may provide all the resistance characteristics necessary for a project illustrates the importance of soil to be strong enough to bear the designed standard loads. Most of the soil failures have been attributed to its poor strength. As we know stabilization of soil by adding lime, cement, bitumen etc. are expensive and therefore require an economic replacement. In egg consumption, India has 5th rank in the world. Hence a huge amount of eggshell wastes are produced every year. In the absence of an effective waste disposal, the utilization of eggshell for soil improvement will be a welcome development. In the same way, Saw Dust Ash could be employed for such similar reasons. Polypropylene has been added as a fibre and resulted in the improvement of tensile strength of expansive soils. In this thesis work, We have studied about the suitability of Egg Shell Powder, Saw Dust Ash and Polypropylene as possible additive materials to improve the strength of soil. Soil samples were collected and stabilized with these additive materials in different proportions. The engineering properties were carried out to access the behaviour of soil with the addition of these additive materials. Addition of Egg Shell Powder, Saw Dust Ash and Polypropylene to soil sample lead to increase in strength and decrease in its Swelling properties. This research investigates an experimental study of improving engineering properties of soil with Egg Shell Powder, Polypropylene and Saw Dust Ash.

KEYWORDS: Egg Shell Powder, Polypropylene, Saw Dust Ash, Stabilisation

I. INTRODUCTION

Nature has bestowed us with everything in its pure form but man has polluted it in a number of ways. Soil is one of the greatest gifts from nature. India is experiencing an unprecedented growth of its urban center due to its developing economy and industrialization. The rapid progress and research over recent past, leads the engineers to accept framed structures as against conventional load bearing structures.

Soil is the uppermost unconsolidated material of the earth present naturally in the universe. It is formed by the decomposition of rocks under the influence of naturally occurring conditions such as wind, rain, snow, heat, etc. It is abundantly available and is the cheapest construction material. It is a complex material because of its highly variable composition and characteristics. The characteristics of soil change according to topography and its location. For safer construction, the properties of soil should match with the design requirements of an engineering structure. Geotechnical engineer plays an important role in this work for checking whether the requirements of the structure are fulfilled by the soil or not. Construction of engineering structures on poor soil involves a great risk. These soils show settlement, low shear strength and high compressibility.

Soil being very dynamic in nature, its properties depend upon several factors such as location, climatic condition of the area, its constituent materials and temperature etc. Very often the available soil is not suitable for construction purposes. Strength, permeability and stability is not as desired by the geotechnical engineers. For studying the engineering

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behavior of soil, we have to deal with the stability of underground structures, retaining structures, foundations, slopes, earthen dams and pavement construction.

II. MATERIALS

(I) SOIL

Expansive Soil were used in this research work. Stability of every structure depends on the type and characteristics of foundation which in turn depends on the type of soil. Many problems erupt if expansive soil or natural soil is to be used in foundation, because of its shrinkage and swelling properties. There are many methods to make natural soil stable for various constructions. Natural soil is comfortable for road work, compared to other types of soil. There are two ways to enhance the quality of sub grade soil -“Replacement of soil” or “Soil stabilization”.

Table 1: Summary of basic properties of the parent soil collected for the experiment.

S.NO	SOIL PROPERTY	SAMPLE
1	Site from where soil is taken	20km from Budgam town
2	Color of Soil	Light Brown
3	Depth at which sample are taken in meters	0.1 m to 0.5 m
4	Nature of soil	Clay Type
5	Classification from plasticity chart	CL

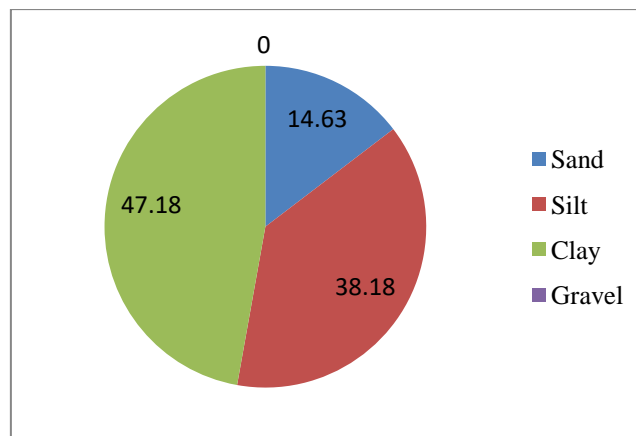


Fig.1: Percentage of different constituents in the selected sample

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Table 2: Typical values of OMC, MDD etc of the concerned sample.

S. No.	Properties	Values
1	OMC	24%
2	MDD	1.82 gm/cc
3	CBR	1.74 %
4	UCS	0.96 kg/cm ²
5	Specific Gravity	2.63%
6	Liquid Limit	48.66%
7	Plastic Limit	27.82%
8	Plasticity Index	21.84%
9	pH	4.06

(II) Saw Dust Ash

Saw dust is one such by-product from Timber industries and Wood cutting factories. Saw dust, itself has little cementitious value but in the presence of moisture it can react and could form cementitious compounds and attributes to the improvement of strength and compressibility characteristics of soils. So in order to achieve improvement in geotechnical properties of soils and also to make use of the industrial wastes, the present experimental study has been taken up.

After collection, Saw dust was cleaned and unwanted impurities like bark and organic content was removed and then it was dried in open atmosphere and burnt. The Saw Dust Ash (SDA) was then sieved through 600 micron sieves to remove the lumps, gravels, unburnt particles and other materials which are detrimental to soil. The Saw Dust Ash passing through 600 microns sieve was used for the laboratory work.

(III) Egg Shell Powder

Eggshells has not been in common use in soil engineering as a stabilizing material and it could be a good replacement for artificially synthesized lime, since its chemical composition is similar to that of lime. Its composition primarily contains calcium, magnesium carbonate (lime) and protein. Egg shells may be of any Oviparous animal. As per ease we have taken chicken egg shells. Chicken eggshell is a waste material from domestic sources such as poultries, hatcheries, homes and fast food joints. The high amount of calcium oxide is associated with the presence of calcium carbonate, which is the main percentage component of eggshell. Thus, the eggshell waste can be considered from the chemical analysis quite similar to calcite calcareous.

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(IV) Polypropylene

Polypropylene (PP), also known as polypropene, is a thermoplastic polymer used in a wide variety of applications. It is produced via chain-growth polymerization from the monomer propylene. It belongs to the group of polyolefin and is partially crystalline and non-polar. Its properties are very similar to polyethylene, but it is slightly harder and more heat resistant. It is a white, mechanically rugged material and has a high chemical resistance. PP is the second-most widely produced commodity plastic (after polyethylene) and it is often used in packaging and labeling. In 2018, the global market for polypropylene was about 85 million tones.

III. METHODOLOGY

Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on natural soil and stabilized soil with PP, ESP and Saw Dust Ash.

3.5.1 Atterberg's Limit Test

3.5.2 Standard Proctor Test

3.5.1 Atterberg's Limit Test

IV. EXPERIMENTAL RESULTS

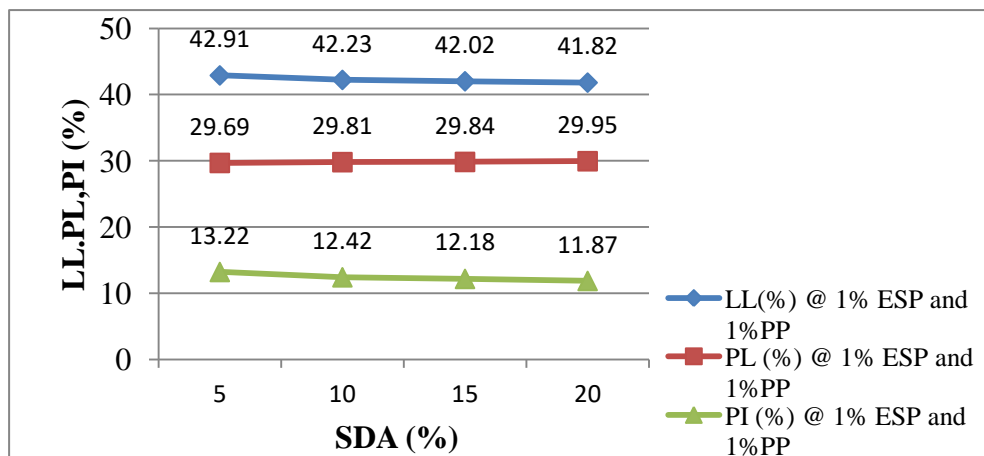


Fig. 2 Variation of LL, PL and PI by varying SDA (5% - 20%) With ESP(1%), PP (1%)

From the above test results we found that there is a gradual decrease in liquid limit and vice versa in plastic limit. On increasing the SDA percentage from 5% to 20% in soil keeping PP and ESP fixed at 1%, we found that liquid limit decreased from 42.91% to 41.82% whereas plastic limit increased from 29.69% to 29.95%

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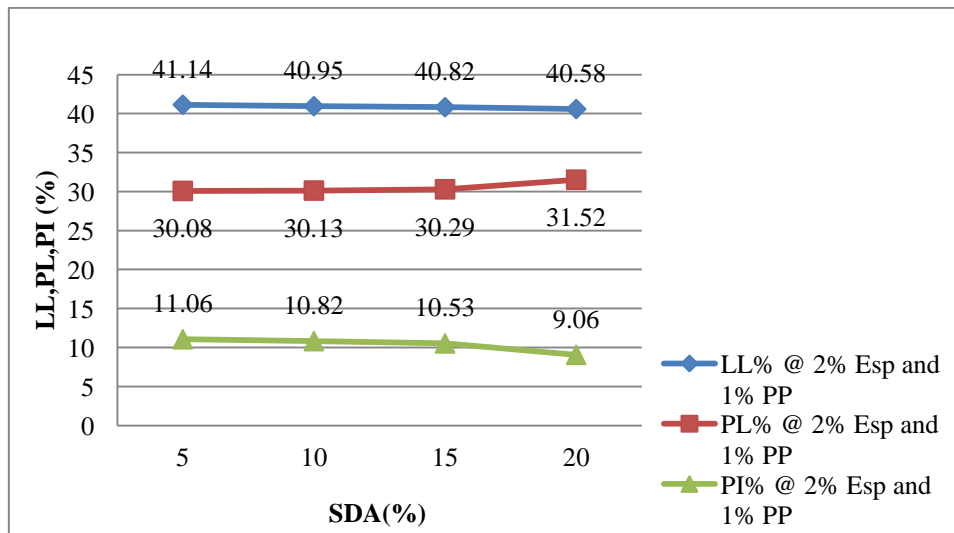


Fig. 3 Variation of LL, PL and PI by varying SDA (5% - 20%) With ESP (2%) and PP (1%).

The graph above shows us clearly that on keeping percentage of Egg Shell Powder and Polypropylene fixed at one percent, liquid limit of the said sample gets decreased by increasing Saw Dust Ash at an interval of 5%. And plastic limit shows the reverse behaviour.

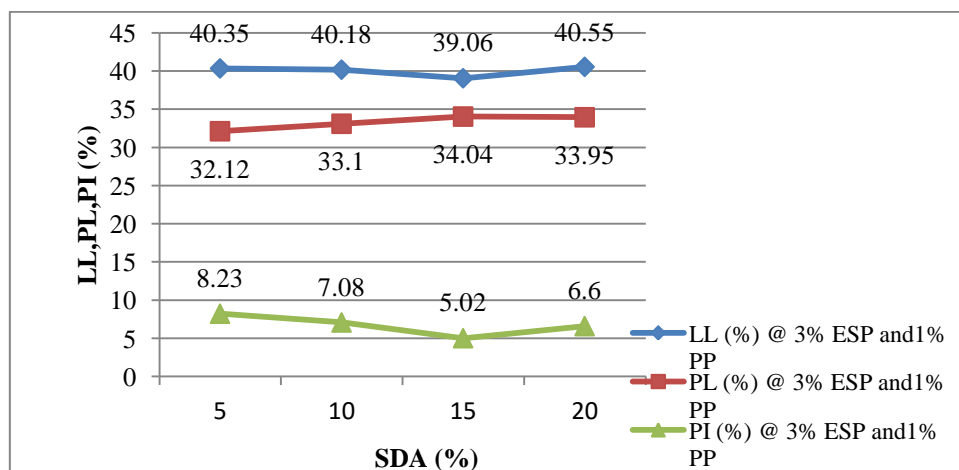


Fig. 4 Variation of LL, PL and PI by varying SDA (5% - 20%) With ESP (3%), PP (1%)

The graph clearly represents that the liquid limit shows a gradual decrement upto 15% addition of SDA in an expansive soil by keeping ESP 3% and PP at a fixed proportion of 1%. On adding more percentage of SDA it showed that vice versa characteristics.

From the above graph (Fig. 4) it could be concluded that 15% addition of SDA with 3%ESP and 1% PP (mix proportion) is the optimum value upto which liquid limit of the said soil could be decreased.

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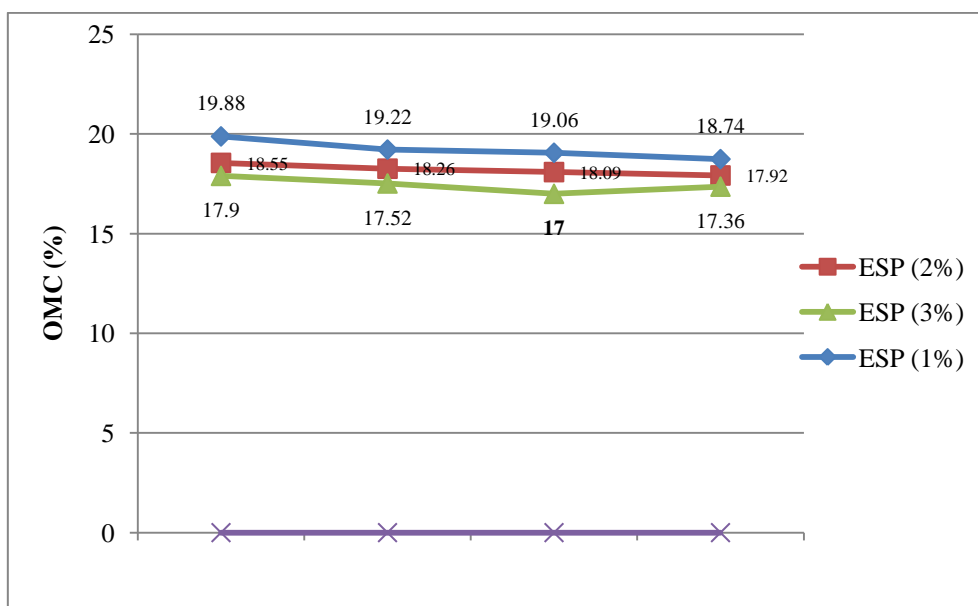


Fig. 5 OMC at (1% - 4%) of ESP with 1% PP and varying combinations of Soil.

Optimum moisture content enables us to know the maximum water content at which soil can be compacted to its extreme level. From the above graphical presentation we could easily predict that the OMC of this soil here in this case is at 3% of ESP and is 17 percent.

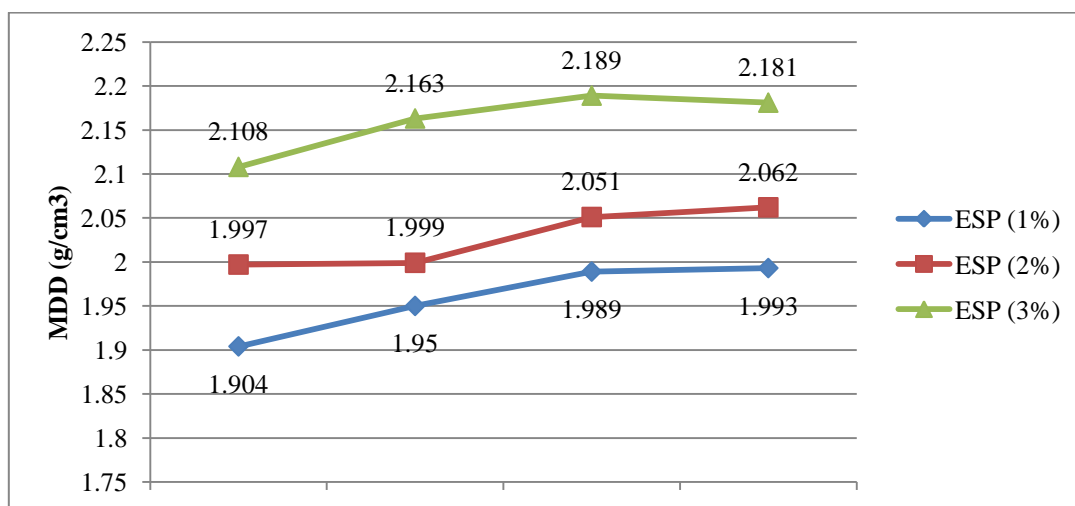


Fig. 6 MDD at (1% - 4%) of ESP with 1% PP and varying combinations of Soil.

Maximum Dry Density increases with the increase in ESP percentage in the said soil specimen. From the test results we found that maximum dry density attained its maximum value of 2.189 gm/cm³ on mixing 3% ESP with the soil having a mix proportion of 1% of PP and 15% of SDA in it.

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Vol. 8, Issue 11, November 2019

V. CONCLUSION

The physical properties and engineering characteristics of virgin soil were studied, which includes moisture content, compaction characteristics and unconfined compressive strength. The addition of Saw Dust Ash (SDA) improved the properties of the virgin soil, making it good for sub-base material.

The following conclusions were made from this experimental study:-

1. We can utilize the eggshell waste as a useful soil stabilizing material. By using the eggshell powder as a soil stabilizer, we can minimize the waste disposal problem of eggshell.
2. The optimum usage of Egg Shell Powder added to the soil was 3%.
3. The liquid limit of the soil decreased from 48.66% to 39.06% whereas, Plastic limit showed a rise from 27.82% to 34.04%.
4. The maximum dry density of soil increased from 1.82gm/cm^3 to 2.189gm/cm^3 on adding 15% SDA, 3% ESP and 1% PP.

Keeping everything in consideration, it can be concluded that fiber reinforced soil can be considered as a good ground improvement technique specially in engineering projects and Egg Shell Powder acts as a cementitious material on weak soils where it can act as a substitute to deep/raft foundations, and makes it economical in all respects.

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