Stabilization of Expansive Soil by using Agricultural Waste

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ABSTRACT--- Generating large quantities of agricultural waste worldwide is facing serious handling and disposal problems. Agricultural waste disposal creates a potential negative environmental impact that causes air pollution, and water pollution ultimately affects local ecosystems. therefore, safe disposal of agricultural waste becomes a challenging task. In many situations, expansive soil has swell when the water comes, and it will shrink it can cause serious problem to the buildings because of swelling characteristics, so we need to improve the characteristics of geotechnical properties. The purpose of this paper is therefore to investigate the use of certain agricultural waste such as corn cob ash, egg shell powder to stabilize the expansive soil. The results of these tests showed improvement in UCC value and swell pressure with the increase in percentage of waste. Hence there is a value addition to these three agricultural wastes serving the three benefits of Safe disposal of wastes, using as a stabilizer and return of income on it. The expansive soil is treated separately at 4% with the above three wastes, 8% and 12% with UCC test and swell pressure being performed. Agricultural waste disposal creates a potential negative environmental impact that causes air pollution, and water pollution ultimately affects local ecosystems. For engineers, therefore, safe disposal of agricultural waste becomes a challenging task. This paper is therefore intended to investigate the use of certain agricultural waste such as corn cob Ash (CCA) and Egg shell powder (ESP).

Key Words: Expansive soil, corncob ash, Egg shell ash.

1. INTRODUCTION

In many parts of India, expansive soils pose a significant hazard to light building foundations. Swelling clays from residual soils may exert pressure to elevate. Expansive soils due to the presence of swelling clay minerals. As they get wet, the clay minerals absorb and expand water molecules; on the other hand, as they dry, they shrink, leaving large vacuums in the soil. Swelling clays can control the behavior of virtually any soil if the percentage by weight of clay exceeds 5 percent. The most profound swelling properties are found in soils with smectite clay minerals, such as montmorillonite. In the field, the deep cracks, in roughly polygonal patterns, on the ground surface can easily recognize expansive clay soils in the dry season. The zone of fluctuation of the seasonal moisture content may extend from 3 to 40 feet deep. This creates cyclic shrink/swell behaviour in the upper portion of the soil column, and cracks can extend to much greater depths than imagined by most engineers. In the upper part of the soil column, this creates cyclic shrink / swell behaviour, and cracks can extend to far greater depths than most engineers imagine. The most obvious way to damage the foundations of expansive soils is by elevating as they swell with increasing moisture. Swelling soils lift and crack slightly loaded, continuous strip bases, often causing distress in floor slabs.

1.1 Scope of study

The aim of the research work therefore, was to further find use for corncob ash and Egg shell powder as a stabilization of expansive soils in the belief that the more use that is found for biomass wastes like corncob and egg shell the less they will constitute an environmental hazard. The specific objective of this work is to investigate the influence of corn cob ash and egg shell powder on the geotechnical properties of locally available soil namely; Free swell Ratio, swell pressure and the Unconfined Compression Strength.

2. METERIALS AND METHODOLOGY

In this study following materials are taken in to consideration.

- Expansive Soil
- Egg Shell Powder
- Corn cob Ash

2.1 Expansive soil:

Expansive soils, also known as swell - shrink soil, tend to shrink and swell with moisture content variation. Because of this soil variation, there is considerable distress in the soil, followed by damage to the surrounding structures. During periods of higher humidity, such as monsoons, these soils absorb water and swell; subsequently they become soft and their capacity to hold water decreases.

2.2 Corncob ash:

Corncob consists of three natural parts: the chaff and the pith that forms the light part and the woody ring that forms the cob's hard part. Ash is the residue of burnt parts of plants such as bark, wood, sawdust, leaves, woody debris, pulp, husk, hulls, fronds and other plant debris. Ash has been used for soil liming and for traditional pest controlled to some crawling pests. Corncob ash is obtained from the residue of combusted corncobs.

2.3 Egg Shell Powder:

Chicken eggshell is a waste material from domestic sources like poultry, hatcheries, homes and restaurants for fast food. They spread eggshells on the ground and dried air for 2 days to facilitate easy friction. The eggshells were broken manually after air drying and milled into powdery forms collected in bags of polythene. Finally, the eggshell powder was sieved through a sieve of 425µ. Eggshell

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powder contains 99.83% of CaO and the rest is made up of Al2O3, SiO2, Cl, Cr2O3, MnO and CuO. A good quality eggshell will contain, on average, 2.2 grams of calcium in the form of calcium carbonate. Approximately 94% of a dry eggshell is calcium carbonate and has a typical mass of 5.5 grams,1 although these values can differ depending on sources. Eggshell Powder Is an Effective Calcium Supplement. Eggshells consist of calcium carbonate, along with small amounts of protein and other organic compounds. Calcium carbonate is the most common form of calcium in nature, making up seashells, coral reefs and limestone.

Table 01 Properties of Soil:

	Parameters	values
1.	Liquid limit	70%
2.	Plastic limit	31.33%
3.	Plasticity index	38.67%
4.	Shrinkage limit	10.54%
5.	Shrinkage Index	16.9%
6.	Specific Gravity	2.70
7.	Optimum Moisture Content	28.5
8.	Max Dry density	1.7g/cm^2
9.	Swell Index	60%
10.	Swell pressure	40.76 kn/m
11.	ucs	86.7 kpa
12.	**Grain Size Distribution**	
	Gravel	0%
	Sand	12.11%
	Silt and Clay	87.89%

2.4 Experiment details

Study on Soil Properties using varying percentages of Egg Shell Powder and corn cob Ash consisted of

Proctor Compaction Test

Unconfined Compressive strength

Free swell index

Swell pressure

The result of optimum moisture content and maximum dry density for stabilized soil.

Table 02proctor compaction test:

Soil With stabilized Material	OMC %	MDD g/ cm^3
4% (CCA)	22	1.5
8% (CCA)	23	1.52
12% (CCA)	21	1.53
4%(CCA) and4% ESP	20	1.63
8% (CCA) and 8 % ESP	21	1.49
12% (CCA) and12 % ESP	19.1	1.62
4% (CCA) and 8 % ESP	24.2	1.67
4% (CCA) and 12 % ESP	25.7	1.71
4% (ESP)	21	1.49
8% (ESP)	22.2	1.57
12% (ESP)	23.1	1.61
8% (CCA) and 12% (ESP)	22.8	1.59

The result of unconfined compressive strength on stabilized soil in Kpa.

Table 03 Unconfined Compressive strength for corn cob ash:

Corn cob ash	0 days	14 days	21 days	28 days
4 %	92.1	107	124	132.5
8 %	107	109.2	115.2	121.7
12 %	87.2	90.4	98.3	109.6

Table 04 Unconfined Compressive strength for Egg shell powder:

Egg Shell Powder	0 days	14 days	21 days	28 days
4 %	97.3	102.7	105.1	107.5
8 %	103	105.2	106.8	109.7
12 %	108.2	111.4	114.1	118.3

Table 05 Unconfined Compressive strength for Egg shell powder and corn cob ash:

Corn cob ash and egg shell powder	0 days	14 days	21 days	28 days
4 %(CCA) and 4 % (ESP)	117.6	147	175.3	181.3
8 %(CCA) and 8 % (ESP)	123.5	126	129.4	138.7
12 %(CCA) and 12 % (ESP)	115.7	154.9	161.4	173.7
4 %(CCA) and 8 % (ESP)	125	162.1	198.3	173.6
4 %(CCA) and 12% (ESP)	148.7	153.1	159.4	162.7
8%(CCA) and 12 % (ESP)	127.4	131.1	134.8	138.1

2.5 Differential Free swell ratio

Free swell ratio for collected soil sample is 60%. Free swell ratio for stabilized soil sample is 31% with proportion of 4% of Corn Cob Ash and 4 % of Egg Shell Powder.

2.6 Swell pressure

Swell ratio for collected soil sample is 40.76 kN/m^2. Swell pressure for stabilized soil sample is 28.12 kN/m^2 with proportion of 4% of Corn Cob Ash and 4 % of Egg Shell Powder.

3. RESULTS AND DISCUSSIONS

3.1 Unconfined compressive strength

From the value of unconfined compressive strength test result with and without stabilized soil, up to 4% to 12% eggshell powder and corn cob ash to the soil the UCS value was increased. Due to the gradual formation of cemented compounds (calcium silicate hydrate) due to the reaction between the calcium carbonate present in the eggshell powder, soil and water, the initial increase in the UCS value was expected. If the addition of 4% corn cob ash and 4% egg shell powder is the highest strength at the curing of 28 days.

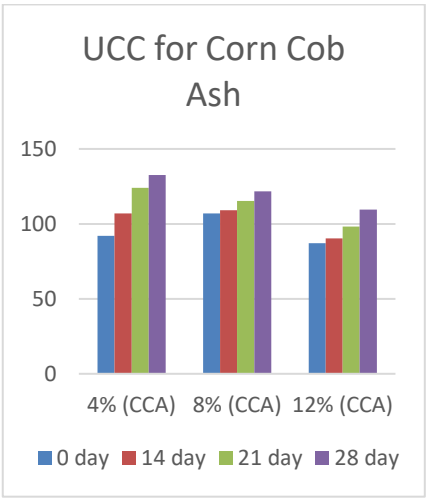

Figure 1 variation of UCC (unconfined compressive strength) with the addition of corn cob ash.

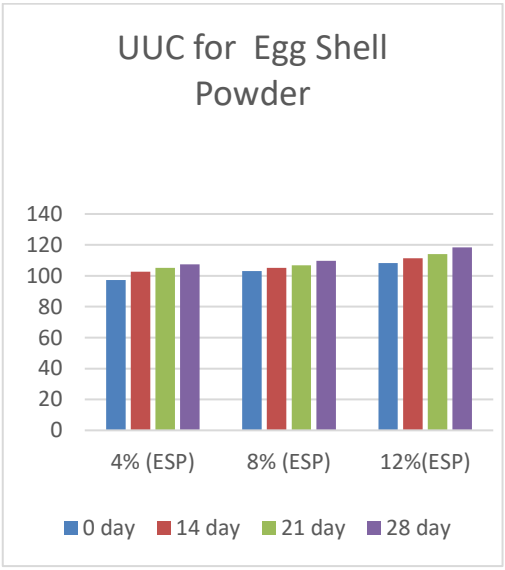

Figure 2 variation of UCC (unconfined compressive strength) with the addition of eggshell powder.

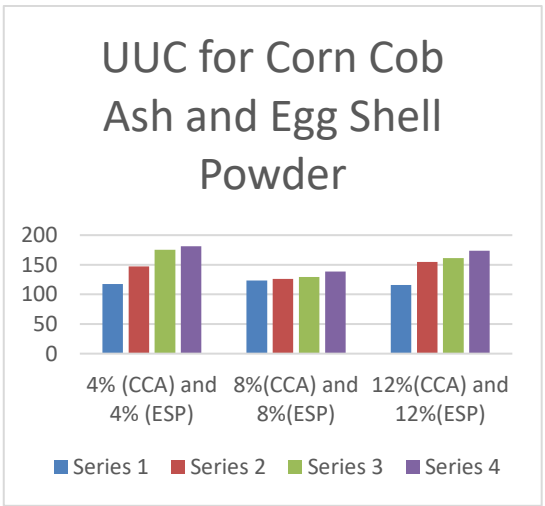

Figure 3 variation of UCC (unconfined compressive strength) with the addition of eggshell powder and corn cob ash.

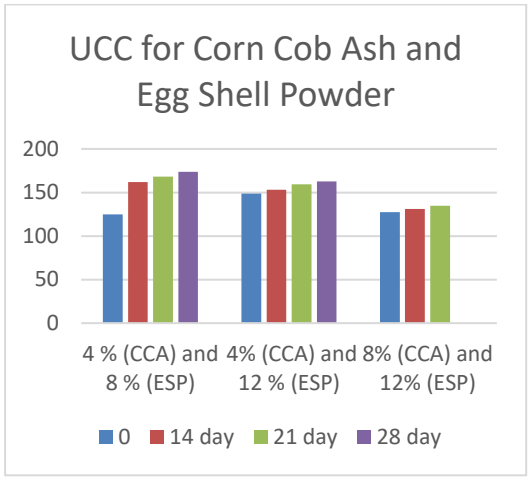

Figure 4 variation of UCC (unconfined compressive strength) with the addition of eggshell powder and corn cob ash.

3.2 Differential Free swell Index

Due to the gradual formation of cemented compounds (calcium silicate hydrate) due to the reaction between the calcium carbonate present in the eggshell powder, soil and water, the initial increase in the UCS value was expected**.** Free swell ratio for collected soil sample is 60%. Free swell ratio for stabilized soil sample is 31% with proportion of 4% of Corn Cob Ash and 4 % of Egg Shell Powder.

3.3 Swell pressure

The expansive clays increase in their volume when they come in contact with water owing to surface properties of these clay types. The pressure which the expansive soil exerts, if it is not allowed to swell or the volume change of the soil is arrested, is known as Swelling Pressure of Soil. Swell ratio for collected soil sample is 40.76 kn/m.Swell pressure for stabilized soil sample is 28.12 Kn/m with proportion of 4% of Corn Cob Ash and 4 % of Egg Shell Powder.

4. CONCLUSION

The following conclusions have been drawn from this experimental study

1. As a useful soil stabilizing material, we can use the eggshell waste and corn cob Ash. We can minimize the waste disposal problem of eggshell and corn cob Ash by using the materials as a soil stabilizer.
2. The optimum usage of eggshell powder and corn cob added to the soil was 4% (CCA) and 4 % (ESP). The free swell index is decreases from 60% to 31%.
3. The unconfined compressive strength increases 89.7 kpa to 181.3 kpa for 28 days curing.
4. And then the swell pressure also decreased from 40.76 kN/m^2 to 28.12 kN/m^2

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