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STABILIZATION OF BLACK COTTON SOIL USING GROUNDNUT SHELL ASH

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Abstract- *Therefore this study is to find the use of Groundnut shell ash as a stabilizing agent for improving the properties of soil. Groundnut shell is an agricultural waste obtained from the milling groundnut. Groundnut shell ash generated from the burning of groundnut in open air for 4 hours. Few attempts have been made with groundnut shell ash with the combination of other materials on soil stabilization, but very scanty attempts have been made to work on only with groundnut shell ash on soil stabilization. %. In our project, groundnut shell ash was added from 2% to12% at 2% interval to soil and examining the optimum percentage of groundnut shell ash. The index properties of the soil are liquid limit, plastic limit, shrinkage limit, free swell index and specific gravity are done. The optimum usage of groundnut shell ash added to the soil is 6%.*

Key words: *Groundnut shell ash, soil stabilization, index properties, optimum usage.*

1. INTRODUCTION

Black cotton soil is highly clayey soil. The black colour in the black cotton soil is due to presence of titanium oxide in small concentration. The black cotton soil has more montmorillonite in structure and black or blackish grey in structure. It is the main reason for expansive characteristics of soil. It has very low bearing capacity high swelling and shrinkage characteristics.

Problem Associated with Black cotton soil

High Compressibility

Black cotton soils are highly plastic and compressible, when they are saturated. Footing, resting on such soils undergoes consolidation settlements of high magnitude.

Swelling

A structure built in a dry season, when the natural water content is low shows different movement as result of soil during subsequent wet season. This causes structures supported by such swelling soils to lift up and crack. Restriction on having developed swelling pressure making the structure suitable.

Shrinkage

A structure built at the end of the wet season when the natural water content is high, shows settlement and shrinkage cracks during subsequent dry season.

2. MATERIALS USED

2.1 Material collection

The following table represents the place of collection of materials for soil stabilization.

Table -1: Material collection

Material	Place of collection
Black cotton Soil	Arumuganeri
Ground nut shell	Kovilpatti

2.2 Groundnut shell ash

Groundnut shell were spread on the ground and air dried for 2 days to facilitate easy milling. After air drying the groundnut shells were manually broken and milled into normal temperature (37◦c) ash forms which were collected in polythene bags. The groundnut shell ash was finally sieved through 425µ sieve.

2.3. Properties of groundnut shell ash

The following are some of the properties of powder.

Groundnut shell ash is odourless.

Groundnut shell ash contains of CaO and remaining consists of Al_2O_3, SiO_2, Fe_2O_3,MnO and MgO

3. MIX PROPORTIONS

Groundnut shell ash was added from 2% to12% at 2% interval to soil and examining the optimum percentage of groundnut shell ash.

4. RESULTS AND DISCUSSIONS

4.1.1 Determination of specific gravity of soil

Table -2: Specific gravity of soil

S. No	Description	Trial 1	Trial 2	Trial 3
1	Weight of pycnometerW_1(g)	44.5	44.5	44.5
2	Weight of pycnometer+soilW_2(g)	75	76	68.5
3	Weightofpycnometer+soil+waterW_3(g)	76	119.5	116
4	Weight of pyconometer+waterW_4(g)	101.5	101.5	101.5
5	Specific Gravity	2.54	2.53	2.53

Average specific gravity = 2.54

4.1.2 Determination of free swell index of soil

Table -3: Free swell index limit of soil

Differential free swell	Degree of expansiveness
< 20	Low
20 – 35	Moderate
35 – 50	High
>50	Very high

4.1.3 Determination of liquid limit of soil

Table- 4: Liquid limit of soil

S.No	Weight of soil(g)	Water added (ml)	Water content (%)(W)	No of blows(N)
1	150	84	58	109
2	150	87	56	72
3	150	90	60	58
4	150	93	62	34
5	150	96	64	15
6	150	99	66	7

Liquid limit (w_L) = Water content corresponding to 25 blows

= 63.5%

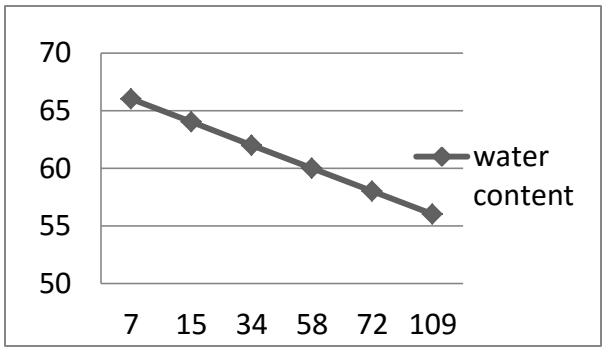

Figure -1: Liquid limit of soil

4.1.4 Determination of plastic limit of soil

Weight of empty pan(W_1) = 13 g

Weight of pan + wet soil(W_2) = 25.5 g

Weight of pan + dry soil(W_3) = 21.5 g

Plastic limit (w_P) = 47%

Plasticity Index (I_P)= Liquid limit – Plastic limit

= 63.5 – 47

= 16.5 %

From the A – line chart, the soil is classified as Clay of Intermediate Compressibility.

4.1.5 Determination of shrinkage limit of soil

Weight of shrinkage cup W_1 = 30 g

Weight of shrinkage cup + wet pat W_2 = 62.5 g

Weight of shrinkage cup + dry pat W_3 = 47 g

Weight of dry pat W_d = 17 g

Weight of water W_w = $W_2 – W_3$ = 15.5 g

Weight of mercury filling shrinkage cupW_1= 582.5g

Volume of shrinkage dish V = W_1 / 13.6

= 337.5 / 13.6

= 24.82 ml

Weight of mercury displaced by dry pat W_2 = 142 g

Volume of mercury displaced V_d = 142 / 13.6

= 10.44 cm^3

Shrinkage limit (w_S) = $\frac{(W-Wd)-(V-Vd)\gamma w}{Wd} \times 100$

= 12 %

4.1.6 Standard proctor compaction test for soil

Diameter of mould = 10 cm

Height of mould = 13 cm

Weight of mould = 2136 g

Volume of mould = 1021.02cm^3

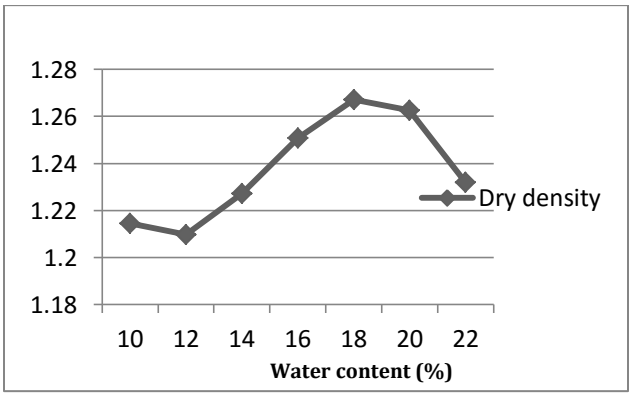

Figure -2: Compaction curve for soil

From the compaction curve,

Maximum dry density = 1.260 g/cc

Optimum moisture content = 18%

4.1.7 Unconfined compressive strength test for soil

Initial length of specimen = 7.4 cm

Initial diameter of specimen = 3.9 cm

Initial weight of specimen = 148 g

Final weight of specimen = 147g

Final length of specimen = 7.0 cm

Final diameter of specimen = 4.1 cm

Initial area of specimen $A_0 = (\pi/4) \times 3.9^2$

= 11.945 cm^2

Axial strain (ε) = $\frac{\Delta L}{L}$

= 0.05405

Average cross sectional area= $\frac{Ao}{1-\varepsilon}$

= 12.63 cm^2

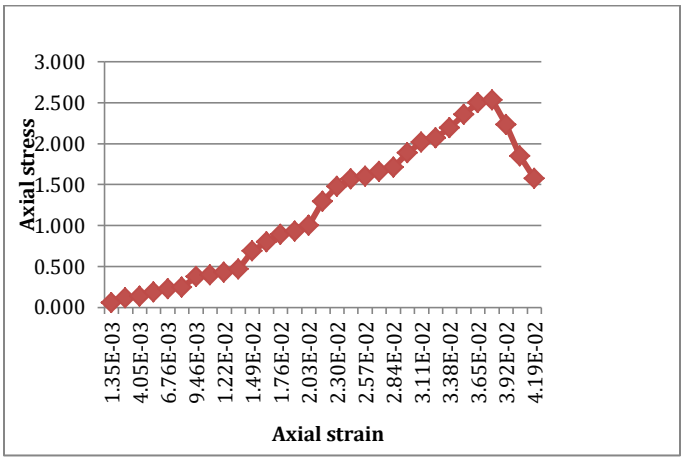

Figure -3: Stress strain curve for soil

Unconfined compressive strength = 252.9kN/m^2

The following table represents the index and engineering properties of soil

Table -5 : Properties of soil

S.No	DESCRIPTION	RESULT
1	Colour	Black
2	**Atterberg limits**	
i	Liquid limit	63.5%
ii	Plastic limit	38.5%
iii	Shrinkage limit	12%
3	Free swell index	20%
4	Specific Gravity	2.54
5	**Compaction characteristics**	
i	Optimum Moisture Content	18%
ii	Maximum dry density	1.260 g/cc
6	Unconfined compressive strength	252.9kN/m^2
7	**Grain size distribution**	
i	Gravel	0%
ii	Sand	12.3%
iii	Clay and silt	87.7%
8	Unified soil classification system	Clay of intermediate compressibility

4.2 Properties of soil with the addition of groundnut shell ash

4.2.1 Variation of liquid limit, plastic limit and plasticity index

The following table describes about the atterberg limits of soil with the addition of different percentage of groundnut shell ash.

Table -6: Variation of liquid limit, plastic limit and plasticity index with the addition of groundnut shell ash

S.No	Amount of groundnut shell ash (%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)
1	0	63.5	38.50	25.00
2	2	62.5	41.70	20.80
3	4	62.0	45.45	16.55
4	6	61.0	47.00	14.00
5	8	62.8	50.60	12.20
6	10	67.8	48.67	19.13
7	12	69.5	43.50	26.00

From table 6, it is observed that the value of liquid limit is approximately decreased by 1% with the addition of different percentage of groundnut shell ash to the soil and the value of plastic limit is increased with the addition of different percentage of groundnut shell ash. Thus the plasticity index values are decreased. With the addition of 2% to 12% of groundnut shell ash at 2% interval to the soil reduces the plastic index and change the soil to non-plastic state .After 6% of groundnut shell ash, the liquid limit value is increased and thereby increasing the plasticity index of soil.

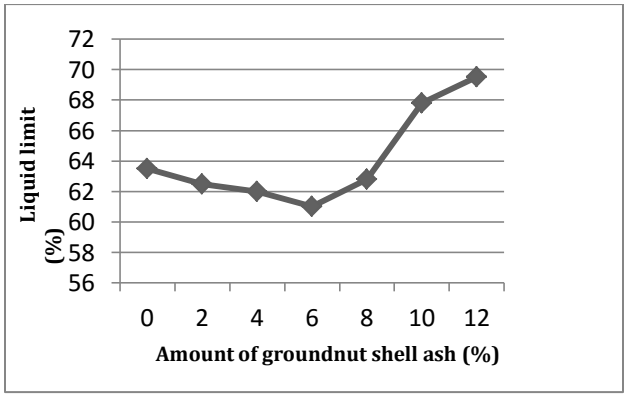

Figure -4: Variation of liquid limit with the addition of groundnut shell ash

Figure 4 represents the variation of liquid limit with the addition of groundnut shell ash to the soil. The liquid limit value is decreased gradually when the groundnut shell ash is added from 2% to 6% and it gradually increasesfrom8% at the interval of 2% to the soil. The gradual decrease in the value of liquid limit is due to the porous property of groundnut shell ash. The decrease in the liquid limit was attributed to the flocculation and agglomeration of clay particles and reduction in surface area and increase in strength.

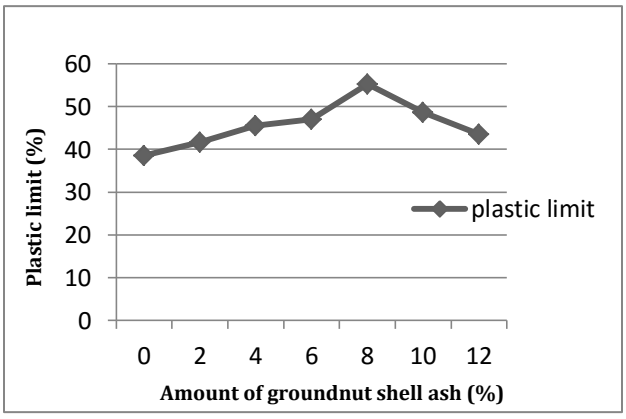

Figure -5: Variation of plastic limit with the addition of groundnut shell ash

Figure 5 represents the variation of Plastic limit with the addition of groundnut shell ash to the soil. The plastic limit value is decreased gradually when the groundnut shell ash is added from 2% to 6% and it gradually increased after 6% at an interval of 2% to the soil. Increase in the addition of groundnut shell ash to the soil sample caused a change in the liquid limits and plastic limits, which consequently affects the plasticity index of the soil. Increase in the plastic limit from 38.5% to 55% is due to increase in the amount of fines amount.

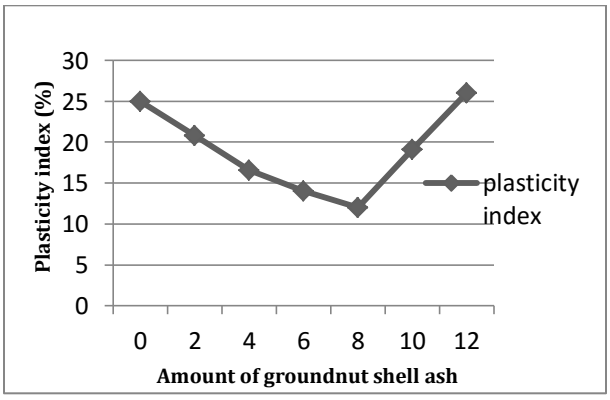

Figure-6: Variation of Plasticity index with the addition of Groundnut shell ash.

Increase in the addition of groundnut shell ash to the soil sample caused a change in the liquid limit and plastic limit, which consequently affects the plasticity index of the soil. The plasticity index of the soil is reduced from 25% to 19.3% with the addition of groundnut shell ash. The reduction of plasticity index is an indication improvement of soil property.

4.2.2 Variation of pH value with the addition of Groundnut shell ash

The following table describes about the variation of pH value of soil with the addition of groundnut shell ash.

Table -7: pH value of soil

S.No	Amount of Groundnut shell ash (%)	pH value
1	0	8.612
2	2	8.678
3	4	8.719
4	6	8.943
5	8	9.031
6	10	9.065
7	12	9.155

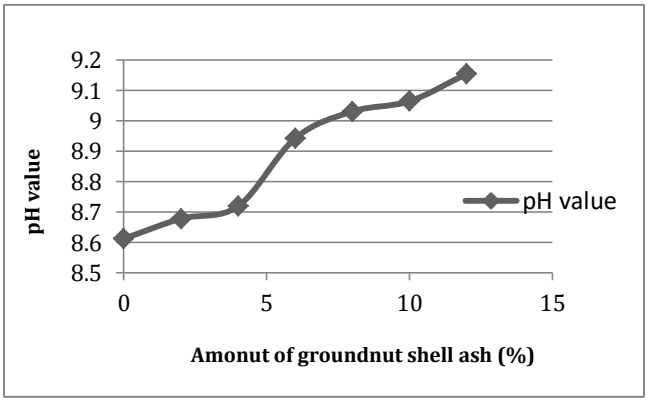

Figure -7: Variation of pH value with the addition of Groundnut shell ash

The pH is the negative log of H^+ ion concentration. From fig 7 the pH of the soil is 8.612 on adding groundnut shell ash from 2 to 12% the pH value increases gradually from 8.612 to 9.155.

5. CONCLUSION

The following conclusions were made from this experimental study

1. We can utilize the groundnut shell waste as a useful soil stabilizing material.
2. The optimum usage of groundnut shell ash added to the soil is 6%

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