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An Analysis on Bearing Capacity Variations of Expansive Soils Blended with Groundnut Shell Ash

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Abstract:

Expansive soils always create loading issues and settles causing structures failure. But when they are compacted and packed using various means they turn strong towards bearing any load until the moisture is not disturbed. In the present study an attempt is made using soil stabilization using the groundnut shell ash which being an additive for binding and impacting the soil particles. The soil is checked for start condition before testing for engineering properties and then mixed with groundnut shell ash in various increasing proportions and tried to enhance the stable behaviour of the expansive soils. The various basic index properties are judged carefully and lab tests are performed for the same. The strength and bearing capacity values are evaluated using various percent mix and soaked and unsoaked conditions are evaluated using the design mix as per requirement. The lab results clearly indicate that a better bearing capacity value is obtained for the expansive soils when they are mixed with groundnut shell ash powder.

Keywords — UCS, CBR test, particle size variations, groundnut shell ash, liquid limit, plastic limit, expansive soil

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I. INTRODUCTION

Since long human kept astonished as to why the earth materials like the top surface having some expansive soils differentiate their behaviour , sometimes they becomes humid and dry, making the surface bear loads sometimes total collapse happens. They felt this may be due to some expected phenomenon, but in due course of time human learnt that soils are made up of minerals and they cause the shrinkage and swell behaviour. This content varies from soil to soil and hence minerals are mainly responsible for change in the nature of soils. The compaction and packing down of all available particles due to heavy loads causes consolidation and making soils bear extreme loads and transfer the same to beneath layers. But when loading is uneven, unexpected settlement is seen and this has made human to think of modifying the soil profiles along with some addition or removal of key components. The heavy structures built on the surfaces of the expansive soils are concern like the leaning tower of Pisa which is a good example as how expansive soils can behave and at the same time can cause great settlements in pavements and in even residential buildings. The health once becomes worse structure has to be abandoned and left over cause great loss in monetary terms else life loss will happen.

Hence bearing capacity of the expansive soils must be considered before taking care of any new construction. This work is forwarded keeping the expansive soils in mind, so that bearing strength can be checked and design helps to make a good structure. Thus addition of additives can be a solution, hence groundnut shell ash is considered as a good additive from the properties point of view and India being a good producer of groundnuts and peanut oil is a great diet potential player. It has good calorific value and after getting the groundnut shell, it can be incinerated to ash, which has good cementitious properties for soil bearing capacity improvement. Apart from the present work and additives are available many in market like the Portland cement, or fly ash or modified lime blended fly ash or even rice husk ash. There is enormous potential of using agricultural waste and hence ground shell ash fits over there as a good material. The groundnuts shells are considered as waste materials and thrown as roughage in fields and dump yard. They are sometimes used as a fuel substitute hence before burning the chemical properties of the ash has to be considered and this can cause great impact on nature as it has very fine particles causing particulate matter pollution and other irritations. Thus the incineration process causes bed ash and this has good binding capacity apart from good silica content hence can be sued to fix the bearing behaviour of expansive soils. There is huge potential of groundnut shell ash as India being an agricultural country and this can have huge potential for making good return in terms of economy and potential of use. There are many sources of energy in India.

and coal being one of them. Burning coal produces fly ash and bed ash. Fly ash is dumped in ponds and reused in multiple instances as per requirement and sometimes can be used for soil stabilization and improving the bearing capacity of the expansive soils, whereas the cases of groundnut shell ash is used less although it is produced in good quantity. There are multiple instances of use of fly ash of type C or type F, but groundnut shell ash is used if in its place its properties can be done better and in good way can be utilized. There is 120000 megawatt of power produces through fly ash and great amount of residue is leftover. Thus ground shell ash too has enormous potentials if used for power generation as our nation is the second largest producer and third largest consumer of groundnuts in the world. This indicates huge scope for the use of groundnut shell ash.

SCOPE OF THE STUDY

Keeping the huge amount of fly ash generated in mind and its earlier researchers indicates that fly ash is being used as an additives in soil stabilization. The use of agricultural products like groundnut shell and its incinerated ash can open door to rural prosperity and growth and potential is possible for its use as a good additive in soil stabilization apart from bearing capacity enhancement. The ash has good moisture retentively nature hence it can also be studied as a good material for soil strength profiling. India currently produces 25 million tons of groundnuts and their ash can have huge dumping causing concern to environment. Earlier groundnut shell ash is used about just 2 percent in 1998 and 2.9 percent in 2006. This slow growth can be increased once its potential is harnessed. With the above in view, experiment on expansive soil has been done with groundnut shell ash as additive. In this study, work has been done to see the effect on bearing capacity of expansive soils using the groundnut shell ash as an additive.

II. MATERIALS TAKEN AND LAB PROCEDURE

1.Groundnut shell ash. 2. Locally available expansive soil

Image 1 groundnut shell

Image 2 groundnut shell ash

Grain size analysis is done for expansive soil and for groundnut shell ash(GNA) by using procedures as per IS: 3104-1964.The specific gravity of soil was determined by using Pycnometer (volumetric flask) as per IS: 2720(part-III/sec-I) 1980. The liquid limit was determined in the laboratory by the help of standard liquid limit apparatus. About 120g of the specimen passes through 425μ sieve was taken. A brass cup was raised and allowed to fall on a rubber base. The value of liquid limit was found out for swelling soil and swelling soil with 20% GNA. The value of plastic limit was found out for swelling soil and swelling soil with 20% GNA as per IS: 2720(part-V)-1986. The Optimum moisture content and dry density of swelling soil with various percentage of groundnut shell ash is taken with weight percentage (0%,10%,20%,30%,40%,50%) was determined by performing the "standard proctor test" as per IS: 2720(part VII)1965 .here we will take rammer of definite weight more than 2.5 kg and taken three or five layers and compact it The collar removed and the excess soil is trimmed of to make it level. The dry density is determined and plotted against water content to find OMC and corresponding maximum dry density. The UCS test was conducted on various sample with groundnut shell ash concentration 0%,10%,20%,30%,40%,50% prepared at OMC, subjected to unconfined compression test. The test so conducted with reference to IS: 2720 part-10(1991) & 4330-5(1970). CBR test were determined soil + groundnut shell ash (0%, 10%, 20%, 30%, 40%, 50%) as per IS: 2720-16(1961).The sample so prepared at OMC. Two samples were made for each concentration of groundnut shell ash, one sample tested at OMC (unsoaked) and other was tested at saturation after four days soaking.

III RESULT AND DISCUSSIONS

Table-1: Mechanical Sieve Analysis of swelling soil

Sieve Size(mm)	Retaining (g)	% retained	Cum retain %age	%age of finer
300	158	33.6	32.33	69
212	128	26.8	58.91	43.23
75	93	19.23	74.12	26.29

Table-2: Mechanical Sieve Analysis of groundnut shell ash

Sieve Size (mm)	Retaining (g)	percentage retain	Cum retain percentage	percentage of finer
2000	4.12	0.62	0.62	99.38
1000	3.59	0.82	1.44	98.56
600	7.32	1.31	2.75	97.25
425	8.16	1.63	4.38	95.62
212	78.56	18.22	22.6	77.4
150	174.3	36.23	58.83	41.17
75	59.08	11.87	70.7	29.3

Table-3: Specific gravity of expansive soil

sampling	Sample-1	Sample-2
Empty wt. of bottle(M1)	125.99	348.81
Bottle wt.+ Dry soilwt.(M2)	175.73	382.72
Bottle wt.+ Soil wt.+ Water wt.(M3)	405.88	158.14
Bottle wt.+ Water wt.(M4)	376.97	388.81
Specific gravity(G)	2.425	2.393

Table-4: Specific gravity of groundnut shell ash

Observation	**Sample-1**	**Sample-2**
Empty wt. of bottle(M1)	103.59	110.51
Bottle wt.+ Dry soilwt.(M2)	107.45	50.21
Bottle wt.+ Soil wt.+ Water wt.(M3)	364.48	369.13
Bottle wt.+ Water wt.(M4)	366.10	397.32
Specific gravity(G)	2.21	2.29

Table-5: Liquid Limit of expansive soil

SL No	Empty wt (g).	Wet soil+ Can wt (g).	Wet wt (g).	Dry wt (g).	Wt. of water (g)	Water content (%age)	No of blows
1	2.36	10.0	7.64	4.64	3.00	62.65	42
2	2.54	13.6	11.06	6.76	4.30	63.60	39
3	2.40	12.6	10.10	6.10	4.00	65.57	28
4	2.51	11.2	8.69	5.19	3.50	67.43	26

5	2.46	14.0	11.54	6.74	4.80	71.21	18

Table-6: Plastic limit of expansive soil

SL No	Can no	Empty wt (g).	Wet soil+ empty wt (g).	Wet wt (g)	Dry wt (g)	Water wt (g)	Plastic limit (%age)
1	52	2.40	5.8	3.40	2.5	0.9	36
2	53	2.48	7.3	4.82	3.52	1.3	36.9
3	30	2.49	6.7	4.21	3.01	12	39.8
Average plastic limit							37.5

Proctor compaction Test of expansive soil Table-7.1: Water content (%)

SL No	Empty wt. (g)	Wet soil+ Can wt (g).	Wet wt (g).	Dry wt (g).	Water wt (g).	Water content (%age)
1	9.63	35.3	25.67	21.77	3.90	17.9
2	9.96	45.1	35.19	29.59	5.60	18.9
3	9.97	41.3	31.33	25.93	5.40	20.8
4	9.64	48.2	38.56	29.76	8.80	29.5
5	9.77	50.1	40.33	32.03	8.30	25.9

Table-7.2: Dry density (g/cc)

SL No	Mass of mould + comp soil (g).	Mass of mould (g)	Mass of comp soil (g)	Bulk density (g/cc)	Water content (%age)	Dry density (g/cc).
1	3930	2385	1545	1.56	17.9	1.32
2	4090	2385	1705	1.73	18.9	1.45
3	4164	2385	1779	1.805	20.8	1.49
4	4175	2385	1790	1.816	29.5	1.40
5	4255	2385	1870	1.897	32.9	1.306

Table-8 : Proctor compaction Test (with 10% groundnut ash) Water content (%)

SL No	Empty wt. of can (g).	Wet soil+ Can wt (g).	Dry soil wt +can wt (g).	Wet soil wt (g).	Dry soil wt (g).	Water wt (g).	Water content (%age)
1	9.36	45.19	38.66	35.83	29.30	6.53	22.28
2	9.88	48.25	40.05	38.37	30.17	8.20	27.17
3	9.47	49.54	39.59	40.07	30.12	9.95	33.03
4	9.69	57.60	45.86	47.91	36.17	11.74	34.45
5	8.67	58.90	44.83	50.23	36.16	14.07	38.91

Table-9: Proctor compaction (20% groundnut shell ash) Water content (%)

SL No	Empty wt. of can (g)	Wet soil+ Can wt (g).	Dry soil wt +can wt (g).	Wet soil wt. (g)	Dry soil wt. (g)	Water wt (g)	Water content (%age)
1	10.05	33.65	29.78	23.60	19.73	3.87	19.61
2	9.97	39.95	34.77	29.98	24.80	5.18	20.88
3	9.54	62.06	49.91	52.52	42.98	9.54	22.19
4	12.89	52.40	41.49	39.51	28.60	10.91	38.14

Table 10: Proctor compaction Test (30% groundnut shell ash) Water content (%)

SL No	Empty wt. of can (g)	Wet soil+ Can wt (g).	Dry soil wt +can wt (g).	Wet soil wt (g).	Dry soil wt (g).	Water wt (g)	Water content (%)
1	9.97	43.98	38.76	34.01	28.79	5.22	18.22
2	9.27	45.72	38.81	36.45	29.54	6.91	23.39
3	9.11	44.90	37.18	35.79	28.07	7.72	27.50
4	9.42	48.64	38.51	39.22	29.09	10.13	34.82

Table-11: Proctor compaction Test (40%groundnut shell ash) Water content (%)

SL No	Empty wt. of can (g)	Wet soil+ Can wt (g).	Dry soil wt +can wt (g).	Wet soil wt (g).	Dry soil wt (g).	Water wt (g)	Water content (%age)
1	9.54	37.86	33.60	28.32	24.06	4.26	17.70
2	9.97	48.98	41.56	39.01	31.59	7.42	23.48
3	10.35	49.47	40.92	39.12	30.57	8.55	27.97
4	9.27	50.35	39.79	41.08	30.52	10.56	34.60

Table-12: Proctor compaction Test (50% groundnut shell ash) Water content

SL No	Empty wt. of can (g)	Wet soil+ Can wt (g)	Dry soil wt +can wt (g).	Wet soil wt (g).	Dry soil wt (g)	Water wt (g)	Water content (%age)
1	9.29	45.30	40.90	36.01	31.61	4.40	13.91
2	9.54	35.88	31.89	26.34	22.35	3.99	17.85
3	10.05	42.68	36.33	32.63	36.28	6.35	24.16
4	9.50	52.55	42.41	43.05	32.91	10.14	30.81
5	9.37	60.49	46.34	51.12	36.97	14.15	38.27

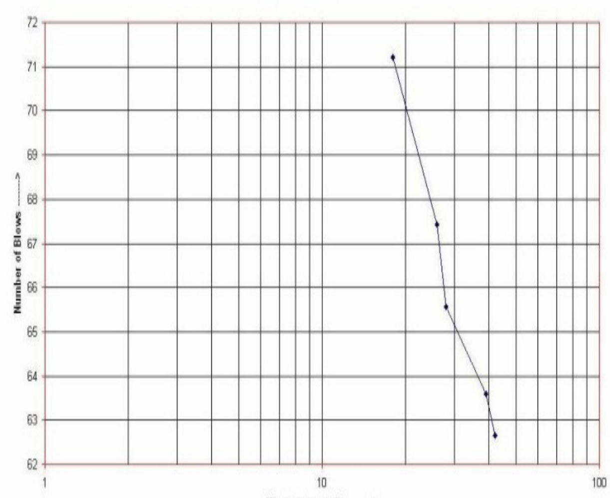

Fig-1: Liquid limit of expansive soil

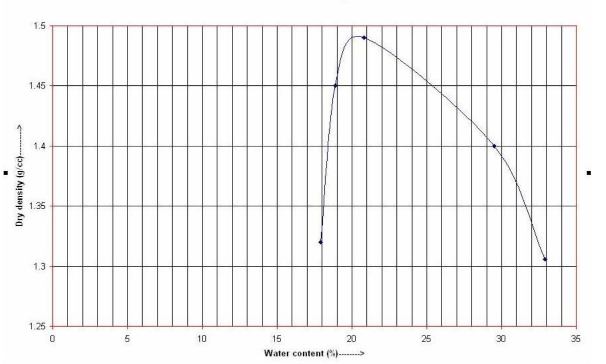

Fig-2: Proctor compaction Test for expansive soil

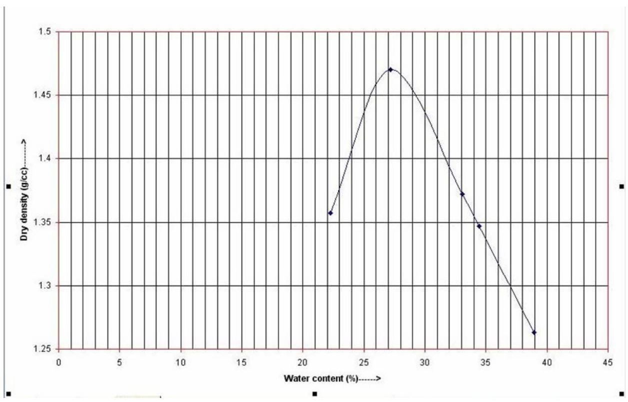

Fig-3: Proctor compaction Test with swelling soil+10% GNA

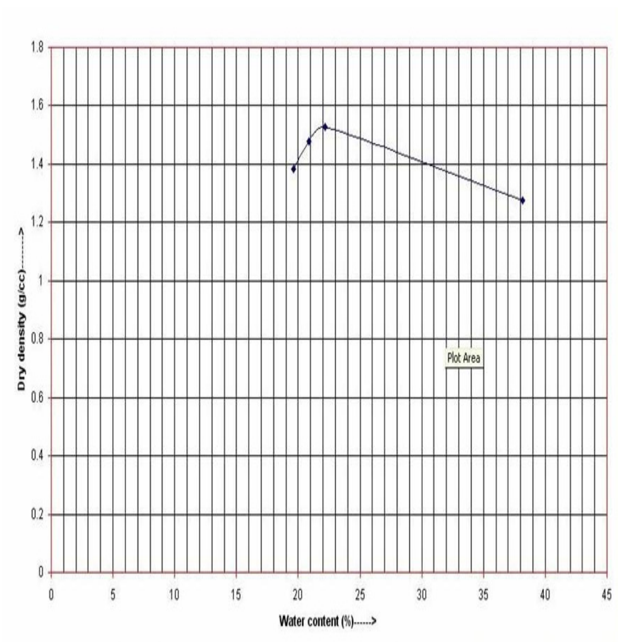

Fig-4: Proctor compaction Test with swelling soil+20% GNA

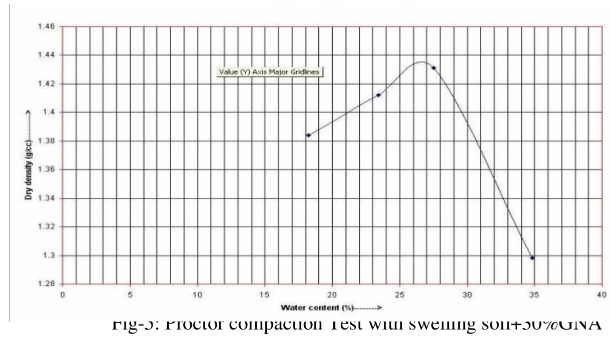

Fig-5: Proctor compaction Test with swelling soil+30%GNA

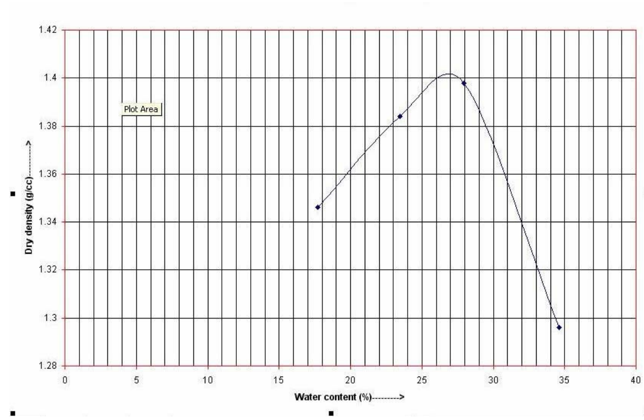

Fig-6: Proctor compaction Test with swelling soil+40%GNA

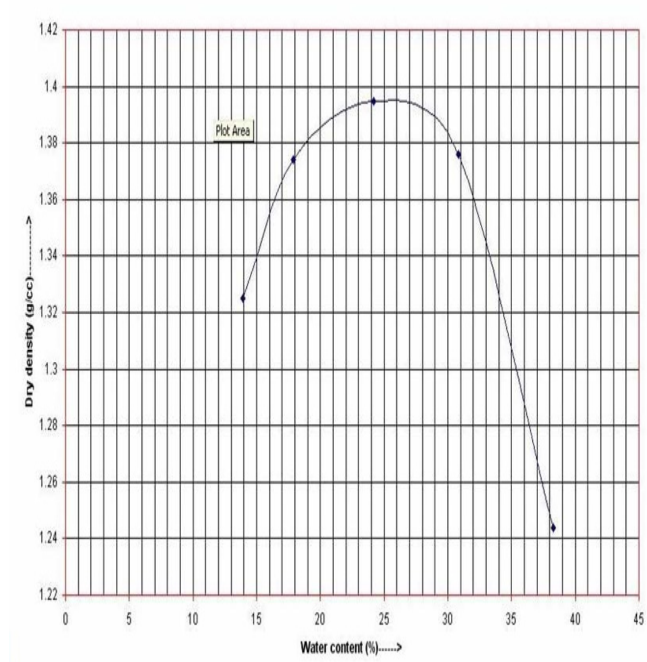

Fig-7: Proctor compaction Test with swelling soil+50% GNA

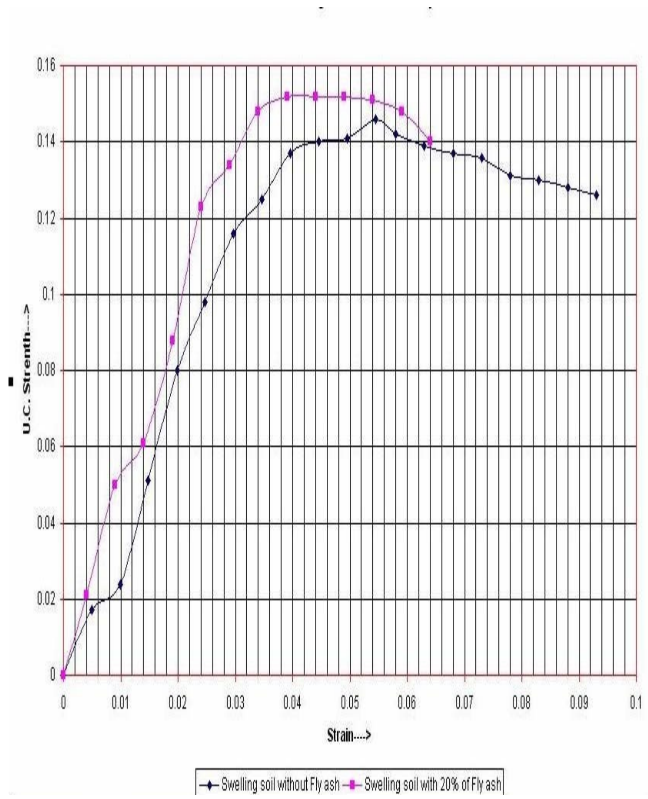

Fig-8: Unconfined compressive strength of soil With/without GNA

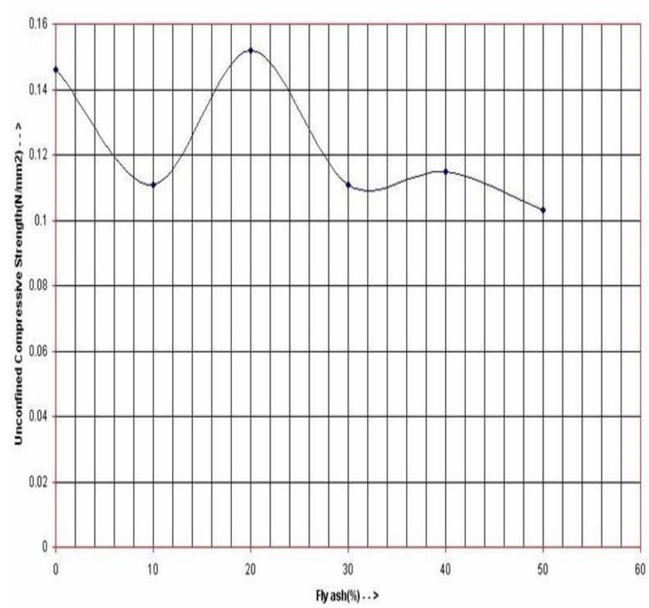

Fig-9: Ultimate unconfined compressive strength of swelling soil with various percentage of GNA

III. CONCLUSIONS

1. Unconfined compressive strength decreases on adding of groundnut shell ash upto10% and then increases up to 20% GNA content. .Then it declines to have another lower value at 30% GNA and takes another peak at 0.116 N/mm at 40% GNA. Beyond this, it again declines.
2. C.B.R value of unsoaked sample tested at OMC with 20% groundnut shell ash content is found to be maximum (23.27 percent). Hence for the maximum C.B.R value the optimum value of GNA mix is 20percent.
3. The maximum dry density is highest (1.54g/cc) and optimum moisture content is least (22.29 percent) found by proctor compaction test, are obtained at 20 percent content of GNA.
4. Atterberg limits are obtained are also optimum when the GNA content is 20percent.

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