IMPROVEMENT OF ENGINEERING PROPERTIES OF EXPANSIVE SOIL WITH ADDITION OF EGGSHELL POWDER AND FLY-ASH

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Abstract - Soil is one of the most valuable materials used in a variety of construction project including earth work. The clay soil acts high strength in dry condition, but exhibit low strength in wet condition. Thus, variation in the characteristic behaviour of the expansive soil result major problem in the engineering properties during construction. Some different approaches are made in order to improve the soil characteristics. Egg Shell powder composition is near to that of lime so it increases the soil stabilization. In this project sample of clay in National Highway-16 near Narayana Engineering College, Gudur collected and conduct the basic tests for that soil sample. After analysing the properties of the soil, Egg Shell Powder has been added in proportion of 3%,6%,9%,12 %,15% and 18% and Fly Ash has been added in proportion of 4%,8%,12% and 16%. The laboratory tests conducted to determine Index and Engineering Properties of soil. By adding Egg Shell Powder and Fly Ash, the behaviour of the Engineering properties is analysed. From this investigation will determine effective percentage of egg shell powder and Fly ash need to be added to increase Engineering Properties of soil.

Key Words: *Eggshell Powder, Fly Ash, Expansive-soil. Engineering properties, Index properties, Soil-characteristics*

1.INTRODUCTION

Soil is an unconsolidated material resulted from the disintegration of rocks. It includes sediments and deposits beneath rivers and seas and on land along with all organic and inorganic materials overlying the bedrock. It thus constitutes the earth's surface both on land and beneath water. The type and characteristics of soil depend largely on its origin. Transportation causes alteration in the size and shape of the particles and sort into different sizes. Cementation due to Carbonates, Oxides or Organic matter provides additional particle binding. Thus, the engineering properties, i.e., Permeability, Deformation and Shear Strength of a soil deposit are governed by the mode of formation, Stress history, ground water condition and physicochemical characteristics of the parent material.

1.1 OBJECTIVES OF THE STUDY

High compressible clays possess comparatively less strength, more compressibility and high swelling characteristics. These properties lead to more settlements and foundation failures. In this investigation an attempt has been made to stabilize a highly swelling soil by Eggshell powder. The scope and objectives of the present work included the following aspects.

1. To analysis the effect of compaction of characteristics of expansive soil with addition of eggshell powder and Fly Ash in different percentages
2. The find the optimum percentages of eggshell powder and Fly Ash to effect better strength of soil

In order to meet the above objectives a series of tests are conducted on high compressible clay without and with addition of Eggshell powder and Fly Ash in different percentages.

2.LITERATURE RIVIEW

2.1 **Influences of fly-ash and eggshell powder on some of engineering properties of al-umara soil**

Asst. Lect. Najwa Wasif Jassim (2012)

The study shows that as the percentages of adding fly –ash and eggshell powder increases, the reduction in the plasticity index amount for all soil samples increases too at different rates. The values of cohesion decreased when the soil samples mixed with fly-ash, while there was an increase in the values of internal angle of friction. In case of using eggshell powder, there was a small increase in cohesion values, but there was a small decrease in the internal angle of friction values for the tested soil. The purpose of this study was to investigate the influences of adding each of fly-ash and eggshell powder on the Atterberg Limits, Cohesion and Angle of Internal Friction of the tested soil. The tested soil is (CL) group according to the unified soil classification system obtained from a site located near Al-Sader Teaching Hospital in Al-Umara City. Each of fly-ash and eggshell powder were added to the soil samples in (2, 4, 8, 12, 16, 20 & 24 %) by weight of samples.

2.2 **Stabilization of Black Cotton Soil by Fly Ash and Egg Shell Powder**

Sunil kumar birkur

Optimum dosage of admixture was found to be 20%. Increment in specific gravity was found to 2.35 to 2.6 at this dosage. Increment in Cu was found to be from 5.71 to 7.77 & Cc was found to be 0.53 to 1.18 at this dosage. Decrement in liquid limit was found to be from 65% to 58% at this dosage. Decrement in plastic limit was found to be from 35% to 32% and plasticity index was found to be from 30% to 26%. Increment in maximum dry density was found to be from 1.583g/c.c to 1.63g/c.c at this dosage. Increment in shear strength was found to be from 0.149kg/cm2 to 0.165kg/cm2 at this dosage. Increment in CBR value was found to be from 2.53% to 2.82%. The maximum dry density, shear strength and CBR value increases upto 20% dosage of admixture and beyond this there is a reduction in maximum dry density, shear strength and CBR value. Liquid limit, plastic limit and plasticity index values decreases upto 20% dosage of admixture and beyond this there is a reduction in liquid limit, plastic limit and plasticity limit.

2.3 **stabilization of black cotton soils using fly ash & egg shell powder**

S.d.r.l.pavani and v.a.mangamma

This seminar, soil stabilization has been done with the help of Egg shell powder, fly ash and Quarry Dust mixed with the soil. The improvement in the shear strength parameters has been Stressed upon and comparative studies have been carried out using different methods of shear resistance measurement.

2.4 **Tensile Strength Test on Clay Stabilized With Fly Ash and Egg Shell Powder Geopolymer**
Nida Alimatul Aqilah, Willis Diana

This study aims to analyze the viability of geopolymer in soil stabilization. Fly ash and eggshell powder were used as a precursor on the geopolymer. Split tensile strength testing was used to evaluate geopolymer stabilized soil specimens. The clay soil was stabilized using Fly ash as a geopolymer precursor at a 20% wt concentration of the unstabilized soil at its optimum water content. Sodium hydroxide and sodium silicate were used as alkaline activators in this study. In the experiments, the molarity of the activator alkaline solution (range from 5-10 molar), the curing duration, and the effect of adding the ESP on the split tensile strength of the soil were all variables.The replacement of ESP for FA improved the split tensile strength, according to the test results. By increasing the molarity of the activator alkaline solution, the soil's tensile strength is improved. When the molarity of the alkaline solution is increased from 5 to 10 molars in clay soil with 20% FA, the tensile strength of the specimens improves by 65.51 percent, 327.78 percent, and 287.71 percent for the curing periods of 7,14, and 28 days, respectively. The split tensile strength increases with the length of the curing period. Furthermore, the 5 percent FA replacements with ESP increased the split tensile strength by 140,26%, 131,35%, and 123,46%, respectively. The utilization of industrial waste products such as FA and ESP as soil stabilizing agents has the potential to be beneficial. The tests revealed that stabilizing the soil with geopolymer materials, including FA and ESP as a precursor, considerably enhanced the soil's tensile strength.

3. EXPERIMENTAL INVESTIGATION

3.1 Raw materials

3.1.1 Eggshell powder

3.1.2 Expansive Soil

3.1.3 Fly ash

3.1.1 Eggshell powder

The eggshell (ES) is a waste material from domestic birds such as poultries, hatcheries, homes and fast foods or indomie joints; which could result to environmental pollution, but if subjected to adequate scrutiny it could be an alternative for soil stabilization. Egg-shell powder contains 99.8% of CaO and remaining consists of Al_2O_3, SiO_2, CI, Cr_2O_3, MnO, and CuO.

Eggshell powder chemical composition

Chemical Composition	Weight (%)
Calcium (**Ca**)	21.1286
Sodium Oxide (**Na2O**)	0.1046
Magnesium Oxide (**MgO**)	0.9261
Phosphorus trioxide (**P2O3**)	0.4149
Sulfuric Oxide (**SO3**)	0.3264
Potassium oxide (**K2O**)	0.0542
Tricarbon monoxide (**C3O**)	76.9922
Ferric Oxide (**Fe2O3**)	0.0132
Strontium Oxide (**SrO**)	0.0396

3.1.2 Expansive soils

Expansive soils containing the clay mineral Montmorillonite generally exhibit Swelling and Shrinkage properties. The mica like group, which includes Illite and Vermiculate can be expansive, but generally does not cause significant problems. Swelling and Shrinkage is due to gain or loss in moisture content. Therefore, during summer when evaporation from the ground and transpiration due to vegetation exceeds the rainfall, the expansive soil dries up and moisture deficiency develops in the soil, giving rise to soil shrinkage.

Index properties of Expansive soil

Properties	Description
Specific gravity	2.62
Liquid limit	58
Plastic limit	18
Plasticity index	40

3.1.3 Fly ash

Fly-Ash is one of the deposits produced in the burning of coal. Fly-debris is by and large caught from the fireplaces of force age offices, while base debris is, as the name proposes, eliminated from the lower part of the heater.

Fig -1 Fly ash

Here in this undertaking, we utilized fly debris by somewhat substitution of concrete. Generally the fly ash used to supplant the concrete upto 30%.So we have taken the substitution of 30% just of fly ash.

Physical properties of fly ash

Fly ash comprises of fine, fine particles transcendently circular in shape, either old or empty, and for the most part nebulous in nature. As a general rule, the particular gravity of coal remains less around 2.0

In light of the grain size dissemination fly ash can be named sandy sediment to silty and Particularly, Indian coal remains are transcendently of residue size, with some dirt - size portion. Fly ash has high unambiguous surface region and low mass thickness. How much unburned carbon and iron effect the shade of fly ash, which can fluctuate from orange to dark red, brown, or white to yellow.

S.NO	Properties	Values
1	Specific gravity	2.3
2	Moisture content	1 9.75%
3	Fineness	0.001 -0.6 mm
4	Maximum dry density	1 .53 g/cm3
5	Permeability	4.87x1 07 cm/s
6	Angle of internal friction	23°-41 °
7	Cohesion	3-34 Kpa
8	Compression of index	0.1 5
9	Coefficient of consolidation	0.1 -0.5 m2 per year

Physical properties of fly ash

Chemical properties of fly ash

The synthetic synthesis of fly ash changes essentially between plants. However, Silicon tide (SiO2) occupies most of the volume of fly ash. According to (Bremseth,2010)the chemical composition of the coal controls the chemical contents of fly ash, American Society l Testing and Materials (ASTM) C61 8- 03 defines two classes of fly ash, class F and class C. These two classes differ from each other in the volume of calcium. The percentage of calcium class F is low whereas in class C is high. According to (de Brito & Saikia,2013) larger member of unwanted chemical components such as free lime and sulphatic are present in high calcium fly ash, which minimize the use of this kind of fly ash. The table below shows the chemical properties of fly ash (Gamage et al, 2011)

S.No	Chemical compound	Low calcium fly ash Class F	High calcium fly ash Class C
1	Silicon dioxide (SiO2)	54.90	39.90
2	Aluminium oxide (Al2O3)	25.80	1 6.70
3	Iron oxide (Fe2O3)	6.90	5.80
4	Calcium oxide (CaO)	8.70	24.30
5	Magnesium oxide	1 .80	4.60
6	Sulphur Trioxide (SO3)	0.60	3.30
7	Sodium oxide (Na2O) and Potassium oxide(K2O)	0.60	1 .30

Chemical properties of fly ash

4.METHODOLOGY

Classification Laboratory tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits test) and engineering property tests (compaction and UCS) were performed on samples A and samples B at their unsterilized states. Eggshell powder was then added to the soil samples in 3%, 6%, 9%, 12%, 15%and 18% by weight of samples. Atterberg's limit, compaction and UCS tests were performed on each of the stabilized samples. Thereafter, the optimum requirement of eggshell on each of the three samples were determined and noted. Fly Ash was added in 4, 8, 12and 16% by weight of samples to the soil stabilized samples at their optimum percentages. Atterberg's limit, compaction and UCS tests were repeated on each of the eggshell stabilized samples and Fly Ash stabilized samples.

5. TESTS PERFORMED

The following tests are conducted on expansive soil to determine the like,

1. Compaction of characteristics
2. Strength of characteristics

5.1 Compaction of Characteristics

Compaction is a process by which the soil grains are rearranged and packed together closely by mechanical methods in order to reduce the volume of air voids and increase density of soil. A typical relationship between water content and Dry Unit Weight is depicted from Compaction Curve. The Water Content is termed as Optimum Moisture Content (OMC) and corresponding Dry Unit Weight as Maximum Dry Unit Weight. This chapter presents the results and discussion on compaction characteristics of expansive soil with addition of egg shell powder with different percentages 3%, 6%, 9%, 12%, 15% and 18% and the results and discussion on compaction characteristics of expansive soil with addition of fly ash with different percentages 4%, 8%,12% and 16%.

5.2 Strength Of Characteristics

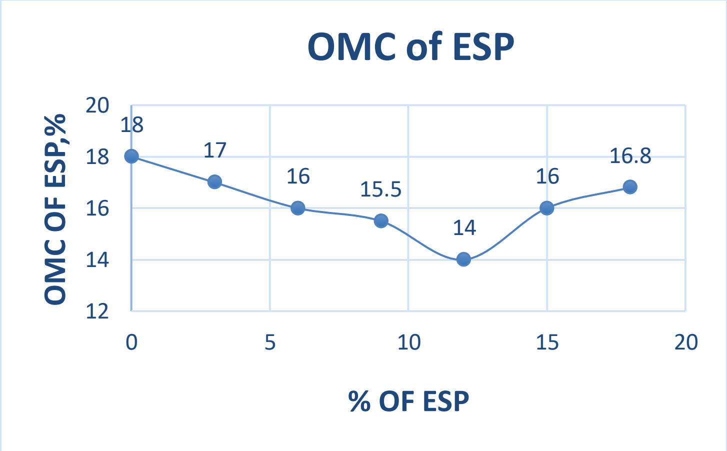
In geotechnical engineering, all the problems are associated in one way or the other with the Shear Strength of the soil. But the Shear Strength is one of the most complicated engineering properties of the soil. The Shear Strength of soil is defined as, its maximum resistance to shear stress just before the failure. The knowledge of Shear Strength of the soil is essential in problems related to Bearing Capacity of soils for design of foundations, retaining structures, pavements etc.

6.RESULT

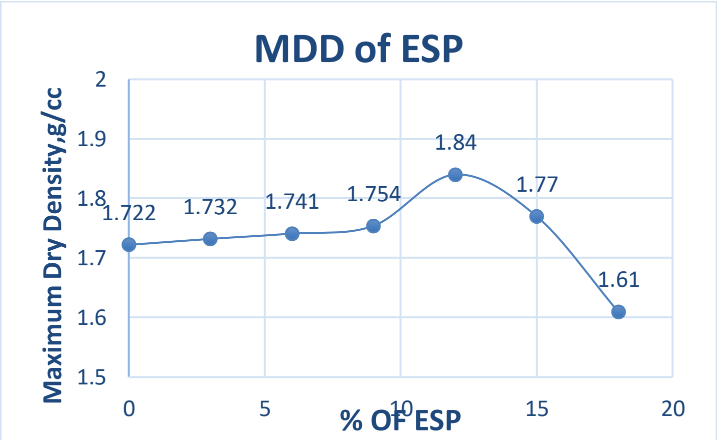
6.1 Effect on Optimum Moisture content and Maximum dry density with addition of Eggshell powder

Percentage of Eggshell added	Optimum Moisture Content (OMC),%	Maximum Dry Density (MDD),g/cc
0	18	1.722
3	17	1.732
6	16	1.741
9	15.5	1.754
12	14	1.84
15	16	1.71
18	16.8	1.61

Result of maximum dry density and optimum moisture content of Eggshell Powder



Optimum Moisture Content (OMC) of Eggshell Powder

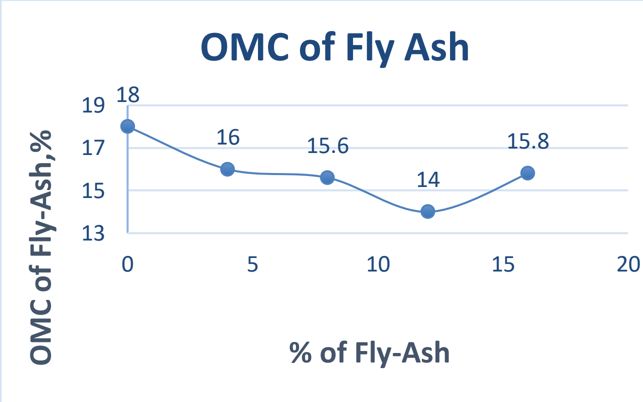


Maximum Dry Density (MDD) of Eggshell Powder

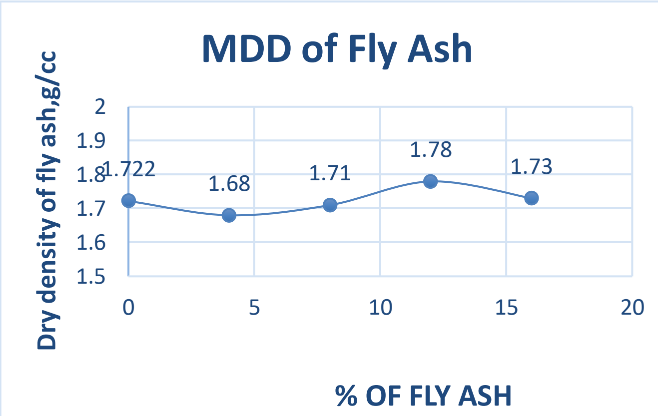
6.2 Effect on Optimum Moisture content and Maximum dry density with addition of Fly Ash

Percentage of Fly Ash added	Optimum Moisture Content (OMC), %	Maximum Dry Density (MDD), g/cc
0	18	1.722
4	16	1.68
8	15.6	1.71
12	14	1.78
16	15.8	1.73

Result of maximum dry density and optimum moisture content of Fly-Ash



Optimum Moisture Content (OMC) of Fly Ash

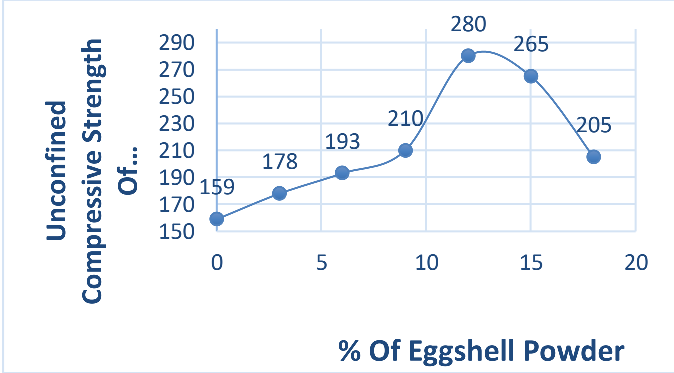


Maximum Dry Density (MDD) of Fly Ash

6.3 Effect on Unconfined Compressive Strength with addition of Eggshell Powder to soil

Percentage of Eggshell added	UCS (Kpa)
0	159
3	178
6	193
9	210
12	280
15	265
18	205

Unconfined Compressive Strength with addition of Eggshell Powder to soil

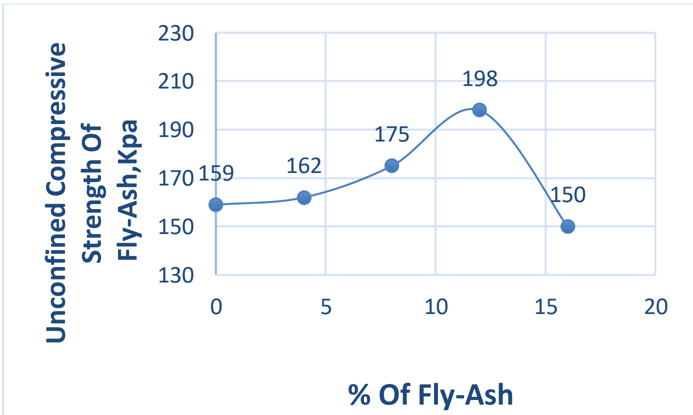


Unconfined Compressive Strength with addition Eggshell Powder

6.4 Effect on Unconfined Compressive Strength with addition of Fly-Ash to soil

Percentage of Fly-Ash added	UCS (Kpa)
0	159
4	162
8	175
12	198
16	150

Unconfined Compressive Strength with addition of Fly-Ash to soil



Unconfined Compressive Strength with addition Fly Ash

7.CONCLUSION

The CH (High compressible clay) soil collected from the National Highway -16 near Narayana Engineering College, Gudur is addition of Eggshell Powder and Fly-Ash. Tests were conducted on admixed soil with percentages of 3% to 18% increment 3% of Eggshell powder and 4% to 16% increment 4% of Fly-Ash after to analyse the effect on compaction characteristics and strength characteristics w.r.t original soil

The following concluding remarks are made from the present work:

1. The Compaction of soil with addition of Eggshell powder and Fly-Ash increased with increase of percentages ESP & Fly-Ash.

2. Maximum increases is observed with addition of Eggshell powder and Fly-Ash to the soil improving from 1.722g/cc (original soil) to 1.84g/cc (Eggshell powder and Fly-Ash) **Increment is about 6.85%** compared to the original soil.

3. The Unconfined Compressive Strength of soil with addition of Eggshell powder and Fly-Ash increased with increase of percentages ESP & Fly-Ash.

4. Maximum increases is observed with addition of Eggshell powder and Fly-Ash to the soil improving from 159kPa (original soil) to 280kPa (Eggshell powder and Fly-Ash) **Increment is about 76.10%** compared to the original soil.

8.REFERENCES

1. Erdal Cokca (2001): "Use of class c fly ashes for the stabilization of an expansive soil", journal of geotechnical and geoenvironmental vol. 127, july, pp.568-573.
2. Amo.o.o (2005):"Effect of egg shell powder on the stabilizing potential of lime on an expansive clay soil", research journal of agriculture and biological sciences, Volume 1(1), pp:80-84.
3. Okonkwo U.N: "Effect of egg shell on strength properties of cement stabilized lateritic soil", journal of geotechnical vol.124, pp.546-554.
4. Phanikumar B.R and Radhey S Sharma (2004):"Effect of fly ash on engineering properties of expansive soil", journal of geotechnical and geoenvironmental vol.130,july.pp764-767.
5. Owyelowe Kea C, Okafor F and Nwachukwe D.G: "Use of Quarry dust on soil stabilization", journal of geotechnical and geo environment vol129,june. pp768-777.
6. Charlie M.O, Nwaiwu J, Samson H, Mohalia Z & Joshua . K. Dwrkwa: "Effect of Quarry dust black soil mixture ", Jordian journal of civil engineering, 2012, volume 6(1).pp.338-346.
7. Koteswara Rao. D , M.Anusha, P.R.T. Pranav, G.Venkatesh [Ijesat] International Journal Of Engineering Science & Advanced Technology Volume-2, Issue-4, 851 – 862
8. Amu, O. O., A. B. Fajobi, and B. O. Oke. "Effect of eggshell powder on the stabilizing potential of lime on an expansive clay soil." Journal of Applied Sciences 5.8 (2005): 1474-1478.
9. Petry, Thomas M., and Dallas N. Little. "Review of stabilization of clays and expansive soils in pavements and lightly loaded structures—history, practice, and future." Journal of Materials in Civil Engineering 14.6 (2002): 447-460.
10. Charlie M.O, Nwaiwu J, Samson H, Mohalia Z & Joshua . K. Dwrkwa: "Effect of Quarry dust black soil mixture ", Jordian journal of civil engineering, 2012, volume 6(1).pp.338-346.
11. Nabil al Joulani: "Effect of Stone powder and Lime on the properties of fine soil", Jordian journal of civil engineering, 2012, vol:6(1),pp:350-366.
12. Karthika Prasad, Prabhu P James, Nissy mathachan and Tess liya Justine: "Effect of

curing on soil stabilized with egg shell", IJSTE- International journal of science technology and engg. Vol 2 Issue 12, june 2016.

13. Muthu kumar and Tamilarasan:"Effect of Egg shell powder in the index and engineering properties of soil", IJETT – volume 11, number 7 may 2014.
14. Birundha, Suguna, Prabhudevan and Vignesh kumar : "Stabilization of clayey soil using egg shell powder and quarry dust", ISSN vol10 number 8 2017