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Strength and Compaction Behavior of sticky Expansive soil by using Fly ash at Bilaspur (CG)

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Abstract: Low bearing capacity, strength, swelling and shrinkage characteristics of the soil are the major cause for the settlements and failure of embankments, slopes and other civil engineering structures. Presently in India, especially in the case of state of Chhattisgarh ratio of coal ash utilization to generation is still less than 60% and therefore it becomes necessary to increase its utilization rate for the sustainable development. In the present experimental study strength and compaction characteristics of locally available soils by partial replacement of coal ash is studied. Proctor test is conducted for different modified energy levels and CBR test is conducted for the different percentages of coal ash to check its compatibility and suitability as a highway subgrade.

Keywords: Coal Ash; Strength; Compaction.

I INTRODUCTION

Soils are materials that are highly uncertain in their behaviour and thus do not exhibit the desired properties for construction. Modification of soil at site is necessary to improve its engineering properties. Low bearing capacity and strength along with swelling and shrinkage characteristics of the soil are the major cause of the for the failures of embankments, slopes and other structures. Stabilization of soil can be done chemically and mechanically. Soil compaction is one of the extensively used method of mechanical stabilization. Pandial et al. (1997) studied density and water content relationships and developed a model for fine-grained soil compaction behaviour based on liquid limit of soil and specific gravity. The obtained set of curves were closely approximated the results of Joslin (1959). Suksun et al. (2013) studied compaction behaviour of fine soils and crushed rocks. At OMC the field compaction of a fine grained shows that initially dry unit weight increases rapidly with energy and then reaches to a constant value close to max dry density.

In India presently coal based thermal power plants generate about 70% of total power. The generation of fly ash at present is about 178 million tons per year and utilization rate is about 107.75 million tons in the year 2015-16. Several research works have been focused on evaluating the engineering properties of fly ash and pond ash for assessing their suitability for construction. Cohesive swelling type of soil needs treatment to avoid the problematic behaviour. Mixing admixtures like lime (Bell 1996), cement (Uddin et al. 1997) is a popular way to improve the properties of cohesive soils. Uses of waste like coal ash as admixtures is now becoming a popular for improving behaviour of soil and also for sustainable development.

Coal ash can also be utilized in reinforced concrete retaining structures, as backfill material mixed with sand or clay. Coal ash when mixed with high swelling clayey materials it improves its properties such as swelling and strength behaviour (Gonawala and Joshi 2013, Phanikumar and Sharma 2004). In the present study an attempt has been made to stabilize locally available soil (clayey soil of Bilaspur, C.G., India) by using coal ash and slag.

II MATERIALS

Materials used in this experimental study were collected from nearby areas of Bilaspur city. Sample collected for the experiment consists of cohesive type of soil having low bearing capacity.

A. Coal ash

Coal ash used in this project were collected from the ash pond of Sipat thermal power plant, Bilaspur (CG), India. The collected coal ash dried in oven and stored in tanks before it was used as test samples. The physical properties are shown in Table-1.

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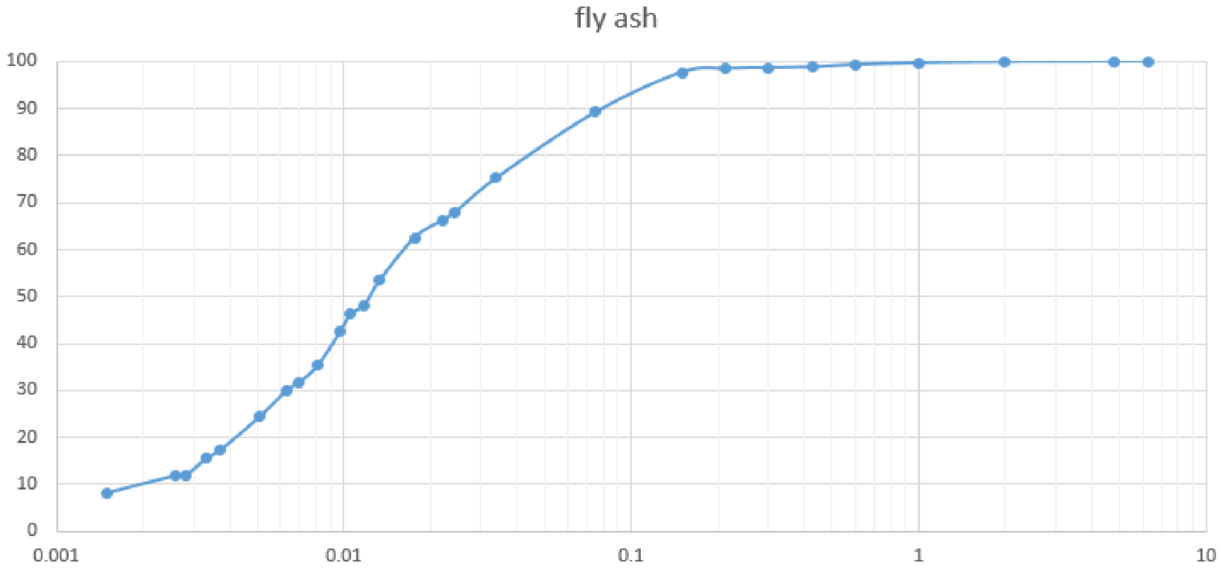

Fig:I Particle size distribution curve of fly ash.

B. Locally available cohesive soil

Soil samples were collected from Rajkishor nagar, Bilaspur, India. Soil samples for experiment and testing was collected from the borrow pit at a depth of 1.5 m from the ground surface. Soil samples obtained can be classified as medium swelling clayey type of soil with specific gravity of 2.76.

Table-I Physical properties of coals ash

Physical Property	**value**	**Physical property**	**value**
Specific gravity	2.20	Medium sand %	0
Silt and clay %	85	C_u	5.60
Fine sand %	15	C_c	1.22

III METHODOLOGY

Index properties of soil and grain size distribution of coal ash was done according to IS: 2720 part-3, 1980. For coarse-grained particles sieve analysis test was conducted according to the IS: 2720, part-4, 1975 and for fine grained particles hydrometer analysis was conducted. The coal ash is a fine grained material, 88% of coal ash was finer than a 75µ. Grain size of the coal ash ranges from size of fine sand to size of silt. The coefficient of uniformity and coefficient of curvature are obtained as 5.65 and 1.26 respectively. Coal ash used here can be classified as uniformly graded soil.

A. Normal Compaction tests

Compaction of soil sample has been done by partially replacing cohesive soil by coal ash in different percentages as 0%, 10%, 20%, 30% and 40% respectively. Light compaction was done according to IS 2720 part VII, 1980 and for heavy compaction IS 2720 part VIII, 1983 was followed.

B. Compaction at different Energy levels

For compaction at different energy levels, mixture of clayey soil sample with coal ash were used.
For variation of compaction energy, number of blows and number of layers were changed.

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Table II: Different energy levels for compaction with 1000 cc mould

Volume of mould (cc)	Weight of hammer (kg)	Number of layers	Height of fall (m)	Number of blows	Energy (J)
1000	2.6	3	0.310	25	593 (E1)
1000	2.6	5	0.310	35	1383(E2)
1000	4.9	5	0.450	25	2704(E3)
1000	4.9	5	0.450	35	3785(E4)
1000	4.9	7	0.450	35	5300(E5)

C. *CBR test*

California bearing ratio tests were performed according to IS 2720 part XVI, 1987. Test were conducted over soil and coal ash mixtures for FA00, FA10, FA20, FA30 and FA40 (i. e. coal ash in soil as 0%, 10%, 20%, 30% and 40%) for soaked and soaked conditions.

IV RESULTS AND DISCUSSIONS

A. OMC and MDD at different energy levels

Maximum dry density of soil tends to increase with increase in compaction energy and optimum moisture content for the same decreases. At water content less than OMC, the effect of increased compaction seems predominant. During compaction the internal sliding of particles occurs and density starts increasing with increase in compactive effort. The slight change in compaction behaviour of soil is observed, due to replacement of fly ash optimum moisture contents increases for the required dry density. Increasing compaction energy after 5300 J energy shows negligible increase in MDD for FA00 and FA10 soil.

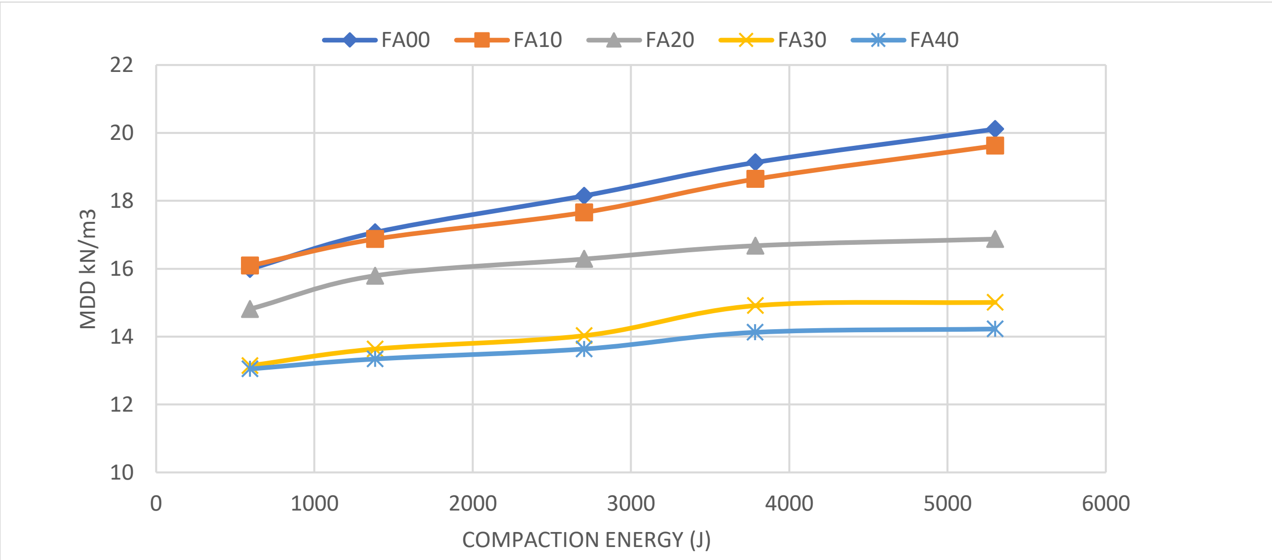

Fig:II Compaction energy Vs Maximum dry density curve for different soil-fly ash mixtures.

B. Compaction behaviour

Compaction behaviour of a soil depends upon its moisture content, amount of compaction or energy imparted for compaction, type of soil and method of compaction etc. In this study clayey type of soil is mixed with coal ash in different percentages. Strength and compaction of clayey of soils are mainly due to cohesion and internal sliding of particles in soil respectively, coal ash used here is a non-plastic and non-cohesive type of soil. Compaction behaviour of both the soils are different. When the coal ash is mixed with the expansive soil, its swelling and shrinkage characteristics decreases. Also mixing coal ash with problematic soil shows acceptable compaction behaviour for the utilization of this waste as a sustainable construction material. Figure 2, shows the variation of dry densities with change in moisture content of a soil with partially replaced coal ash. Increase in coal ash content leads to decrease in dry density. Replacement of soil up to 20 % shows negligible change for higher compaction energies in value of MDD although OMC increases.

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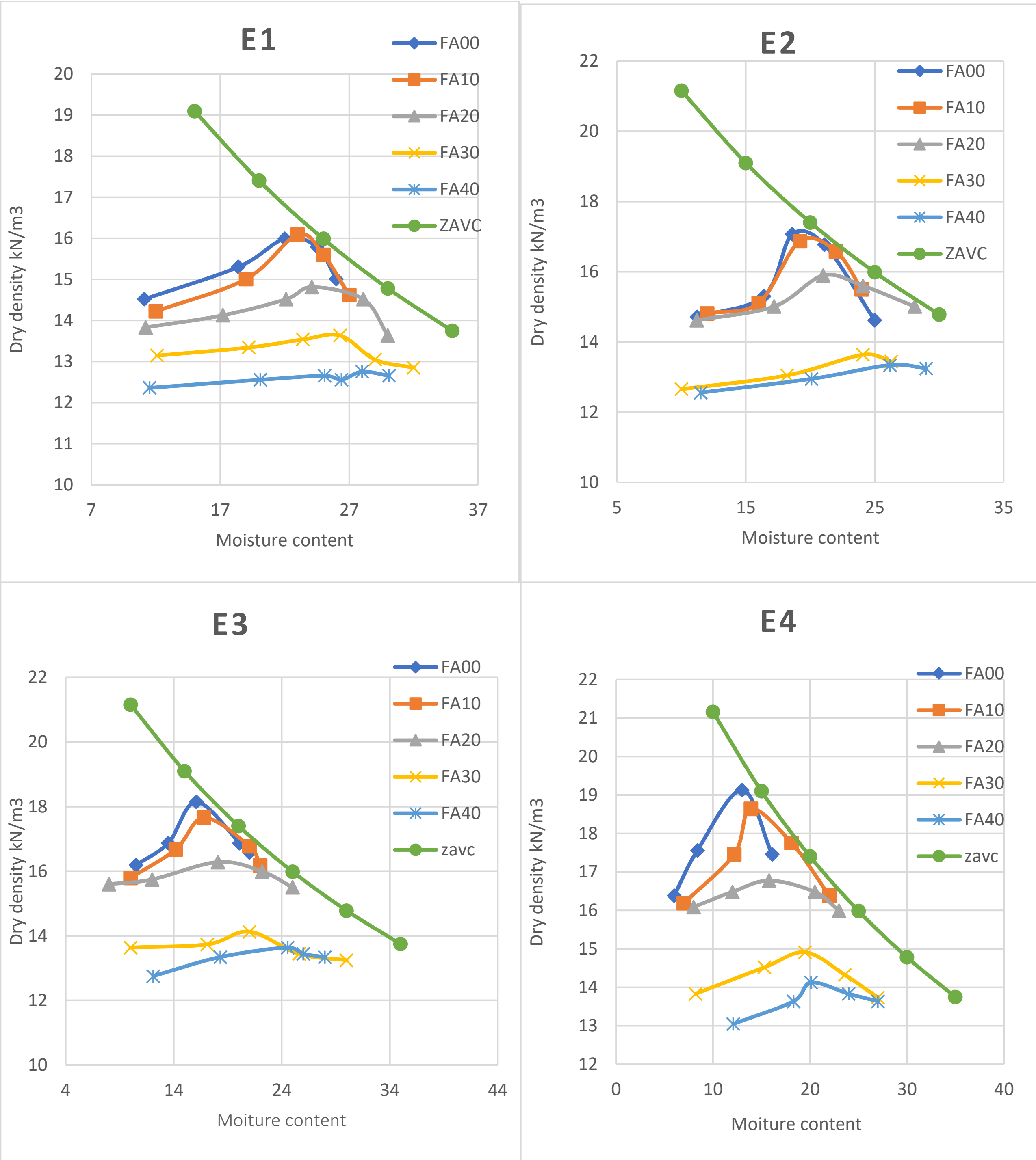

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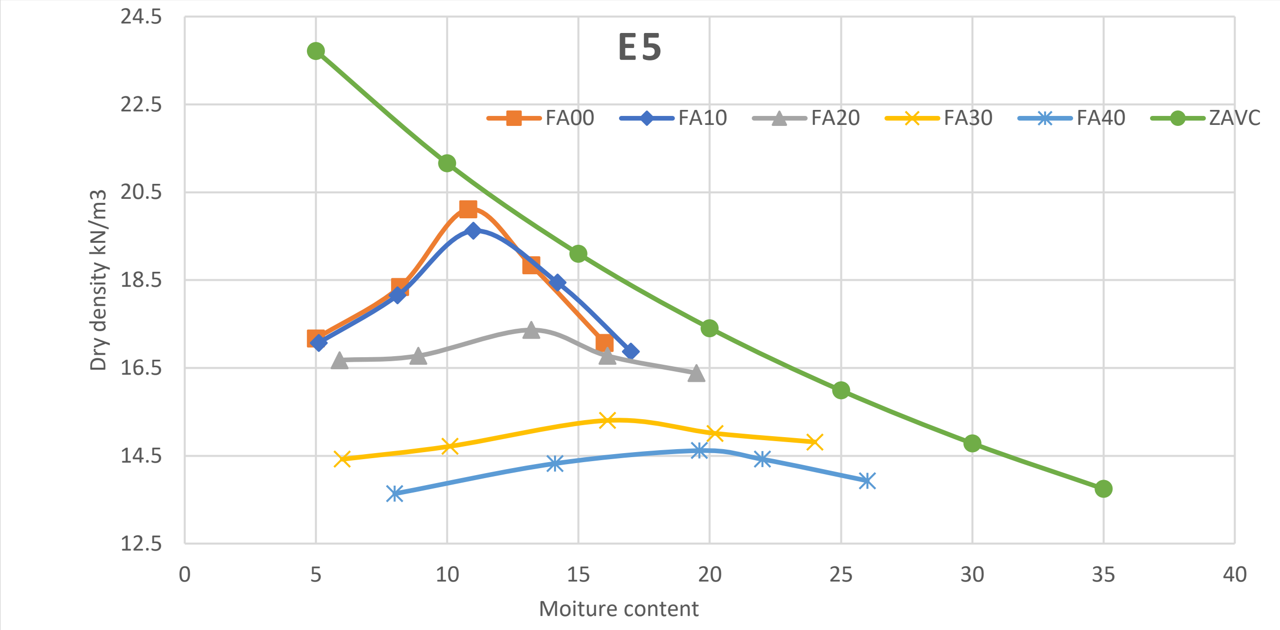

Fig. III Moisture content vs dry density curves for different compaction energies with fly ash contents (E1) 593 J (E2) 1383 J (E3) 2704 J (E4) 3785 J (E5) 5300 J.

B. CBR strength variation

CBR strength of soil is tested for the FA00, FA10, FA20 and FA40 compacted under heavy compaction energy. The test is conducted for soaked and unsoaked conditions.

The CBR values of soils for unsoaked conditions tends to decrease with decrease in MDD values. The frictional component of coal ash increases the soaked CBR strength of the soil as the friction component is less effected by moisture in comparison with cohesion component of the soil.

In soaked conditions the CBR values tends to increase with coal ash content up to 30% because of decrease in cohesion and increased frictional components. After FA20 CBR values decreases because of improper compaction due to increase in coal ash content.

V CONCLUSIONS

For the sustainable development in the field of construction utilization of waste material like coal ash is necessary, and this experiment shows the results which may be useful for the utilization of coal ash in embankment or in compacted subgrade as a construction material.

Compaction characteristics of locally available is studied with a partial replacement of coal ash and following points were observed:

- Maximum dry density increases with increase in compaction energy. FA00 and FA10 shows negligible change in MDD after 5300 J energy, while for FA30 and FA40 soils change was negligible after E4 compaction energy.
- Increasing coal ash content increases the OMC value for the given dry density.
- Upto 20 % coal ash replacement shows 0 to 10% decrement in MDD values and 40% coal ash reduces MDD by 30-40%.
- CBR values in soaked conditions tends to increase with increase in coal ash content up to 30% because of decreased cohesion and increased frictional components.

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REFERENCES

[1] A. Ghosh, C. Subbarao, Hydraulic conductivity and leachate characteristics of stabilized fly ash. Journal of Environmental Engineering, 1998, 124(9), 812-820.

[2] B. A. Mir, A Sridharan, Physical and Compaction Behaviour of Clay Soil–Fly Ash Mixtures, Geotech Geol Engineering, 2013, 31:1059–1072 DOI 10.1007/s10706-013-9632-8.

[3] D. H. Gray, Y. K. Lin, Engineering properties of compacted fly ash. J. Soil Mech. Found. Div., 1972, 98(4), 361–380.

[4] F. G. Bell, Lime stabilization of clay minerals and soils, Eng. Geol., 1996, 42(4), 223–237.

[5] H. Suksun, S. Apichat, P. Chamket, A. Chinkulkijniwat, Compaction behavior of fine-grained soils, lateritic soil sand crushed rocks. Soils and Foundations, 2013, 53(1), 166–17.

[6] J.C. Joslin, Ohio's typical water-density curves, American Society for testing and materials. Special Technical Publication STP, 1959, 239, 111–118.

[7] K. Uddin, A. S. Balasubramaniam, D. T. Bergado, Engineering behavior of cement treated Bangkok soft clay. Geotech. Eng., 1997, 28(1), 89–119.

[8] T.S. Nagaraj, A.J. Lutenegger, N.S. Pandian, M. Manoj, Rapid estimation of compaction parameters for field control. Geotechnical Testing Journal, 2006, ASTM 29 (6),1–10.

[9] Pandian, N.S., Nagaraj, T.S., Manoj, M., 1997. Re-examination of compaction characteristics of fine-grained soils. Geotechnique 47 (2), 363–366.

[10] Phanikumar, B. R., and Sharma, R. S. (2004). Effect of fly ash an engineering properties of expansive soils. J. Geotech. Geoenviron. Eng., 10 .1061/(ASCE)1090-0241(2004)130:7(764), 764–767.

[11] R. J. Gonawala, N. H. Joshi, Strength and fly ash-sand backfilled reinforced earth wall under surcharge strip loading. Proc., Indian Geotechnical Conf., Indian Geotechnical Society, New-Delhi, India, 2013.

[12] S. Hazra, N. R. Patra, Performance of counterfort walls with reinforced granular and fly ash backfill, Experimental investigation. Geotech. Geol. Eng., 2008, 26(3), 259–267.

[13] S. P. Singh, N. Roy, S. Sangita, Strength and hydraulic conductivity of sedimented ash deposits treated with lime column, International Journal of Geotechnical Engineering, 2016, DOI: 10.1080/19386362. 2016.1208415.

[14] S. P. Singh, S. Sangita, Mitigation of leaching of major and trace elements from pond ash deposits by lime column treatment, International Journal of Geotechnical and Geological Engineering, 2016, DOI: 10.1007/s10706-016-0080-0.