Research Paper on Effect of Different Chemicals on the Compaction and Unconfined Strength of Fly Ash Lime Mix

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ABSTRACT

Most developed and developing countries all over the world have huge resources of waste materials such as fly ash. These waste materials contain large quantities of impurities which may pollute the subsoil or ground water if disposed-off in an open environment. The quantities of these waste materials produced around the world are huge and causing disposal problems that are both financially and environmentally expensive. One method to reduce some portion of the fly ash is by mixing them together in the presence of stabilizer like lime and utilizing the composite so produced for civil engineering applications. Further, in India, extensive road network is under construction. Civil engineers around the world are in search of new alternative materials which are required both for cost effective solution for roads and for conservation of scarce natural resources. In this context, flyash– lime mixed with varying content of chemicals like calcium chloride, sodium hydroxide and sodium sulfide hold promise as alternate materials for use in roads. The research programme included

INTRODUCTION

In recent years the philosophy of recycling has taken a grip of all of society. Household waste is separated and recycled, and there is a growing demand on the industries to do likewise. Some industrial waste is directly harmful, and both people and the environment should be protected from exposure to it. But most materials that have been considered waste can be recycled and used as a raw material in other applications. For example, the Swedish environmental legislations require that waste producers strive to implement recycling of waste material to an extent as large as possible. This means that, instead of producing a product and waste, most industries produce a primary product and a number of secondary products.

A power and heating plant is no exception, it produces heat and electricity, and furthermore it produces secondary products in the form of different types of ash. The difference between a secondary product and waste is that the secondary product is generally both useable and not dangerous to people and the environment. Important however is that technical and environmental properties of the secondary products are evaluated from requirements related to the specific application. In many cases it saves both a lot of energy and a lot of money, to use a recycled material instead of conventional ones. Since fly ash has some stabilizing properties, it is a natural next step to investigate the possibility to use it for soil stabilization.

OBJECTIVE

As a step in the direction of the problem described in the previous section the main objective of the dissertation work is to study the effect of different chemicals on the compaction and unconfined compressive strength of fly ash lime mix.

The main objective can be divided into the following sub-objectives:

- To study the compaction behavior of lime stabilized fly ash.
- To study the effect of different chemicals on the compaction behavior of lime treated fly ash.
- To study the unconfined compressive strength on the optimum values obtained from the compaction test at different curing periods.
- To study SEM, XRD and EDS tests of stabilized fly ash at different curing period.

An extensive laboratory testing programme was devised and the results were analyzed to critically assess the effect of different chemicals on the compaction and unconfined compressive strength of fly ash lime mix suitable for pavements construction.

MATERIALS USED AND EXPERIMENTAL PROGRAMME

As outlined in the previous Chapter, it is proposed to study the strength of flyash-lime with varying chemical contents cured for 7, 14, and 28 days. This chapter presents the details about the materials and the experimental procedures adopted along with the apparatus used and a summary of the test programme.

Fly ash was procured from the Guru Gobind Singh Super Thermal Power Plant, Ropar, Punjab, India. The elemental composition was determined from SEM-EDS given in Table.1

From the chemical of the fly ash are given in Table 2, it has been observed that the combined content of major oxides (SiO_2+Al_2O_3+Fe_2O_3) present are greater than 70% and content of CaO is less than 20%. It employees that the fly ash under study is a Non-Self- Cementing fly ash, also known as Class F fly ash (ASTM C618). It was chosen due to its availability in abundance as compared to class C fly ash.

Table 1 Elemental Composition of Fly Ash

Elements	Weight %	Atomic %
C	29.88	38.40
O	55.20	53.25
Al	6.33	3.62
Si	8.60	4.72

Table 2 Chemical Properties of Fly Ash

S. No.	Constituents Present	Value (%)
1	Loss of I nition	4.52
2	Silica (SiO_2)	56.32
3	Alumina (Al_2O_3)	30.87
4	Iron Oxide (FeO_2)	4.94
5	Magnesium Oxide (MgO)	1.58
6	Calcium Oxide (CaO)	0.70

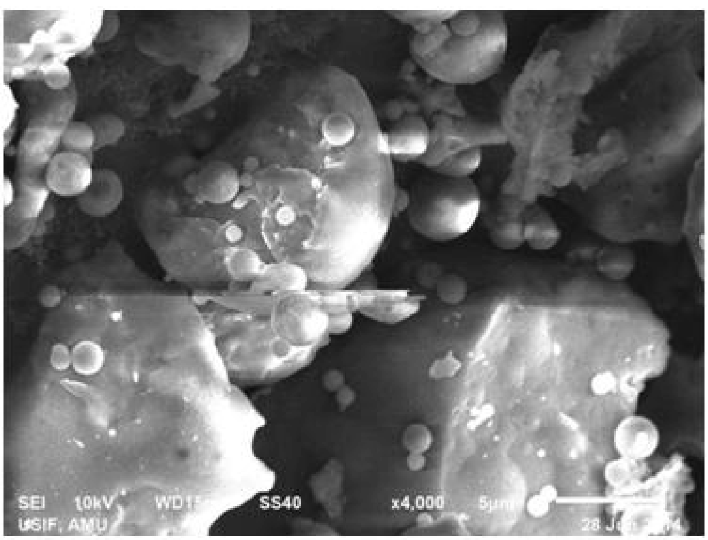

Fig. 1 SEM of thefly ash (10kV, x4000, 5µm)

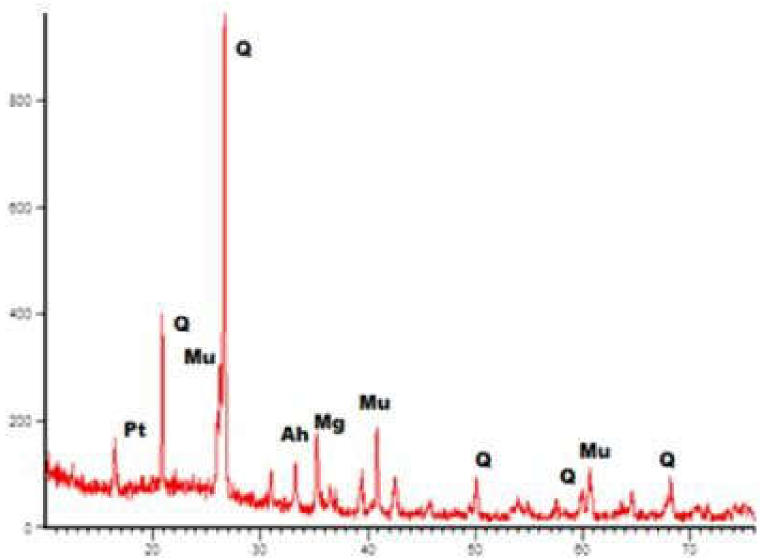

Fig. 2 X.R.D. of Fly Ash Unconfined Compressive Strength Test

Unconfined compressive strength is one of the most widely referenced properties of stabilized soils. Because strength is directly related to density, this property is affected in the same manner as density by degree of compaction and water content. For strength testing, specimens are generally tested at their maximum dry density and optimum moisture content. The unconfined compressive strength test may be classed as a shear strength test, since it is essentially a triaxial test with zero lateral pressure. For soil stabilization work, the test serves much the same purpose as for concrete work. Particular uses of the test are to determine the suitability of the soil for stabilization with a given stabilizer and to compare different mixture to specify the stabilizer content to be used in construction, and to provide a standard by which the quality of the field processing can be assessed. The measured strength value is not used for design purposes, nor is the modulus of the elasticity that can be determined from the stress-strain curve. Rather, the unconfined compressive strength data are principally significant for control purposes and are as indicator of durability. The unconfined compressive strength is taken as the maximum load attained per unit area, or the load per unit area at 15% axial strain, whichever occurs first during the performance of a test. Based on the value of unconfined compressive strength qu, the quality of subgrade soil can be considered is given in Table 3.

Table 3 Relationship between UCS and quality of sub-grade soil (Das B. 1994)

Quality of Sub-grade	UCS (KPa)
Soft sub-grade	25-50
Stiff sub-grade	100-200
Very stiff sub-grade	200-380
Hard sub-grade	>380

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CONCLUSIONS

The quantity of fly ash, a waste material produced around the world is huge and causing disposal problems that are both financially and environmentally expensive. One method to reduce some portion of the flyash disposal problem is by mixing them together in the presence of stabilizer like lime and chemicals, utilizing the composite so produced for civil engineering applications. Civil engineers around the world are in search of new alternative materials which are required both for cost effective solution for roads and for conservation of scarce natural resources. Towards this end compaction and unconfined compressive strength tests were conducted on flyash-lime-chemcial composites. The studies were reported.

On the basis of the results and discussion presented in this chapter, the following is concluded.

- The unconfined compressive strength of the fly ash-lime-calcium chloride composite is increased with the increase in curing period. Comparatively it gives more strength then fly ash-lime.

- The unconfined compressive strength of the fly ash-lime-sodium hydroxide is increased with the increase in curing period. It gives more strength as compared to fly ash-lime-calcium chloride composite significantly.
- The unconfined compressive strength of the fly ash-lime-sodium sulfide is increased with the increase in curing period. It gives less strength as compared to fly ash-lime- calcium chloride and fly ash-lime-sodium hydroxide composite.

- The unconfined compressive strength of all the composites are mostly in the agreement with the past studies by various researchers.

- The fly ash-lime and the added chemical composites can be categorize as hard subgrade (Das, 1994).

FUTURE SCOPE OF WORK

From the current study the suitability of flyash-lime and different chemical mix has been demonstrated. However to enable field applications the following research is desirable.

1. Different other additives can also be used to modify the properties of fly ash.

2. Large-scale model tests on flyash-lime and different chemicals like Sodium metasilicate, Sodium Silicate, Sodium Chloride, Sodium Sulphate, Potassium Hydroxide, Potasium Chloride, Ferric Chloride, EDTA etc need to be conducted to further validate of the composite for use in highway pavement.

3. Roads pavements are subjected to many loading cycles due to the traffic. To simulate the field condition, studies are required to analyze the behavior of the flyash-lime and different chemical mix using dynamic tests.

4. Large scale model tests and instrumented field trials may be conducted on flyash- lime a mix to validate the results.

5. Leaching behaviour of the fly ash-lime and different chemical mix needs to be studied so that the composite in contact with water may not pollute the ground water due to the presence of hazardous chemicals and heavy metals.

6. The other laboratory test like CBR, Brazilian tensile strength, slake durability of stabilized fly ash can also be done for better understanding.

7. A correlation among different parameters using available technique can also be developed.

REFERENCES

[1]. Chand, S.K. and Subbarao, C. (2007), “Strength and Slake Durability of Lime Stabilized Pond Ash”, Journal of Materials in Civil Engineering, ASCE, 601- 608.
[2]. Doherty R., Phillips D. H., McGeough K. L., Walsh K. P., and Kalin R. M. (2006)
[3]. “Development of modified flyash as a permeable reactive barrier medium for a former manufactured gas plant site, Northern Ireland”, Environ Geol, 50: 37– 46.
[4]. Davis R.E., (1949) “A review of pozzolanic materials and their use in cement concrete”, Special Technical Publication, ASTM, 99: pp. 3-15
[5]. Das S. K. and Yudhbir (2005) “Geotechnical Characterization of Some Indian Fly Ash”, Journal of Materials in Civil Engg., Vol. 17, pp. 544-552.
[6]. Das. S.K., and Yudhbir (2006), “Geotechnical properties of low calcium and high calcium fly ash.” Geotechnical and Geological Engineering, 24, 249-263.
[7]. DiGioia A.M., Mclaren R.J., Burns D.L. and Miller D.E., (1987), “Fly ash design manual for road and site application”, vol. 1: Dry or conditioned placement, Manual prepared for EPRI, CS-4419.
[8]. Das B. (1994): Principles of Geotechnical Engineering. PWS-Kent Publishing Company, Boston, 3 rd ed. Al-Aghbari M. Y. and Dutta R. K. (2009), “Stabilization of Sand with Cement By-Pass Dust”, International Journal of Geotechnics and Environment, Vol. 1, No. 1, pp. 19-32.
[9]. Al Bakri A. M. M., Kamarudin H., Omar A. K., Norazian M. N., Ruzaidi C. M., Rafiza A. R. (2011), “The Effect of Alkaline Activator Ratio on the Compressive Strength of Fly Ash-Based Geopolymers.” Australian Journal of Basic and Applied Sciences, Vol. 5(9): 1916-1922.
[10]. Al Bakri A. M. M., Kamarudin H., Bnhussain M., Nizar I. K., Rafiza A. R. and Zarina Y. (2011), “Microstructure of different NaOH molarity of fly ash based green polymeric cement.” Journal of Engineering and Technology Research Vol. 3(2), 44-49.
[11]. Ahmaruzzaman M., (2010), A review on the utilization of fly ash, Journal of Progress in Energy Combust. Sci., 36 pp. 327-363.

[12]. Astuti W., Wahyuni E. T., Prasetya A., and Bendiyasa I. M. (2012), "The Effect of Coal Fly Ash Treatment with NaOH on the Characters and Adsorption Mechanism toward Methyl Violet in the Solution."3rd International Conference on Chemistry and Chemical Engineering, Singapore, Vol. 38, 155-160.

[13]. Bera, A.K., Ghosh, A. and Ghosh, A. (2007). "Compaction Characteristics of Pond Ash." Journal of Materials in Civil Engineering, 19, 349-357.

[14]. Bureau of Indian Standards (1980). Methods of test for soils; determination of water content dry density relation using light Compendium of Indian standard on soil engineering, IS 2720, Part 7, New Delhi, India.

[15]. Bureau of Indian Standards. (1973) „„Methods of test for soils: determination of unconfined compressive strength IS 2720 (Part 10).""Compendium of Indian standards on soil engineering, New Delhi, India.

[16]. Chandra S., Pawan K. S. and Anubhav, (2008), "Effect of Over Consolidation Ratio on Shear Strength Behavior of Fly Ash", The Journal of Solid Waste Technology and Management, USA.