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An experimental study on expansive soil with Eggshell and Fly ash

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***Abstract*—This report presents the analysis of soil using Eggshell powder and Fly ash in soil stabilization for different engineering properties. As solid waste disposal being a major environmental problem, because of unavailability of lands for disposal. Due to fast growth in construction industry, land is not available as per construction requirements. For dealing with these problems, solid waste can be incinerating toreduce its volume by 80%, and further can be used as soil stabilization material. It enhances the soil properties and solves the problem of solid waste disposal in city. This work deals with estimation of engineering properties of soil i.e., maximum drydensity vs. optimum moisture content. Experimental work shows that use of 3% E.S.P & 15% Fly ash by weight of soil can improve the properties at largerextends. The foundation of a building or road is an essential part for effective transmission of load to the subsoil present beneath it.**

Index Terms. Fly ash, Eggshell powder, Expansive soil, UCS

I. INTRODUCTION

Many researchers attempt to stabilize the different type of soil with use of Cementous materials or waste or as a combination; here we discuss some of works based on use of waste ash which used in combination with Cementous material or used separately. For soil stabilization, various materials are being used like stone dust, Rubber tyre, bagasse ash, industrial waste etc. 2.2 Overview of literature Soil-stabilizing factors have long been in use so that cement was first used as a stabilizing factor in road construction in the US in early twentieth century. Still, it was not until 1960 that scientific investigations began on additives to clay to improve its strength profile. At the time, adding lime or cement to clay was found to significantly improve clay strength properties including shear and compressive strengths. Since then, geotechnical scientists have conducted extensive research on the effect of additives on soils, particularly clays. Studying strength properties of improved clays, Diamond (1975) concluded that such clays may be used in runway substructure, earth dams and hydraulic structures where they are vulnerable to erosion. Chen (1975) conducted studies on the lime proportions necessary to stabilize clays and reported that 2-8 percent lime was necessary to stabilize clays. Construction Industry Research and Information Association (CIRIA) studied the effect of delayed compaction of soils mixed with additives and reported that any delay in compaction process following the addition of additives prevented soil density to reach its maximum value. Hammond (1992) conducted studies on improving and increasing the strength of clay soils stabilized with lime and concluded that clay-lime mixture was so strong that it can be used to stabilize canal side slopes and to build structure foundations when the foundation bears a moderate load. Kumar et al. (2007) investigated the effect of fly ash, lime and polyester fibres on compaction and strength properties of expansive soils. They reported that cured seven-day, fourteen-day and 28-day specimens of clay-lime-fly ash mixture showed higher unconfined compressive strength than specimens without fly ash mixture. They also found that polyester fibres significantly increased the strength of soil-lime-fly ash mixture. Almost every industrial activity ends up with the exhaustion of natural resources, which results in the accumulation of products or wastes. In the modern world, wastes and refuses have come to be a serious problem so that a line of research is devoted to investigating how wastes may 5 be used without taking a toll on the society. The accumulation of wastes often brings about adverse outcomes. For example, a report published in Britain. estimates eggshell wastes to range from 10,000 to 11,000 tons per year, which specifically poses a problem as to how to use these wastes. Using wastes as alternatives offers two major advantages: preservation of natural resources and elimination of voluminous wastes. Some potential wastes to use in road construction and soil stabilization include coal shale, pulverized fuel ash, furnace clinker, eggshell powder, iron slag, incinerator ash and agricultural wastes, among others. Some of these wastes are widely in use in the world for a variety of purposes. As an example, studies have been conducted on the use of eggshell powder to stabilize nonadherent soils in Japan. Stabilizing agents such as lime and pitch are expensive and need to be replaced economically. Research has shown that eggshell is a rich source of lime, calcium, and protein so that it may be used as an alternative to such soil stabilizers as lime because it contains lime-like ingredients. Used as source of lime in agriculture, eggshell proved to contain a considerable amount of lime [1, 13]. In the present study, eggshell powder was used as an alternative to stabilize expansive soils. To this end, various laboratory experiments were carried out on soil specimens mixed with different percentages of additives (1-25% weight percent) and the effect of eggshell powder was examined on Atterberg properties of the specimens. Sivapullaiah et al. (1996) presented the effect of fly ash and lime, on the index properties of expansive soils such as liquid limits, plastic limits, and free swell. The studied soil was black cotton soil. The results showed that the index properties of this soil were significantly varied by addition fly ash. It is observed that the domain of alteration depends on the particle size distribution, free lime content and pozzolanic reactivity of the fly ash. The effect of the coarseness of fly ash particles is to decrease the activity. Thus, fly ash can decrease the plasticity index of the soil. The effect of the addition of fly ash is to significantly improve the physical properties and workability of the black cotton soil. Mirsa (1998) examined clay stabilization with Class C fly ash. Physical and chemical properties of fly ash and compaction and strength behaviour of soils stabilized with Class C fly ash were discussed. Examples were prepared by blending a small proportion of bentonite with kaolinite. Furthermore, fly ash had a rapid hydration characteristic. So, higher densities and strengths 6 were achieved when the compaction is performed with little or no delay. However, delayed compaction produces low densities and strength. It was observed that the stabilization characteristics are related to the soil mineral type and plasticity. The laboratory studies indicated that use of Class C fly ash in soil stabilization was dependent on the ash contents, water content, compaction delay, strength development with time and curing methodology and the type of clay mineral. Thus, these Class C fly ashes are particularly suited for use as soil improvement agents. Cokca (2001) used from high-calcium and low-calcium class C fly ashes for stabilization of an expansive soil and evaluation of the expansive soil-lime, expansive soil cement, and expansive soil-fly ash systems. Lime, cement, and fly ash were added to the expansive soil at different percentages. The specimens were subjected to chemical composition, grain size distribution, consistency limits, and free swell tests. Also, the Specimens with fly ash were cured and after that they were subjected to free swell tests. It can be concluded that the expansive soil can be successfully stabilized by fly ashes. Furthermore, plasticity index, activity, and swelling potential of the samples decreased with increasing percentage of stabilizer and curing time. Puppala et al. (2001) used from fly ash and fibre reinforcement methods, to treat and increase the strength of two expansive soils. In this regard, Physical tests such as Atterberg limits, standard Proctor compaction and other tests like unconfined compressive strength, shrinkage, and free swell were conducted on both raw and treated clay samples. Both methods showed an increase in unconfined compression strength of the soils. Improvement with fly ash decreased free swell, plasticity, and linear shrinkage strains of raw soils. Fibre reinforcement decreased the vertical shrinkage strains. Whereas it increased the free swell values. In general, the fly ash treatment method can be used to stabilize expansive soils, and fibres can be used to increase the strength and decrease the shrinkage potentials of expansive soils. In addition, the important point is that fibres alone will not provide comprehensive stabilization. Another advantage of the two methods was that both stabilizers were recycled waste products and therefore their use in soil stabilization will reduce landfilling costs. Kumar and Sharma (2004) presented a study of the efficacy of fly ash in improving the engineering characteristics of expansive soils. An experimental program evaluated the effect of the fly ash on the free swell index, swell potential, swelling pressure, plasticity, compaction, 7 strength, and hydraulic conductivity characteristics of expansive soil. The results showed that the plasticity, hydraulic conductivity and swelling properties of the blends decreased and the dry unit weight and strength increased with an increase in fly ash content. The resistance to penetration of the mixtures increased significantly with an increase in fly ash content for a certain water content. Excellent correlation was obtained between the measured and predicted undrained shear strengths and the undrained cohesion of the expansive soil blended with fly ash increased with the fly ash content.

II. METHODOLOGY

Long term performance of pavement structures often depends on the stability of the underlying soils. Engineering design of these constructed facilities relies on the assumption that each layer in the pavement has the minimum specified structural quality to support and distribute the super imposed loads. These layers must resist excessive permanent deformation, resist shear, and avoid excessive deflection that may result in fatigue cracking in overlying layers. Available earth materials do not always meet these requirements and may require improvements to their engineering properties to transform these inexpensive earth materials into effective construction materials. 3.2 Mechanisms of stabilization The stabilization mechanism may vary widely from the formation of new compounds binding the finer soil particles to coating particle surfaces by the additive to limit the moisture sensitivity. Therefore, a basic understanding of the stabilization mechanisms involved with each additive is required before selecting an effective stabilizer suited for a specific application. Chemical stabilization involves mixing or injecting the soil with chemically active compounds such as Portland cement, lime, fly ash, calcium, or sodium chloride or with viscoelastic materials such as bitumen. Chemical stabilizers can be broadly divided in to three groups: Traditional stabilizers such as hydrated lime, Portland cement and Fly ash; Non-traditional stabilizers comprised of sulfonated oils, ammonium chloride, enzymes, polymers, and potassium compounds; and By-product stabilizers which include cement kiln dust, lime kiln dust etc. Among these, the most widely used chemical additives are lime, Portland cement and fly ash. Although stabilization with fly ash may be more economical when compared to the other two, the composition of fly ash can be highly variable. The mechanisms of stabilization of the traditional stabilizers are detailed below. 3.2.1 Traditional Stabilizers Traditional stabilizers generally rely on pozzolanic reactions and cation exchange to modify and/or stabilize. Among all traditional stabilizers, lime probably is the most routinely used. Lime is prepared by decomposing limestone at elevated temperatures. Lime-soil reactions are complex and primarily involve a two-step process. The primary reaction involves cation 10 exchange and flocculation/agglomeration that bring about rapid textural and plasticity changes. The altered clay structure, because of flocculation of clay particles due to cation exchange and short-term pozzolanic reactions, results in larger particle agglomerates and more friable and workable soils. Although pozzolanic reaction processes are slow, some amount of pozzolanic strength gain may occur during the primary reactions, cation exchange and flocculation/agglomeration. Extent of this strength gain may vary with soils depending on differences in their mineralogical composition. Therefore, mellowing periods, normally about one-day in length but ranging up to about 4-days, can be prescribed to maximize the effect of short-term reactions in reducing plasticity, increasing workability, and providing some initial strength improvement prior to compaction. The second step, a longer-term pozzolanic based cementing process among flocculates and agglomerates of particles, results in strength increase which can be considerable depending on the amount of pozzolanic product that develops, and this, in turn depends on the reactivity of the soil minerals with the lime or other additives used in stabilization. The pozzolanic reaction process, which can either be modest or quite substantial depending on the mineralogy of the soil, is a long-term process. This is because the process can continue if a sufficiently high pH is maintained to solubilize silicates and aluminates from the clay matrix, and in some cases from the fine silt soil. These solubilized silicates and aluminates then react with calcium from the free lime and water to form calcium-silicate-hydrates and calcium aluminates hydrates, which are the same type of compounds that produce strength development in the hydration of Portland cement. However, the pozzolanic reaction process is not limited to long term effects. The pozzolanic reaction progresses relatively quickly in some soils depending on the rate of dissolution from the soil matrix. In fact, physio-chemical changes at the surface of soil particles due to pozzolanic reactions result in changes in plasticity, which are reflected in textural changes that may be observed relatively rapidly just as cation exchange reactions are. Portland cement is comprised of calcium-silicates and calcium aluminates that hydrate to form cementitious products. Cement hydration is relatively fast and causes immediate strength gain in stabilized layers. Therefore, a mellowing period is not typically allowed between mixing of the components (soil, cement, and water) and compaction. In fact, it is general practice to 11 compact soil cement before or shortly after initial set, usually within about2 hours. Unless compaction is achieved within this period traditional compaction energy may not be capable of developing target density. However, Portland cement has been successfully used in certain situations with extended mellowing periods, well beyond 2 to 4 hours. Generally, the soil is remixed after the mellowing periods to achieve a homogeneous mixture before compaction. Although the ultimate strength of a soil cement product with an extended mellowing period may be lower than one in which compaction is achieved before initial set, the strength achieved overtime in the soil with the extended mellowing period may be acceptable and the extended mellowing may enhance the ultimate product by producing improved uniformity. Nevertheless, the conventional practice is to compact soil cement within 2 hours of initial mixing. During the hydration process, free lime, Ca (OH) 2 is produced. In fact, up to about 25 percent of the cement paste (cement and water mix) on a weight basis is lime. This free lime in the high pH environment can react pozzolanic ally with soil, just as lime does and this reaction continues if the pH is high enough, generally above about 10.5. Fly ash is also generally considered as a traditional stabilizer. While lime and Portland cement are manufactured materials, fly ash is a by-product from burning coal during power generation. As with other by-products, the properties of fly ash can vary significantly depending on the source of the coal and the steps followed in the coal burning process. These by-products can broadly be classified into class C (self-cementing) and class F (non-self-cementing) fly ash based on AASHTO M 295 (ASTM C 618). Class C fly ash contains a substantial amount of lime, Cao, but almost all of it is combined with glassy silicates and aluminates. Therefore, upon mixing with water, a hydration reaction like that which occurs in the hydration of Portland cement occurs. As with Portland cement, this hydration reaction produces free lime. This free lime can react with other unreacted pozzolana, silicates and aluminates, available within the fly ash to produce a pozzolanic reaction, or the free lime may react pozzolanic with soil silica and/or alumina. Class F ash, on the other hand, contains very little lime and the glassy silica and/or alumina exists almost exclusively as pozzolana. Therefore, activation of this pozzolana requires additives such as Portland cement or lime, which provide a ready source of free lime. The hydration or "cementitious" reactions and the pozzolanic reactions that occur when fly ash is blended with water from the products that bond soil grains or agglomerates together to develop strength 12 within the soil matrix. As discussed previously, maintenance of a high system pH is required for long term strength gain in fly ash-soil mixtures. The kinetics of the cementitious reactions and pozzolanic reactions that occur in fly ash stabilized soils vary widely depending on the type of ash and its composition. Normally, class C ashes react rapidly upon hydration. However, class F ashes activated with lime or even Portland cement produce substantially slower reactions than Portland cement - soil blends. Generally, compaction practice of fly ash - soil blends vary depending on the type of ash used or whether an activator is used, but the standard practice is to compact within6 hours of initial mixing

VII. CONCLUSION

1. Experimental study of soil stabilization with Eggshell powder and Fly ash shows use of 3% E.S.P &15% F.A with soil enhances soil properties viz. Unconfined compression test,and compaction.
2. This study shows instead of having simply disposal of Solid Waste, which is also not possible due to lack of land availability, we can improve soil properties by using waste ash.
3. Using solid waste as stabilising material is cheap as well as eco-friendly method of soil stabilization, which solves the waste disposal problems as well as enhances soil properties.

4. The soil maximum dry density increased by 5.01%.
5. The Soil unconfined compression test increased by 6.86%

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REFERENCE

[1]S.Chen,B.Mulgrew,andP.M.Grant,–Aclusteringtechniquefordigital communications channel equalization using radial basis function networks,‖ *IEEETrans.onNeural Networks*, vol. 4,pp.570-578,July1993.

[2] J. U. Duncombe, –Infrared navigation—Part I: An assessment of feasibility, ‖*IEEETrans. ElectronDevices*,vol.ED-11,pp. 34-39,Jan.1959.

[3]C.Y.Lin,M.Wu,J.A.Bloom,I.J.Cox,andM.Miller,–Rotation, scale and translationresilient publicwatermarkingforimages,‖*IEEETrans.ImageProcess.*, vol. 10,no.5,pp.767-782, May2001.

[4]A.CichockiandR.Unbehaven,*NeuralNetworksforOptimizationandSignalProcessing*,1sted.Chichester,U.K.:Wiley,1993,ch.2,pp.45-47.

[5]W.K.Chen,*LinearNetworksandSystems*,Belmont,CA:Wadsworth,1993, pp. 123-135.

[6]H.Poor,*AnIntroductiontoSignalDetectionandEstimation*;NewYork: Springer-Verlag, 1985,ch.4.

[7]R.A.Scholtz,–TheSpreadSpectrumConcept,‖in *MultipleAccess*,N.Abramson,Ed. Piscataway,NJ:IEEEPress, 1993,ch.3, pp. 121-123.

[8]G.O.Young,–Syntheticstructureofindustrialplastics‖ in*Plastics*,2nded.vol.3,J.Peters,Ed.NewYork:McGraw-Hill,1964,pp.15-64.

[9]S.P.Bingulac,–Onthecompatibilityofadaptivecontrollers,‖in*Proc.4thAnnu.AllertonConf.CircuitsandSystemsTheory*,NewYork,1994, pp.8-16.

[10] W.D. Doyle–Magnetization reversal in films with biaxial anisotropy, ‖in*Proc. 1987INTERMAG Conf.*, 1987, pp. 2.2-1-2.2-6.

[11] G. W. JuetteandL. E. Zeffanella, –Radionoisecurrentsnshort sections on bundle conductors,‖presentedattheIEEESummerPowerMeeting,Dallas,TX,June 22-27,1990.

[12] J.Williams,–Narrow-bandanalyzer, ‖Ph.D. dissertation, Dept.Elect.Eng., Harvard Univ. Cambridge, MA,1993.

[13] N. Kawasaki, –Parametric study of thermal and chemical nonequilibriumnozzleflow,‖ M.S. thesis,Dept.Electron.Eng.,OsakaUniv.,Osaka,Japan, 1993.

[14] J.P.Wilkinson,–Nonlinear resonant circuit devices,‖ U.S.Patent3624 12,July16, 1990.

[15]*LetterSymbolsforQuantities*,ANSIStandardY10.5-1968.

[16]*TransmissionSystemsforCommunications*,3rded., WesternElectricCo.,Winston-Salem,NC,1985, pp. 44-60.

[17] *Motorola Semiconductor Data Manual*, Motorola Semiconductor ProductsInc. Phoenix,AZ, 1989.

[18]R.J.Vidmar.(August1992).Ontheuseofatmosphericplasmasaselectromagneticreflectors.*IEEETrans. PlasmaSci.*[Online].21(3).pp. 876-880. Available: http://www.halcyon. com/pub/ journals/21ps03-vidmar