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A REVIEW PAPER ON STABILIZATION OF EXPANSIVE SOIL USING FLY ASH

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ABSTRACT

Construction is one of the important parts of Indian budget and is an essential part of the development. Today About 51.8 million hectares of land in India has swell-shrink soil(Black Cotton soil).Characteristics of swell-shrink soil,is that they are very hard in dry state but they lost their strength when get wet .this soil create problem to construction, it is major challenge for geotechnical engineering to overcome this problem. Soil stabilization is widely used in foundation and road pavement construction. This is done by improving the soil properties like volume stability, strength, durability. In this process removal or substitution the problematic soil is done. To get better result we are using additional materials such fly ash obtained from thermal power plant. With various proportions of this ash i.e. 10%, 20% & 30% the problematic soil is stabilized..

***Keywords**: Stabilization, Expansive soil, Fly Ash*

I. INTRODUCTION

Expansive soil

Swell-Shrink soils, which are also called as expansive soil, have the affinity to swell and shrink with change in moisture content. Due to this variation in the soil, major distress occurs in the soil, which is result into damage to the superimposing structures. In the periods of greater moisture, like rains, these soils swallow the water, and swell; consequently, they become soft and their water holding capacity weakens. While in drier seasons, like summers, these soils lost the moisture held in them due to evaporation, which resulting in their pretty harder. Usually found in semi-arid and arid areas of the world, these type of soils are viewed as potential natural hazard – if not stabilized, these can result into extensive damage to the constructions built on it, alsotriggering loss in human life. Soils whose composition has presence of montmorillonite, causes these kinds of properties.

Fly Ash

A waste material removed from the gases originating from coal furnaces in thermal power plant, is called fly ash. The main usages of fly ashes in the earliest ages were used as hydraulic cements and fly ash stand close resemblance to volcanic ashes. These ashes were assumed to be one of the finest pozzolans (binding agent) used in and around the world. The demand of electric power supply has exponentially amplified these days due to growing urbanization and industrialization. This growth has caused in the increase in number of power supplying thermal power plants which uses coal as a fuel to produce electricity. The mineral deposit that is left after the burning of coal is the fly ash. The Electro Static Precipitator (ESP) of the power plants accumulates these fly ashes. Production of fly ash comes with two major fearsi.e. safe disposal and management of fly ash.

As the composition of complex features of wasters which are produced from the industries, and their hazardous nature, these wastes had need of being disposed in a safe and effective method, so as to not interrupt the ecological system, and not causing any danger to human life and environment. Environmental pollution is impending unless these industrial wastes are pre-treated earlier their disposal. Fly ash particles are generally round in size, and this thing makes it easy for them to blend and flow, to make a suitable mixture. Both amorphous and crystalline nature of minerals is the content of fly ash produced. Its content differs with the variation in nature of the coal used for the burning practice, but it mainly is non-plastic silt. For waste linings, fly ash is animpending material that can be employed; and in mixture with certain minerals (lime and bentonite), fly ash can be recycled as a barrier material. In present situation, the production of this waste material in actual (fly ash) is extreme more than its current consumption.

II. LITERATURE REVIEW

Sharma *et al.* (1992) studied stabilization of swell-shrink soil using mix of fly ash, gypsum and blast furnace slag. They found that fly ash, gypsum and blast furnace slag in the amount of 6: 12: 18 reduced the swelling pressure of the soil from 248 kN/m2 to 17kN/m2 and increased the unconfined compressive strength by 300%.

Srivastava *et al.* (1997) studied the modification in micro structure & fabric of expansive soil due to adding of fly ash and lime sludge from SEM photograph and found changes in micro structure and fabric when 16% fly ash and 16% lime sludge were added to problematic expansive soil. Srivastava *et al.* (1999) have also described the results of experiments carried out to study the consolidation & swelling performance of expansive soil stabilized with lime sludge & fly ash and the finest stabilizing result was obtained with 16% of fly ash & 16% of lime sludge.

Cokca (2001) used up to 25% of Class-C fly ash (18.98 % of CaO) and the treated specimens were cured for 7 days and 28 days. The swelling pressure is start to decrease by 75% afterwards 7 days curing and 79% with 28 days curing at 20% addition of fly ash.

Pandian *et al.* (2001) had made an effort to stabilize expansive soil with a class –F Fly ash & observed that the fly ash might be an effective additive (about 20%) to improve the CBR of Black cotton soil (about 200%) significantly.

Turker and Cokca (2004) used Class C and Class F type fly ash along with sand for stabilization of expansive soil. As expected Class C fly ash was more effective and the free swell decreased with curing period. The best performance was observed with soil , Class C fly ash and sand as 75% , 15% and 10% respectively after 28 days of curing.

Satyanarayana *et al.* (2004) studied the combined effect of addition of fly ash and lime on engineering properties of expansive soil and found that the optimum proportions of soil: fly ash: lime should be 70:30:4 for construction of roads and embankments.

Phani Kumar and Sharma (2004) observed that plasticity, hydraulic conductivity and swelling properties of the expansive soil fly ash blends decreased and the dry unit weight and strength increased with increase in fly ash content. The resistance to penetration of the blends increased significantly with an increase in fly ash content for given water content. They presented a statistical model for forecast the untrained shear strength of the treated soil.

Baytar (2005) studied the stabilization of expansive soils using the fly ash and desulpho- gypsum obtained from thermal power plant by 0 to 30 percent. Varied percentage of lime (0 to 8%) was added to the expansive soil-fly ash-desulphogypsum mixture. The treated samples were cured for 7 and 28 days. Swelling percentage reduced & rate of swell amplified with increasing stabilizer proportion. Curing resulted in further reduction in swelling percentage and with 25 percent fly ash and 30 percent desulphogypsum additions reduced the swelling percentage to levels comparable to lime stabilization.

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Amu *et al .(2004)* utilized fly ash and cement mixture for the stabilization purposes of expansive soil. Three distinct classes of samples: (i) 12% cement, (ii) 9% cement + 3% fly ash, and (iii) natural clay soil, were taken to be verified for Maximum dry densities (MDD), Unconfined compressive strength (UCS), Optimum Moisture Contents (OMC), California Bearing Ratios (CBR), and the Undrained Triaxial tests. The results of this test indicated that the sample with 9% cement and 3% fly ash showed better results with respect to CBR, OMC, MDD, and shearing resistance, in comparison to the other two samples. This indicated the value of fly ash as a stabilizing agent.

Sabat *et al.* (2005) studied the stabilization of expansive soil using fly ash-marble powder mixture. He concluded that the optimum proportions of soil, fly ash, and marble powder in the mixture in percentage by weight to give the best result were 65%, 20% and 15% respectively.

Rajesh *et al.* (2006) talked about experimental investigation of clay beds stabilized with fly ash-lime segments and fly ash segments. An observation of swelling in clay beds of 100 mm thickness strengthened with 30 mm diameter fly ash-lime and fly ash segments. There was a considerable decrease in heave in both fly ash-lime and fly ash columns. However, lime-fly ash mixture generated better results.

Wagh (2006) used fly ash, rock flour and lime separately and also in combination, in different proportion to stabilize black cotton soil from Nagpur Plateau, India. Addition of either rock-flour or fly ash or both together to black cotton soil improve the CBR to some extent and angle of shearing resistance increased with reduced cohesion. However, in addition to rock-flour and fly ash when lime is mixed to black cotton soil CBR value increases considerably with increase in both cohesion and frictional resistance.

Phani Kumar and Sharma (2007) studied the effect of fly ash on swelling of a highly plastic expansive clay and compressibility of another non-expansive high plasticity clay. The swell potential and swelling pressure, when determined at constant dry unit weight of the sample (mixture), decreased by nearly 50% and compression index and coefficient of secondary consolidation of both the clays decreased by 40% at 20% fly ash content.

III. METHODOLOGY

To check the effect of fly ash as a stabilizing addition in black cotton soils, sequence of tests, where the material of fly ash in the black cotton soil was diverse in value of 10% to 30% (multiples of 10) by weight of the whole quantity in use. The Indian Standard codes are followed through the transmission of the following experiment:

- Standard Proctor Test – IS : 2720 [Part 7] - 1980
- Unconfined Compressive Strength (UCS) test – IS : 2720 [Part 10] - 1991
- California Bearing Ratio (CBR) test – IS : 2720 [Part 16] - 1987
- Free Swell Index Test – IS 2720 [Part 40] - 1977
- Liquid & Plastic Limit Test – IS 2720[(Part 5] – 1985

Analysis results of lab tests

Black cotton soil is combined with varying percentage of fly ash (from 0% to 30%, Intervals of 10) by weight to observe its result as a stabilizer on the expansive soil.

- Maximum Dry Density (MDD) was observed to change with variable content of fly. The maximum value observed being at fly ash content of 30% by weight.
- The variation in Unconfined Compressive Strength (UCS) of the soil with variable content of fly ash is observed. The test result shows the variation of UCS with varying fly ash content. The maximum value of UCS was found with the mixture of soil and 20% fly ash content by weight.
- Both dry& wet California Bearing Ratio (CBR) tests are conducted with variable content of fly ash in the black cotton soil. From the graphical comparison of these values against the varying fly ash content, it can be found that 20% fly ash and 30% fly ash content gave the maximum value of CBR intensity in dry & wet soil-fly ash mixture individually.
- The liquid limit & plastic limit of the soil-fly ash mixture varied with the varying fly ash content. Plasticity index values were calculated from these trials, which showed a consistent decreasing pattern with the increase of fly ash content.
- From the free swell ratio tests on the mixture, the value of free swell ratio declined with the increasing fly ash content.

IV. CONCLUSION

Based on the results obtained &assessments made in the present study, the following Conclusions can be drawn:

- The Maximum Dry Density (MDD) value of the expansive soil primarily decreased with the adding of fly ash. Then, it showed increment with increasing fly ash content in the mixture. The maximum value of MDD was detected for a mixture of soil & 30% of fly-ash content by weight. The MDD values constantly decreased afterwards.
- The Unconfined Compressive Strength (UCS) of the soil with variant of fly ash content showed similar inclination as that of the MDD values, except the point that the peak value was observed for a fly ash content of 20% by weight.
- In California Bearing Ratio (CBR) tests of soil conducted with variable fly ash content, the CBR increased slowly with the increase in fly ash content till its assessment was 20% by weight of the total mixture; it decreased afterwards.
- The change in California Bearing Ratio (CBR) tests of soil with varying fly ash percentage wasuneven. It reduced with the initial addition of fly ash (10% by weight of total mixture), & then increased till fly ash content reached 30% by weight of total mixture. The values decreased afterwards.

- With the increasing fly ash content in the mixture, the decrease in value of free swell ratio was observed. This decrease was also countered by the plasticity index values. Plasticity index values are directly proportional to percentages swell in an expansive soil.

Thus, fly ash as an stabilizer decreases the swelling, & improves the strength of the black cotton soil

REFERENCES

1. *Bose B. (2012), Geoengineering Properties of Expansive Soil Stabilized with Fly Ash, Electronic Journal of Geotechnical Engineering Vol. 17, pp. 1339-1353.*
2. *Cokca E. (2001) Use of Class C fly ash for the stabilization of expansive soilASCE Journal of Geotechnical and Geoenvironmental Engineering. ,Vol. 127, Issue 7, pp. 568–573.Holtz W. G. and Gibbs H. J. (1956), Engineering properties of expansive clayTransactions ASCE. Vol. 121 pp. 641–677.*
3. *Kumar A., Walia B.S. and Bajaj A. (2007), Influence of Fly Ash, Lime and Polyester Fibers on Compaction & Strength Properties of Expansive Soil. Journal of Materials in Civil Engineering.Vol. 19, Issue 3 pp. 242 to 248.*
4. *Malik A. and Thapliyal A. (2009), Eco-friendly Fly Ash Utilization for Potential for Land Application, Critical Reviews in Environmental Science and Technology, Vol. 39, Issue 4, pp. 333-366.*
5. *Phanikumar B.R. , Sharma R. S. (2004), Effect of Fly Ash on Engineering Properties of Expansive Soil, Journal of Geotechnical and Geoenvironmental Engineering. Vol. 130, Issue 7, pp. 764-767.*
6. *Phanikumar B. R.And Naga Reddayya S.And Sharma R.S. (2001),Volume Change Behavior of Fly Ash Treated Expansive Soils, 2nd International Conference on Civil Engineering, Indian Institute of Science, Bangalore, India. Vol. 2, pp. 689–695.*
7. *Phanikumar B.R. And Sharma R. (2007), Volume Change Behavior of Fly Ash-Stabilized Clays, Journal of Materials in Civil Engineering, Vol. 19, Special issue: Geochemical Aspects of Stabilized Materials, pp. 67–74.*
8. *Phanikumar B.R. (2009), Effect of Lime and Fly Ash on Swell, Consolidation and Shear Strength Characteristics of Expansive Clay: A comparative study, Journal of Geo-mechanics and Geo-engineering: An international journal, Vol. 4, Issue 2, pp. 175-181.*
9. *Prakash, K. and Sridharan, A. (2009), Beneficial Properties of Coal Ashes and Effective Solid WasteManagement,Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, ASCE, Vol. 13, Issue 4 pp. 239 to 248*