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Variation of Properties of an Expansive Soil Mixed with Quarry Dust and Fly Ash

P. Indiramma[1], **Ch. Sudharani**[2]

[1] *Research Scholar, Dept. of Civil Engineering, S.V.University College of Engg, Tirupati*
[2] *Associate Professor, Dept. of Civil Engineering, S.V.University College of Engg Tirupati*

[1]indu_svuce2000@yahoo.com, [2]sudhajawahar@gmail.com

***Abstract*— Soil is a natural aggregate of mineral particles. Soils are classified into coarse–grained and fine-grained soils. Majority of the coarse-grained soils suit for the construction activities. Problems pose to the structures raised in/on or with fine-grained soils and few coarse-grained soils due to their water absorption characteristic and thereby swelling. Swelling soils are also known as expansive soils and are known to be very weak to support the structures. Various methods of stabilizations are in usage to make the expansive soils suit according to the specifications of construction industry. A simple, cheap, effective and reliable method of stabilization is the thought of the day. To maintain sustainable environment, there is a need to utilize industrial wastes for improving the properties of soils. Hence an attempt is made in this paper to stabilize an expansive soil using quarry dust and fly ash (Investigation is carried to find the properties selected expansive soil alone and on soil-mixtures with fly ash and quarry dust. The variations in liquid limit, plastic limit, compaction characteristics and strength characteristics are critically discussed**

***Keywords*— *Expansive Soil, Stabilization, Quarry Dust & Flyash*.**

I. INTRODUCTION

Certain types of expansive soils are very weak and they cannot be used as foundation layers or as a construction material. Different methods are adopted to stabilize these types of soils to suit the specifications of construction industry, which incurs more effort and money. In order to reduce the expenditure towards stabilization, studies using industrial wastes are being carried out to reduce the pollution by dumping and save the environment. Literature reference on these studies indicates the potential use of industrial wastes for stabilization of soils. In this paper an attempt has been made to stabilize the expansive soil using quarry dust and fly ash. Fly ash is a waste by-product from thermal power plants, which uses coal as fuel.

It is estimated that about 120 million tones of fly ash is being produced from different thermal power plants in India consuming several thousand hectares of precious land for its disposal causing severe health and environmental hazards. In order to utilize fly ash in bulk quantities, ways and means are being explored all over the world to use it for the construction of embankments and roads. In spite of continuous efforts made and incentives offered by the government, hardly 5-10% of the product ash is being used for construction purposes like brick making, cement manufacture, soil stabilization and as fill material. Quarry waste is a general term for any material that is generated from the processing of stone at quarries. About 20–25% of the total production in each crusher unit is left out as the waste material-quarry dust. A series of processes produces different types of quarry waste: i.e., screenings, settling pond fines, and baghouse fines. Screenings are the fine fractions of crushed stone produced after the stone is initially crushed and separated with a No. 4 (4.75mm I.S sieve). Settling pond fines are produced when the stone is washed after crushing in order to separate coarser aggregate. The fines in the wash are discharged into settling ponds which settles by gravity. Baghouse fines can be described as the dust collected at dry plants.

The experimental findings available in the literature confirmed that the plasticity index, activity and swelling potential of the expansive soil samples decreased with increasing percent of flyash as stabilizer with curing time and the optimum content of fly ash in decreasing the Swell Potential was found to be 20%. Conclusions are made for using both high –calcium and low calcium class C fly ashes as effective stabilizing agents for improvement of expansive soils. The undrained shear strength of the expansive soil blended with fly ash increased with the increase in the flyash content. Few studies are available in literature on addition of quarry dust as stabilizer for improvement of soil properties. It is reported that for

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improvement of CBR value of soil the optimum proportion of quarry dust is 40% to 60% of soil. However, these techniques are successful only to a partial extent and hence the attempts to devise better techniques are still going on. In the present work, investigations are made using fly ash and quarry dust separately as admixtures to the selected expansive soil and also combinedly as admixtures to the same soil. The expansive soil collected from Tiruchanur near Tirupati. Tests were carried out on the soil alone as well as the soil mixed with flyash and quarry dust. The variations in plasticity characteristics, compaction characteristics with light compaction, and the undrained shear strength is presented and discussed.

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II. EXPERIMENTAL STUDY

Materials used

Expansive soil is collected from Tiruchanur area near Tirupati, Andhra Pradesh . Fly ash is collected from Vijayawada Thermal Power Station in Vijayawada. Quarry dust is collected from Ramapuram quarry near Tirupati. The basic properties of materials used in the present investigation are presented below

Soil Used

Liquid Limit=101%, Plastic Limit=29%, Classification=CH (Clay of High Compressibility) Optimum moisture content=14%, Maximum dry density=16.57kN/m^3 Unconfined Compressive Strength= kPa

Quarry Dust

Maximum Dry density=18.2 kN/m^3, Optimum Moisture Content=14%

Fly Ash

Maximum Dry Density=12.69 kN/m^3, Optimum Moisture Content=22%

III. ADMIXTURE PROPORTIONS AND TESTS CONDUCTED

In the present investigation, tests were conducted in three series. In first series expansive soil is mixed with flay ash from 5% to 25% in increments of 5%. In second series expansive soil is mixed with quarry dust from 5% to 25% in increment of 5%. In third series equal proportions of fly ash and quarry waste are mixed with soil varying from 5% to 25% in increment of 5%. In order to find the plasticity characteristics of the selected soil alone and the soil mixtures, liquid limit and plastic limit tests are conducted as per IS:2720 partV-1985. The compaction characteristics are determined by conducting standard proctor test as per IS: 2720 PARTVII-1983. The Shear Strength of the unmixed and mixed soil were determined by conducting unconfined compression test as per IS:2720 Part-X-1991.

A. Plasticity Characteristics

The percentage of variation of liquid limit with respect to the admixture is given in fig. 1. It is observed that, as the percentage of admixtures such as fly ash, quarry dust and mixture of fly ash and quarry dust increases, the liquid limit decreases with a maximum of 25% of admixtures in all the three tests.

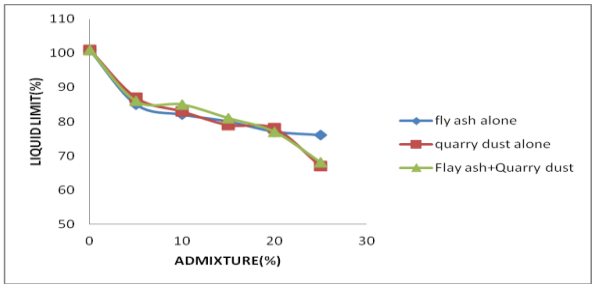
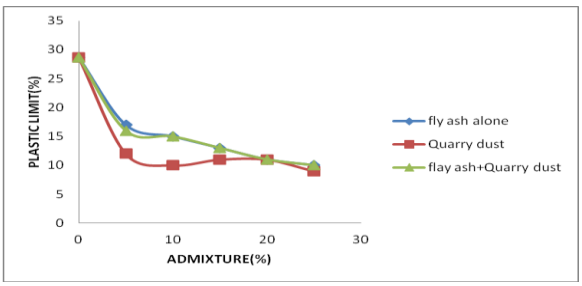


Fig 1.Variation of liquid limit with percentage increase of admixtures

B. Plastic Limit

The percentage of variation of plastic limit to the admixtures is given in fig. 2. It is observed that as the percentage of admixtures increases, the plastic limit decreases. Maximum percentage of decrease in plastic limit occurs at 25% of admixtures in all the three series of tests.

Fig. 2 Variation of plastic limit with percentage increase of admixtures



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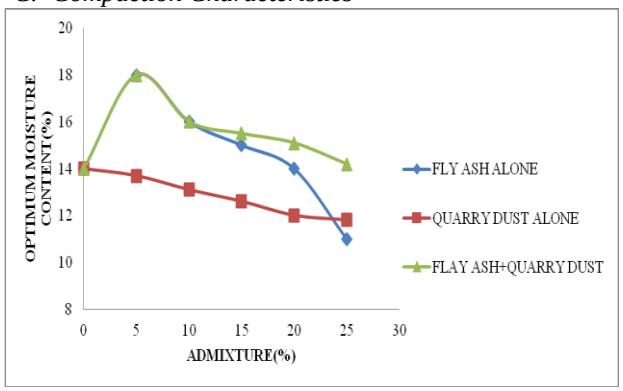
C. Compaction Characteristics



Compaction characteristics of the soil are assessed by determining the optimum moisture content and maximum dry density. These are the control parameters governing the soil behavior. The percentage variation of the optimum moisture content to the admixtures is given in fig. 3. As the percentage of admixtures increases, optimum moisture content increases by 5% of admixture and then decreases at all other percentages

Fig. 3 Variation of the optimum moisture content to the admixtures

D. Dry Density

The variation of maximum dry density with the percentages of admixtures is given in fig. 4. It is observed that as the percentage of admixtures increases, maximum dry density decreases up to 5% then increases up to 20% and then decreases. The dry density is less than that of the natural soil

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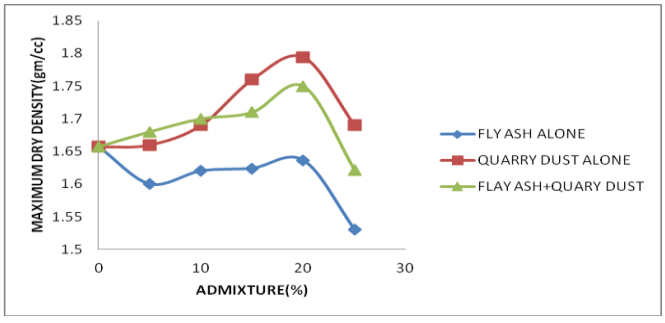

Fig 4 Variation of maximum dry density with percentage increase of admixtures

E. Unconfined Compression Test

The percentage variation of the unconfined compressive strength with the percentages of admixtures is given in fig. 5. It is observed that as the percentage of admixtures increases, unconfined compressive strength decreases at 5% then increases up to 20% and then again decreases

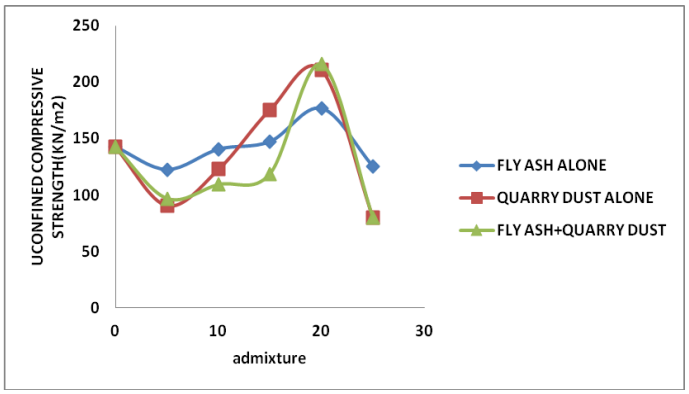

Fig. 5 Variation of maximum dry density with percentage increase of admixtures

IV. CONCLUSIONS

As the percentage of admixtures i.e. fly ash alone/quarry dust alone/combination (fly ash +quarry dust) increases liquid limit decreases. Maximum percentage of decrease in liquid limit occurs at 25% of admixture in all the three cases. As the percentage of admixture i.e. fly ash alone/quarry dust alone/combination (fly ash +quarry dust) increases plastic limit decreases. Maximum percentage of decrease in plastic limit occurs at 25% of admixture in all the three cases. As the percentage of admixture increases optimum moisture content decreases in all the three cases. Maximum increase in optimum moisture content occurs at 5% of admixture. As the percentage of Quarry dust alone and combination (fly ash and quarry dust increases up to 20% and then decreases. But in the case of fly ash alone as the admixture increases maximum dry unit weight decrease up to 5% then increases up to 20% then decreases. The dry density is less than that of natural soil. As the percentage of admixture increases unconfined compressive strength decreases at 5% of admixture and then it increases at up to 20% then again decreases.

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