EFFECT OF FLY ASH ON STRENGTH AND SWELLING ASPECT OF AN EXPANSIVE SOIL

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Abstract - *Swelling soil always create problems more for lightly loaded structures than moderately loaded structures. By consolidating under load and changing volumetrically along with seasonal moisture variation, these problems are manifested through swelling, shrinkage and unequal settlement. As a result damage to foundation systems, structural elements and architectural features defeat the purpose for which the structures are erected. An attempt to study such unpredictable behavior and through research on how to bring these problems under control form the backdrop for this project work. Pre-stabilization is very effective method in tackling expansive soil. Therefore a number of laboratory experiments are conducted to ascertain host of soil engineering properties of a naturally available expansive soil before and after stabilization. Pre and post stabilized results are compared to arrive at conclusion that can thwart expansive soil problems.*

Index properties of expansive soil like liquid limit, plastic limit and shrinkage limit with and without fly-ash have been compared. Along with these Atterberg limits, grain size distribution has also determined. The swelling potential of expansive soil is determined with different percentage of fly-ash. For different percentages of fly-ash 1) maximum dry density and 2) optimum moisture contents are found by the proctor compaction test and the comparison graphs are drawn. The strength aspects of expansive soil are determined for soil specimens with different fly-ash concentrations through Unconfined Compression Test and California Bearing Ratio Test and the results are compared through the graphs.

Key Words: Maximum dry density, Optimum moisture content, Unconfined compressive strength, Fly ash, Cost effective.

1. INTRODUCTION

For centuries mankind was wondering at the instability of earth materials, especially expansive soil. One day they are dry and hard, and the next day wet and soft. Swelling soil always create problem for lightly loaded structure, by consolidating under load and by changing volumetrically along with seasonal moisture variation. As a result the superstructures usually counter excessive settlement and differential movements, resulting in damage to foundation systems, structural elements and architectural features. In a significant number of cases the structure becomes unstable or uninhabitable.

Even when efforts are made to improve swelling soil, the lack of appropriate technology sometimes results volumetric change that are responsible for billion dollars damage each year. It is due to this that the present work is taken up. The purpose was to check the scope of improving bearing capacity value and reduce expansiveness by adding additives. There are number of additives for soil modification like ordinary Portland cement, fly ash, lime fly ash etc.

In many centuries, coal is the primary fuel in thermal power plant and other industry. The fine residue from these plants which is collected in a field is known as fly ash and considered as a waste material. The fly ash is disposed of either in the dry form or mixed with water and discharged in slurry into locations called ash ponds. The quantity of fly ash produced world wide is huge and keeps increasing every day. Four countries, namely, China, India, United State and Poland alone produce more then 270 million tons of fly ash every year.

Presently, India produced nearly 100 million metric tons of coal ash that is expected to double in next 10 years. The most common method adopted in India for disposal of coal ashes is the wet method. This method requires, apart from a large capital investment about 1 acre of land for every 1 MW of installed capacity. Thus ash ponds occupy nearly 26,300ha of land in India. The utilization of fly ash was just 3% in 1994, but there is a growing realization about the need for conservation of the environment in India.

EXPANSIVE SOIL

2. LITERATURE REVIEW

The key element which imparts swelling characteristics to any ordinary non-swelling soil is a clay mineral. There are several types of clay minerals of which Montomorillonite has the maximum swelling potential. The origin of such soil is sub aqueous decomposition of blast rocks, or weathering in situ formation of important clay mineral takes place under alkaline environments. Due to weathering conditions if there is adequate supply of magnesium of ferric or ferrous oxides and alkaline environments. Along with sufficient silica and aluminum, it will favor the formation of montomorillonite. The depth of expansive soil is shallow at the place of formation with the parent rock underneath. The alluvium deposits can be much deeper in low lying and flat areas, where these soils transported and deposited.

Soil stabilization technique is done on relatively weak soil to improve its shear strength, load bearing capacity, filter, drainage system etc. The improvement behavior of soil.

3. EXPERIMENTAL PROCEDURES

Liquid Limit

The liquid limit was determined in the laboratory by the help of standard liquid limit apparatus. About 120g of the specimen passes through 425µ sieve was taken. A groove was made by groove tool an IS: 9259-1979 designates. A brass cup was raised and allowed to fall on a rubber base. The water content correspond to 25 blows was taken as liquid limit. The value of liquid limit was found out for swelling soil and swelling soil with 20% fly-ash.

Plastic Limit

The value of plastic limit was found out for swelling soil and swelling soil with 20% fly-ash as per IS: 2720(part-V)-1986.

Free swell Index

The free swell index for swelling soil as well as soil+fly-ash mix (0%,10%,20%,30%,40%,50%) was determined as per IS:2720 (part-II). The procedure involved in taking two oven dried soil samples (passing through 425µ IS sieve), 20g each were placed separately in two 100ml graduated soil sample. Distilled water was filled in one cylinder and kerosene (non-polar liquid) in the other cylinder up to 100ml mark. The final volume of soil was read after 24hours to calculate free swell index.

OMC AND MDD

The Optimum moisture content and dry density of swelling soil with various percentage of fly- ash (0%,10%,20%,30%,40%,50%) was determined by performing the "standard proctor test" as per IS: 2720(part VII)1965. The test consist in compacting soil at various water contents in the mould, in three equal layers, each being given 25 blows of 2.6kg rammer dropped from a height of 31cm. The collar removed and the excess soil is trimmed of to make it level. The dry density is determined and plotted against water content to find OMC and corresponding maximum dry density.

4. EXPERIMENTAL OBSERVATION

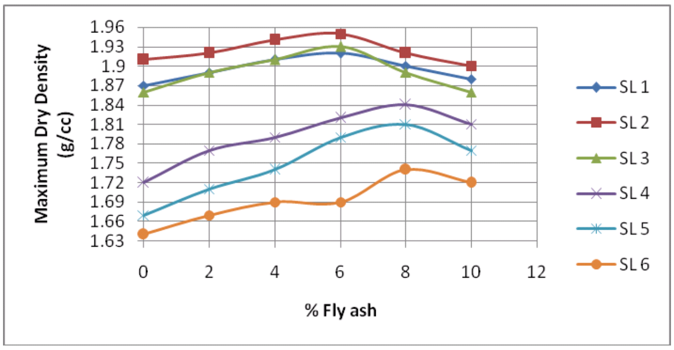

Figure -1: Variation of maximum dry density with fly ash content

From the Figure 1, it can be observed that the maximum dry density of the soil increases with the increase in fly ash content and attained a maximum value at 6% of fly ash content and then further addition of fly ash leads to decrease in maximum dry density.

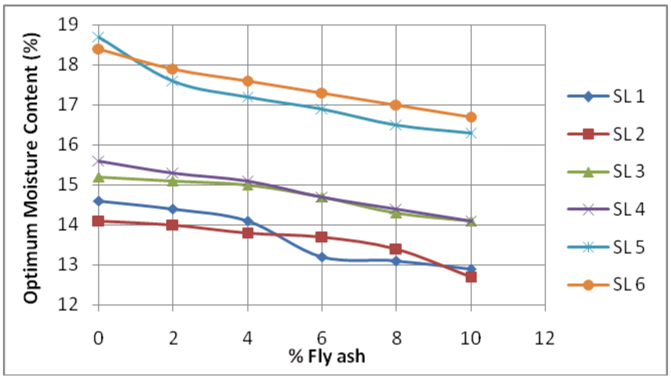

Figure -2: Variation of optimum moisture content with fly ash content

From the Figure 2, it can be observed that with the addition of fly ash to the soil, the optimum moisture content start decreasing.

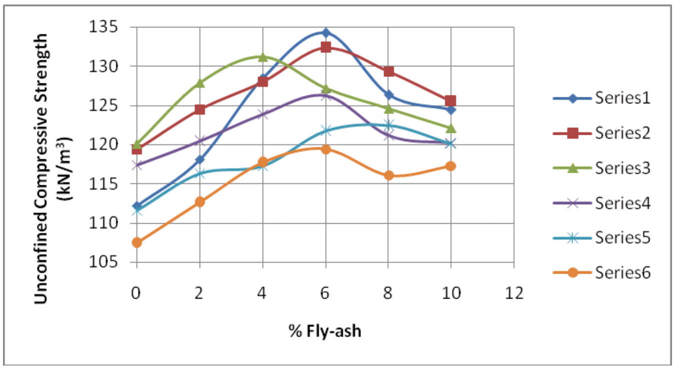

Figure -3: Variation of unconfined compressive strength with fly ash content

From the Figure 3, it is observed that with the increase in fly ash content the unconfined compressive strength is increasing and attained a maximum value at 6% of fly ash and then on further increase in fly ash content the unconfined compressive strength decreases.

Swelling potential	Plasticity index
Low	0-15
Medium	10-35
High	35-55
Very high	55 and above

Table-1: Swelling potential Vs plasticity index

5. CONCLUSIONS

[1] On increasing fly-ash content free swell index decreases steadily to a lowest value at 20% fly-ash and then it increases slightly to have a peak at 40% fly-ash content. Beyond 40% Fly-ash. it again declines.

[2] Unconfined compressive strength decreases on adding of fly-ash up to 10% and then increases up to 20% fly-ash content to have the greatest value of qBu max =0. 152N/mm. Then it declines to have another lower value at 30% fly-ash and takes another peak (at 0.116 N/mmP P at 40% fly-ash. Beyond this, it again declines.

[3] C.B.R value of unsoaked sample tested at OMC with 20% fly-ash content is found to be maximum (23.27 percent).Hence for the maximum C.B.R value the optimum value of fly-ash mix is 20 percent.

[4] The maximum dry density is highest (1.54g/cc) and optimum moisture content is least (22.29 percent) found by proctor compaction test, are obtained at 20 percent content of fly-ash.

[5] Atterberg limits are obtained are also optimum when the fly-ash content is 20 percent.

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