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Soil Stabilization Using Low Lime Flyash

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Abstract:

The current practice is to modify the engineering properties of the native problematic soils to meet the design specifications. Nowadays, soils such as, soft clays and organic soils can be improved to the civil engineering requirements. This state of the art review focuses on soil stabilization method which is one of the several methods of soil improvement. Soil Stabilization is the alteration of soils to enhance their physical properties. The correct stabilization of foundation soils constitutes an increasingly important issue in the present civil engineering world. The objective of this paper was to stabilize the clayey soil with the help of low lime fly ash and to investigate the potentially important factors affecting the stabilization process, such as fly ash % in the mixture and water content.

Keywords — **Soil stabilization, fly ash, water content.**

I. INTRODUCTION:

Soil stabilization is a technique introduced many years ago with the main purpose to render the soils capable of meeting the requirements of the specific engineering projects. In this work the possibility of stabilizing clayey soil using low lime fly ash without cement is investigated. Clayey soils have very low strength which may not be safe and suitable for construction purposes. To overcome that liability, some treatment needs to be done so that the construction becomes safe and the cost is also under control. For this purposes, stabilization process of clayey soils have been carried out by many researchers to set up guidelines and clear ideas to follow for undergoing constructions.

B R Phanikumar (2004)(1): Studied the effect of fly ash on engineering properties of expansive soil through experimental set up. The effect on parameters like free swell index (FSI),swelling pressure, plasticity, compaction, strength, swell potential and hydraulic conductivity of expansive soil was studied. The fly ash contents was varied from 0, 5, 10,15 and 20% on a dry weight basis and they concluded that increase in fly ash content reduces plasticity characteristics and the FSI was reduced by about 50% by the addition of 20% fly ash. The hydraulic conductivity of expansive soils mixed with fly ash decreased with increase in fly ash content, due to the increase in maximum dry unit weight with an increase in fly ash content. There was a decrease in the optimum moisture content and increase in maximum dry unit. Hence the expansive soil is rendered more stable. The shear strength of the expansive soil also increases with the increase in the ash content. That concluded the addition of fly ash improves the characteristics of expansive soils.

B R Phanikumar (2007)(3): This paper presents, by way of comparison, the effect of fly ash on the volume change of two different types of clay, one a highly plastic expansive clay and the other a non-expansive clay, also of high plasticity. Expansive clays swell on absorbing water and shrink on drying. Non expansive clays undergo large compression at high water contents. The effect of fly ash content on free swell index, swell potential, and swelling pressure of expansive clays was studied. Compression index and secondary consolidation characteristics of both expansive and non expansive clays were also determined. Swell potential and swelling pressure, when determined at constant dry unit weight of the sample mixture, decreased by nearly 50% and, when determined at constant weight of clay, increased by nearly 60% at 20% fly ash content. Compression index and coefficient of secondary consolidation of both the clays decreased by 40% at 20% fly ash content.

S. Kolias et al. (2005) (14)had shown the potential benefit of stabilizing organic soils with high calcium fly ash but this depends on the type of soil, the amount of stabilizing agent and the age. The study of the formation of the hydraulic products during the curing of organic soil containing as a stabilizing agent high calcium fly ash shows that a significant amount of tobermorite is formed leading to a denser and more stable structure of the samples. A further addition of cement provides better setting and hardening and the combination of these two binders can increase the early as well the final strength of the stabilised material. The free CaO of fly ash reacts with the organic soil constituents(SiO2 and the other aluminium silicates) leading to the formation of tobermorites and calcium aluminum silicate hydrates as well.

J. Prabakar et al. (2003)(15) found that addition of fly ash reduces the dry density of the soil due to the low specific gravity and unit weight of soil. The reduction in dry density can be in the order of 15-20%. The void ratios and porosity varies by the increasing amount of fly ash in soils. By adding fly ash up to 46%, the void ratios of soils can be increased by 25%. The shear strength of fly ash mixed soil is improved due to the addition of fly ash. The shear strength is increased nonlinearly with the increase in fly ash content in soil.

Zalihe Nalbantoglu (2004)(16)carried out his work to study the effectiveness of Class C fly ash as an expansive soil stabiliser. The fly ash treatment is effective in improving the plasticity of both the soils he used. The crossing of the A-line from the clayey region to the silty region occurred in both soils. The reduction in the swell pressure values of both soils indicates that the swelling of the soils is prevented under smaller pressure values. Thus, high swell potential values are not expected beneath the smaller foundation pressures. The fly ash treatment causes changes in the mineralogy of the treated soils and produces the new secondary reaction minerals. The formation of these new pozzolanic reaction products causes the soils to become more granular and result in less water absorption potential. Utilization of fly ash as a stabilization material for soil appears to be one of many viable answers for handling the fly ash waste problem. Since there is much more fly ash that is disposed of rather than utilized making more productive use of fly ash would have considerable environmental benefits, reducing land, air and water pollution.

Jyoti S. Trivedi et al. (2013)(17) created a model to study the optimum utilization of fly ash for soil sub grade stabilization. It had been observed that the soil containing 20% fly ash gave the best results of soil stabilization as compared to other proportions (0%, 10%, 20%, 30% & 40 %). The Evolver model has the capability to integrate the consequence of every input constraint for any required output constraint concurrently. So, from their model the fraction of fly ash to be added for different types of soil for maximum stabilization can be determined.

II. MATERIALS AND METHODS

A. Materials:

1) Clayey Soil: The clayey soil used in the process was collected from a site which is water logged and dumped with clayey matter for a long period of time and the soil was collected within 1m from the ground surface.. The properties of the soil are listed in Table 1.

Soil	γ_{dmax}	OMC (%)	W_L (%)	W_P (%)	G_S
CS	0.995	41.5	37.5	23.8	1.82

TABLE I: PHYSICAL PROPERTIES OF THE CLAYEY SOIL.

2) Flyash: The fly ash used for the stabilisation process is a low lime fly ash.

B. Methodology:

The study is carried out in the following processes:

1. The clayey soil sample is collected from the site and it is tested in the laboratory for its engineering properties.
2. Clayey soil- fly ash mixture specimens were prepared at fly ash contents of 5%, 10%, 15% (based on dry weight). The soil–fly-ash mixtures are designated as FA0, FA5, FA10, FA15 respectively.
3. Different OMC's are determined for the different mixtures of soil and fly ash.
4. The samples are created by blending fly ash at their respective OMC sand is then cured for 0, 3and 7 days.
5. The samples are then tested for strength on their respective curing days and the values are compared.
6. Other engineering properties are also evaluated for the clayey soil and the clayey soil-fly ash mixtures and are compared.

III. RESULTS AND DISCUSSIONS

A. Proctor Compaction Test: The void ratio of soils depends upon the shape of the grains, the uniformity of grain size, and the conditions of sedimentation. The addition of fly ash in soils changes the porosity and void ratio within the range of void ratio of fly ash and soils. So the change in the OMC and maximum dry density will be seen. The variations in optimum moisture content and maximum dry density with change in fly ash content are shown in figure 1.

From the figure 1, it is clear that with the increase in percentage addition of fly ash in the clayey soil, the optimum moisture content of the soil-fly ash mixture remains same while the maximum dry density of the mixture goes on increasing.

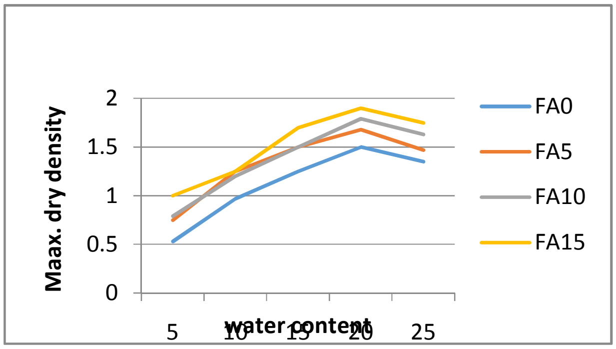

Fig 1: Variation of maximum dry density with water content

B. Atterbergs Limit Test: This test is performed in the laboratory to determine the plastic and liquid limits of a fine grained soil in accordance with ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils with the help of Casagandre's apparatus.

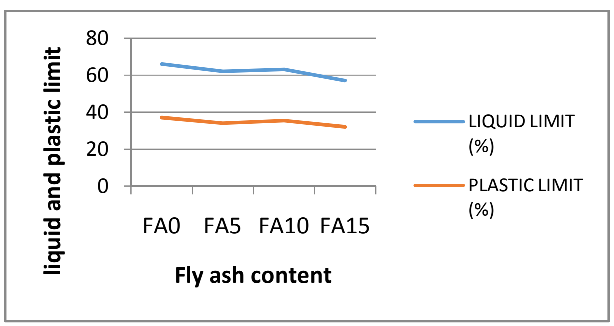

Fig 2:Liquid limit and plastic limit distribution curve

The figure 2 shows that by adding flyash as stabilizing agent the values of Atterberg's limit are decreasing with increasing the percentage of stabilizing agent.

C. Unconfined Compression Test

The specimens prepared from soil-fly ash mixture were tested for its strength on different curing period of 0, 3 and 7 days and the results were compared. The variation of the unconfined compressive strength of the soil- fly ash mixture for different percentage of fly ash and for different curing period is shown below.

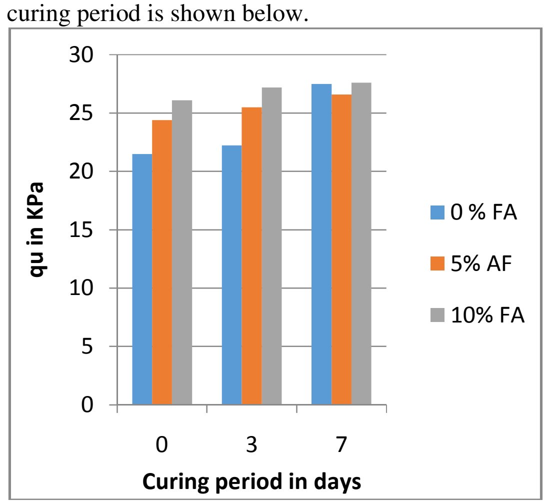

Fig: 3Comparison of $q_u$with curing period for all Fly Ash Mix

The unconfined compressive strength of the clayey soil is increased by the mixing of fly ash . The strength is increased for all the percentages mix of fly ash but it has been seen that for 10% mix the strength achieved is maximum.

IV.CONCLUSIONS

From the results it is concluded that the impact of low lime flyash on clayey soil is positive, by replacing soil by 10 to 15 % flyash it gives maximum improvement in the engineering properties of soil.The compressive strength of soil increased from 21.9 KPa at 0% flyash to 26 KPa at 10% flyash. The maximum dry density increased from 1.5 g/cc to 1.9g/cc at an optimum moisture content of 20% with increase in flyash.

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