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A REVIEW ON STABILIZATION OF SOIL USING FLY ASH

Abhishek Yadav
1Phd Student, Structural Engineering Department, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P, India.

Vikas Srivastav
Associate Professor, Structural Engineering Department, Sam Higginbottom University of Agriculture, Technology and Sciences,Prayagraj, U.P, India.

Abstract- For soils to be suitable for civil engineering work, they must meet existing local requirements for index properties in addition to a certain strength and design criteria. Typically, specifications limit these properties to some optimal values which in most cases are project work specific. Fly ash is the combustion by-product of sub-bituminous coal in electric power plants and requires being landfilled. However, the reuse of these types of wastes in the interest of sustainable construction is healthier for the environment. The use of fly ash as a binding admixture not only enhances the engineering properties of soil but also reduces the use of energy and greenhouse gases. The objective of this review is to use Fly ash as soil Stabilization, to investigate the effectiveness of fly ash in the stabilization of organic soil. The presence of organic content in the soil has detrimental impacts on the physical and strength behavior of the soil.
Keywords: Fly ash, Stabilization, Index properties, Compressive strength.

Introduction: The modification/stabilization of engineering properties of soils is recognized by engineers as an important process of improving the performance of problematic soils and makes marginal soils perform better as a civil engineering material. The application of chemicals such as ordinary Portland cement, lime, fly ash etc. or a combination of these often results in the transformation of the soil index properties which may involve the cementation of the particles. (Amadi 2010). Fly ash disperses the soil cement clusters into smaller clusters, thereby increasing the reactive surface for hydration and pozzolanic reactions. Due to these pozzolanic characteristics, the shear strength and bearing capacity of the organic soil can be increased by stabilizing it with fly ash. Fly ash reduces the plasticity index and shrinkage limit, which has a potential impact on the engineering properties of fine-grained soil (Nath et al. 2017). Fly ash was successfully used for stabilizing expansive clays. The strength characteristics of fly ash stabilized clays are measured through unconfined compressive strength (UCS) or California Bearing Ratio (CBR) values. Depending upon the soil type, the effective fly ash content for improving the engineering properties of the soil varies between 15 to 30%. (Brooks 2009). Constructions over soft soil are one of the most frequent problems in many parts of the world. The typical approach to soil stabilization is to remove the soft soil and substitute it with a stronger material of crushed rock. Due to the substantial cost of replacement, alternative methods to the problems are assessed. The study of using coal combustion residues,

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fly ash, is carried out to observe the effectiveness of its addition on the stabilization of soft soil. This is one of the approaches to overcome the increasing amount of solid waste generated by the population. As land is a very valuable commodity and landfills are fast diminishing, the disposal of the ash generated from solid waste incineration poses increasingly difficult problems for the municipalities. A practicable solution to the disposal problems would be the reuse of solid waste ash for civil engineering applications. (Geliga and Ismail 2010). An alternative to stabilizing soil is by introducing geopolymer. Geopolymer is a product of the alkali activation of aluminosilicate materials present in industrial waste materials such as fly ash(Dungca et al., 2010).

Fly Ash Properties	**Values**
Liquid limit(%)	84
PlasticLimit(%)	Non-plastic
Specific Gravity(%)	2.09
Maximum Dry Density(kn/m^3)	13.2
Optimum moisture content	27

Atterberg Limits

Soils containing fines display the properties of plasticity and cohesiveness where a lump of soil can have its shape changed or remolded without the soil changing in volume or breaking up. This property depends on the amount and mineralogy of the fines and the amounts of water present, generally known as moisture content. As the moisture content increases clayey soil will become softer and sticker until it cannot retain its shape when it is described as being in a liquid state. If the moisture content is decreased, the soil becomes stiffer until there is insufficient moisture to provide cohesiveness when the soil becomes friable and cracks or breaks up easily if remolded. This is described as semi-plastic solid or semi–solid (Geliga and Ismail 2010).

Atterberg limits are particularly useful indices often used directly in specifications for controlling soils for use in engineered fills. While the LL(Liquid limit) is a measure of the water content at which the soil behaves practically like a liquid but has a small shear strength, the PI(Plastic index) indicates the magnitude of the water content range over which the soil remains plastic. In general terms, the higher the plasticity index, the higher the potential to shrink as the soil undergoes moisture content fluctuations. (Amadi 2010).

Liquid limit (LL) and plastic limit (PL) of soil mixed with different percentages of FA and RHA have been estimated in the laboratory following IS: 2720 (Part 5) – 1985, it is found that the PI value of soil decreases with the increasing proportion of FA and RHA. It can be seen that RHA was more effective in reducing the PI than FA. (Yadu et al. 2011).

Specific Gravity

The specific gravity of the soil is 2.76 which is within the range of 2.6 and 3.4 for lateritic soils. The incorporation of fly ash with a specific gravity of 2.06 resulted in mixtures with lower specific gravity i.e. 2.66, 2.55, 2.49, 2.42 respectively for 5, 10, 15, and 20% fly ash contents. The generally low specific gravity of fly ash which resulted in a reduced unit weight of lateritic soil - fly ash mixtures as compared to the soil alone is an attractive property for its use in geotechnical applications. (Amadi 2010)

The variation of specific gravity of fly ash is the result of a combination of many factors such as gradation, particle shape, and chemical composition. This low specific gravity of fly ash results in low dry density. This is because of microbubbles of air entrapped in ash particles. The trapping of air increases the surface area hence the volume of fly ash (Geliga and Ismail 2010).

The specific gravity of stabilized soils has been estimated following IS: 2720 (Part 3) – 1985. It is found that the addition of FA and RHA decreases the specific gravity of the soil. This decrease in specific gravity can be due to the lower value of specific gravity of FA and RHA: 2.09 and 2.04 respectively. The rate of decrease in specific gravity due to RHA is high as compared to FA. (Yad et al., 2011)

Mechanical Properties

Mechanical properties of stabilizing soil using fly ash including Compaction characteristics and Compressive strength are reviewed.

Compaction Characteristics

Dry unit weights were generally lower after the addition of fly ash. The maximum dry unit weight of soil mixtures expectedly decreased with higher fly ash contents while optimum water content increased as the amount of fly ash in the mixture increased from 0 to 20%. The decrease in dry unit weight with increasing fly ash content is expected because the addition of fly ash with a specific gravity of 2.06 resulted in mixtures with a lower specific gravity which invariably resulted in reduced dry unit weight. On the other hand, the increase in OMC with higher fly ash content could be a result of the extra water required for the hydration of the fly ash to take place(Amadi 2010).

The effect of fly ash on the optimum moisture content (OMC) and maximum dry density of soil indicates that the maximum dry density decreases with the increasing amount of fly ash, while the optimum moisture content gradually increases for both types of soil. (Nath et al., 2017).

The higher void content could tend to limit the buildup of pore pressures during compaction, thus allowing the fly ash to be compacted over a larger range of water content (Bose 2012).

It has been observed that both (Maximum dry density) MDD and OMC (Optimum moisture content) decrease with an increasing percentage of FA. The decrease in the MDD can be attributed to the replacement of soil by the FA(Fly ash) and RHA(Rice husk ash). The increase in OMC due to the addition of RHA may be caused by the absorption of water by RHA. This implies that more water is needed to compact the soil with RHA mixture (Yadu etal.2014).

Compressive strength

The addition of fly ash to the organic soils resulted in a significant increase in unconfined compressive strength relative to that of the unstabilized soil. It is found that the final unconfined compressive strength achieved varies depending on the organic soil and the fly ash. In addition, the compressive strength of fly ash-treated soil increases with the increase in curing times. (Nath et al. 2017).

On increasing the fly ash content from 0 to 90% for the samples, the unconfined compressive strength increases at 20% fly ash -80% clay mix and then decreases with further addition of fly ash. The optimum fly ash content for improving the shear strength of the treated soils under the presented conditions is 20 %. (Bose 2012).

Stress-strain behavior of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the fly ash content was increased from 0 to 25%. (Brooks 2009).

Fly ash can be used to stabilize bases or subgrades, to stabilize backfill to reduce lateral earth pressures, and to stabilize embankments to improve slope stability. Typically stabilized soil depths are 15 to 46 centimeters (6 to 18 inches). The primary reason fly ash is used in soil stabilization applications is to improve the compressive and shearing strength of soils. (Geliga and Ismail 2010).

Conclusion

1. Fly ash shows good engineering property for soil stabilization and also helps in consuming the abundantly available fly ash.

2. Both values of liquid limit and plastic limit increase and the plasticity index decreases with increasing percentages of fly ash content.

3. The unconfined compressive strength increases with the increasing percentages of fly ash content.

4. The moisture content decreases and the dry density increases gradually in addition to fly ash.

5. Maximum Unconfined compressive strength was obtained at 20% fly ash mix with clay and further addition of fly ash reduces the strength i.e optimum value of fly ash addition is 20%.

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