Influence of Fly Ash, Wastepaper Sludge Ash and Polypropylene Fibre on Compaction and Strength Properties of Subgrade

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Abstract : *Clay soil is a distinct weak material which shows unpredictable behaviour. Some waste materials like fly ash, waste paper sludge ash, rice husk ash etc, in addition to natural and synthetic fibres can be used to make the soil suitable for construction. Waste paper sludge ash is the fine waste product that is obtained from the oxidation of waste paper sludge in paper recycling industries. Fly ash is also the fine waste that is obtained from the combustion of coal at thermal power plants or at electric power plants. Fly ash has minimal cementitious nature, however within the sight of dampness, it responds synthetically and structures cementitious mixes that pertain to advancing the properties of soil. Inclusion of these materials will result in the increment of physical and chemical properties of clay soil. Some anticipating properties that need to be enhanced are California bearing ratio, shear strength, liquidity index, plasticity index, unconfined compressive strength, bearing capacity etc. The principal goal of this entire research was to assess the influence of fly ash, waste paper sludge ash in addition with polypropylene fibre to stabilize the soil, so as to improve the properties like strength, volume stability and durability of soil. The series of test to be carried out were compaction tests, unconfined compression tests, California bearing ratio, direct shear and Atterberg limits test at the optimum moisture content.*

Key Words: soil stabilization, clay, fly ash, waste paper sludge, polypropylene fibre.

1. INTRODUCTION

Expansive soils need treatment preceding use as a designing material. These treatments are generally classified into two procedures, viz. soil modification and soil stabilization. Soil stabilization is the path towards mixing and blending materials in with soil to improve certain properties of the soil. The procedure may incorporate the mixing of soils to the accessible admixtures that result in the change of degree, surface or versatility, or then again go about as a binder for cementation of soil. Soil modification is the adjustment procedure wherein there is improvement in certain properties of the soil, however it does not bring about the noteworthy increment in soil quality and durability. Soil properties like strength, compressibility, workability, swelling potential and volume change susceptibility might be altered by various soil stabilization and modification strategies. Stabilization is procured by thermal, mechanical, chemical or electrical means.

Clay is an expansive soil that creates a problem in design and construction of civil engineering structures. At the point when clay soil interacts with water, swelling occurs and, shrinks when water content declines in the view of which structures are damaged. It makes more harm to the asphalts and light buildings than some characteristic risk including earthquake and flood. In India, it is found in the Indian Deccan Plateau which covers about 0.8×10^6 km^2 (approx. 20% surface area).

If we explain clay in the engineering terminology, it is the fine-grained soil having molecule size underneath 2 microns. The behaviour of soil widely relies on the water content. Plasticity index is the fundamental parameter to classify the fine-grained soil which is determined from two other primary parameters which are liquid limit and plastic limit. Shrinkage limit is likewise the parameter to characterize clay. Plasticity index associates with the building properties like over-consolidation ratio, unconfined compressive strength etc.

The conduct of clay soil depends greatly upon the measure of various earth minerals like illite, kaolinite and montmorillonite. Among the three montmorillonite has the greatest potential to swell and shrink.

2. LITERATURE REVIEW

Garcial *et al.* (2008) has worked on the pozzolanic properties of paper sludge waste. It was found that the utilization of paper sludge in pozzolanic material production allows a disposable residue to be included in the cycle of the materials. It focused on the potential of waste paper sludge as a crude material for yielding a product with pozzolanic action, at 700^0 C for 2 hours. The organic matter disappears and the calcined sludge becomes operative by moulding kaolinite mineral into met kaolinite.

Brooks (2009) has worked on soil stabilization with fly ash in addition to rice husk ash. It was found that UCS increased from 660 to 1300 kPa, on addition of RHA from 0 to 12%. The CBR value improved from 1.5 to 10. Swell decreased with addition of fly ash. The ideal value of fly ash came out to be 25% and that of RHA came out to be 12%.

Senol (2011) has worked on the effect of fly ash and polypropylene fibre content on the soft soils. It was found that the fibre incorporations expanded the quality of the fly ash samples and changed their brittle nature into flexible one. The soil sample was prepared at two different percentages of fibre and fly ash. The fibre content was taken as 0.5% and 1% of the weight of soil, and, the fly ash content was taken as 10% and 15% by weight of soil. A series of test i.e., UCS, compaction tests and Atterberg's limit tests were performed.

Khalid *et al*. (2012) has worked on clay soil stabilized using WPSA. It was found that optimum percentage of admixture used was 10% at maximum compressive strength of 737 KPa. Addition of 10% of admixture has increased the compressive strength as compared to virgin soil, from 0 days to 28 days of curing. The CBR value of the stabilized soil was increased about 1.5 times the unstabilized soil for unsoaked sample and 3.6 times the unstabilized soil for soaked sample.

Sabat & Pradhan (2014) has worked on fibre reinforcement fly ash stabilized expansive soil mix, as subgrade material in flexible pavement. It was found that optimum percentage of fly ash for stabilization was 20%. With addition of 20% of fly ash, UCS got increased to 58%. The CBR value got increased to 91% for soaked sample. Also, the optimum percentage of polypropylene was found to be 1%.

Pal *et al*., (2015) has worked on stabilization on soil using polypropylene fibber as waste fibre material. It was found that there is a need to utilize the waste fibre of polypropylene obtained from various industries across the country to improve the properties of soil. This will be useful in decreasing the requirement of the valuable land for the disposal and also decreases the harmful environmental impacts.

Khalid *et al.* (2015) has worked on soft soil subgrade stabilization using waste paper sludge ash. It was found that ideal percentage of class C WPSA to stabilize the soft soil for sandy clay is 10%, at the maximum compressive strength of about 720 KPa. The stabilized soil improved the compressive strength 22 times as compared to unstabilized soil. The effective strength was found to be improved in addition to increase of about 35% of internal friction. Also, the cohesion of stabilized soil was increased by 38%. The absolute quality and the effective strength got improved due to the crystal formation from the pozzolanic reaction.

Teja (2016) has worked on soil stabilization using randomly distributed polypropylene fibre. It was found that there was an increase in cohesion as its value was observed to be 19.6%. Also, there was an increase in the angle of internal friction. Thus, randomly distributed polypropylene fibre is not recommended for the stabilization of soil.

Priya *et al.* (2017) has worked on stabilisation of clayey soil using polypropylene fibre. It was found that with increase in the content of polypropylene fibre, free swell index value of reinforced soil decreases to zero at 1% of fibre. The liquid limit of soil got increased. The MDD initially got increased and then got decreased lately. The UCS value also got increased firstly and then got decreased lately. Thus, it is clear that the soil is not subjected to any volumetric changes with the addition of fibre. Also, the strength of the soul was improved. Hence, it was found that polypropylene fibre cab be effectively used for the stabilization of clay.

Dixit (2017) has worked on optimum use of polypropylene fibre improves soil properties. It was found that there was a reduction in MDD in the range of 3% to 14% and increase in the OMC in the range of 1% to 9%because of the adsorption of water molecules by fibre surface. Also, the value of cohesion firstly increases up to the addition of 2.25% fibre and then decreases for the addition of 3% of fibre. The angle of internal friction follows the same trend as above. The CBR value also increased first at 2.25% of fibre and then decreased at 3% of fibre. Thus, it can be concluded that polypropylene fibre can be considered as a soil stabilizer.

Nagaraju & Kumar (2017) worked on an experimental study on paper mill lime sludge. It was observed that soil treated with lime sludge had improvement in CBR value. MDD got increased with the increase in the content of lime sludge. Also, the OMC got decreased with increase in the content of lime sludge.

Malik & Kaur (2018) has worked on influence of lime sludge on the compaction and strength properties of soil when mixed with RHA and polypropylene fibre. It was found that the addition of RHA improved the geotechnical properties of parent soil. On addition of lime sludge by proportion of and RHA, OMC increased and MDD decreased. Lime sludge was added by proportion of 2%, 4%, 6%, 8%. Specific gravity was found to be increased and plasticity was found to be decreased. Not only the strength of the clay soil increased but, it enhanced the durability of soil as well.

Kumar & Goyal (2019) has worked on increasing the strength of soil using fly ash and polypropylene fibre. It has been found that at addition of 0.1% of polypropylene and 7% of fly ash, MDD got increased. Also, there was an overall increase in CBR which came out to be 37.46%. There was a net increase in cohesion and internal angle of friction. The fibre mixes developed resistance towards sudden failure. From the observations, it was concluded that the thickness of subgrade was reduced to around 25mm, as per IRC: SP-20.

3. CONCLUSION

Every year a lot of waste from thermal plants and paper industry is generated which occupies a huge space. Thus, it becomes necessary to find a solution for its disposal. Based on review of literature, one of the solutions is to use this waste to enhance of soil. Also, build on literature, the polypropylene acts as soil reinforcement, enhancing soil properties. A test program was embraced to explore the single and integrated effect of fibres with the thermal plant residue fly ash and waste paper sludge ash.

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