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# USAGE OF FLYASH AND JUTE FIBER COLLECTIVELY FOR STABILIZATION OF SOIL – A REVIEW

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## ABSTRACT

Generally, clay has undesirable engineering properties like low bearing capacity and high compressibility. Thus the improvement of soil at a site is necessary. There are many stabilizers to improve the strength of soil like gypsum, rise-husk ash, cement, lime, used rubber tires etc. In the present study, the review analysis for the usage of Flyash as stabilizer and jute fiber as reinforcement to improve the properties of Expansive soil will be carried out.

## I. INTRODUCTION

To improve strength and durability, soil stabilization is the most suitable option. The researchers have developed a number of soil stabilization techniques that includes a compaction, dewatering and the addition of some natural material to the soil. Soil plays an essential role to as it is the base of every construction project. So, we need to get a better understanding and information about the various properties of soils and the factors that influence those properties. Here soil properties have been changed in this research with the aid of randomly dispersed plastic fibers. Since soil is the elementary material, which find application in civil engineering such as building, highways, bridges; road, railway tracks and is responsible to maintain the stability of structure. Soil of different types is available in earth surface and can be distinguished on the basis of particle size, and their mechanical properties. Clay soil is one of them that consists of fine-grained particles in addition to metal oxide and some organic matter. Depending on the materials composition, clay soil also has different properties. In this study, soil stabilization is carried out to improve the engineering properties of the soil by adding coir fiber and polypropylene fiber (PPF) as subgrade. Several tests have been conducted to enhance the engineering properties of the soil with coir fiber, and polypropylene fiber (PPF). Clay is an inorganic soil comprises of certain minerals that provide plastic properties while mixing with water. Due to the consistence of engineering properties of soil, it is used in construction sites such as road, building to strengthen the building/road foundation. In the dry state, clay soil behaves like a rock-solid, whereas coming in Contact with water, behaves like plastic material. With the increase in the quantity of water, clay soil becomes sticky such as soften and cohesive. In this situation, clay stabilization is necessary and needed to enhance soil's engineering/mechanical properties.

## II. LITERATURE REVIEW

**Toe et al. (2006)** have examined the behavior of Jute Fiber-reinforced bentonite at the displacement of large shear. This can be done through several ring shear analysis has been carried in which normal stresses come in a range of 20 – 400 kPa. The composition of Bentonite or Jute Fiber has been molded at an initial moisture content of 170% including the length of fiber is 12 or 24 mm. Considerably the thickness of fiber is 0.023 and the content of fiber by dry weight is either 1.5 or 3%. It has to be determined that the enhancement of peak shear increases as per the increasing both of fiber length as well as the content. From the experiment it has been analysed that soil strength has been reduced for long horizontal plane. After testing the fibers have been exhumed and seen that the fibers included both extended along with broken with the predominance of broken fibers.

**Tang et al. (2007)** have tested twelve number of soil samples that have been designed by the addition of PPF in percentage of 0.05%, 0.15% and 0.25% by soil weight. Also, cement has been mixed in percentage of 5 and 8. After 1, 14, and 28 days of curing period performance on the basis of unconfined compression and direct shear tests have been analyzed. The test results show an enhancement in the strength of soil while mixing with the cemented one and obtained better results in terms of Unconfined Compressive Strength (UCS), lowered stiffness including the loss of post-peak strength, and modified the brittle behavior of cemented soil towards higher ductile material. Using scanning electron microscopy (SEM), the interactions among the interface with both fibre surface has been examined. The bond strength, as well as friction at the interface, appears to be just the prevalent method control the advantage of reinforcement.

**Kumar et al. (2008)** analyzed the performance of PPF-reinforced flying ash subsoil on its strength. A number of tests have been performed on the constructed sub-base. According to the results of the compression test, it has been examined that the increase in fiber content leads to a reduction in the maximum dry density (MDD) of the soil. Percentage increase in CBR value with both wet and dry condition with CBR test has been examined. The capacity of soil to bear stress under small stain condition has also been analysed and concluded that the UCS has been increased in a direct relation with the addition of fibre content.

**Ayyappan et al. (2010)** have studied the effect of fibers in terms of its content as well as length on the properties of soil-fly ash prepared sample, which was later reinforced by fiber. From this investigation, it has achieved four key conclusions. (i) The UCS has been improved significantly after the addition of fiber in the soil fly ash mixed sample. (ii) Compressive strength has been reduced with the addition of higher fiber length material whereas in case of soil fly ash sample the strain energy absorption ability has been increased, (iii) the optimal percentage of fiber has been accepted as 1 % in the dry sample of soil fly ash. The optimal fiber length of 12 mm is acceptable for real application.

**Jiang et al. (2010)** experiments have been done to analyze the soil features that was reinforced by short JF. The impacts of fiber content, along with its length, fiber additive effects have been studied. It has clear from the result of analysis the UCS, cohesion and the calculated internal friction angle of improved soil is higher as compared to the parent soil. These three components are increases initially through rapidly decrease by increasing fiber content and fiber length. At last, it has concluded that the presence of Jute Fiber effectively contributes to strength as well as stability of the parent soil.

**Nsaif, M. H. (2013)** provided an easy way to recycle plastic wastes as reinforcing material in the field of civil engineering. Reinforced soil construction is an efficient and durable technique designed to increase soil strength and stability. The technique is used in several applications, ranging from retaining foundations and embankments to underfoot and surface stabilization subgrades. The analysis on combining bits of plastic waste with two soil forms such as clayey soil and sandy soil at various mixing ratios i.e. 0.2, 4, 6, 8 in percentage by weight. Corresponds to these two types of soils, the direct shear test examined the shear strength parameters named as cohesion intensity and angle of internal friction of reinforced and unreinforced samples. Moreover, the number of compaction tests has been conducted on clayey soil mixed with distinct percentages of waste parts. It has to be seen that, due to increased internal friction, there is a major improvement in soil strength.

**Gurmel S. Ghataora et al. (2014)** have analyzed the impact of discrete randomly focused PPF as a stabilizing agent in soil. The results of this study were compared with untreated soil and enhanced samples that played a management role. The experiment has been shown that the addition of discrete synthetic fibers have not to be analyzed as an effective one. Better strength has been examined with the appearance of water content approximately about 21 to 33%.

**Li et al. (2014)** conducted the direct tensile test on discrete fiber-reinforced soil using the novel approaches. The tensile strength increases as the fiber content increases. An increase of 65.7 % in the tensile strength has been observed with the increase in the fiber content raises from 0% to 0.2%. With the change in the strength of prepared sample, there is a change in the tensile strength has also been observed. Due to the reason that more dry density tends to greater connections among soil particles. Also, with the increase in the water content, the degradation in the tensile strength of the fiber mix soil sample has been examined. This is because with the addition of water content the bound between he fiber surface and the soil elements has been weakening.

**Soğancı, A. S. (2015)** have experimented to test the impact of JF on swelling characteristics of "Apa-Hotamış" conveyance channel expansive soil. The effects of fiber on expansive soil compaction, unconfined compressive strength and swelling characteristics have been analyzed. As a result of this review, it is established that the Jute Fiber stabilization technique is a quite effective ground-improvement process. It could be quite simple to use in contrast to other stabilization approaches in lots of geotechnical engineering areas. The incorporation of fiber inside unreinforced and strengthened soil has produced an increase in expansive soil's unconfined compressive power. Rising fiber content had increased peak axial stress and decreased post-peak strength losses.

**Anggraini et al. (2015)** have examined the tensile strengths and compression of natural and treated soft soil. The sample of soil has been treated with natural soil, lime and coir fiber and tests have been conducted to determine the indirect tensile test and UCS test. It has to be cleared from the result of this work, with the addition of lime, coir fiber and increasing curing time, both tensile and compressive strengths improved. From the test results, the UCS relationship of correlation agreed with the indirect tensile strength has expected for the soft soil.

**Tiwari, S., & Tiwari, N. (2016)** used waste fiber to stabilize the soil. Tests such as direct shear tests and in UCS tests have been performed on two soil samples to assess the shear strength of unsaturated soil. Different amounts of 0, 0.05, 0.15, and 0.25 contained the fiber. As per the result of this experiment, the specific gravity of soil has increased by 0.03% by adding 0.05% amount of fiber.

**Tang et al. (2016)** conducted reinforced soil with varying percentages of fibers. The tests have been carried out with dry density and water content on Tensile and Desiccation. After adding PPF, there is an increase in the strength of soil, reduction in the brittle feature of soil has been seen. Also, the availability to appear surface crack has been reduced with the increase in the content of fiber.

**B. N Srinivasa et al. (2017)** have studied the influence of distributed PPF on the shoulder soil in a random way. The effect of PPF has been examined by measuring the different parameters on shear strength, and CBR. Following assumptions can be made from the outcomes of this study. The additional amount of Jute Fiber to soil leads to a decrease in dry density of up to 1.91% and no substantial improvement in the optimal moisture content is observed. Increment in CBR of 413 % has been observed when the PPF of 0.6 % has been added to the shoulder soil. Due to the increment in fiber content, the cohesion value increases slightly and about 39% enhanced has been seen in the internal friction angle.

From the above discussion, it is obvious that, with the addition of pp fibres, shear strength and soil penetration resistance improve. That may be resulted in deducted of soil erosion in the shoulders as per the increment of shear strength. At the end of this work, it has to be recommended to use PPF as an additive to strengthen the shoulder soil in those areas that are vulnerable to shoulder erosion.

**Harichane et al. (2018)** have analyzed the impact of lime including natural pozzolana in two ways separately and through integrating on the shear strength of the soil. The findings showed that the plasticity index for CH-class clay soil has been decreased significantly for the sample prepared after the addition of lime. Also, a higher decrease in the plasticity index value has been observed for soils that was labeled as CL clay for naturally stabilized specimens in contrast to lime-stabilized pozzolan. In addition, samples of lime showed that both the joint and the internal friction angle increased over time.

**Sune et al. (2018)** have studied the impact of soil strength by utilizing the geotextile materials such as regular black cotton soil, JF, Jute based on natural protector compaction test. The experiment has been conducted by mixing these two fibers in a distinct proportion in percentages such as 1%, 2%, 3%, 4% and 5% correspondingly. The black cotton soil is made after blasting the rocks and it can be used to heal cracks in high temperature and also if the moisture appears in soil. This is due to the fertile property by which water can hold for a long duration of dilation.

**Kavitha et al. (2019)** selected fibers to improve different parameters of soil based on the cost-effective and eco-friendly method. The samples of clay in this experiment are gathered from India, Devakottai and Tamil Nadu. For soil stabilization, the used fibers are sisal, Jute and combined of these two fibers. In soil samples the sisal fibers are used in proportion of 0.1%, 0.2%, 0.3% and 0.4%. Likely the Jute fiber has been mixed in an amount of 0.5%, 1%, 1.5% and 2% and hybrid fiber mixed with soil samples on a random basis. The impact of additional fiber on soil stabilization has been examined through conduction different tests.

**Shukla et al. (2019)** provided a sustainable solution for the infrastructure of transportation. To fetch the social benefits, construction and maintenance of transportation is an important key. The corrosion of the road network is caused due to the bad construction of the road. To overcome from this construction issue, in this research, the authors have focused on to search for a sustainable solution to remove the problem of flexible pavement that contributed the most in the transportation system. One previous incident of pavement failure along with its solution is also explained. The actual orientation of fiber in the soil is including stressed as well as unstressed configuration represented through the soil-fiber matrix. The experiment on pavement distresses, the number of fibre reinforcement, and matrix hypothesis of soli fibre including its properties in the infrastructure of the road is reflected in this research work.

**Oluyemi-Ayibiowu et al. (2019)** evaluated the effect of coir fiber as natural reinforcement in lateritic soil stabilization, which is known as clayey silt. Coir fibers output is evaluated separately for its effect on soil strength. The test of the index properties on the natural soil samples i.e. "A" and "B" Natural and treated soil sample compaction characteristics were calculated using standard Proctor process. For natural soil, the unconfined compressive strength (UCS) value of 58.59kpa and 87.89kpa increased to a maximum of 359.31kpa and 261.16kpa for samples A and B, respectively, to 0.4% fiber content. 52apart from this, the California bearing ratio (CBR) values improved with an increase in fiber content from 14.52% to 23.28% and from 12.47% to 18.92% respectively for soaked samples A and B, and from 17.26% to 27.18% and then varying from 15.2% to 21.9% respectively corresponds to un-soaked samples "A" and "B". The results show that 0.4% of coir fiber content for laterite soil is more optimal and effective.

**Vasudevan, T. S., & Jaya, V. (2019)** demonstrated that optimum fly ash percentage for kaolinite stabilization declines based on increasing organic material. With the increase in the organic content, the shear strength of stabilized sample has been reduced. The index, compaction behavior as well as the kaolinite's shear strength has been affected due to the occurrence of organic content. Less than 14% of organic material varying gradually, however, the permanent variation is obtained corresponds to higher organic material.

**Singh, K., & Mittal, A. (2019)** examined the stabilization of a fine-grained soil using plastic waste. There are four different proportion of plastic waste i.e. 0, 0.5, 1 and 1.5 in the percentage of dry soil weights are used to prepared samples in a combined way. As per Indian standard experimental procedures, differences in compaction characteristics and unconfined compressive force are investigated. The percentage decrease, as well as an increase in the specified parameters concerning their untreated value, is calculated.

## III. FINDINGS FROM LITERATURE REVIEW

The above considered publications can be concluded with the statements that, Minimal experimental work has been listed for binary usage of Flyash and Jute Fiber. The incorporation of Optimization and simulation tools is to a limited extent only, the algorithms used are outdates and vitals parameters has been nullified, thus leads to vague or irrelevant results. The correlation and implications of the various outcomes was not showcased in the considered literature and Thereby, creating a wide scope of further study, so as to get the benefits of laboratory investigations on practical field.

## IV. CONCLUSION

Various types of soils are available among them clay is most useful in road construction basically in the area of civil engineering. This kind of soil is a fine-grained naturally obtained product through rock or soil containing one or, higher clay minerals including residues of metal oxides and organic matter. Because of their water content, clays are porous and become stiff, brittle and non-plastic at drying or firing. Geological clay deposits consist mainly of phyllosilicate minerals which involve different quantities of water retained in the structure of the mineral. As per the content of the soil's material, clay may appear in different colours, from white to dull grey or brown to dark orange-red. The general structure of clay soil is given in figure 1.2. Typical with their swelling and shrinking properties are the clay soils with differences in the moisture regime. By and large, this type of soil poses a significant challenge to the strength and integrity of the structures constructed over them and their action is undependable. Improving such undependable soils is imperative.

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