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Experimental Study about Soil Improvement with Glass Fibers

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Abstract : ***Soil stabilization methods are important in dealing with for geotechnical engineering and transportation engineering departments. In addition to that, soil stabilization is becoming an alternative for increasing the strength properties of cohesive soils. There are a lot of stabilization methods and one of the most important stabilization methods is the soil stabilization with glass fibers. In this study, serious tests have been applied in the laboratory to investigate the availability of soils with glass fiber for increasing the bearing capacity and decreasing consolidation settling. For this purpose, the cohesive soil were prepared adding 0%, 5%,10%, 12%, 15%, 17% and 20% with glass fiber for determining effect of glass fiber strength at cohesive soil's road subgrade. According to results, all combinatons of glass fibers showed higher improvement engineering properties of soil. In according to that, this study indicates mixture containing 17% rubber particles is the best suitable solution in the stabilization of cohesive soils.***

Keywords : Soil stabilization, Unconfined compression test, Glass fiber

I. Introduction

Successful soil stabilization techniques are necessary to assure adequate subgrade stability, especially for weaker or wetter soils. Application rate of the selected stabilizing agent is important, both for durability and for cost considerations [1]. The use of glass fiber stabilizing agents is somewhat less common, but worthy of consideration. It was recognized before the Christian era began that certain geographic regions were plagued with surface materials and ambient conditions that made movement of men and materials difficult, if not impossible, over the paths between villages and towns. The Mesopotamians and Romans separately discovered that it was possible to improve the ability of pathways to carry traffic by mixing the weak soils with a stabilizing agent like pulverized limestone or calcium. This was the first chemical stabilization of weak soils to improve their load-carrying ability [1]. It was further discovered, through trial and error, that as long as the improved soil bases were protected against the damaging effects of excessive moisture content, they remained stable and capable of carrying increasing traffic volume and heavier loads in the carts and wagons. The use of stone slabs as the wearing surface over these conditioned soil bases was perfected by these technologically-advanced civilizations. In fact, a few sections of roadways built by the Romans are still in remarkably good condition 2000 years following their construction. Obviously, throughout history, there have been a number of improvements in the equipment and technology employed for the material stabilization application [1]. As many of construction is concentrated in populated urban areas, there is increasing need to construct on soft subsoils, which were considered unsuitable for construction. So, stabilization with glass fiber materials can be used as an important alternative method in the construction of geotechnical and geoenvironmental substructure on soft subsoils. There are a lot of studies about soil stabilization with addictive materials [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17] but there is a limited study about stabilization with glass fiber [18] in the literature.

II. Material and Methodology

In this study, glass fiber stabilization have been used to increase the bearing capacity of high way soils. For this purpose, test mixtures were prepared adding 0%, 5%, 10%, 12%, 15%, 17% and 20% with glass fibers for detecting effect of strength at cohesive soil's. Soil samples have been prepared at optimum water content and unconfined pressure tests have been carried out. In the examinations, clay samples which were taken Çukurova region and below the 0.074 mm screen area were used. Experiments were performed at soil mechanics laboratory of Çukurova University on clay samples. The liquid limit value of the cohesive material is approximately 42% and the plastic limit value is approximately 24% [18]. The grade of the soil was determined as a medium plastisite clay (CI) according to TS 1500 [19]. In the experiments, unconfined compression test machine (Figure 2 - Figure 3) has been used. The unconfined compression test is used to measure the shearing resistance of cohesive soils which may be undisturbed or remolded specimens. An axial load is applied using either strain-control or stress-control condition. According to the ASTM standard [20], the unconfined compression strength is defined as the compressed stress at which an independent cylindrical sample of soil will lose out in a basic compression test. On top of it, in this test process, the unconfined compressed strength is afflicted as the maximum load reached per unit area, or the load per unit area at 15% axial strain, whatever comprises first during the performance of a test. The vertical load has been applyed until the loading decreases on the specimen significantly. When the vertical load have decreased, the strain deformation graph has been drawn by completing the experiment. In order to soils, the undrained shear strength is essential for the definition of the bearing capacity of foundations. The undrained shear strength (qu) of clays is usually determined from an unconfined compression test. The sample has been removed the compression device and has been taked a sample for determining water content.

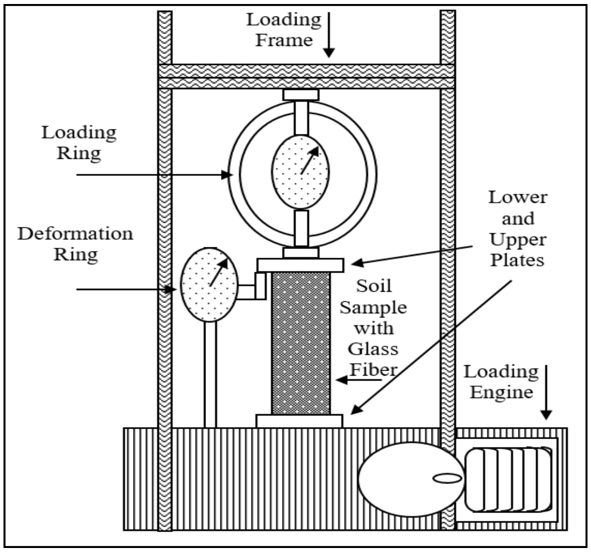

Figure 2. Schematic View of Unconfined Compressive Test

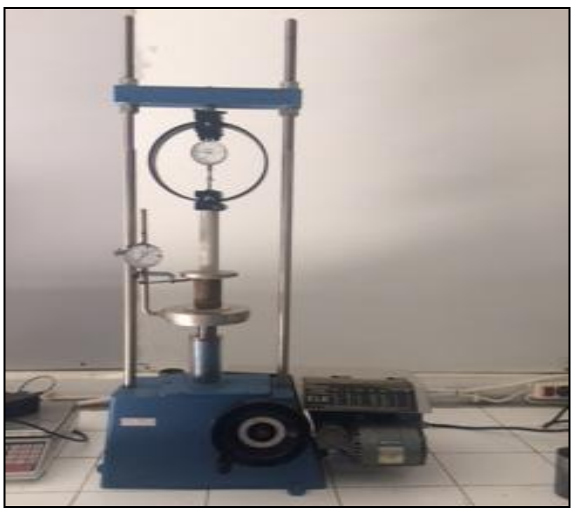

Figure 3. Unconfined Compressive Test Machine

III. Results and Tables

In this study, serious tests have been applied in the laboratory to investigate the availability of soils with glass fiber for increasing the bearing capacity and decreasing consolidation settling. Six different medium plasticity clay soil-mixtures prepared in the laboratory and each experiment's unconfined compressive strength calculated as Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7. According to this figures, nonlinear behaviour was observed in curves in all experiments.

Figure 3 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 5% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa [22]. Hence, it has been concluded that when 95% of medium plasticity clay soil and 5% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 152 kPa [23].

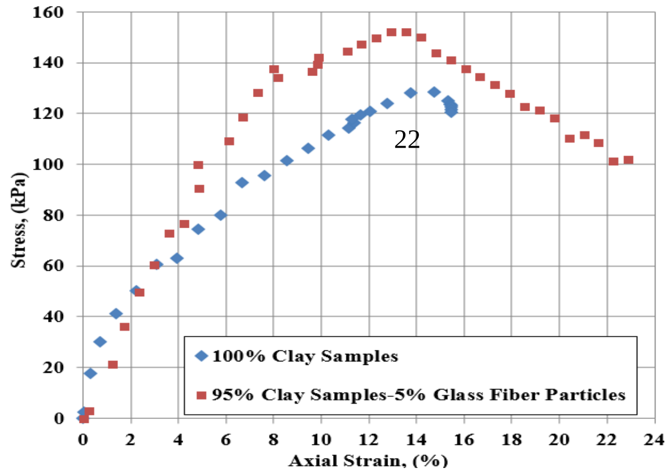

Figure 3. Stress-Axial Strain for only Clay Sample and Clay with 5% of glass fiber [18]

Figure 4 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 10% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa. Hence, it has been concluded that when 90% of medium plasticity clay soil and 10% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 168 kPa.

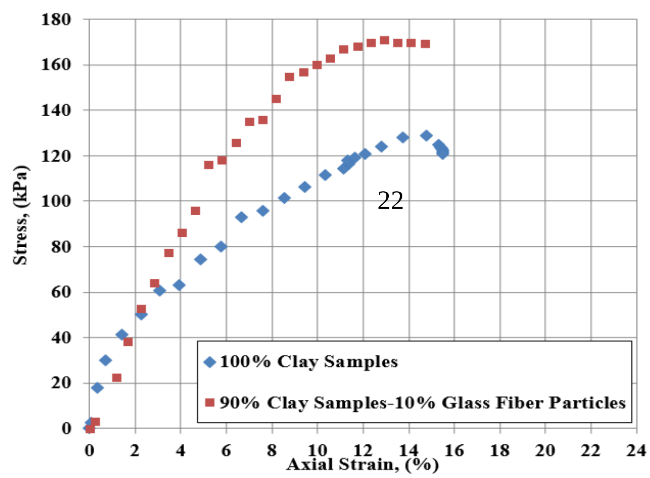

Figure 4. Stress-Axial Strain for only Clay Sample and Clay with 10 % of glass fiber

Figure 5 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 12% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa. Hence, it has been concluded that when 88% of medium plasticity clay soil and 12% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 172 kPa.

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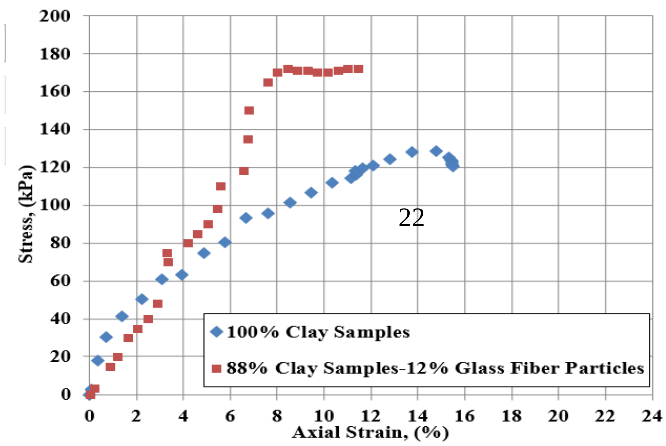

Figure 5. Stress-Axial Strain for only Clay Sample and Clay with 12 % of glass fiber

Figure 6 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 15% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa. Hence, it has been concluded that when 85% of medium plasticity clay soil and 15% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 180 kPa.

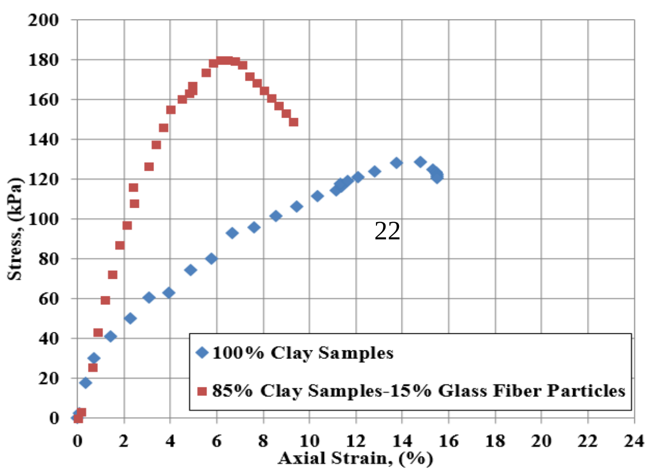

Figure 6. Stress-Axial Strain for only Clay Sample and Clay with 15 % of glass fiber

Figure 7 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 17% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa. Hence, it has been concluded that when 83% of medium plasticity clay soil and 17% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 199 kPa.

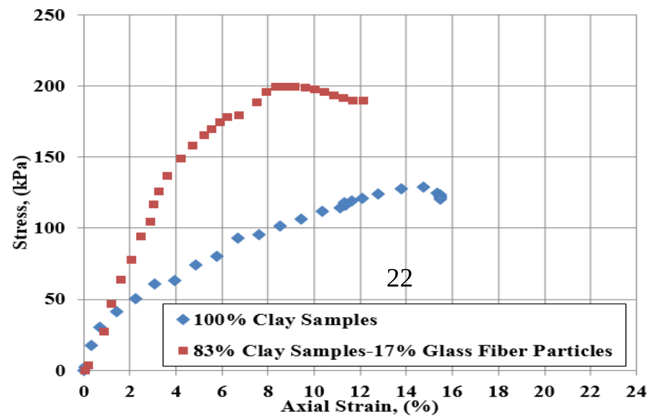

Figure 7. Stress-Axial Strain for only Clay Sample and Clay with 17 % of glass fiber

Figure 8 shows the comparison of unconfined compression strength at the medium plasticity clay soils and medium plasticity clay soils with 20% of the glass fiber mixture. The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa. Hence, it has been concluded that when 80% of medium plasticity clay soil and 20% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 198 kPa.

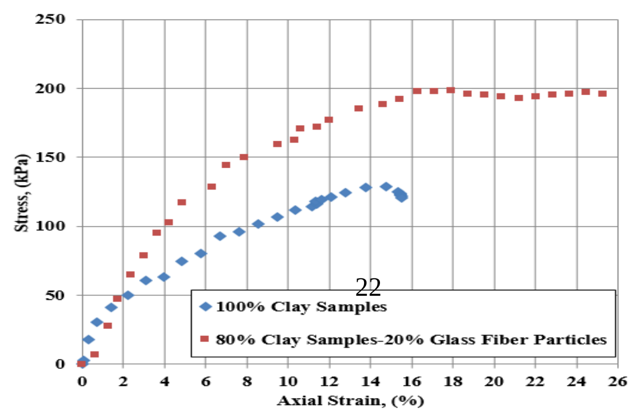

Figure 8. Stress-Axial Strain for only Clay Sample and Clay with 20 % of glass fiber

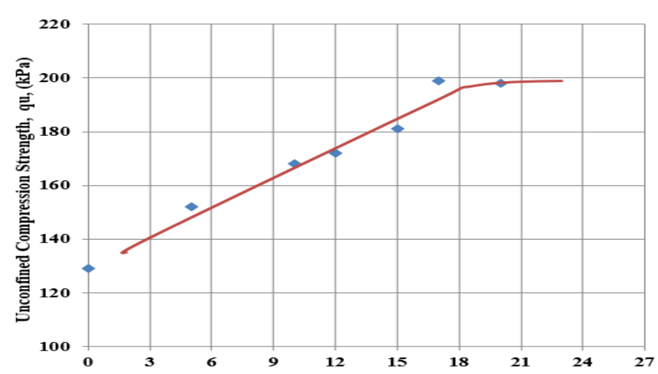

Figure 9. Comparison of Unconfined Compression Strenght of Samples

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Figure 9 shows the unconfined compression strenght at medium plasticity clay soils formed by mixing different proportions of glass fibers by only medium plasticity clay soils. With respect to the data obtained from experiments, it is obvious that the maximum unconfined compressive strength of mixtures reached when mixed medium plasticity clay soil with the different proportions (5%, 10%, 12%, 15%, 17% and 20%) of glass fibers shows respectively 152 kPa, 168 kPa, 172 kPa, 181 kPa, 199 kPa and 198 kPa. According to results, a considerable improvement has occurred for all proportions of glass fiber in the medium plasticity clay soil In addition to that, this study indicates mixture containing 17% glass fiber is the best suitable solution in the stabilization of medium plasticity clay.

IV. Conclusion

In this study, glass fiber stabilization have been used to increase the bearing capacity of high way soils. For this purpose, test mixtures were prepared different proportion of glass fibers for detecting effect of strength at cohesive soil's.

The unconfined strength for only medium plasticity clay soils (100% medium plasticity clay) has been determined 129 kPa.

It has been concluded that;

- when 95% of medium plasticity clay soil and 5% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 152 kPa.
- when 90% of medium plasticity clay soil and 10% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 168 kPa.
- when 88% of medium plasticity clay soil and 12% of glass fiber blended, the unconfined compressive
- strength of the mixture increases from 129 kPa up to 172 kPa.
- when 85% of medium plasticity clay soil and 15% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 180 kPa.
- when 83% of medium plasticity clay soil and 17% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 199 kPa.
- when 80% of medium plasticity clay soil and 20% of glass fiber blended, the unconfined compressive strength of the mixture increases from 129 kPa up to 198 kPa.

It is considered that mechanical improvement is observed in the blend of glass fiber.

Using glass fiber particles in transportation and geotechnical engineering applications may be feasible to consume the waste of materials.

They can effectively use as soil reinforcement beneath foundations, high ways embankment and retaining wall etc. However, it has been observed that glass fibers only provide mechanical improvement.

A considerable improvement has occurred for all proportions of glass fiber in the medium plasticity clay soil In addition to that, this study indicates mixture containing 17% glass fiber is the best suitable solution in the stabilization of medium plasticity clay.

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