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Effects of Stabilizer Content on Soil Properties – Review and Correlations

NoorA.Al-Abri* Rihab F. Al-Yahmadi* SubhiA.Ali**
**FYPstudent,Dept.ofCivilandEnv.Eng,CollegeofEngineeringandArch.,Unv.ofNizwa,-Oman*
***Professor,Dept.ofCivilandEnv.Eng,CollegeofEngineeringandArch.Unv.ofNizwa,- Oman,*

Abstract. *Soil reinforcement is a technique used to improve the physical and mechanical properties of soil. The result of the cohesive and cohesionless soil using different type of reinforcement such as jute fiber, coconut coir fiber and Bamboo fiber are taken from different studies. The effects of reinforcing different soils with different material on the strength and compaction characteristics of soil are considered. These effects are analyzed using statistical methods to determine some relationships reflecting the effects of the reinforcement content on the strength and compaction characteristics of the specified soils. Proper relationships are obtained for the geotechnical engineering uses.*
KEY WORDS: *Reinforcement, Compaction, ,Moisture content, Dry unit weight, Compressive strength*

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I. INTRODUCTION

One of the recent developed approaches to improve the soil mechanical properties is the soil reinforcement which is first recommended in 1963 by French investigator Vidal [1].The principles of the improvement based on providing additional tensile strength for the soil by means of creating what is called a frictional cohesion between the reinforcement and the soil particles. Since the soil has no tensile strength, therefore an appreciable improvement taken place by reinforcing with a certain type of reinforcement. Different reinforcement have been used since time of developing this technique[2- 6]. All these type are based on studies and research which have been conducted over all these years. Metals and Geosynthetics of strips, meshes, grids and fibers were used. Natural material like plant fiber leafs and mats were used as well. The strength, compaction characteristics, consolidation behaviors and shear strength of the soils have been found to be improved with reinforcing the soil. Many studies for different soil using various types of reinforcement have been published each for a particular case, aim and objectives [7 -27].

In this study, a combination of some of these objectives are created by determination a correlations between reinforcement and the produced improved soil properties as strength and compaction characteristics. This is considered to be a step towards helping in shortening time ofsearch and in using different reinforcement for various soils in project design.

II. METHODOLGY

The following steps are followed to conduct the method of this study:

1) Collection and reviewing of some published studies regarding the effects of reinforcing different soils with various materials on the strength and compaction characteristics of soil including the maximum unit weight and optimum moisture content.

2) Classifying the effects of reinforcement or stabilizer content on individual soil properties for different reinforcements.

3) Combine thestudies variables and develop expressions and relations describing the effects of reinforcements on soil strength, maximum dry unit weight and optimum moisture content.

III. RESULTS AND DISCUSSION

Effect of jute fiber on maximum dry unit weight, optimum moisture content and unconfined compressive strength:

The results adopted from the previous reviewed studies regarding the effect of Jute fiber as a percentage on the compaction characteristics and unconfined compressive strength of the reinforced soil are presented. These results are taken from reference 7, 8, 9, 10, 11, 12, 13,14 and 15. The fiber content range used is (0.25-5%) by weight of dry soil. These studies considered the cohesive soil as clay, expansive clay, black cotton soil and alkaline soil. As a hole, it is considered (9) Nine different studies.

Effect of jute fiber on strength of reinforced soils

The relationships given in Figure1 show that as the Jute fiber content increasing the strength providing that the rate of increase is higher for higher percentage of the fiber. This relation covers the soil having a plasticity index of (3 to 29%).This relation fitting the expression given on the graph.

In case of the soils having a narrower range of plasticity index (17%-29%), figure 2 shows a different relation which indicating an increasing of strength with fiber content up to maximum value of about 260 KN/m^2 at 1.1% of fiber after which the strength will reduce for higher content of fiber. Therefore, the optimum fiber content is 1.1% for the strength. This behavior can be attributed to the fact that for plasticity (3%_29%) the effect of water absorption increases the strength for all, while for the limited plasticity (17%-29%) the strength is affected by the absorption which very high giving optimum value of stabilizer. The obtained relations are given on graphs.

Effect of Jute fiber content on maximum dry unit weight of reinforced soil

Figure 3 shows the effect of Jute fiber content on the dry unit weight. It is clear that no remarkable effect can be seen of the Jute fiber on the dry unit weight and the relation appear as an asymptotic linear to the fiber content axis. A general relation obtained is shown on the graph.

For the soil of plasticity index of (17%-29%), the relation of Jute fiber with dry unit weight shown in Figure 4. This relation shows a slight increase of the dry unit weight with fiber content providinga high rate of increase at high fiber content. This behavior is due to higher moisture content for higher plasticity index and higher absorption of water from the soil to increase the unit weight.

Effect of Jute fiber on optimum moisture content of reinforced soil

Figures 5 and 6 show the relationships of the Jute fiber content versus the moisture content for all soil and for soil having plasticity index (17-29%) respectively. It can be seen that the moisture content increase with the fiber content for both cases. In soils of a high plasticity index (Figure 6), the rate of increase is higher due to higher absorption of water.Relationships are shown on figures.

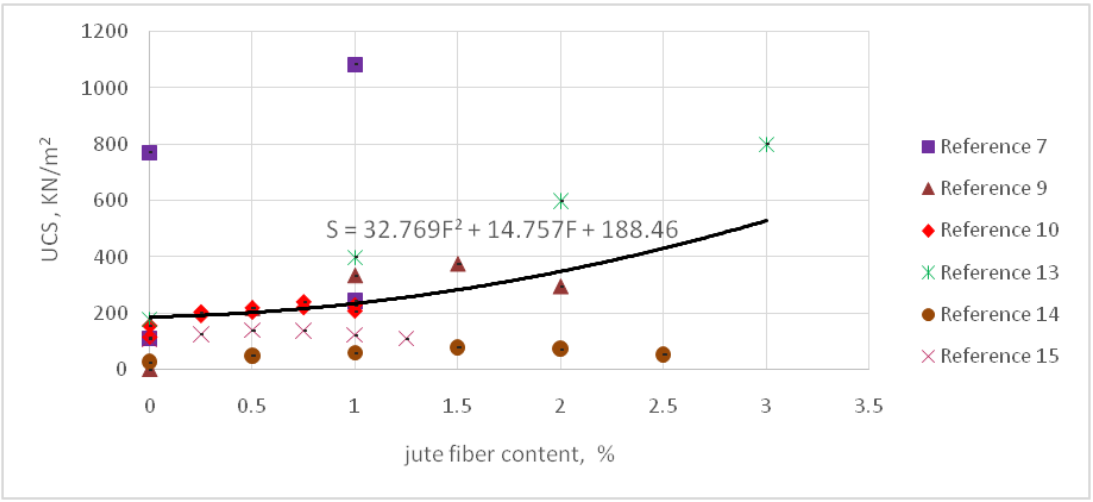


Figure 1-Effect of jute fiber on the compressive strength,UCS, of reinforced soil, PI from (3% - 29%)

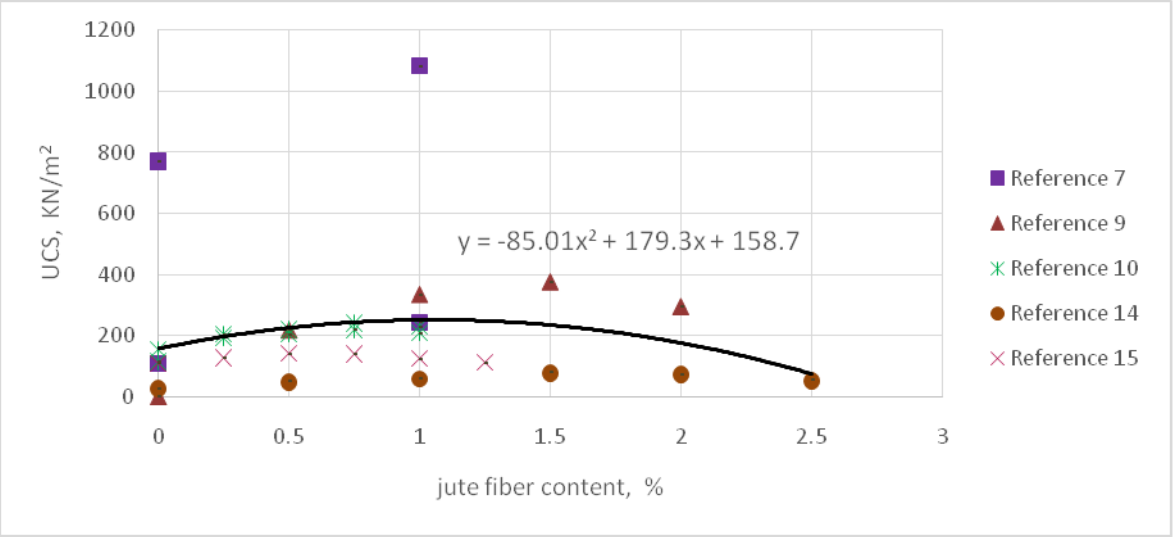


Figure 2- Effect of jute fiber on compressive strength of reinforced soil,PI (17% _ 29%).

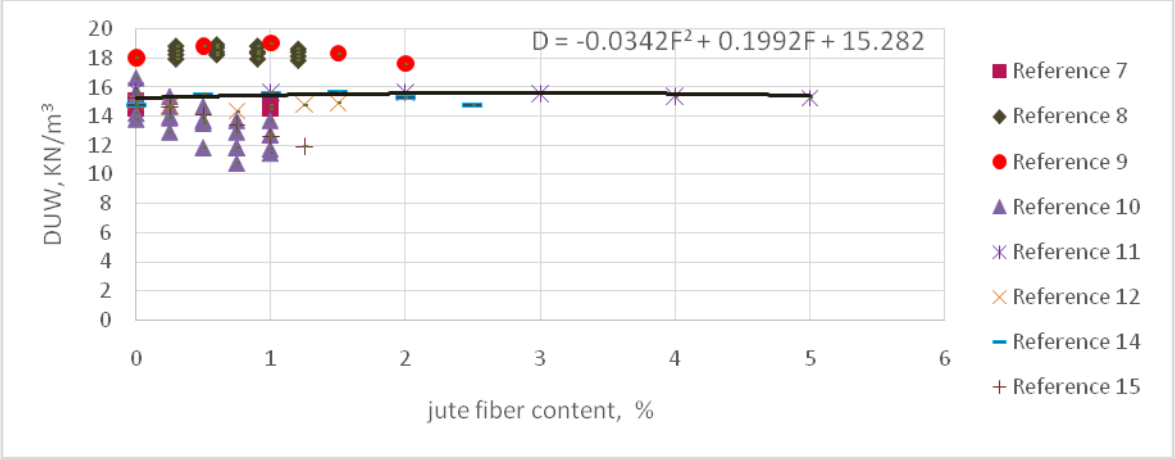


Figure 3 -Effect of jute fiber on maximum, DUW, dry unit weight of reinforced soil, PI (3% - 29%).

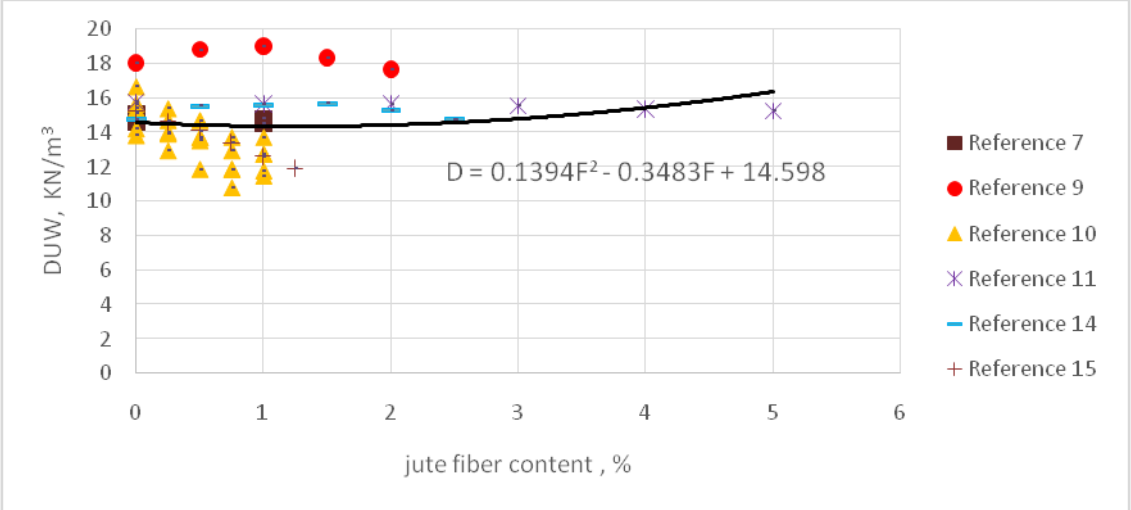


Figure 4- Effect of jute fiber on maximum dry unit, DUW, weight of reinforced soil,PI (17% - 29%).

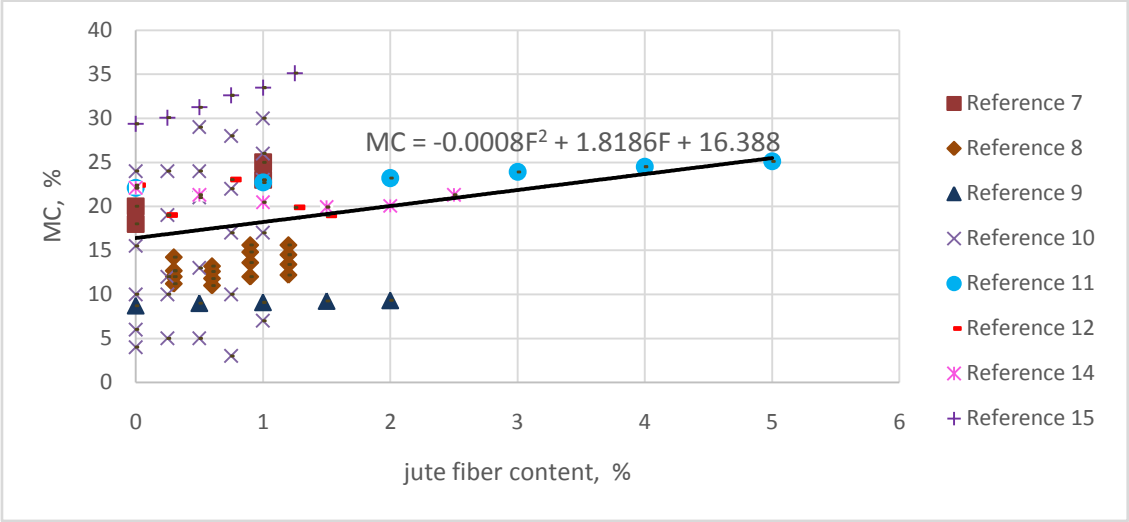


Figure 5- Effect of jute fiber on Optimum moisture content, MC, of reinforced soil,PI (3% - 29%).

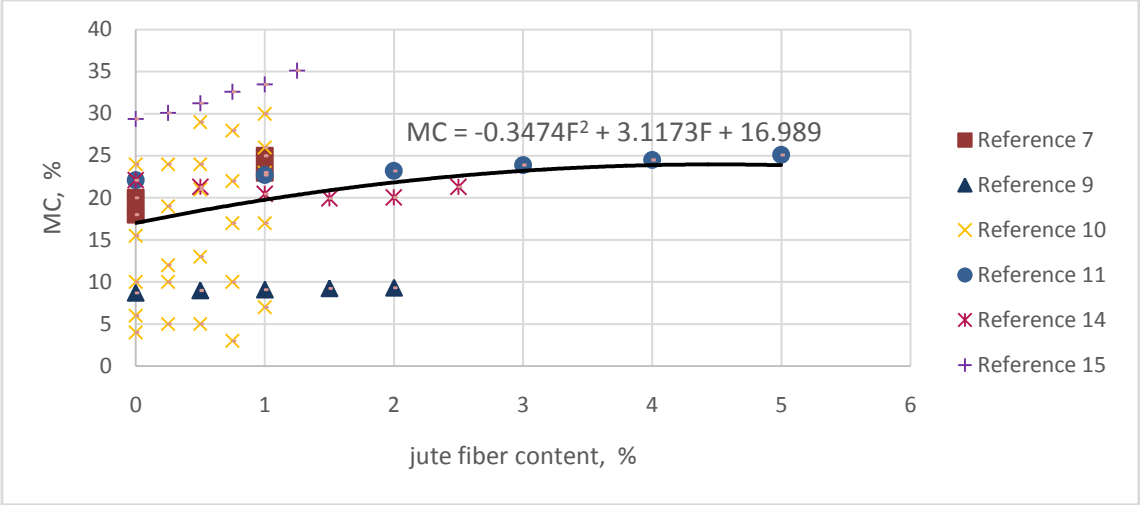


Figure 6- Effect of jute fiber on the optimum moisture content of reinforced soil, PI from (17% - 29%)

Effect of Coconut coir fiber on maximum dry unit weight, optimum moisture content and unconfined compressive strength:

The results adopted from the previous reviewed studies regarding the effect of Coconut coir fiber content on the compaction characteristics and unconfined compressive strength of the reinforced soil are presented. These results are taken from reference 16, 17, 18, 19, 20, 21, 22 and 23 . The fiber content range used is (0.25 - 2%) by weight of dry soil. These studies considered the cohesive soil as clay, clayey sand and soft soil. As a hole, it is considered (8) eightvarious studies.

Effect of Coconut coir fiber content on strength of reinforced soil

The relationships given in Figure 7 shows that as the Coconut coir fiber content increasing the strength increasing providing that the rate of increase is lower for higher percentage of the fiber. This relation covers the soil having a plasticity index of (6 to 40%). The expressions are shown on figures.

In case of the soils having a narrower range of plasticity index (14%-25%), figure 8 shows a different relation which indicating an increasing of strength with fiber content up to maximum value of about 150 KN/m^2 at 0.7% of fiber after which the strength will reduce for higher content of fiber. Therefore, the optimum fiber content is 0.7% for the strength. This behavior can be attributed to fact that for plasticity (6-40%)the effect of water absorption increases the strength for all, while for a limited plasticity (14-25%) the strength is effectedby the absorption and shows an optimum value of stabilizer content.

Effect of Jute fiber content on maximum dry unit weight of reinforced soil
Figures 9 and10 show the relationships of the Coconut coir fiber content versus the maximum dry unit weight for all soils and for soil having plasticity index (14-25%) respectively. It can be seen this relationship indicated a decrease of maximum dry unit weight with fiber content and then increase beyond 0.6% content. Expressions are given on figures.

Effect of Coconut coir fiber on optimum moisture content of reinforced soil
Figures11 and 12 show the relationships of the Coconut coir fiber content versus the optimum moisture content for all soil and for soil having plasticity index (14-25%) respectively. It is clear that generally the moisture content slightly increasing with the fiber content for both cases.

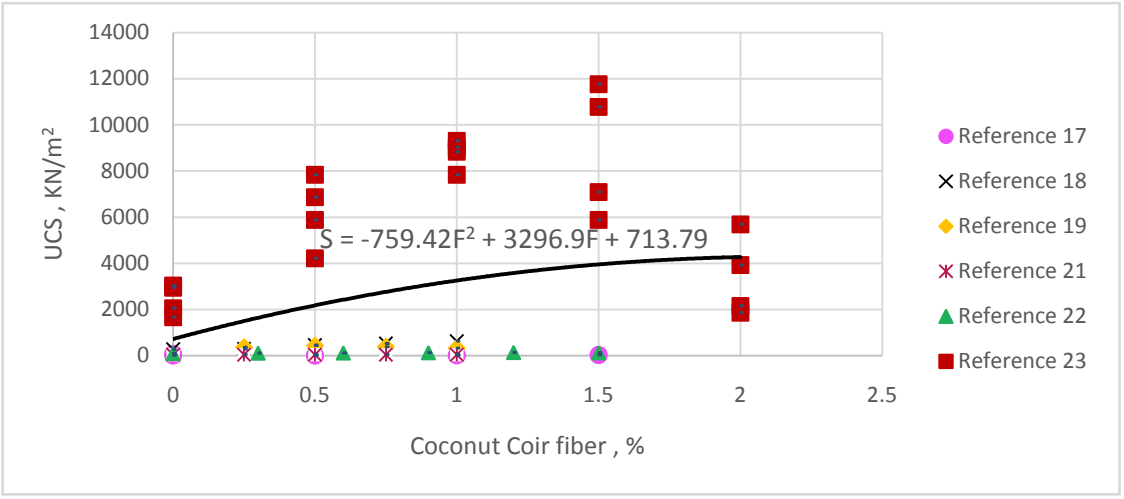


Figure 7- Effect of coconut coir fiber oncompressivestrength of reinforced soil, PI (6% - 40%).

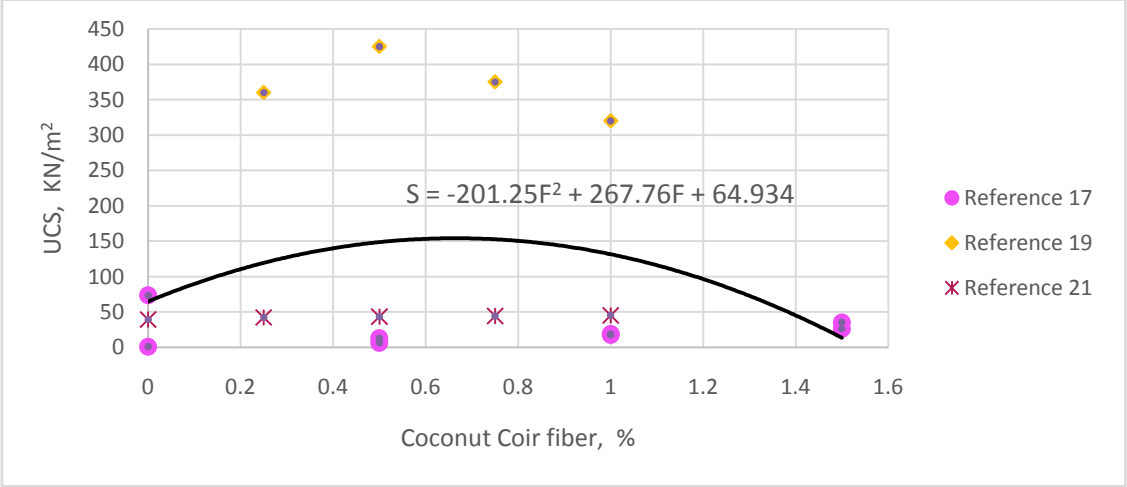


Figure 8- Effect of coconut coir fiber on compressive strength of reinforced soil, PI (14% - 25%).

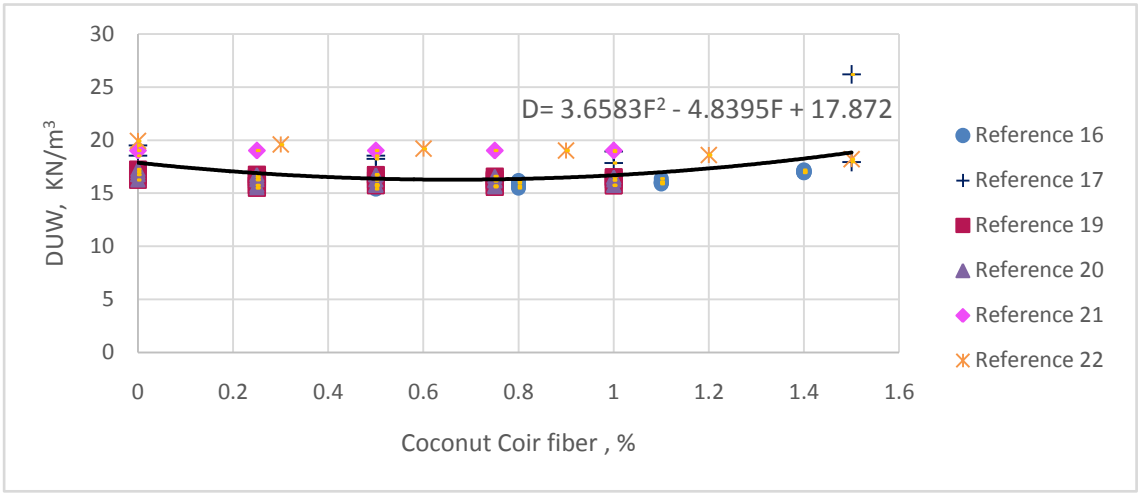


Figure 9 Effect of coconut coir fiber on maximum dry unit weight of reinforced soil, PI (6% - 40%).

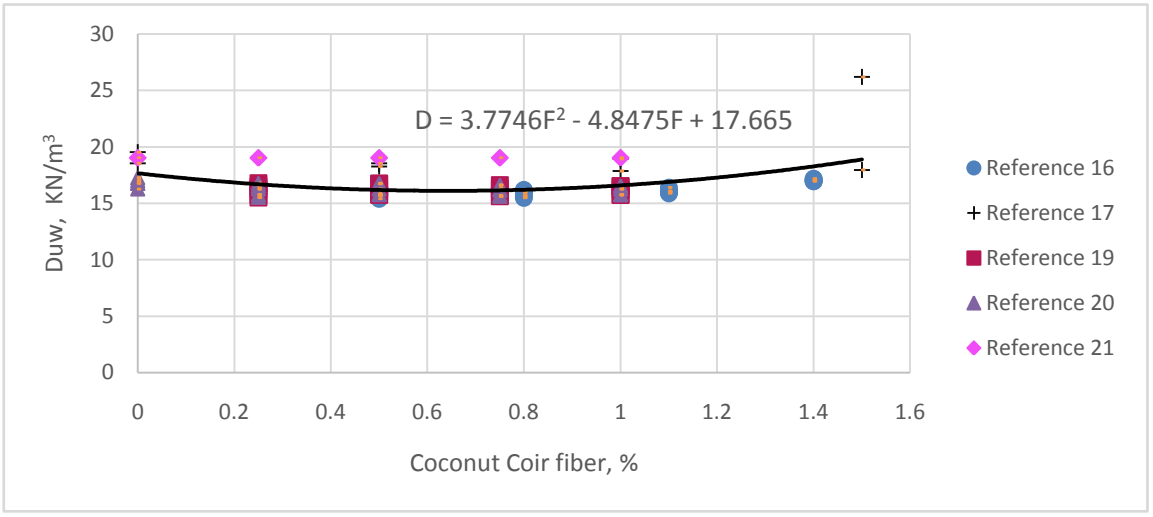


Figure 10 Effect of coconut coir fiber on the maximum dry unit weight of reinforced soil, PI(14% - 25%).

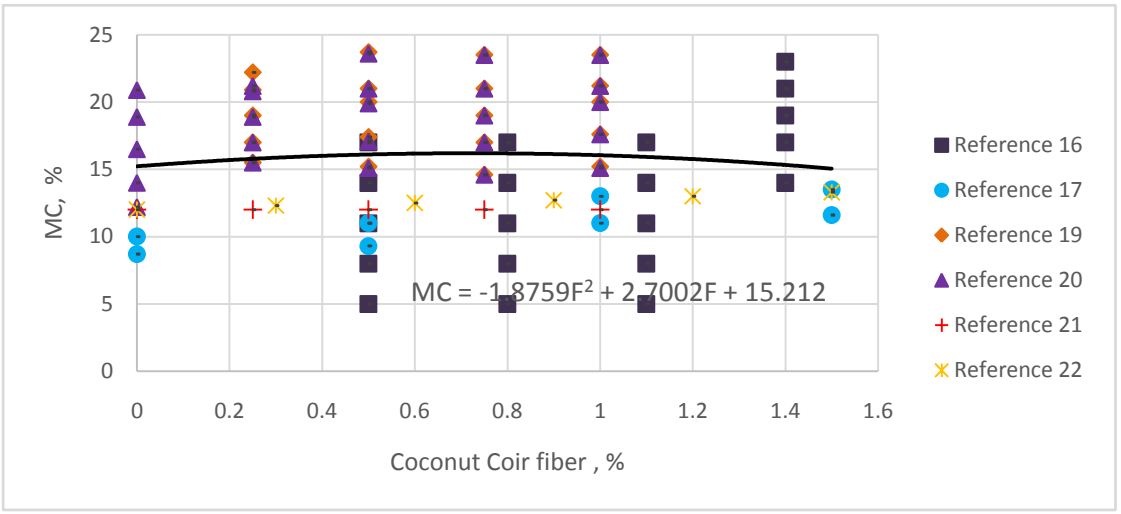


Figure 11- Effect of coconut coir fiber on optimum moisture content of reinforced soil, PI (6% - 40%).

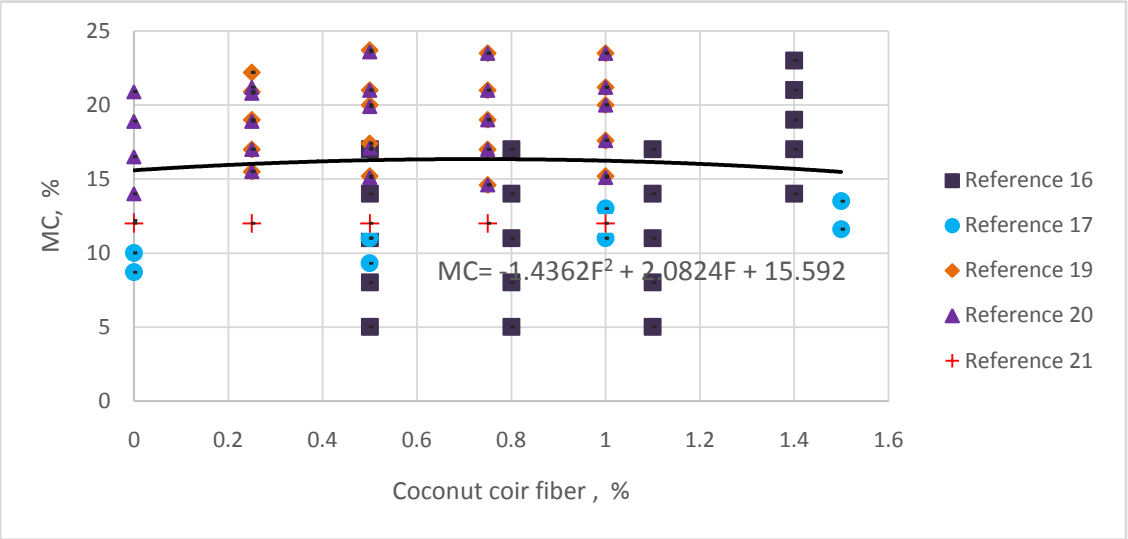


Figure 12 .Effect of coconut coir fiber on optimum moisture content of reinforcedsoil, PI (14% - 25%).

Effect of Bamboo fiber on maximum dry unit weight, optimum moisture content and unconfined compressive strength:

The results adopted from the previous reviewed studies regarding the effect of Bamboo fiber content on the compaction characteristics and unconfined compressive strength of the reinforced soil are presented. These results are taken from reference 24, 25, 26, 27 and 28. The fiber content range used is (0.25 - 5%) by weight of dry soil. These studies considered the clayey soils, Kanto loam and silty sand. it is considered (5) fivevarious studies.

Effect of Bamboo fiber content on strength of reinforced soils

Figure 13 shows a decrease of strength with the fiber content for all soils considered including a cohesionless soil. The decrease in strength is due to a combinations of results from cohesive and cohesioless soils. It is clear that for each type of soil the effect is increasing the strength with the fiber content.

In case of the soils having a narrower range of plasticity index (12-13%), figure 14 shows increasing of strength with fiber content up to maximum value of about 180 KN/m^{2}at 3% of fiber after which the strength reduces for higher content of fiber. Therefore, the optimum fiber content is 3%for the strength. Expressions are given on graphs.

Effect of Bamboo fiber content on maximum dry unit weight of reinforced soil

The effect of Bamboo fiber content on the maximum dry unit weight is given in figure 15. It can be seen that as the bamboo fiber content increasing the maximum dry unit weight decreasing. This is due to the specific gravity of the fiber which is less than the soil particles.

Effect of Bamboo fiber on optimum moisture content of reinforced soil

Figure16 shows the effect of bamboo fiber content on the optimum moisture content. It can be seen that a non-remarkable effect of the bamboo content on the optimum moisture content is seen, and the relation appear as an asymptotic linear to fiber content axis. The expression representing this effect is shown on graph.

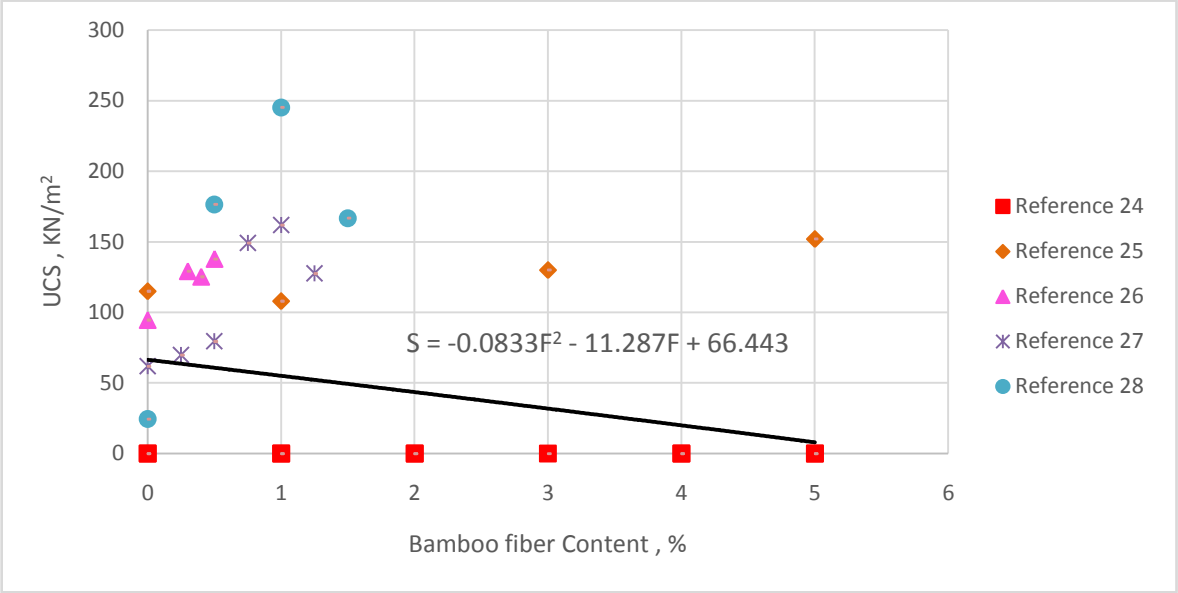


Figure 13- Effect of bamboo fiber on compressive strength of reinforced soil, PI (0% - 20%).

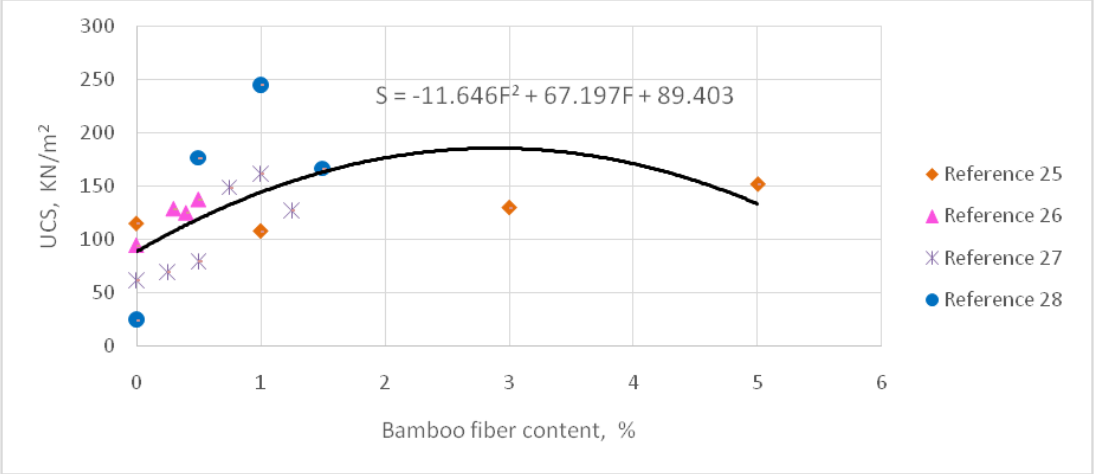


Figure14- Effect of bamboo fiber on compressive strength of reinforced soil, PI (12% - 13%).

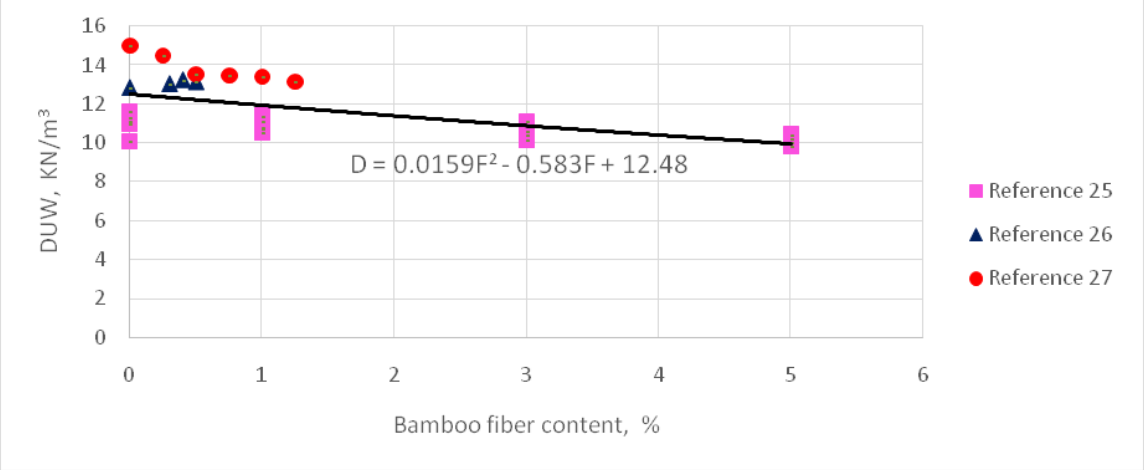
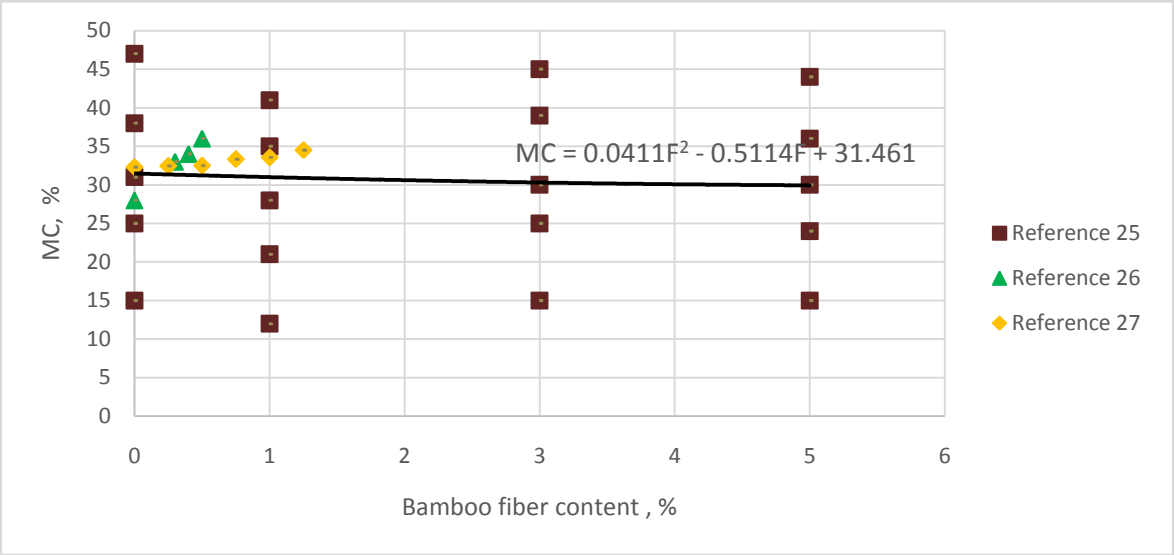


Figure15- Effect of bamboo fiber on maximum dry unit weight of reinforced soil, PI (0% - 20%).



Figur16- Effect of bamboo fiber on optimum moisture content of reinforced soil, PI (0% - 20%).

IV. CONCLUSIONS

1-The maximum strength of the stabilized soil is increasing with stabilizer content, providing that the relations are non-linear.

2- The stabilizer content has a little or no effects in decreasing the maximum dry unit weight.

3-The optimum moisture content is increasing with increasing the stabilizer continent.

4-For soils of high plasticity index (12-29%), the strength of stabilized soil is increasing with the stabilizer content up to certain value after which decreasing for higher content giving an optimum percent of the stabilizer content.

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