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Strength And Compaction Behaviors Of Soil Reinforced By Using Randomly Distributed Date Seeds

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Abstract. The soil reinforcement recently becomes as an area of concern in soil improvement to the geotechnical engineers. Using the locally available materials for improvement is one of the main factors affecting the projects feasibility analysis. Selection of waste materials as a reinforcement in soil plays an effective role against global solid pollution. In this study, the date seeds are used as a soil reinforcement to improve Nizwa cohesive soil properties. The compressive strength and compaction characteristics of soil before and after reinforcement are investigated using different percentages of date seeds. Remarkable increase of the compressive strength is obtained for seeds content ranging from 4% to 16%. The compressive strength is found to increase more than 50% for 16% reinforcement, while the maximum dry unit weight is slightly reduced.

Keywords; Cohesive soil, Date seed, Strength, Dry unit weight, Reinforcement

I. INTRODUCTON

Soil properties improvement using different types of fiber is considered to be one of the recent techniques for reinforcing the soil. Metal fibers, polymeric fibers, glass fibers, natural materials like plant fibers, and plant seeds as a fibers found to be an effective reinforcement for improving the soil properties. In addition, Plant leaf mats also used as an effective reinforcement.
Bamboo used as reinforcement for cohesive and cohesionless soils providing that the compaction and strength characteristics were found to be improved with increasing the number of reinforcing layers [1, 2]. The date palm leaf fibers used to reinforce the soils and indicated an increase in strength, maximum dry density and optimum moisture content of the reinforced cohesive and cohesionless soils [3, 4]. The shear strength parameters and consolidation properties of cohesive soil were found to be improved by using the date palm leaf fibers as a reinforcement [3,5]. CBR as a soil strength was found to be increased with reinforcing the soil by the date palm leafs [6].The mechanical properties of expansive clay was determined to be improved after reinforcing the soil by Coconut coir fibers [7]. California Bearing Ratio and strength properties of Jute fiber reinforced soils were investigated and indicated an appreciable enhancement with increasing the fiber content [8, 9, 10, and 11].
The objectives of this study are to investigate the effects of reinforcing Nizwa cohesive soil on its strength and compaction characteristics by using a locally available date seeds as reinforcement materials.

II. MATERIALS AND METHODOLOGY

2.1 Soil

Fine grained cohesive soil was selected from Ghobrate Nizwa area, which is located at 10 kM north of the city center, Nizwa- Oman. The samples were selected from a depth of 0.5-1.0 m in order to avoid the effect of surface erosion and transported filling materials.

2.2 Water

Potable water was used in all study experiments including the compaction and the process of soil reinforcement.

2.3 Palm Date Seed

The date seeds were taken from the local area. These materials locally are considered as solid waste material. The seeds were oven dried at a temperature of (90-100)^{o}C for 24 hours in order to prevent any probable future germination [12]. The average length and diameter of the seeds are (19-21 mm) and (6-7 mm) respectively. The specific gravity of seeds used is 1.48. Figure 1 shows a sample of the date seeds used.

Figure 1. Date seed sample

2.4 Experimental Program

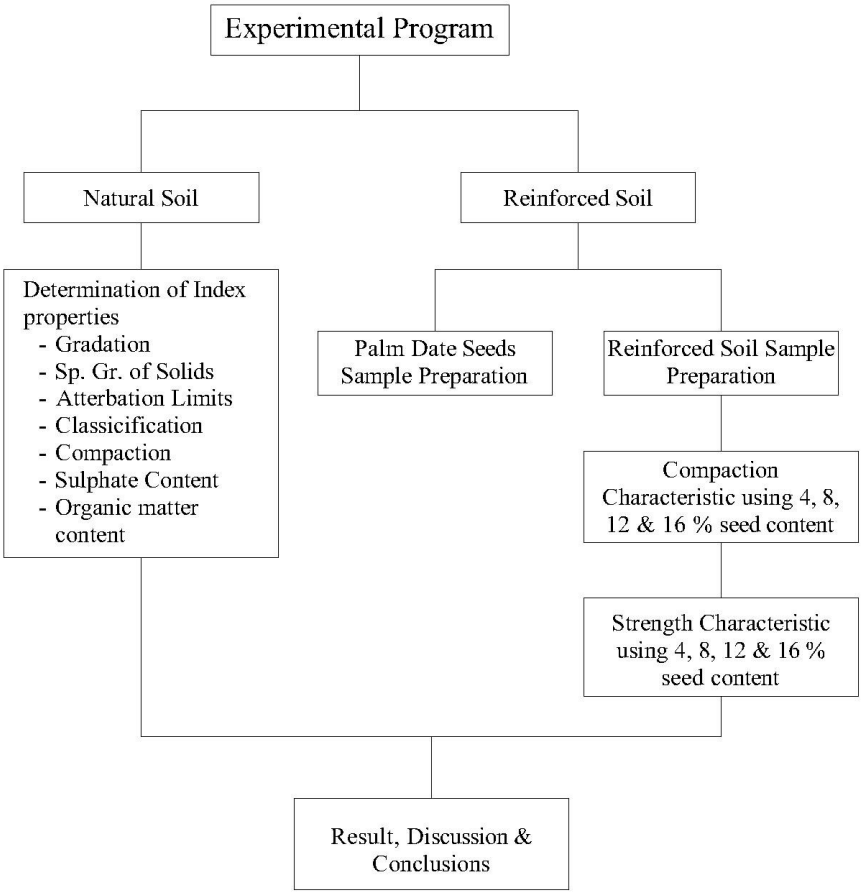

Figure 2. Study experimental program

2.5 Preparation of reinforced soil specimens and testing

The selected date seeds were washed properly to remove all the remaining date fruit pieces, then oven dried for 24 hours at 90-100^{o}C to prevent any probable future germination of the seeds [12]. The reinforced soil samples were prepared by compacting the soil using cylindrical molds of 102 mm in diameter and 105 mm high. Soil was mixed with the specified content of seed thoroughly in dry condition and the recommended amount of water is added and the mixing was repeated again to get a uniform mixture. Three equal layers were compacted in the mold using Standard Proctor Compactive Energy. Seed content of 4, 8, 12, and 16% of dry soil were used, providing that for

each seed content at least 5 molds were compacted at different moisture content to investigate the compaction characteristics. After compaction completion, the samples were extruded from the molds and subjected to unconfined compressive loading for strength determination. Figure 3 shows a schematic section in compacted date seeds reinforced soil sample.

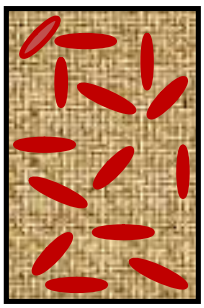

Figure 3. Schematic section in soil – date seeds sample.

III- RESULTS AND DISCUSSION OF RESULTS

3.1 Index properties of natural soil

Index properties of the soil are given in Table 1. The soil is classified according to Unified Soil Classification System as Silt with low plasticity (ML). The grain size distribution curve of the soil is shown in figure 4.

Table 1. Index properties of soil

Characteristic	**value**
Liquid limit, %	**36%**
Plastic Limit,%	**26%**
Plasticity Index, %	**10%**
Specific gravity of solid	**2.70**
Finer than #200 sieve, %	**58%**
Maximum unit weight, kN/m^3	**17.8**
Optimum moisture content,%	**12.3%**
Organic content,%	**0.4%**
Sulphate content,%	**0.002%**
Unified Classification (USCS)	**ML**
AASHTO Classification	**A-4**

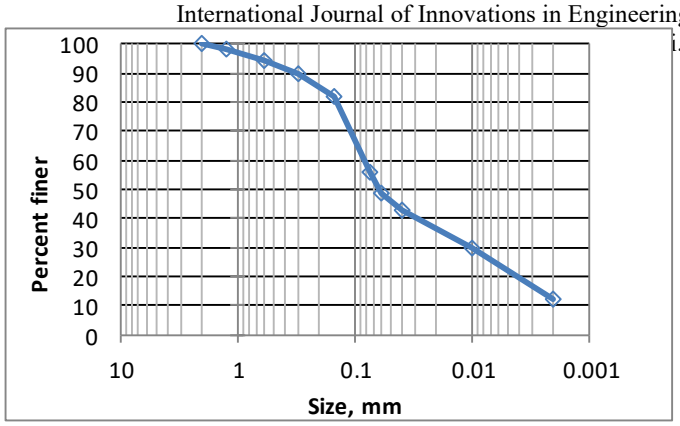

Figure 4. Grain size distribution curve of natural soil

3.2 Compaction Characteristics

3.2.1 Natural soil

The compaction characteristics of natural soil are shown in Figure 5. It is indicated a maximum unit weight of 17.80 kN/m^3 and optimum moisture content of 12.3%. A systematic behavior of soil compaction is obtained.

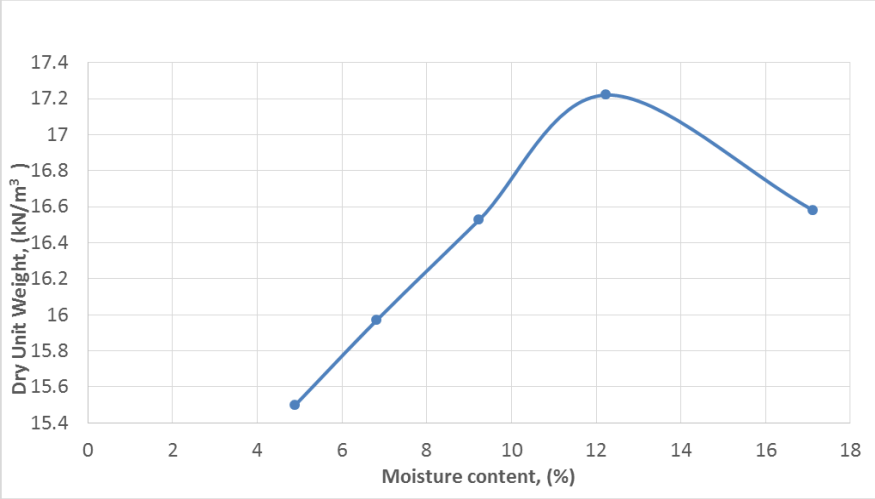

Figure 5. Compaction characteristics of natural soil

3.2.2 Date seeds reinforced soil

The relationships between dry unit weight and moisture content of reinforced soil using 0, 4%, 8%, 12% and 16% seed content are shown in Figure 6. Identical compaction curves are obtained for soil of various reinforcement content. The rate of dry unit weight increase with moisture content in dry side of optimum is shown to be higher than that of the decrease rate in wet side of optimum. This indicates that, the soil is more sensitive to water in dry side than the wet side of optimum.

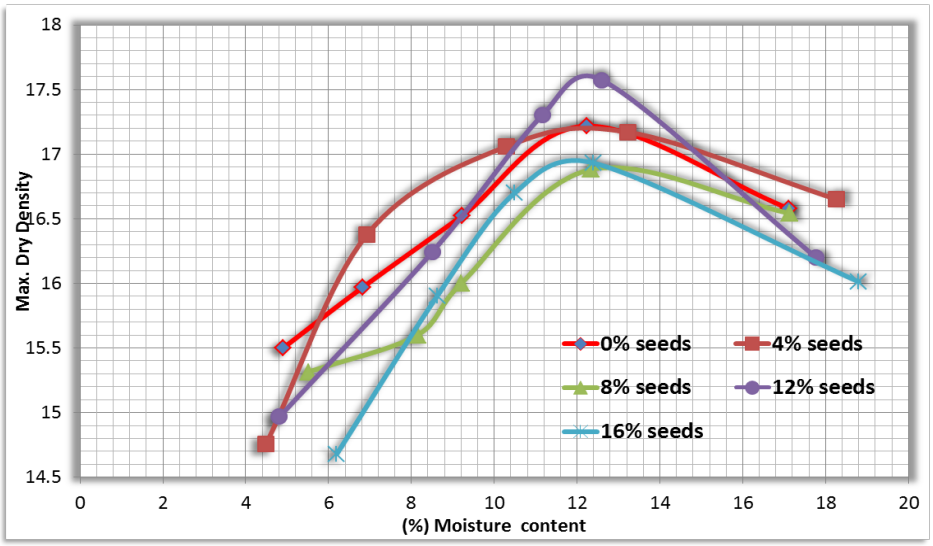

Figure 6. Compaction curves of reinforced soil for different reinforcement content

Effect of reinforcement content on the maximum dry unit weight of the reinforced soil is given in Figure7. It can be seen that, as the date seed content increasing the maximum dry unit weight decreases. This can be attributed to the fact that the specific gravity of the date seed is less than that of the soil solid

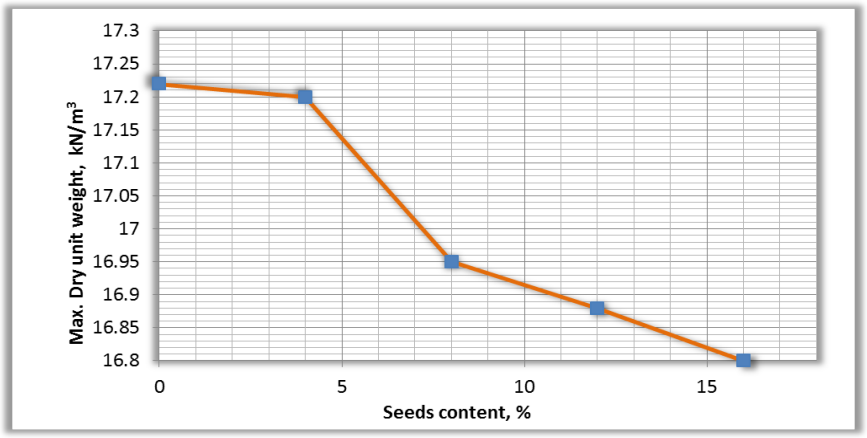

Figure 7. Effect of date seed content on maximum dry unit weight of reinforced soil

The reinforcement of the soil with different date seed contents showed no significant effects on the optimum moisture content of the reinforced soil, see Figure 8. This indicates that the water absorption of the date seeds is similar to that of soil solid.

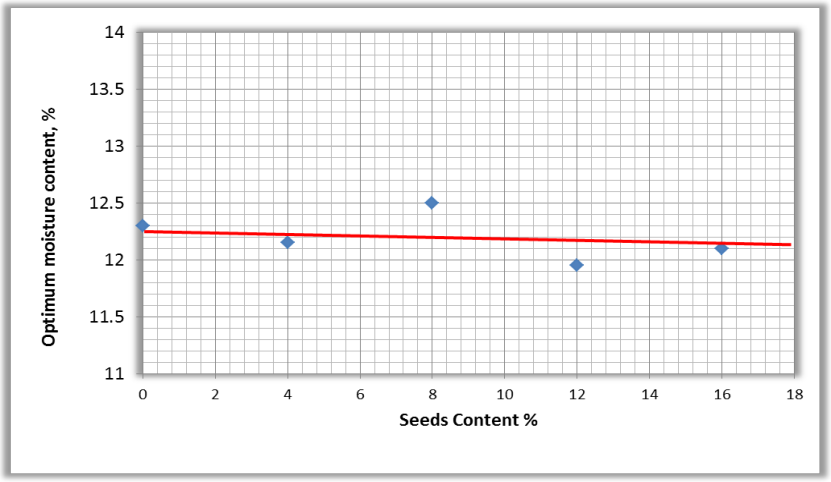

Figure 8. Effect of seeds content on the optimum moisture content of reinforced soil

3.3 Strength Characteristics

Figure 9 shows the unconfined compressive strength – moisture content relationships for different date seed content. It can be noted that for any defined seed content the strength of the reinforced soil is increasing with the moisture content up to maximum value after which the strength is decreasing as the moisture content is increasing. The maximum strength appeared to happen corresponding to certain optimum moisture content. In general; the seed content has no noticeable effect on the optimum moisture content since approximate same value has found for all seed contents.

The effect of reinforcement content on the maximum unconfined compressive strength is shown in Figure 10. The maximum strength increases as percent of the date seed increasing. The rate of increase is shown to be higher for the elevated values of the reinforcement content. An increase in strength of 54% is obtained for soil reinforced with 16% of date seed.

The strength increase due to date seed reinforcement can be attributed to creation of friction resistance between the soil particles and the seed surface area. The friction resistance of all the soil particles in contact with a single seed element surface area generating a binding force between these soil particles since all connected with the same binder element. Therefore; an additional cohesion is obtained between soil particles which are increase the overall compressive strength of the soil [13, 14].

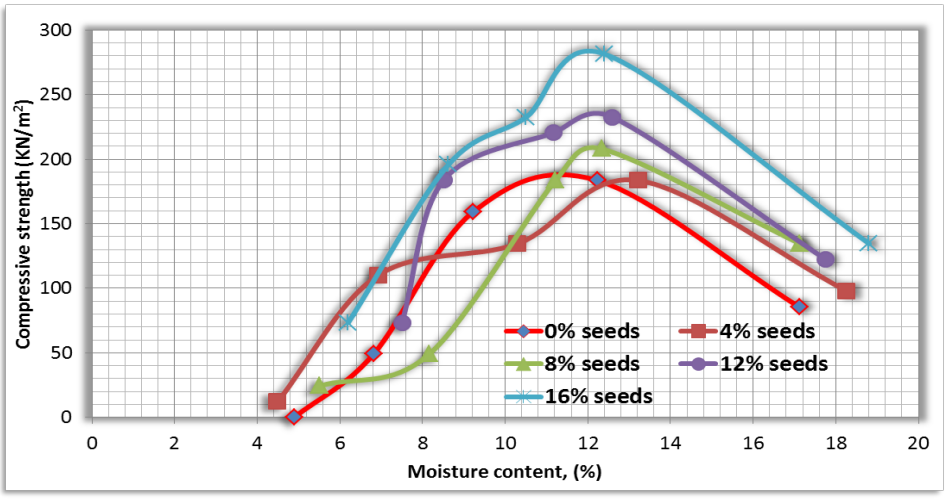

Figure 9. Strength - Moisture content relationships for different seed content

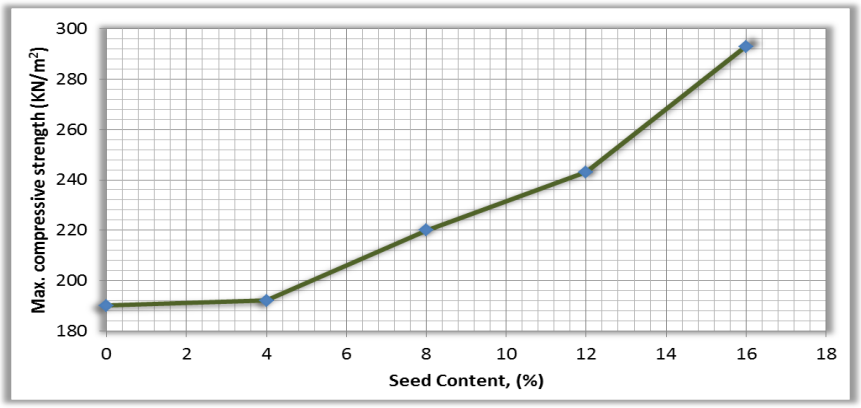

Figure 10. Effect of seed content on maximum compressive strength of soil

IV. CONCLUSIONS

1. The maximum dry unit weight of date seed reinforced soil is decreasing as the seed content increasing.
2. The date seed content has no significant effect on the optimum moisture content of reinforced soil.
3 The maximum unconfined compressive strength of the soil is improved appreciably as a result of reinforcing using date seeds.
4 An increase in compressive strength of more than 50 % is taken place when the soil reinforced by 16% of date seed.

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