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EFFECT OF DUNE SAND ON THE COMPRESSIVE STRENGTH OF A MATRIX SOIL OF SANDY-CLAY-GYPSUM

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ABSTRACT

In this work, we study the effect of dune sand content on the compressive strength of a matrix soil of sand-clay-gypsum. The content of dune sand added to soil is: 2%, 4% and 6%. The samples prepared were kept in an oven for 24 hours at a temperature of 20 °C. The results obtained demonstrate that the mechanical resistance has a significant increase at 2% to 4% of dune of sand. But this mechanical resistance decrease at 6% of dune sand, the ideal percentage is 4% with a resistance of 3.54 MPa.

Key words: Sand-clay-gypsum, dune sand, compressive, strength.

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1. INTRODUCTION

The treatment of low bearing soils is a common and ancient practice recognized worldwide, during the projects of civil engineering and public works, including road works (layers of form, pavement, road, highway, railway...etc.). The treatment of soils by mineral additions has found a better place in the field of geotechnics through the recovery of poor soils without going to use borrowing materials of good quality. This imports a significant reduction in transport costs and limit material deposits and project lead times.

Several studies have been carried out by different researchers to improve the physico-mechanical properties of the soil by the incorporation of several stabilizing agents such as

treatments with (lime, pozzolana, cement, fly ash, etc.) [1-3].The effectiveness of such agents is based on the formation of bonds between the particles of soil. The most applied stabilizers are cement and lime. These additions are usually added to clay soils to improve their geotechnical properties (physical and mechanical). This process is beneficial for reducing plasticity and increasing the resistance of soil.

The researches carried out also show a considerable improvement in the compressive strength of soils treated with cement or lime [4-6]. Okagbue and Ochulor (2007) indicate that compressive strength increases with increasing cement content. The unconfined compressive strength of a clay increases with increasing lime content and curing period [7-9].

The presence of certain types of salts during or after stabilization increases the compressive strength of the clay soil [10-14]. (Gadouri H, Harichane K, Ghrici M. 2016) found that the compressive strength increases for the samples of the two clay soils treated with natural pozzolana in the presence of gypsum (CaSO4.2H2O) compared to those that were treated without the presence of gypsum (CaSO4.2H2O).

This work consists of studying the effect of dune sand on the mechanical properties of the soil of sand-clay-gypsum by different contents of 2, 4 and 6%, the treated samples are kept in an oven for 24 hours at 20 ° C. This will make it possible to select the optimal dosages, as well from the point of view of mechanical strength.

2. CHARACTERIZATION OF THE MATERIALS USED

The experimental program consists of performing a series of tests to determine the parameters which allow the identification and characterization of the materials used.

2.1. Soil

The soil used in this study comes from the Abadla region (South-west of Algeria) (Figure 1) The physico-chemical properties of this material are shown in table 1

Figure 1 Sandy -clay-gypsum

Table 1 The results of physico-chemical properties of soil

N°	Parameter	Symbols	Contents
1	Color		Reddish
2	Natural water content	W_{nat}(%)	8.0
3	Moist density	γ_h(KN/m^3)	2.26
4	Dry density	γ_d(KN/m^3)	2.10
5	Liquidity limit	W_L(%)	24.65
6	Limit of plasticity	W_P (%)	14.28
7	Plasticity index	I_P (%)	10.37
8	Methylene blue value	VBS	3,3
9	Optimum water content	W_{op} (%)	8.0
10	Maximum dry density	$\gamma_{d\text{-}max}$ (KN/m^3)	10
11	Silica	S_iO_2 (%)	76,06
12	Sulfate	SO_4 (%)	5,74
13	Chloride	Cl^- (%)	0,248
14	Carbonate	C_aCO_3(%)	17,95

2.2. Dune Sand

The dune sand is taken from the town of TAGHIT (Figure 2). The results of the physico-chemical identification tests for dune sand are shown in Table 2

Figure 2 Dune sand

Table 2 Results of Physico-chemical Identification Tests for Dune Sand

N°	Parameter	Symbols	Contents
1	Color		yellowish
2	Equivalent of sand (visual)	ES_V (%)	93,33
3	Equivalent of sand(piston)	ES_P (%)	85,71
4	Volume weight dry	γ_d(KN/m^3)	2,66
5	Methylene blue value	VBS	0,4
6	Silica	S_iO_2 (%)	92,21
7	Sulfate	SO_4 (%)	Trace
8	Chloride	Cl^- (%)	0,035
9	Carbonate	C_aCO_3(%)	7,75

3. EXPERIMENTAL PROCEDURE

In our case, the treatment procedure begins by drying the material in an oven at 60 ° C for 24 hours, then we carefully mix our dry material for 15 min at different percentages of dune sand (2%, 4% and 6%) according to (NF EN 197-1, (2001)) [15] , until homogeneous material is obtained.

3.1. Simple Compressive Strength

In order to evaluate the effect of additions, simple compression tests were performed on soil samples according to ASTM D2166 (2000) [16]. Each sample is compacted in a cylindrical mold at the optimal water content and maximum dry density deduced from compaction tests (modified proctor) [17].after demolding, the samples are stored for 24 hours in an oven at 20 ° C. the value of the compressive strength is the average of two tests performed on each sample type (figure 3) and (figure 4). The results found are shown in table 3.

Figure 3 Cylindrical mold used to prepare test pieces

Figure 4 Machine for simple compression test

4. RESULTS AND DISCUSSION

4.1. Influence of Dune Sand on the Compressive Strength of the Tested Soils

The results of the effect of dune sand on the simple compressive strength of stabilized soil are shown in table 3.

Table 3 Effect of sand dune content on simple compressive strength

N°	Soil + dune sand in (%)	Simple compressive strength at 24 hours at 20 ° C in MPa
1	0	2,65
2	2	3,10
3	4	3,54
4	6	2,96

The simple compressive strengths obtained on samples stored for 24 hours in an oven at 20 ° C increase significantly from 2% to 4% dune sand. This growth of the resistances is due to the increase of silica brought by dune sand, but at 6% of dune sand leads to a decrease of the resistance (figure 5). This decrease in resistance is reflected in the reduction of the cohesion and plasticity of the clay [18-20], under the effect of high silica content which tends

to make the dispersive material by weak cohesion and that by saturation of the material, because the adhesion between the grains of the clay and the grains of silica was complete.

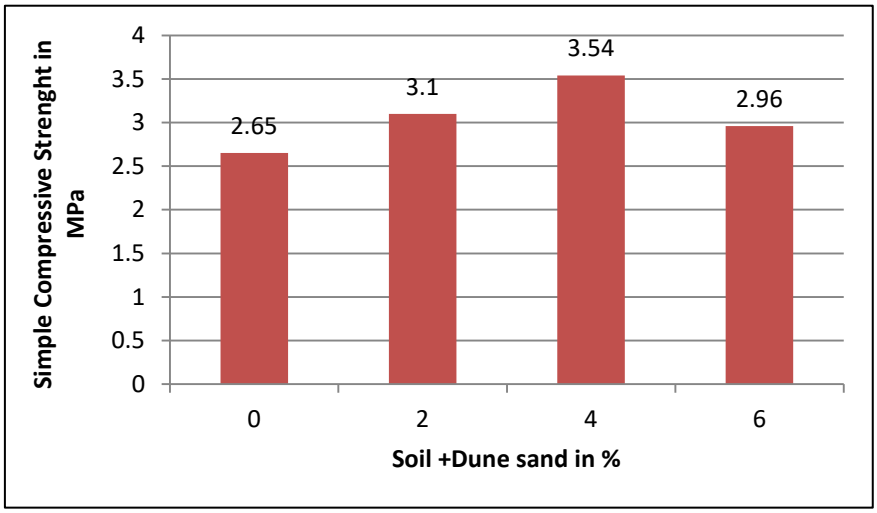

Figure 5 Effects of different percentages of dune sand on the compressive strength of tested soil

5. CONCLUSIONS

This study presents the experimental results of the effect of additions of dune sand on the simple compressive strength of matrix soil of sandy-clay-gypsum. On the basis of the results obtained, the following conclusions can be drawn:

- The stabilization by adding dune sand increases significantly the resistance for the percentages from 2% to 4%. But at 6%, there is a decrease in the resistance. The ideal percentage is 4% with a resistance of 3.54 MPa.

- The increases and decreases in resistance depend on several factors: the content and type of the additive used and the mineralogical composition of the soil which can play a very important role in chemical reactions [21-22].

- The technique of stabilization by adding dune sand is an effective and economical material for the treatment of soils. This local material is widely available in the region at very reasonable prices.

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