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Mechanical Behavior of Clay Reinforced by Layers of Polymer

[1]Rehab Bekkouche Souhila, [2]Boukhatem Ghania, [1]Mendjel Djenette

[1]Department of Civil Engineering, Skikda University, Algeria
[2]Department of Civil Engineering, Annaba University, Algeria
[1]Correspondence Author: *solrehab@yahoo.fr*

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Abstract:

In this work, we suggest the use of polymers as additives to coherent soils in order to know their influence on the latters, an experimental study in the laboratory was carried out on a clayey soil reinforced by layers in polymers. Our findings clearly showed that the adding of a small percentage of polymer increases sensibly the inflated character of the latter. This conclusion is completely justified by the experimental planning of the essays realized by the laboratory.

Key Words: Soil Stabilization, Polymer, Expansive clay, compressibility

Introduction:

In civil engineering the phenomena of shrinking inflation of certain clayey soils and some geological clayey formations induces differential tamps which are demonstrated by disorders affecting mainly constructed structures in surfaces and buried sets [1]. Although its drawbacks, the properties of its inflated clays make some materials very interesting in numerous applications, particularly, in geotechnics of the environment for the construction of working fences to stale parcels of nuclear wastes stored in depth, for the elaboration of the stone of the dams in the soil [2], [3]. The improvement of mechanical characteristics of the soils, the stand of all work in the land of civil engineering, is a worry to agrotechnicians. A technical reinforcement of soils consists in improving the initial resistance and the mechanical characteristics of soil by resistant inclusion. Among the most useful methods for improving the behavior of soils, we can cite the reinforcement of soils by geosynthetic layers (geotextile and plastic). The use of plastic materials in the field of civil engineering and public works is not really a new event. A certain number of studies and experimentation was realized. In civil engineering, polymers make a part of materials which allow to realize different geotechnical sets of retaining, of protection of the basins of tightness, under the causeways, in the tunnels… their use requires mastering their behavior to a long term (the duration of exacted life is generally of the order of 100 years). As a general rule, the lapses of its sets are of a mechanical order [4]. Now, the works of researches treat essentially the problem of determining the quantity of polymer adsorbed by the clay. The themes carry generally about the effect of structural nature of the additive or the clay, the nature of the existing cations in the system, and the load of polymer or also the effect of the ionic load (or the salinity) of the environment [5]- [10]. The advantages which can represent a reinforcement solution by geosynthetic are put in evidence by the different authors [11]-[14]. They insist on the economic interest of this solution according to other heavy solutions (for example: pillars of the soil treated with cement or pillars which are ballasted). [15] Evoke the environmental problems which are settled more and more in cases of total purge, for the putting in the depositing of excavation. Polymers, which are organic salts, are attracted by the surface of the clay when they carry positive charges and, in certain pH conditions, by the ends of the sheets when the charges they carry are negative. The large size of these molecules allows a kind of encapsulation which limits the subsequent hydration of the clay. The interaction of the polymers with the clay depends on the type of the clay, the grain size and nature of the exchangeable cations [6]. It has been shown that the combination of a salt and a polymer could be more effective vis-à-vis the stabilization than the mere use of one or the other component [16]. Our study interests most on the influence of this addition on some mechanical characteristics of clay because it was proved by former studies the very

positive effect of this addition on the improvement of properties of the inflation of clayey soils.

Localization and Identification of the Site:

The ground subject of this study is reshuffled clay of Elhadeik region which is situated in the North of Skikda (a town in the North East of Algeria). The sampling was done by a hydraulic shovel to a depth of 40 cm.

The Property of Polymer:

The material of reinforcement used is composed of plastic layers (translucent polyethylene) commercially available of weak density, white in color and soluble in water. It is a natural biodegradable polymer of a high performance developed for providing the needs of technologies specialized in drilling. Table I regroups the characteristics of the reinforcement of the used material.

Table 1: Properties of Polymer Used in the Trials

Property	Quantity
Appearance: Whitish, very fluid powder PH 1% soil: approximately 7 Dispersal: very good Toxicity: non-toxic	25 Kg multiplying the paper bags in internal polyethylene in block wrapped and fastened.

The Experimental Program:

The experimental program in this study consists of evaluating the effect of different percentage of polymer or some geotechnical parameters (pressure of inflation, coefficient of compressibility and coefficient of inflation). The quantities of clay and polymer for the preparation of mixtures are determined according to a massive percentage: (the material in the natural state, the material reinforced by a percentage of 5% of polymer and the material reinforced by a percentage of 10% of polymer)

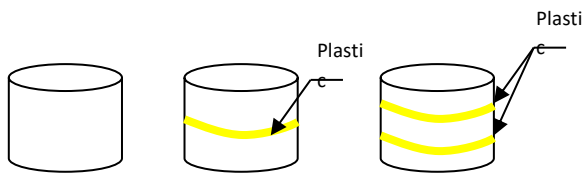

Figure 1: Emplacement of layers of polymer in test pieces

Results and Discussions:

In order to study the inflation of the clay mixed with different rates of polyethylene and to evaluate the effect of adding polyethylene on this parameter, a series of essays to the oedometer was realized on some specimen made by mixing to a water content of 22% and a dry density of 1.6 and compacted statistically in a ring of oedometer (H= 19 mm, d =70 mm) to a press aid. The sample is subjected to the weight of the piston only, and contacted with a water reservoir at zero load. The variation in the height of the piston is measured as a function of time until it stabilizes. The swelling curve (Fig. 2) presents two parts that can be analyzed, by analogy with the consolidation process, such as primary and secondary phases of swelling. The final value of the swelling, after stabilization, allows us to calculate the relative change of the volume of the sample which is expressed in percentage. The same procedure is used to study the swelling of the samples in the presence of different polymers rate.

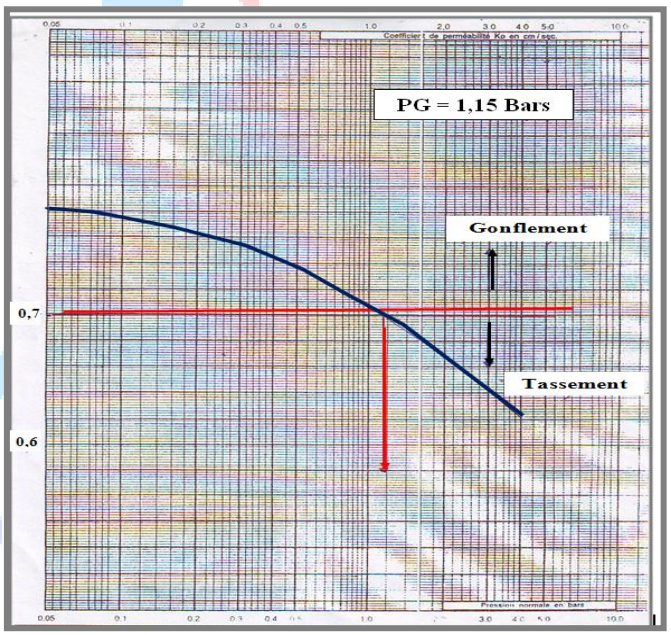

Figure 2: Curve of free swelling of the untreated clay

The obtained results are presented in Fig. 3, 4, 5 and 6. It is found that the paces of the obtained curves are too much similar to those obtained in literature [16]. The effect of adding polymer is visible. Its curves show that the potential of inflation increases in a substantial way by adding 5%. This proves that the inflation is related to plasticity and it affects the pure particles [17], [18].

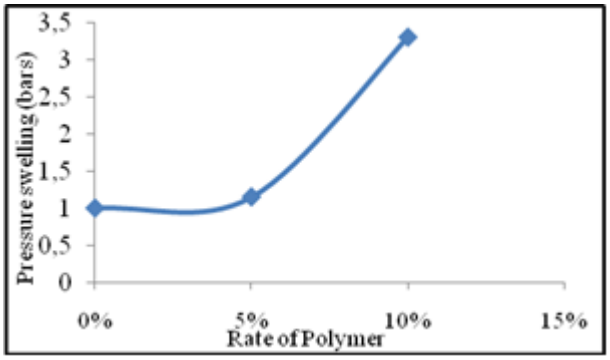

Figure 3: Curve of inflation functioning of the percentage of polymer

Another parameter of an important compressibility, which is the constraint of pre-consolidation (Fig. 4). The latter corresponds to the effective constraint which is vertical, and maximum supported by specimen in the course of its preparation by static compacting. It appears that the dosage in polymer from 5% has a negligible effect on the pressure of pre-consolidation [19], [20].

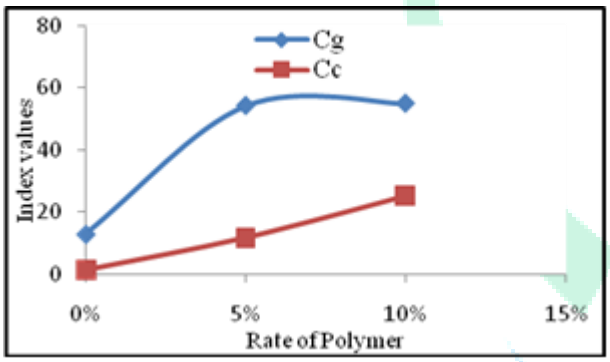

Figure 4: Variation of Pressure Compressibility in function of the rate of the polymer

In order to visualize better the variation of the compressibility, Fig. 5 gives the evolution of indications of compressibility (Cc) and of inflation (Cg) in function of percentage of polymer.

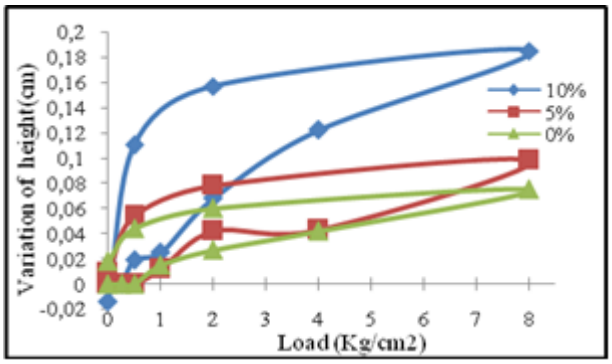

Figure 5: Variation of index values Cc and Cg in function of the rate of the polymer

The two indications increase with the increase of the percentage of polymer added in a substantial way by adding 5%. One possible mechanism is the progressive coverage of the clay surface in contact with the polymer, which grows with the increasing of the polymer levels Finally, the vertical shifts were measured with the help of a captor of shift related to a billsticker. The captor of the used shifts allows having a precision of the order of 0.01 mm. the vertical deformations were corrected with taking into account the deformations of the system "frame-cell- captor" which were evaluated using a wedge in steel being able to be considered as not being deforming. It was noted that the variations of volume deformations is also influenced by the presence of the rate of the polymer. The graphs of evolution of volume deformations in function of weight represented in figure 5 interpret a known behavior: its graphs have the same aspect and indicate that there is an important increase of the volume of specimen from the addition of 5% of polymer.

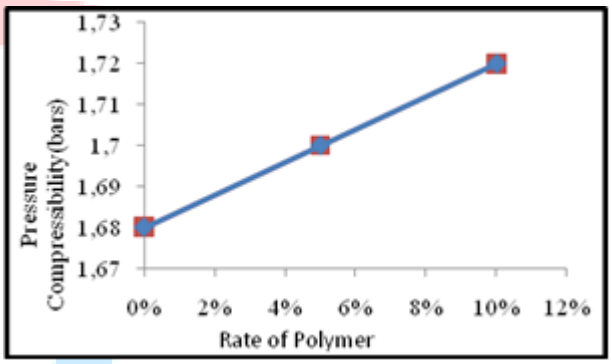

Figure 6: Variation of the height in function of weight

Numerous works were consecrated to description of the behavior of inflated coherent soils. These works have put in evidence that adding polymer rigidify the soil, increases its pressure of preconsolidation and its resistance. In our study, we discovered that the mechanical loads realized in a room temperature revealed the effect of adding polymer on the compressibility of clay: the inflation is due to hydration, the dependence of parameters of compression (Cc) and of inflation (Cs) and the increase of pressure of pre-consolidation due to hydration [21].

Conclusions:

The clays and the clayey rocks are incontestably very interesting in the frame of storage of wastes for a long time. At the same time as an elaborated barrier or like a natural geologic barrier. Like salt, they possess the capacity to realize around the works of stocking an auto-wrapping. They possess more many properties which interest the stocking. This study allowed us to study the behavior of clayey inflated soils used for the conception of elaborated barriers. The objective of this work is to answer a

question which concerns the effect of treating the soil by adding polymer on the parameters of inflation. According to these results, we noticed that the increase of the percentage of polymer provokes an improvement of the capacity of inflation of clay. The potential of inflation of the reconstituted soil increases from 5% of polymer. So, the trials of inflation on the clay studied showed well the increase of inflation with the growth of the rate of polymer.

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