PalArch's Journal of Archaeology of Egypt / Egyptology

INVESTIGATE THE WAY OF FIXING THE ROAD THROUGH SOIL STABILIZATION AND SANDY LIME MATERIALS IN PAVEMENT

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Zabihollah Tajbakhsh, Mohammad Reza Adlparvar: Investigate the Way of Fixing the Road through Soil Stabilization and Sandy Lime Materials in Pavement -- Palarch's Journal Of Archaeology Of Egypt/Egyptology 18(4), ISSN 1567-214x

Keywords: road stabilization, soil stabilization, sand materials, lime, road pavement

ABSTRACT

Considering to the wide existence of fine-grained clay soils in the country, there are many problems in the stability of the bed of civil projects, which requires a stabilization before the construction. In this research soil and lime stabilized properties are considered. The obtained results of experiments and studies have shown the extraordinary effect of lime on soil clay resistance. The percentages of lime were 0%, 6%, 10% and 14%, and the processing times of the samples were performed according to the schedule of zero days, 14 days and 28 days, after which the compressive strength test was performed and the end of the desired time. The results of single-axial compressive strength show different treatments with different lime percentages. After 10-day increment, the compressive strength of the specimens significantly increased after 28 days. On the other hand, the addition of 14% of lime causes a slight increase in the compressive strength of the samples; this is due to the fact that the soil's free space is saturated with lime; consequently, there is no more lime in the increasing process of resistance while increasing the cost of the sample.

INTRODUCTION

Considering to the extensive presence of clay superfine soil in our country, clay fines have created many problems in the stability of the development projects, which requires stabilization before construction (Ahmadinejad 2011). To stabilize the soil, various stabilizing materials are used such as cement, lime, pitch, chloro-calcium or sodium (Azarfar 2013). In road construction, soil and stabilized stone with lime materials are used to create bulkhead and to construct underlying and basements layer and pavements, as well as to a pavement of roads, railways and airports. Soil consolidation is mainly done for the following reasons (Behbahani 2015):

1. Improvement of technical properties of soils (underlying and basements layer and procedure)
2. Adjustment of soft soils and low resistance
3. Stabilizing the soil, reducing moisture or reducing the dust

4. Repair and repair of worn out pavements, roads and so on
5. Factors of the atmosphere (frost, etc.)

In general, the main purpose of soil stabilization is to provide lower thickness with the stabilization of desired resistance. Soil stabilization with sand material is a method used in road construction to improve the quality of materials, so that materials can be obtained with proper specifications for use in pavement layers. When the construction site is considered to be inadequate to the technical expert, the route should be changed. However, if it is not possible to change the path of the road or change the soil due to the some reasons (Tabataba'i 2014); the soil stabilization method should be economically considered. And determine the amount or percentage of soil stabilization is used with the help of resistance test (Hessami 2015).

The utilization of lime is one of the most effective methods for improving the technical characteristics of clay soils that are commonly used. The stabilization of clay by lime means the combination and mixing of lime with optimum moisture in the form of calcium hydroxide (live and out lime ...) with clay soil and blending the mixture, which stabilizes clay soil due to chemical reactions of clay and lime. And, in principle, lime will have a good chemical reaction with most clay soils (Ganjian, Mohandes and Hossein 2012). The most commonly used limestone, which is usually used to stabilize grained soils, such as: live and out lime (((mgo2) Ca (OH) and Live dolomitic lime (Ca (OH) 2). Clay soil stabilization, with live lime , dolomite, lime is similar to cementation; with the difference that lime is unaffected by the stabilization of grainless clay soils and the content of organic matter (organic matter reduces hydration) (Ganjian, Mohandes and Hossein 2012). In this research, used lime is liked powder, unsweetened, and grade 40 to the 14%, and also used clay in the typical type of used constructional and bakery products was 40%.

Factors for choosing the type of a stabilizing agent depends on a lot of factors, such as weather conditions of the area, soil, type of usage, operating cost, abundance and ease of use in the area and the rate of loading and operation. Stabilizing materials such as cement, lime, bitumen, chlorocalcium or sodium are used to stabilize the soil.

Effect of lime percentage on clay compressive strength

What is being evaluated in this paper is the effect of adding lime to clay, which is studied through a unconstrained compressive strength test (single axis). The results of experiments and studies have shown that superfine lime has a significant effect on soil resistance, which is economically feasible due to the economically used percentage.

Soil properties and stabilized lime with materials

- **Density**

The density of stabilized soils with lime has high value. It is noteworthy; kept in mind; controlling the result of the fixation process at the workshop is based on specific weight. The moisture content and especial dry weight can be considered as the characteristics of soil and lime mixing. Considering the importance of optimum moisture content in volume considerations. With increasing moisture content, the water

pressure of the cavity considerably increases, and ultimately this case causes slipping or instability of the slopes. By comparing the two laboratory samples, it can be seen that (Ahmadinejad 2011) soil mixture with 4% of lime is less progress relative to the natural soil; therefore, the probability of creating a slipping phenomenon in it is much less than that of a natural soil (Behbahani 2015; Tobra 2010).

- **Durability**

The main purpose of the durability of stabilized soils with lime is to resist them against the repetition of freezing ice. The long-term effect of moisture on these materials is usually not very severe and the ratio of the resistance of the saturated specimens to the compressive strength of the unsaturated samples is between 0.70 and 0.85. Stabilized soils with lime lose some of their resistance due to melting freezing. The resistance of stabilized soils with lime depends on their initial compressive strength against the freezing of the melt. And as much as its compressive strength, it is more resistant to melting ice and less resistance to it (Figure 1). If the stabilized soil is a type of lime-containing soil, its high initial resistance compensates for the loss of resistance to this phenomenon (Tabataba'i 2014).

- **Resistance**

Evaluation of the resistance of stabilized soils with lime can be done by performing various tests. The most commonly used tests include the California loading ratio test, the unconstrained compression test (single-axis (CBR)), indirect tensile test and three-axis test.

- **Antimicrobial resistance**

Usually, immediately after adding lime to soil, the soil strength and resistance significantly increase (Figure 2). This increase instantaneously facilitates the movement resistance of road machinery, and the soil for pavement.

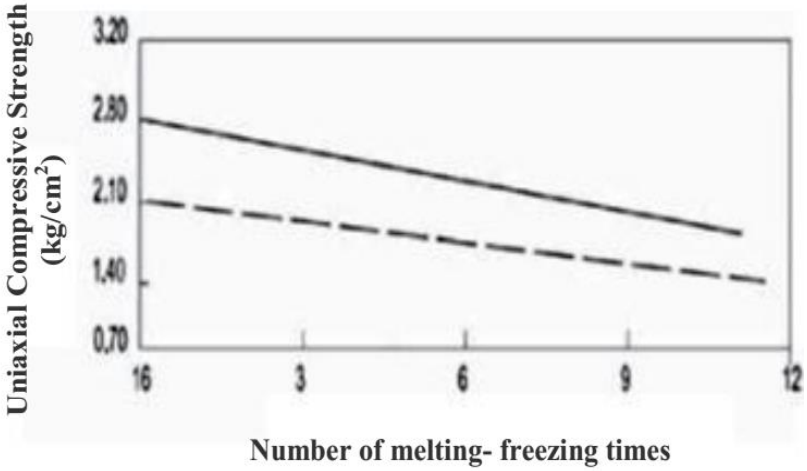

Figure 1. Number of melting-freezing times

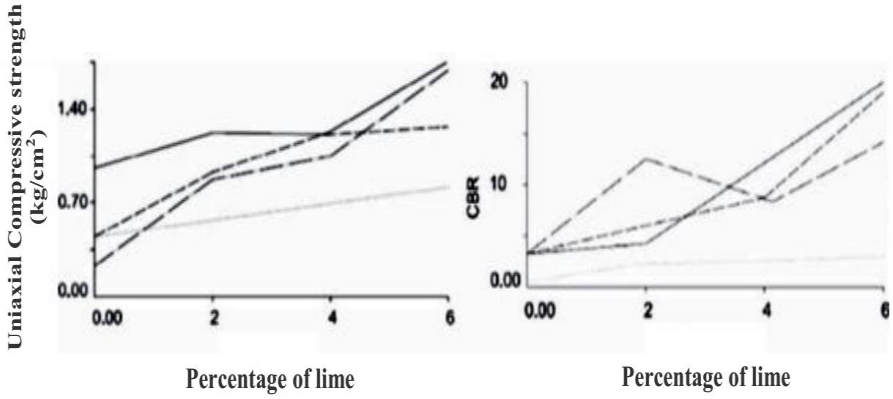

Figure 2. Percentage of lime

Long-term resistance

One-axial compressive strength of fine-grained soils, Which become optimal in percentage, usually varying between 1.70 and more than 20 kg /per cm2 and depends on the soil. Conducted Experiments on lime-modified soil samples showed that these soils, after mixing with 5% lime and acting for 75 days at 50 ° C, had an average resistance of 110 kg / m The obtained results in practice show that the resistance of stabilized soils continues over time, and in some cases, this increase in strength lasts for more than 10 years. Numerical request of natural soil compressive strength and stabilized soil resistance with lime are used as an indication of the degree of reaction between Pozzolani mixtures of soil and lime. Significant increase in soil resistance is a sign of the reaction of soil and lime, which confirms that the soil is probably stabilized with lime and this method can be used to utilize the soil in the pavement. Determination of tensile strength of stabilized soils with lime which is used in pavement layers has particular importance. Because the layers of these materials act like a slab because of their high resistance.

- **Fatigue**

The fatigue phenomenon is a phenomenon that occurs in viscosity materials. By adding lime fatigue life increases and shows a longer resistance to self-replicating. In Figure 3, the results of the flexural fatigue test have been shown on several stabilized soil samples; these curves are very similar to concrete fatigue curves and other cementitious materials. The fatigue strength of the samples in the test for 5 million times is between 41 to 66 percent of their final flexural strength, which is an average of 54 percent.It should be noted that since the resistance of stabilized soils with lime increases with time and heat of the environment; therefore, if the created tensile forces are constant in this aggregate during loading, the ratio of these stresses to the final strength of the materials decreases with time. And as a result, the number of uploading will be increased (Hessami 2015).

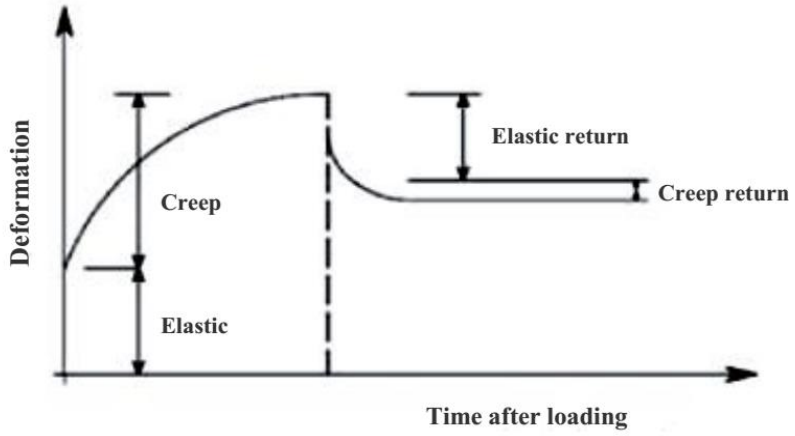

Figure 3. Time after loading

- **Stress strain**

The stabilized soils with Lime should have a stress strain curve (stress variation and relative deformation) in order to investigate their behavior analysis in the pavement layers (Figure 4). Stabilized soils with Lime have higher final stress and strain (change in shape relative) are less than pure soil.

In Figure 5, the effect of increasing the tensile stress strain on the stabilized sample has been shown with a weight percentage of 5%, 48 hours and 50 ° C (Behbahani 2015; Teimuri 2006). The purpose of the soil-stabilized design is to determine the percentage of suitable lime for soil with specific characteristics to be used in certain conditions. Determination of lime percentage to the dried weight of soil is carried out after investigating the effect of lime on the technical specification of the stabilized materials. The technical specifications to be examined depend on the purpose of the stablisizing, and generally include the limits of Atterberg, the ability to inflammation, the strength of the materials before and after the operation, the strength of the stabilized materials is determined by the California method of loading, or the test of one-axial pressure. stabilized soil scheme with lime usually involves preparing the samples, performing them, conducting the necessary tests and selecting the criterion of the design, and finally determining the percentage of lime. The preparation of soil and mixes lime is done in such a way that at first a certain amount of soil and lime are mixed together and then added to the required amount of water, which is well mixed to perfectly integrate. In most methods, soil and lime mixtures are prepared in optimum moisture content. Typically, mixture of soil and lime are abondon for one or more hour after mixing with each other, so that they cannot fit. Then Atterberg test is performed on samples.

Samples should be performed before the test; the operation of the samples is usually carried out for a certain time in laboratory heat or at higher temperatures. Because the way in which the samples are exposed in the test results is very effective. Therefore, one should not differentiate between samples whose treatment conditions are different. In terms of purpose and soil stabilization, they are divided into two groups (Behbahani 2015; Tabataba'I 2014).

1. The first group includes methods that: the purpose of soil

stabilization is to reduce the properties of the dough, reduce the inflation or increase the immediate resistance.

2. The second group includes methods in which the goal of soil stabilization is to increase the strength and durability of the materials.

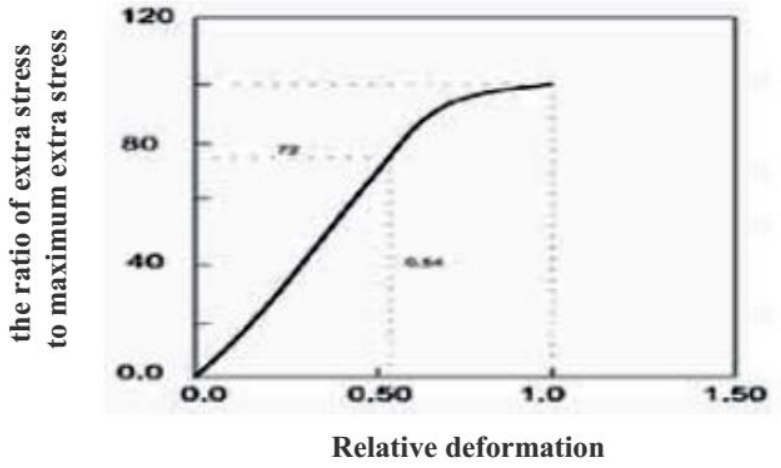

Figure 4. Relative deformation

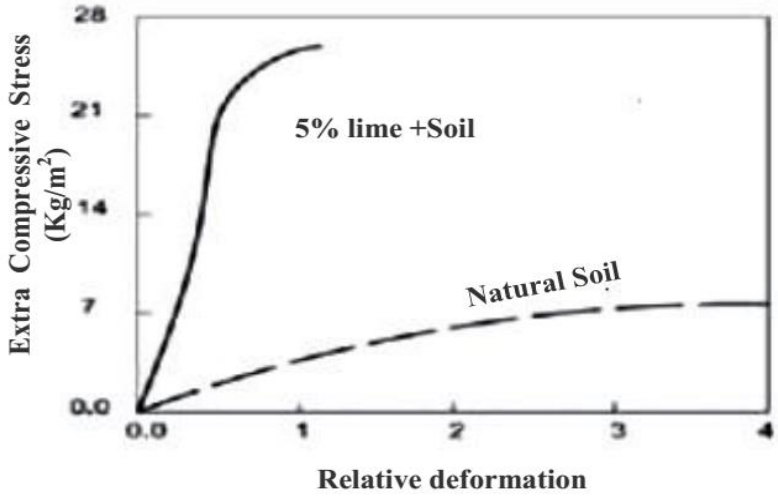

Figure 5. Relative deformation

Implementation of soil stabilization with lime

Over the past 30 years, significant progress has been made in the implementation of Lime concrete. In the study of scientists from different countries, which had only two devices for stabilizing soil with lime, there are more than 20 types of machinery today due to the production of various methods for the stabilization of lime. The method and equipment used to stabilize the soil with lime depend on many factors such as soil type, soil stabilization, problem complexity, environmental issues and pavement characteristics.

Effect of lime percentage on clay compressive strength

The effect is the additions of lime to the clay, which is studied by unlimited compressive strength test (single axis). The results of the

experiments and studies have shown the effect of ultrafine lime on soil clay resistance, which is economically feasible in terms of the economical used percentage in development projects. The way of the test is in order: first, the soil with lime and water is combined with each other perfectly and after that cylindrical specimens are formed by using the Ashtou density method. The amount of used water to make samples is optimal for moisture content. The obtained samples were done in a temperature of 50 ° C for 2 days and then it is being tested under a single axial pressure.

In some regulations, in order to stabilized soil become usable with lime as the basis for pavement, the uniaxial compressive strength of the material should be at least 10-50 kg for 2 days at a temperature of 50 ° C/m^2. This value is at least 7 kg / m^2 for used materials in the substrate.The samples are prepared in three layers, each layer with 25 impacted jam, with optimum moisture content. The percentage of lime was 6%, 10% and 14%, and the processing time of the samples was performed according to the schedule of zero days, 14 days and 28 days after the end of the desired time. To prevent the dried of the samples during the curing period, each sample is wrapped in a cellophane and placed in a container of water. In addition to the above time, samples were boiled in boiling water at 100 ° C for 8 hours and tested as early results (9.8).

Results of Lime Use in Clay Soil

The main factors in increasing the strength of the samples is the curing time, which completes the chemical interactions between clay lime. In Figures (6) to (8), the effect of curing time is shown on single-axis compressive strength. Considering to the relevant figures, The more time it takes, the greater the compressive strength. The results of single-axial compressive strength tests under different processing times with different lime percentages (Table 1) show that up to 10% increase in lime, the compressive strength of the samples after 28 days significantly increased. This increase was due to the reactions between lime and clay, and the adherence of particles to each other and lime deposits. On the other hand, adding 14% of lime become a slight increase in the compressive strength of the samples; this is due to the fact that the soil's free space is saturated with lime. The high temperature in the treatment also increases the compressive strength of the soil. However, due to the fact that the limestone and clay chemistry is prevented from operating in practice, the tests of boiled samples in normal mood have lower results. Another effect of the use of lime in soil is the reduction of soil permeability. The lower the percentage of lime, the higher the permeability will be. On the other hand, with increasing the records of the samples, the permeability decreases (Ahmadinejad 2011). Lime also affects the durability and stability of mechanical properties of soils. Because penetration decreases by 6% and 10%. Therefore, the durability and qualitative stability of mechanical properties will be developed. The more compressive strength, in other words, the durability and the stability of the soil; the resistance to the freezing of the melting ice will be greater. It also increases the time; the technical characteristics of the soil are improved and have high resistance (Azarfar 2013).

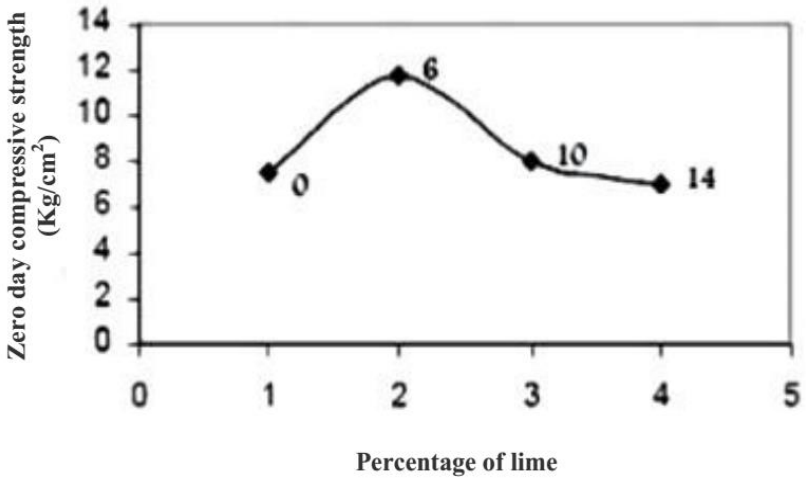

Figure 6. Percentage of lime

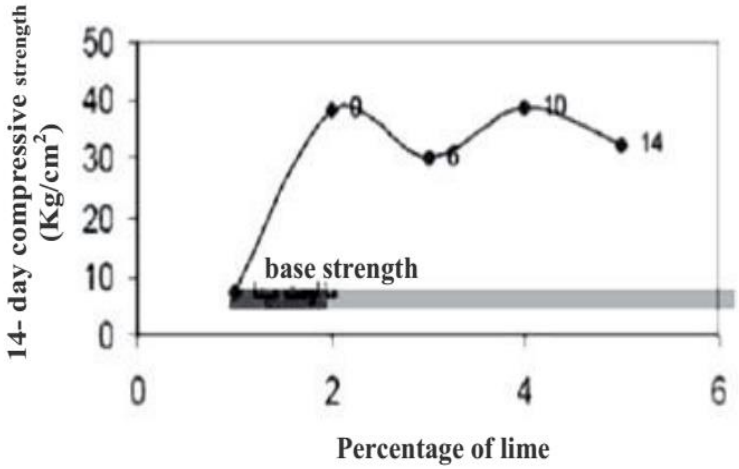

Figure 7. Percentage of lime

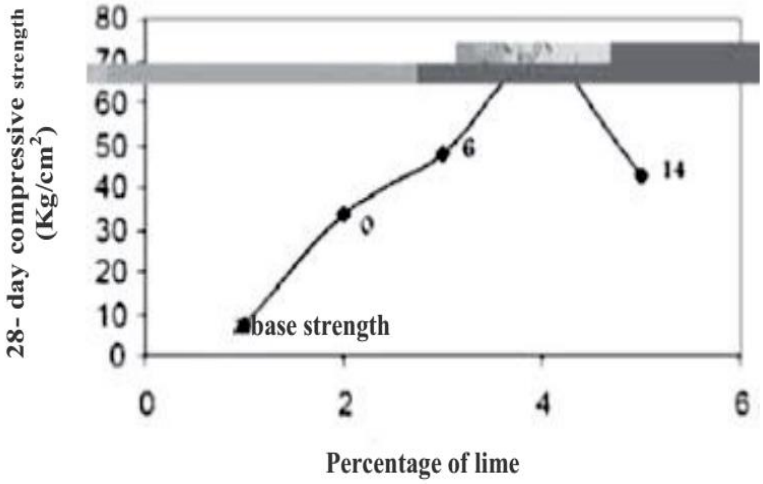

Figure 8. Percentage of lime

Table 1. Results of uniaxial compressive strength at different processing times.

Percentage of lime	Zero-day compressive strength (kg/m^2)	14-day compressive strength (kg/m^2)	28-day compressive strength (kg/m^2)	100 degree compressive strength (kg/m^2)
0 percent	7.5	-	-	-
6 percent	11.50	30.10	47.78	25.37
10 percent	8	39	70.12	32.13
14 percent	7	32.25	42.58	18.32

Investigate the compressive strength of stabilized soils with lime

Determination of the compressive strength of stabilized soils with lime is carried out by unconstrained pressure test (single axis) (Hessami 2015).

Immediate resistance of samples

After adding lime to clay, the final compressive strength and soil sustainability increase significantly; this increase is a function of the percentage of a lime consumed percentage. Considering to the conducted experiments on the samples was equivalent, which this amount is about 6% calcareous samples with the resistance of samples of zero percent.In the samples of zero percent of limestone is an empty space; this space is filled with lime in samples of 6 m 211.50 percent. In samples with 10% resistivity, it is almost zero-percent samples of lime, which can be due to the replacement of unbaked limestone instead of clay soil. In specimens of 14%, as noted earlier, resistance decreases (Teimuri 2006).

Long –term resistance

In all the different percentages which is prepared , the resistance has increased with increasing curing time. Even in 14% lime samples, which has less resistance than other percentages. At present, the highest resistance that has been made during different times is related to samples of 10% lime, 28 days records, at 70.12 (Tobra 2010).

Being economic of the project

This project is applicable to road construction projects. In some cases, that lime-modified soil is used as a layer of pavement system, the overall thickness decreases on the pavement. Sometimes the soil that is located at the site of the project, for example, if the soil under the structures of the buildings is soft and not suitable in terms of compressive strength, a modified method for this soil is to carry out excavation and re-excavation at the site, which will be very expensive

Another method is relatively cost-effective and will be the best result of resin. Soil modification is the method by mixing with lime. According to the results, we can have a good compressive strength by adding 10% lime (Ismail Zadeh Shahri 2012).

CONCLUSION

The reaction rate of soil and stone depends on the type of used lime,

the degree of mixing of particles and optimal moisture content. Live lime is more effective than lime, and pure lime is better than un-pure lime. The way to mix, to prepare samples, maintain and treat conditions is one of the most important issues in the product. .

The better the process of mixing soil and lime, the better the resistance will be. After treatment, calcareous samples showed a significant increase in compressive strength and in some cases increased to 10 times higher than the initial day. The optimum moisture content had a significant effect on the structure of the samples. For samples the zero percent of lime, 10 percent of the weight of lime, used water (500 gr of clay and 50 cc of water), and for samples that have lime, water content, 10 percent clay and 50 percent lime weight (according to lime percentage).The presence of lime, before being deposited in soil, causes slipping and lubrication due to more moisture absorption and makes it easier to make samples (Hessami 2015).

The use of lime and soil clay modification, according to the project's economic report, will not only reduce the cost of operations but also increase the stability of structures and reduce the consumption of materials in construction.

Suggestions

At the end, we propose some suggestions: be careful that the soil clay improves when adding lime to it at the best possible time. Lime is not produced free of charge in the soil and all the used lime is completely combined with soil. For this reason, care should be taken to determine the optimum moisture content. To achieve better results, specialized software and special modern equipment can be used to analyze the microscopic position at the same time as macroscopic results. The ambient temperature is important for the processing of calcareous specimens, hence the subject matter of the present research (Standard Dimensions of Pavement of New Roads 2011).

Funding: N/A

Conflict of interest: The authors declare that they have no conflict of interest.

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