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TERM AND TYPES OF SOIL STABILIZATION

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Abstract

During the construction of a structure (road, building, etc.), it is necessary that the soil, where the structure will be located, meets the designed characteristics (physical, mechanical and deformation). In case, during the examination of the said soil, it is determined that it does not meet the given criteria, the improvement of the soil is started. This paper will describe the basic principles and types of soil stabilization.

Keywords: *soil stabilization, structures, soil, soil characteristics*

1. INTRODUCTION

The basic ground, on which some of the construction objects will be located, must meet the requirements of the construction project. If it does not meet the prescribed conditions and qualities, soil improvement should be done. There are two ways: ***complete soil replacement*** and ***soil stabilization.***

The complete replacement of the soil is more expensive and time-consuming process, and in particular care should be taken to use the nearest loan site with material of the required characteristics, due to the economic effect. That is why soil stabilization is used in most cases.

Soil stabilization is a procedure that involves changing the properties of the basic soil, in order to obtain a substrate that meets the requirements of construction projects.

Depending on the type of soil to be stabilized, two methods of stabilization are applied: mechanical and chemical.

Mechanical methods are usually used with incoherent soils. With such types of soil, the granulometric composition is changed and such a mixture is mechanically acted upon until the required properties of the material are obtained (required load capacity, water permeability, etc.).

With the chemical stabilization method, depending on the type of soil, cement and lime are used. By adding these materials, the physical, chemical and mechanical properties of the base soil are improved and changed.

2. THEORETICAL BASIS OF SOIL STABILIZATION

Soil stabilization is a process in which the soil's resistance to the effects of traffic and climatic influences is improved by adding binders, so that it can continuously

receive the traffic load and its resistance to the effects of water and frost is increased in the medium and long term [1].

Soil stabilization is a group of earthworks technologies for improving soil characteristics during the construction process and for improving mechanical and load-bearing properties. The two main technological methods are soil improvement and soil consolidation [2].

Stabilized soil is any natural material that has been processed in such a way that its bearing capacity is improved and maintained, as well as to acquire resistance to the action of atmospherics (weather influences) [3].

These are just some of the definitions of soil stabilization, which scientists have been dealing with for many years. Almost all definitions of soil stabilization imply the use of additional materials, all with the aim of improving the characteristics of the basic soil.

Soil stabilization is very often applied in places where the basic soil has unsatisfactory physical and mechanical characteristics and where replacing the material is an extremely expensive solution.

The main methods of soil strengthening are: ***physical-chemical, mechanical and structural.***

Physico-chemical methods of soil strengthening are considered highly effective. We distinguish:

1. Mechanical stabilization i
2. Stabilization using different types of mixtures:
   - lime stabilization,
   - cement stabilization,
   - chemical stabilization,
   - stabilization with fly ash,
   - bitumen stabilization,
   - stabilization using geotextiles and fabrics.

Mechanical soil stabilization is mainly used for non-coherent or weakly coherent types of soil. Adding certain fractions to the existing soil changes the initial granulometric composition. Some of the materials can be brought to a state of good geomechanical properties by the compaction process.

Chemical soil stabilization is associated with modifying soil properties by adding chemically active materials. It is important to know two facts: the property of the materials included in the mixture and the result after mixing and how the material will behave after stabilization [4].

The most commonly used binders used in soil stabilization are lime and cement. Which binder to use depends on the type of soil. Lime is used for fine-grained, bound soil, while cement is used to stabilize incoherent and weakly coherent soils.

In order to make it easier to determine which type of binder to use, depending on the granulometric composition and consistency limits of the base soil, Mirko Stanković, M.Sc., gave a tabular representation of the decision-making process.

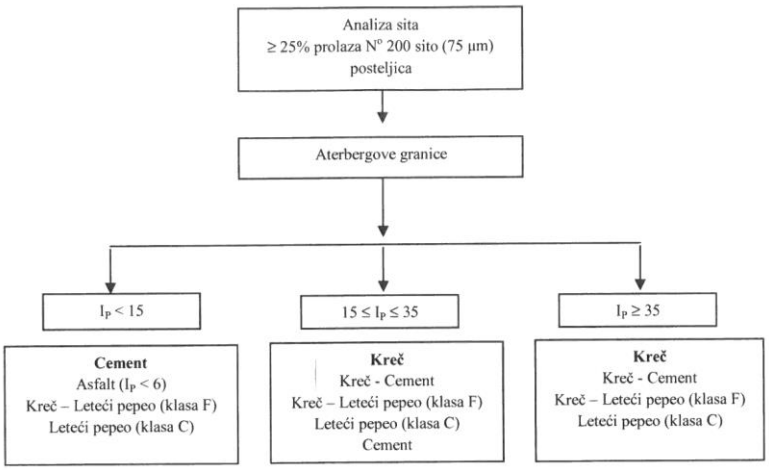

Figure 1. *Some of the decision-making elements on soil stabilization [4]*

2.1. Stabilization with cement

Stabilization with cement is suitable for coarse-grained soils and soils on the transition to fine-grained. Depending on the amount of cement, they differ:

1. **Cement soil**, which is a homogeneous material containing 5-15% cement in relation to the mass of the soil. The cement fills the pores and a cement lattice is formed in which the soil grains are trapped. Stabilized soil has a high strength of 2-7 MPa, is resistant to erosion, moisture and frost. It is applied to the bearing layer of traffic roads;
2. **Cement-improved soil** contains 2-5% cement. Soil grains are connected by cement only on part of the surface and no cement grid is formed. It is used to stabilize the placenta.

Figure 2. *The process of stabilizing the base soil with cement in the field [2]*

2.2 Stabilization with lime

This type of stabilization is suitable for fine-grained soils. Stabilization is done by adding 2-8% of slaked lime in relation to the soil mass. A chemical reaction occurs between slaked lime and clay minerals and changes the properties of the soil. The mineralogical composition of the clay affects the strength of the reaction, soil moisture decreases, a solid skeleton is formed and the granulometric composition changes (clumping occurs). Over a longer period of time, a pozzolanic reaction occurs - the reaction of lime with active silicates and clay minerals. The grains stick together and thus increase the strength of the soil. The plasticity index, I_P, decreases . This method is more economical than cement stabilization. There is a noticeable effect of stabilization on increasing the bearing capacity of the soil.

Figure 3. *The process of stabilizing the base soil with lime in the field [2]*

2.3. Chemical stabilization

The principle of chemical soil stabilization is to prevent the chemical binding of absorbed water or to provide the necessary water content, which will provide the material with the necessary cohesion. Various chemical additives are used for this purpose. The problem is that these funds are, in the main, very expensive and relatively unavailable to the broad market.

2.4. Bitumen stabilization

This type of stabilization is applied to all types of materials. It causes the effect of particles sticking together, thus increasing cohesion. The amount of bitumen used ranges from 2-4%, exceptionally in some cases up to 10%.

2.5. Stabilization with ash

Ash is a product of coal combustion in thermal power plants. Depending on the type of coal, class C ash is obtained, which has self-binding properties, i.e. only water is needed to start the reaction, and class F ash, which has only pozzolanic properties, i.e. in addition to water, an activator is also needed for the reaction to occur. The optimal ash

content in the mixture is 10-30%, which depends on the type of soil and ash. The stabilization effect is reflected in an increase in strength and load capacity, while the plasticity index and swelling decrease.

The problems of soil stabilization, which arise when using the mentioned materials, are reflected in the following:

Dosing of these supplements is done in small quantities, so even distribution on the field is difficult to implement.

Depending on the mineralogical composition of the soil material being stabilized, the chemical reaction that takes place between the stabilizer and the base soil also depends. Therefore, the effectiveness of using stabilizers is called into question.

Before starting the stabilization process in the field, it is necessary to conduct a series of laboratory tests, in order to prove the effectiveness of the stabilizer. In addition to laboratory tests, field tests are also very important, which will confirm the results obtained in the laboratory. All this requires a longer time period of testing [4].

3. CONCLUSION

Soil stabilization is applied in the case when the complete replacement of the soil is economically unprofitable (e.g., the distance of the loan site with quality material from the construction site, etc.).

Soil stabilization aims to improve the basic characteristics of the soil, such as: bearing capacity, shear resistance, compressive strength, and plasticity and swelling of the material are reduced.

In order to determine exactly what type of stabilization we will apply, it is necessary to determine the basic physical parameters of the soil material (granulometric composition and Atterberg consistency limits).

It should be borne in mind that, although a good amount of stabilization material is made, there are problems that arise during the process itself, such as: uneven dosing and small amounts of soil stabilization material, mineralogical composition of the basic soil, and the like.

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