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STRENGTHENING OF SUBGRADE SOIL USING MODIFIER

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Abstract: *As a result of the type and number of cars moving on automobile roads and the movement of heavy trucks in their composition, various deformations occur in the road surface. As a result, the roads are being repaired before the required service period. Also, the issue of using local soils for the base layer of the automobile roads is urgent. In order to increase the stability of the road, it is possible to carry out soil stabilization works at the base of the road. In this article, laboratory research works on strengthening of subgrade soil with the help of modifier was carried out. The effect of the modifier on the reinforced soil has been studied.*

Key words: *subgrade, soil, strength, stabilizer, cement, Acropol GSM.*

Introduction. Currently, as a result of the increase in the number of heavy vehicles, the loads on the automobile roads are also increasing. As a result, various deformations occur before the service life of automobile roads. In addition, the shortage of raw materials used for the base layer of the road and the transportation costs of transporting the materials lead to an increase in the total cost of road construction. Therefore, in places where there is a shortage of local stone materials, the issue of using primers reinforced with binders is urgent. In order to increase the strength of local soils, the implementation of stabilization works by adding various

additives and modifiers to the subgrade soil is considered as an engineering solution.

The main part. In the climatic conditions of Uzbekistan, there is frequent precipitation in autumn, winter, and spring. One of the main indicators determining the strength of the road depends on the calculated parameters of the road base soil (*E*-module of elasticity, φ-angle of internal friction, *C*-bond strength) [1]. It is known that the road base loses its strength as a result of the impact of waterlogging of the soil. This causes various deformations in the pavement due to the movement of heavy vehicles on automobile roads [2,3,4]. For this reason, the application of the Acropol GSM modifier, which is currently widely used in practice and produced by foreign countries, to the road base has been experimentally tested in laboratory conditions.

Modifier Acropol GSM is produced by the company "STRIM" of the Russian Federation. Acropol GSM – soil crystallize based on compounds of alkaline earth metals and products of hydrothermal synthesis of silicic acid and amphoteric metals. Designed for the construction of soil-cement roads of categories II-IV and road bases of categories I-IV in various climatic zones. Significantly increases the strength of the road base. As a result of the use of the material, a very durable and flexible layer of road surface is formed, connected at the molecular level [5].

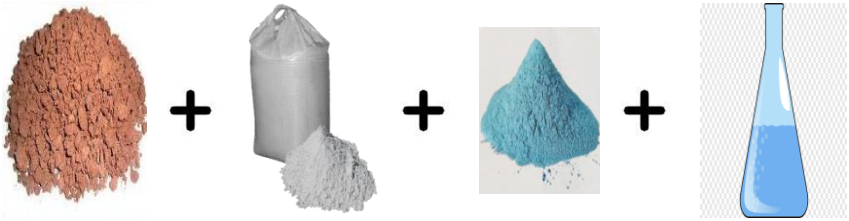
Method. First, in laboratory conditions, the soil type was determined according to GOST 25100 [6] and the maximum density at optimal moisture according to GOST 22733 [7]. According to it, it was determined that the grunt type is sandy loam (supes) (Table 1).

Table 1

Humidity at the yield point, W_y %	22,3
Humidity at the rolling point, W_r %	16,6
Plasticity number, I_p	5,7
Optimal humidity, W_{op} %	14,5
Maximum dry density soil, ρ g/cm^3	1,83

Then the laboratory work was carried out according to GOST 23558-94 [8] according to the scheme shown in Fig. 1. Accordingly, M400 brand Portland cement is added to the soil in the amount of 4% and 6%, the Acropol GSM modifier is added to the soil in the amount of 0,10%, 0,12%, 0,14%, 0,16% and 14% of water was added to achieve optimal moisture,

and samples were prepared using a press. Portland cement is one of the most common and inexpensive mineral binders used to strengthen the soil.



Soil | Cement (4,6%) | Acrapol GSM (0,10 – 0,16%) | Water (14%)

Fig. 1. Scheme of preparation of reinforced soil samples under laboratory conditions

Results. The samples were dried for 28 days and their maximum density was determined (Table 2-4).

Table 2

Soil		Soil + 4% cement		Soil + 6% cement	
Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3
2,08	1,86	2,10	1,88	2,10	1,88

Table 3

Soil + 4% cement +Acropol GSM (0,1-0,16%)							
Acropol GSM – 0,10%		Acropol GSM – 0,12%		Acropol GSM – 0,14%		Acropol GSM – 0,16%	
Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3
2,10	1,89	2,11	1,90	2,12	1,90	2,10	1,88

Table 4

Soil + 6% cement +Acropol GSM (0,1-0,16%)

Acropol GSM – 0,10%		Acropol GSM – 0,12%		Acropol GSM – 0,14%		Acropol GSM – 0,16%	
Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3	Density when wet, ρ, g/cm^3	Density when dry, ρ, g/cm^3
2,10	1,88	2,10	1,89	2,12	1,90	2,11	1,89

The compressive strength of the finished samples was checked using a modern “Universal Test Machine” press. The results are displayed on a computer graph (Fig.2).

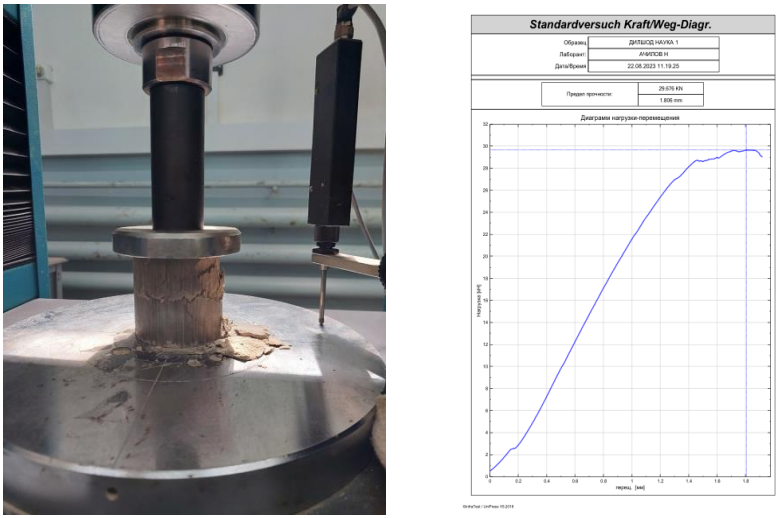


Fig. 2. Results from the “Universal Test Machine” press in graphic form

As a result of processing the results of the study, the compressive strength of the reinforced soil in the mixture of soil and cement without adding a modifier is shown in Table 5, and the result when a modifier is added is shown in the graph in Fig. 3.

Table 5

Compressive strength, R, MPa		
Soil	Soil + 4% cement	Soil + 6% cement
3,6	7,29	8,39

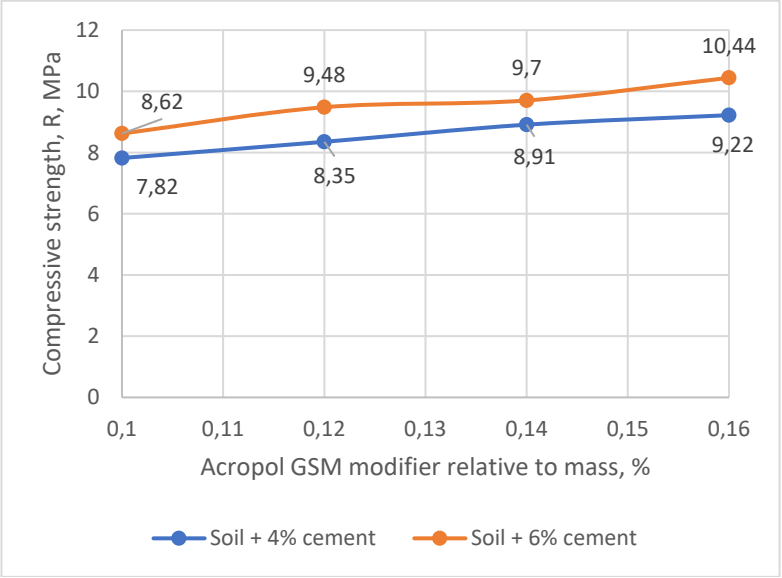


Fig. 3. A graph of changes in compressive strength when a modifier is added to reinforced soil

Conclusion. Laboratory studies showed that the modifier increased the strength of the primer. Taking into account the climatic conditions of Uzbekistan, the use of stabilization works at the base of the road makes it possible to reduce the volume of earthworks, reduce the consumption of transported sand and gravel materials, ensure the elevation of the slope and the priority of the base, reduces unevenness of subsidence and increases the service life of the road.

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