ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 6, Issue 10 , October 2019

Field of Engineering-Geotechnical Works at Section of the Main Structures of the Pskem HPP on River Pskem

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ABSTRACT:In this article presents results of geomechanical studies. In accordance with the statement of work and the schedule, the following works were performed:

- stamp tests were conducted on six concrete dies located in the research adit on the right bank of the Pskem River. All tests were performed at the site of the dam;
- data of 6 stamp tests (deformation) were processed and analyzed;
- the obtained results of field studies are compared with the data of the engineering and geological documentation of the experimental sites.

KEY WORDS: soil dam, slope fastening, filtration, filtration strength, filter cups, slope stability, rapid decrease in the water level in the reservoir,

I.INTRODUCTION

Experimental sites were selected taking into account the topography of the rock surface, blockiness of the massif, the selected shear direction, etc. In particular, the sites were chosen within which there was no significant difference in the heights of the rock surface, which could lead to an overestimation of the shear parameters of the massif [1].

Before concreting the dies, the geological engineering documentation of all the sub-stamp areas was carried out and profiles of their surface were sketched in the direction of shear and in the orthogonal direction.

II. METHODS OF RESEARCH

In accordance with the engineering-geological description of the massif described in the report of JSC Hydro project [3], the test sites are located in rocks of the Neogene age, represented by massive-layered siltstones. From table 1. it is seen that the value of the coefficient of fracture voidness on the sub-stamping sites is negligible and ranges from 0.04 to 0.83% with an average value of 0.23%.

Table 1. The number of cracks and the KTP value at the sub-stamping sites

Number of pad	7	8	9	10	11	12
Number of cracks	10	10	9	6	14	8
KTP,%	0,05	0,18	0,05	0,04	0,26	0,83

According to the classification of NR 23.13330.2011 [4], rock massifs with the indicated KTP values are classified as very weakly fractured and slightly cracked massifs. An exception is the base of the BSh-12 stamp, which refers to medium-crack massifs.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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In conformity with the Program of the present work [5], at each of the 6 experimental sites, deformation studies of the properties of the siltstone mass were carried out at first, and then shear tests were performed. Deformation experiments were carried out with rocks in a water-saturated state (before the experiments and in the process of their conduct, water was in the recesses surrounding the dies).

Deformation experiments were carried out by the method of static loading of a rock surface through a hard concrete stamp. Each experiment included 5 load-unloading cycles with maximum specific loads in the cycles σmax = 1,0; 2.0; 3.0; 4.0 and 5.0 MPa. In each cycle, the normal stamp load increased and decreased in steps (the experiments included 5–7 steps at the loading stage and 4 steps at the unloading stage).

According to the results of the experiments for each cycle "load-unloading", the deformation moduli E and elastic moduli Eu of the array were determined using the following formula [2]:

$$E(Ey)=b*w(1-\nu^2)\Delta\sigma/\Delta s,$$

where: b is the width of the stamp; ν Poisson's ratio of rock (assumed to be 0.25); Δσ is the change in the normal pressure (voltage) applied to the stamp; ΔS-change in the sediment of the base of the stamp caused by the corresponding change in pressure Δσ; w is a constant coefficient taking into account the shape and stiffness of the stamp (as applied to the tests under consideration, w = 0.88 [2]).

It should be noted that the value of the Poisson's ratio within its possible values affects the magnitude of the deformation modulus to a very small extent.

An example of the graphs of the dependence s = f (σ) is shown in Fig. 1.

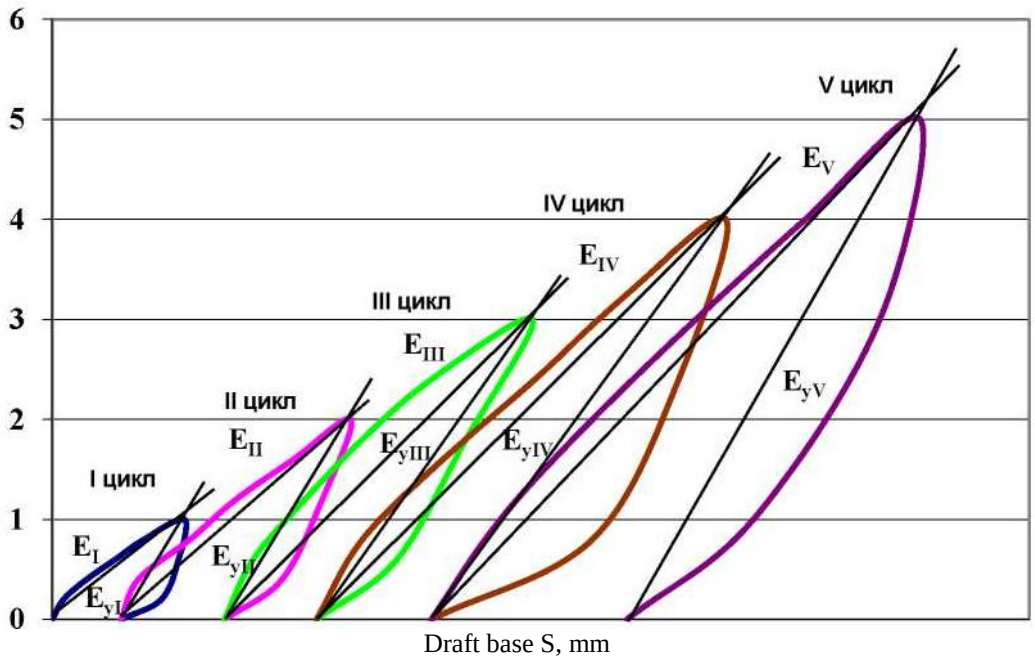

Fig. 1. Example graphs s = f (σ) when performing stamp experiments
Ei, ...*Ey*are the deformation modules at different loading cycles, *Ey* are the elastic modules

For definiteness, hereinafter, deformation and elasticity moduli will be understood as their average values obtained in the 4th and 5th test cycles, which are given in columns 4 and 7 of Table 2.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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Table 2. Values of the deformation moduli E and elastic moduli Ey of the array obtained in stamp experiments

Stamp number	Values of the modulus of deformation and elasticity, MPa						(Ey)aver/(E)aver
	E			Ey			
	4th cycle	5th cycle	Average	4th cycle	5th cycle	Average	
1	2	3	4	5	6	7	8
BSh-7	1925	2188	2057	2357	2977	2667	1,30
BSh -8	5022	4894	4958	6243	6144	6194	1,25
BSh -9	9625	8750	9188	10500	10694	10597	1,15
BSh -10	6243	7219	6731	6794	8493	7644	1,14
BSh -11	3039	3438	3238	4053	4310	4181	1,29
BSh -12	4915	5156	5036	5634	5662	5648	1,12

As can be seen from table 2, the magnitude of the deformation moduli of the array E in the experimental sections varies from 2060 to 9190 MPa with an average value of 5200 MPa. The minimum deformation modulus for the test plots was obtained on concrete stamp No. 7 (BSh-7), and the maximum - on stamp No. 9 (BSh-9). The ratio of the elastic moduli to the deformation moduli of the array varies from 1.12 to 1.30, averaging 1.21.

Recommended calculated modules of deformation and elasticity of the massif for each site are given in Table 3. The calculated modules were calculated as average values between the modules of the 4th and 5th cycles, with the values obtained being rounded up to 100 MPa.

Table 3. Recommended design values of deformation moduli E and elastic moduli Ey of sub-stamping areas

Stamp number	7	8	9	10	11	12	Average
E, MPa	2100	5000	9200	6700	3200	5000	5200
Ey, MPa	2700	6200	10600	7600	4200	5600	6200

III.CONCLUSION

Consequently, results of geomechanical studies of an array of siltstones, performed in the right-bank experimental adit in the section of the dam section of the Pskem hydroelectric station.

Field geomechanical studies included stamping experiments to determine the deformation properties of the array. These studies were performed at 6 sites located in the experimental adit. The experiments were carried out on concrete dies with a base size of 0.7m x 0.7m. A total of 6 deformation tests were performed. The stamps shifted in the direction from the upper to the lower pool, which corresponded to the direction of the main loads that will act on the dam.

The value of the coefficient of fracture voidness (CFV) of rocks at the experimental sites is insignificant and averages 0.23%. In accordance with the existing classification, the tested rocks were mainly weakly fractured and very slightly fractured.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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During the engineering and geological documentation of the experimental sites, no sub horizontal cracks were found, oriented towards the upper or lower pools, along which stamp shifts could occur.

In compliance with the results of deformation tests, the deformation moduli E of the rock mass in the experimental sections vary from 2100 to 9200 MPa with an average value of 5200 MPa.

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