Analysis of changes in the strength characteristics in operation

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ABSTRACT: The authors propose to conduct the investigations to determine the strength characteristics of geosynthetic materials that have been the reinforcing elements of armogruntovoy construction for 27 years and according to the results of the research to determine the regular change in strength properties with regard to the original material. As a geosynthetic material a polyester mesh (pic. 1) produced at one of the factories in Perm region is used. The mesh was a reinforcing element of the supporting wall in the city of Perm.

Keywords: Geogrid, creep, strength.

1 INTRODUCTION

Nowadays geosynthetic materials along with steel, concrete and wood became the main materials in construction. Experience of using geosynthetics in international practice is great and totals hundreds examples. In Perm krai first constructions with using of geosynthetics appeared in the middle of 80s of last century. 30 years. Since then a great experience of using such constructions has been accumulated. Almost all this constructions continue to perform their project functions. One of the first reinforced ground constructions built in Perm was retaining wall on Elkina Street constructed in 1986. While in operation significant lateral strains appeared and installation of retaining constructions was required (Fig. 1). The main reason for emergence of strains was lack of experience in the design of retaining walls from the reinforced ground. In 2013 this retaining wall was dismantled and the new one was built (Fig. 2). When work on dismantling reinforced ground retaining wall an opportunity to sample reinforcing interlayers of polyester, which had served for 26 years, arose (Fig. 3).

Fig.1. Retaining wall with retaining constructions

Fig.2. New retaining wall

Investigation of former operating reinforcing interlayer samples allows obtaining quantitative values of changes in strength properties of geosynthetic materials. Nowadays it is not well studied how strength properties and strain characteristics which are the part of these constructions are changed. Existing tests for long-term strength do not give us 100% assurance in accuracy of comparison with the real behaviour of the material in the construction.

Fig.3. Geogrid sample extracted from the soil

Geomorphologically the site is located within the buried until 1973 arroyo of the Danilikha river cutting through left-bank above the floodplain IV terrace of the Kama river. At present altitudes of the ground surface within the site are 138,88-145,90 m (Perm system of elevations). Terrain of the site is steep with significantly sloped from east to west filled soil terraces. The slope is turfed and planted with shrubs.

2 EXPERIMENTAL PART

Experimental studies of strength properties and strain characteristics were carried out in two stages. The first stage was to study extracted from the retaining wall geogrid tensile characteristics, the second stage was to study tensile characteristics of new analogous geogrid.

Studies have been carried out by Construction Technology and Geotechnics Department laboratory of Perm National Research Polytechnic University together with central laboratory of JSC "Krasnokamsk metal mesh works".

For carrying out tests tensile testing machine MT-136 was used (Fig.4). The machine allows measuring strength and strains in tensile, compression and bending tests using samples of controlled size (thread, tape, textile fabric, wire, film, plastic, rubber and other materials satisfying engineering capabilities of the machine), maximum load is 100 kN. The machine mode of operation is based on converting force measuring strain gauge sensor applied to the test sample tighting force into analog electrical signal changing proportionally to the tighting force of test sample. Lower grip works, upper is fixed. In machine handling takes place semiautomatic mode. Filling test sample into the grips occurs manually. Directly control of the machine is implemented on a computer. The program sets the speed of the control grip, records sample elongation, applied efforts.

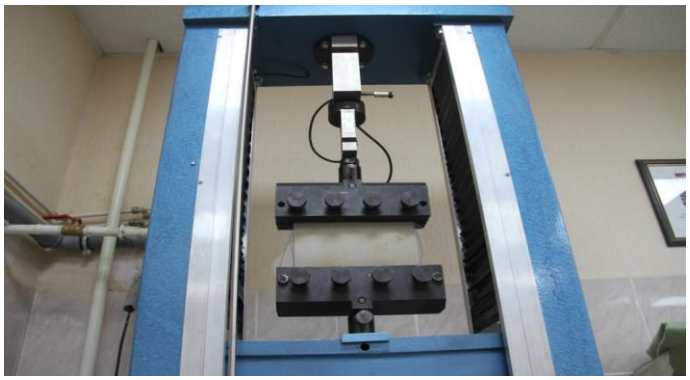

Fig.4. Tensile machine MT-136

3 RESULTS

As a result of the test the following parameters were obtained.

Table 1. Strength characteristics of geogrids

Parameter name	New grid		Used grid	
	Along	Across	Along	Across
The average value of the breaking load, kN/m	120,2	100,4	108,4	83
The strength of the used grid toward the new, %	-	-	82,7	90,2
The average value of breaking elongation, %	18,88	-	26,09	28,19

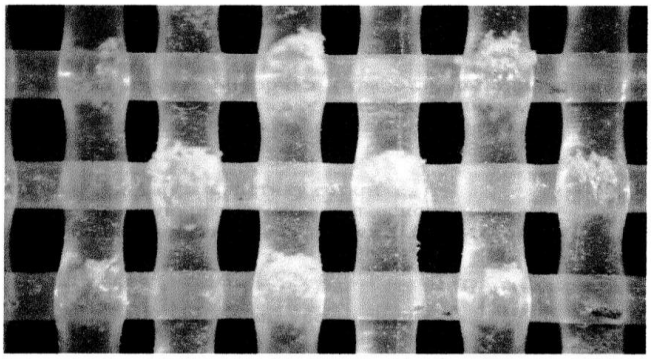

Fig.5. Used grid

According to EBGEO it is necessary to carry out creep tests in order to determine reduction factor A_1.

$$A_1 = \frac{1}{\beta} \quad (1)$$

Where β – materials utilization rate

$$\beta = \frac{F}{R_{B,ko}} \quad (2)$$

Where F – rupture strength for creep tests, $R_{B,ko}$ – rupture strength for short-term tests

Using as a creep test data on used grid coefficients A_1 и β are, respectively, 1,11 и 0,902 for 26 years of use of the materials. The result is a dependency graph of materials utilization rate (β) from time.

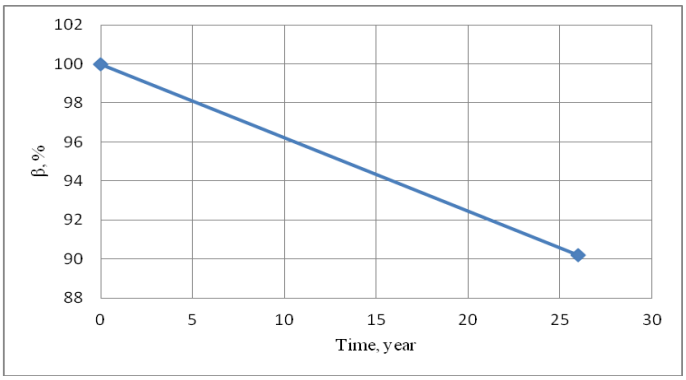

Fig.6. Dependency graph of materials utilization rate from time

Based on the graph in Fig.6. by extrapolation the coefficient A_1 can be determined for 100 years of use of the materials, it is 1,93.

4 CONCLUSIONS

According to the results of tests the following conclusions can be made:

The greatest loss of grid strength is observed along the fibers (along the current load) 17,3%. Loss of strength across the fibers is 9,8%.

Hundredfold magnification of used grid (Fig.5) shows that across the fiber exfoliation of the material with its subsequent destruction starts.

According to EBGEO for polyester materials the coefficient A_1 is in the range from 1,5 to 2,5. According to carried out above extrapolation the coefficient A_1=1,93. Thus, for 100 years of polyester geogrid operation the experimental data correspond to the EBGEO design rules.

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