Measures for eliminating infiltration into operating hydraulic structures can be effected in most cases only by working inside the structures from the side opposite the head of water. As a rule, the infiltration is controlled by injecting different types of grouts into the concrete through holes or under a plaster applied by means of deep cementation, silication, or tarring. However, these methods are complex, costly, and difficult and do not completely stop the infiltration. In some cases they are only temporary. Thus, cementation of the concrete in the structures at the Kaunas hydroelectric plant had only a casual effect; infiltration was eliminated only at separate portions of the cemented concrete.

In recent years, use is increasingly being made of synthetic materials, especially construction glues based on epoxy resins. They have excellent waterproofing properties, strong adhesion to concrete and other construction materials, and corrosion resistance. Epoxy compounds are being widely used for preparing waterproofing and anticorrosive coatings and for repairing defects in concrete surfaces. The waterproofing coatings based on epoxy resins are characterized by their high reliability and durability. Quick-action aminophenol hardeners for epoxy resins have been developed which ensure hardening of the compositions in a humid medium and under low temperatures.

The above facts indicate the possibility of using epoxy compositions for waterproofing pervious concrete surfaces. In this case it is necessary to consider the measures required for eliminating temporarily the infiltration so as to prevent the applied waterproofing materials from being "eroded" by the moving water. For this purpose it is possible to place on the pervious concrete portions a provisional surcharge designed to equalize the water pressure.

As a rule, waterproofing coatings are applied on hydraulic structures in such a way that the acting water head compresses the coating against the concrete surface instead of pulling it away. As shown by investigations, waterproofing coatings made from epoxy resins can resist also the "pulling" of the hydrostatic pressure. In tests on reinforced concrete disks with waterproofing coatings acting under compression and "pulling" it was found that under hydrostatic pressures of 5-6 kg/cm² the coatings did not rupture and the concrete did not exfoliate. Paint coatings as well as coatings reinforced with glass fiber (glued) were tested.

To evaluate the possibility of applying waterproofing coatings on concrete surfaces in the presence of high-head infiltration the following experiment was conducted. Reinforced-concrete disks 180 mm in diameter and 80 mm thick, in which through cracks had been artificially made, were placed in a waterproofing-testing installation, where high-head infiltration through the cracks was produced. Under these conditions epoxy glues were applied on the free pervious surface of the concrete samples over an area of 90 cm²; in the first case the glue had the following composition by weight: 100 parts of ÉD-6 epoxy resin, 20 parts of dibutyl phthalate (DBF), and 30 parts of AF-2 hardener; in the second case the same composition with 50 parts of cement added was used. The glued layer was first covered with a polyethylene membrane and later with a sheet of microporous rubber, which was compressed against the concrete by applying a pressure of 0.5 kg/cm², thus ensuring a back pressure adequate to withstand the infiltrating water. After these preparations the samples were tested for permeability under the action of hydraulic pressure tending to pull the waterproofing coating away from the concrete. The pressure was increased by stages up to 1 kg/cm². For an initial pressure of the infiltrating water of 0.25 kg/cm², a period of action of the back pressure of 2 h, and a curing period of 80 h without back pressure, the destructive water pressure in the tests was 3 kg/cm². When the pressure of the infiltrating water was 0.5 kg/cm² and the periods of action of the pressure and the back pressure were 4 and 20 h, respectively, the destructive pressure was 6 kg/cm².

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Fig. 1. Experimental installation for applying a waterproofing coating on a reinforced-concrete slab with cracks through which water infiltrates under high pressure. 1) Frame; 2) rubber gasket; 3) pneumatic rubber cylinder; 4) wooden board; 5) waterproofing coating; 6) expansion bolts; 7) reinforced-concrete slab; 8) clamp.

Fig. 2. Large-scale model of a pervious construction joint in a gallery. 1) Reinforced-concrete blocks; 2) cement-grouted joint; 3) pressure chamber; 4) barrel; 5) hose; 6) pressure tank; 7) waterproofing coating on pervious joint.

In order to select the composition of the glue for the vertical and horizontal floor surfaces, on which it was to be applied at a temperature of 10-12°C, the adhesion of the coating on the wet concrete was determined on the basis of the following formula, by weight: 100 parts of ÉD-6, 20 parts of DBF, 30 parts of AF-2, and 100 parts of cement. The hardening period for this composition was 30 min. To determine the adhesion value on the wet concrete (grade-500 concrete) the coating was applied under water and on a wet surface; a polyethylene membrane was placed on the coating, a load which created a pressure of 0.6 kg/cm² was applied, and the sample was maintained in the water for 10 days. Subsequently, annular slots were drilled in the samples, and threaded beads for securing the stem of the adhesimeter were glued on the slots using the epoxy composition. The value of the adhesion between the coating and the concrete was 12.6 kg/cm² when the coating was applied on wet concrete and 11.6 kg/cm² when it was applied under water.

In order to approximate prototype conditions the following experiment was carried out (Fig. 1). A 500 x 500 x 30-mm reinforced-concrete slab containing many through cracks was connected to a metal chamber by using clamps. Water at a pressure of 1.2 kg/cm² was then admitted into the chamber; this water infiltrated rapidly through the cracks in the slab. Two layers of glass fiber were glued on the open surface of the slab using glue having the above-mentioned formula. The glue was previously applied on the glass fiber in a 2-3-mm-thick layer by means of a spatula. The 250 x 450-mm plaster thus obtained was placed on the slab. To compress the plaster against the concrete and to create the back pressure required to counteract the infiltration through the cracks a temporary load was created using a rubber cylinder filled with compressed air and maintained in position by means of a wooden board fastened with anchor bolts. The air pressure in the cylinder was 1.2 kg/cm², the time of holding back pressure was 3 h, action time of the pressure from the infiltrating water after removal of the back pressure was 0.5 h, and the curing period, without water pressure applied before carrying out the waterproofing tests, was 20 h. Pulling tests on the waterproofing coating were carried out under the action of a hydrostatic pressure which reached a value of 3 kg/cm²; when the coating was finally pulled away. Actually, the coating itself was not detached; rather, the reinforced-concrete slab was ruptured. After completing the test it was found that under the action of the back pressure the epoxy glue had penetrated into the cracks at several places and had even traveled all the way through the slab, so that portions of it could be seen on the opposite surface of the slab. This test revealed the possibility of waterproofing pervious cracks in concrete structures.

To improve the waterproofing techniques, large-scale tests were conducted on 2 x 2 x 2-m box-section reinforced-concrete blocks (Fig. 2). To simulate the actual size of a pervious construction joint in a gallery the two