larity is preserved for all variants of the waterway. In transitional regimes of dropping the load and loss of drive, the intensity of the pressure fluctuations increases in the spiral casing to 0.13H and in the draft tube to 0.1H.

The experimental values of the fluctuations are recorded in the zone of the gate apparatus in a counterflow regime (to 0.55H) and runaway regime (to 0.45H). This level of unsteadiness is practically independent of the form of the draft tube. That is, the character and level of the hydrodynamic disturbing forces in the flow for the powerhouse with the sharply bent draft tubes is analogous to the frequency responses of pressure fluctuations in the standard waterway.

CONCLUSIONS

1. The layout of the powerhouse of a PSS in drop shafts with a nonstandard waterway of the pump-turbine with a specific speed of 220 for heads up to 100 m are comparable in their hydraulic, energy, and dynamic characteristics to a standardized waterway, which enables recommending it for use in designs of medium-head PSSs.

2. The use of drop shafts when constructing a PSS on soft ground provides substantial technical—economic advantages of such a variant of the layout of the hydro development.

INCREASE OF THE RELIABILITY OF POLYMER COATINGS OF CONCRETE

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Polymer materials used for improving a number of properties of ordinary cement concretes, such as insufficient resistance to corrosive effects, permeability for fluids under pressure, insufficient crack resistance, poor resistance to abrasion and cavitation, and low decorative and artistic expressiveness, have presently become widespread in construction practice.

The existing methods of combining polymers with concretes are still rather complex and do not always provide reliability and longevity of the combined work of these two different materials. In this respect, most promising are concrete articles with a polymer coating formed during molding, which can be made without substantial restructuring of the established methods of production at enterprises of the construction industry.

A characteristic feature of the developed and investigated technology of concrete articles is the layer-by-layer application on formwork of the face and contact layers of the polymer composition with subsequent placement of the concrete mix, its vibratory compaction, and heat and moisture treatment.

When using stiff and moderately stiff concrete mixes, during placement and vibrocompaction the polymer composition of the contact layer is distributed in the voids between grains of the coarse aggregate with the formation of a transition layer approaching concrete-polymers in structure.

The presence in the face polymer layer of pigments and appropriate preparation of the formwork in combination with a special lubricant makes it possible to obtain coatings with high decorative and service characteristics of a diverse color range from a dull to glossy surface simulating finishing materials in appearance.

In the investigations that were conducted, filled compositions on a base of epoxy resins were used for the contact layers of the polymer composition, and compositions on a base of various synthetic resins selected depending on the service conditions of the articles were used for the face layers.

A comparative evaluation of the reliability of cohesion of the face layer with the hardened concrete was carried out by measuring the stresses under normal pulling on cube specimens of the same compressive strength with a polymer coating obtained by two methods: by application of the polymer composition the hardened concrete and by application on the formwork during molding. A concrete mix of composition 1:2:1:3:8 with W/C = 0.45, which after 28-day normal hardening had a compressive strength corresponding to concrete of class V20, was used for making the specimens.

Fig. 1. Schemes of testing the specimens: a and b) specimens with a coating applied on hardened concrete with various depths of the saw cut; c and d) specimens with a coating obtained during molding with a different depth of the saw cut; 1) metal mushroom; 2) polymer face layer; 3) transition layer; 4) concrete; 5) plane of detachment.

On the coating of the hardened specimens we made 50-mm-diameter circular saw cuts to which we cemented metal mushrooms with their subsequent detachment. The conditional distance of the plane of detachment from the surface of the coating was calculated from the mass of the detached part of the specimens.

To obtain the most reliable picture when evaluating the adhesive strength of the polymer coating to the concrete, the following schemes of testing the specimens (Fig. 1) were used depending on the method of formation of the polymer coating and depth of the cut.

Schemes of specimens with a polymer coating applied on hardened concrete (specimens of type I) are shown in Fig. 1a, b, and schemes of specimens with a polymer coating obtained during molding (specimens of type II) are shown in Fig. 1c, d. The results of the tests are given in Table 1.

In the case of a cut to the thickness of the coating and to a greater depth in specimens of type I, the plane of detachment is in the concrete—polymer contact zone, and practically regardless of the depth of the cut polymer inclusions are absent in the plane of detachment. The character of failure of specimens of type I gives grounds to assert that when the polymer coating is applied on a hardened specimen, cohesion of concrete to the polymer coating is less than the axial tensile strength of concrete, since the union of the polymer layer with the concrete passes through the surface zone of the specimen having low strength characteristics.

In specimens of type II detachment occurs through the transition layer when the depth of the cut is equal to the thickness of the polymer face layer, and with an increase of depth of the cut detachment occurs through the concrete beyond the limits of the transition layer.

The location of the plane of detachment on specimens (Fig. 1c) with the coating formed during molding at a depth beyond the limits of the thickness of the transition layer permits the assumption that in this zone, apparently, occurs concentration of shrinkage stresses caused by a change in the structure of the material in connection with the presence of the polymer face coating and transition layer.

A visual study of the planes of detachment on specimens (Fig. 1d) permits establishing that the cause of the increase of cohesive strength of the polymer face layer with the concrete of specimens with the coating obtained during molding is the presence in the planes of detachment of 10-18% inclusions over the area of the polymer component, i.e., detachment occurs through the transition layer. Such inclusions are absent on control specimens. Consequently, the presence in specimens of a transition layer containing the high-strength polymer component promotes an increase of strength and, consequently, reliability of the cohesion of the polymer face layer with the concrete.

The experiments showed that the cohesive strength of concrete with the polymer coating formed during molding is approximately 4 times greater than in the case of applying it on hardened concrete, and the plane of detachment passes through the transition layer.

A number of problems related to the effect of the parameters of the polymer composition of the contact layer on characteristics of the transition layer were also investigated. For this purpose, the effect of finely ground filler on the rheological properties of the composition used as the contact layer was first of all established. The relative viscosity of the investigated compositions was determined by means of the VP-3 instrument from the area of the impression on a glass before the start of hardening. Filling of the polymer composition, consisting of epoxy resin ÊD-16, polyethylene polyamine, and MGF-9 polyester and the diluent furfuryl alcohol, was carried out with ground quartz sand with a specific surface of 2700-3200 cm$^2$/g.