EXPERIENCE IN RESTORING THE RUNNER PIT LINING AT
THE SVETOGORSK HYDROELECTRIC STATION

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At present the problem of repairing hydraulic structures, many of which have been operating for 40-50 years and during this time have exhausted a considerable part of their performance life, is becoming ever more pressing. For hydraulic structures constructed 50 years ago the time has come for overhaul and reconstruction.

Repair of hydraulic structures is complicated by the fact that with the high demands imposed on the quality of the materials used and carrying out the works, these works, as a rule, are carried out in comparatively small volumes in difficulty accessible place, and in the shortest possible time. The introduction of highly efficient technology with the use of modern building materials is required for their realization at a high technical level. One of the promising types of building materials for repair works is cast concrete mixes with additions of surface-active agents suitable for delivery to the concreting blocks through small-diameter pipes by means of a concrete pump or by gravity that do not require vibratory compaction of the concrete mix during placement. Such compositions are indispensable when concreting heavily reinforced blocks, toothing, and difficultly accessible closed spaces.

The current level of concreting technology makes it possible to obtain concrete of high plasticity with a wide range of properties with respect to strength V20-V50, water impermeability to W16, and frost resistance from R100 to R600. The high cohesion of such mixes and possibility of regulating the setting time permit transporting them considerable distances without segregation, placing them from any height without organizing construction joint, preserving uniformity, and obtaining high-quality monolithic structures. The use of cast concretes substantially reduces works and shortens the time of carrying them out. For example, when replacing the cast-iron lining on one of the turbine-generator units of the Serebryanka hydrostation, concreting the toothing behind the lining by the traditional technology with vibratory compaction required carrying out a number of additional labor-intensive operations: for access to the toothing behind the lining, its upper 400-mm-high flange was cut off and installed separately after placing concrete behind the lining, and the upper part of the toothing was caulked with concrete manually. All this had a negative effect on the quality of the concrete masonry.

The repair works at the Svetogorsk hydrostation can serve as positive experience in this respect. In 1995 a segment of the cast-iron lining of the No. 3 unit was displaced 20 mm into the runner pit. Some of the bolts and the anchors holding the segment were cut off. A 4.5-m-long washout was found in the reinforced-concrete mass behind the lining.

Repair and restoration works were carried in February-March 1996 by the hydrotechnical construction joint-stock company Orggidrostroi in accordance with a plan incorporating the recommendations of the B. E. Vedeneev All-Russian Hydraulic Engineering Research Institute (VNIIG) concerning the composition of high-plasticity concrete mixes selected specially for conditions of carrying out works on the given object. According to the plan, cutting out toothing with a 0.8 x 2-m section behind the runner pit lining with restoration of the anchors, replacement of the cut-off bolts, and subsequent concreting of the cut-out toothing were specified for placing the displaced segment in the original location. Due to the approach of the spring flood, the time of curing the concrete until it gained a strength of 300 kg/cm² specified by the plan was shortened to 7 days at a temperature of 4°C. To make new holes strictly opposite the already existing ones in the cast-iron lining, boreholes were marked off on the concrete surface by means of a special device. The anchors, made according to State Standard GOST 243721-80, were secured in the boreholes by means of expanding collets and were sealed by injection of a high-strength cement grout on a base of the composition "TsMID" (one of the modifications of repair compositions developed at VNIIG). After this, the anchors, installed coaxially with pins of the same diameter packed into the lining holes, were connected by electric-arc welding to these pins as paired cover plates.

Work on installing the anchors and reinforcing the block was carried out from the end of the toothing with retreating toward its start, and therefore preparation of the block for concrete was done simultaneously during
Fig. 1. Section through concreting block: 1) concrete mass; 2) cast-iron lining; 3) pins; 4) collet anchor; 5) reinforcing cage; 6) coupling.

reinforcing. It included cleaning the metal from a film and rust, cleaning the concrete from dust, and treating the concrete surfaces with special compositions – primers – improving adhesion of the new concrete to the old. Concreting the cavity was complicated not only by difficult accessibility but also by the high percentage of reinforcement and anchors (Fig. 1). This ruled out the direct participation of people in placing and compacting the concrete mixes and hindered spreading of the mixes and filling the space being concreted. The use of fluid concrete mixes capable of self-distribution made it possible to overcome these difficulties successfully. Since such situations are to a certain extent typical and carrying out works on concreting such structures is complicated, the technology of cast concretes, in our opinion, is the most effective method of performing the works in such situations.

The characteristics of the plan were the delivery of the cast concrete mix in a swivel bucket by a motor vehicle along an earth road and its feeding to the block from a height of 20 m without the use of a concrete pump through a concrete-placing pipe having 20-m vertical upper and 12-m horizontal lower sections (Fig. 2). The swivel bucket was delivered by a bridge crane to the receiving hopper of the concrete-placing pipe made in the form of a funnel with a capacity of 1 m³ and was loaded into it from a height of 1.5 m. Then the concrete mix was transported along the concrete-placing pipe by gravity. During development the specialists of VNIIG gave special attention to preventing possible segregation of the concrete mix during transportation from the concrete plant to the placement site and during passage through the 20-m vertical section of the concrete-placing pipe. The provision of cohesion and uniformity of the high-plasticity mix during transport, delivery through the pipe from the indicated height, and distribution inside the block with a complex configuration was achieved by regulating its cohesion by additions of...