CONCLUSIONS

1. The possibility of constructing arch dams without cracks was proved by the experience of constructing the Miatla hydrostation. And prevention of cracking is achieved not by imposing more stringent requirements on the temperature regime and increasing the expenditures on its regulation but rather as a result of a fundamental change in the technology, which made it possible to reduce the cost of regulation in comparison with the traditional technology.

2. An increase of the allowable temperatures of the concrete mix to 23° and maximum temperature of the concrete to 45°, an increase of the cooling rate of concrete in the period after the temperature peak to 2°/day, and an increase of the rate of growth of the dam in height to 8 m/month were substantiated as a result of on-site investigations performed during construction of the Miatla dam.

3. With the tiered technology the time of covering the blocks, continuous pipe cooling, and insulation of the faces from temperature shock acquire main significance for preventing cracking. The experience of constructing the Miatla dam permits raising the question about removing restrictions on the rate of growth of the structure in height, temperature of the concrete mix, maximum temperature of the concrete, height of the blocks, cooling rate, and possibly the dimensions of the blocks in plan (within expedient limits) in the tiered technology of concreting with times of covering the blocks of less than 7 days with continuous intense pipe cooling in combination with insulation of the faces in the cold season.

LITERATURE CITED


REINFORCED-CONCRETE PANELS FOR FORMING GROUT JOINTS AS AN ELEMENT OF TIERED TECHNOLOGY

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An important component of the tiered technology of constructing an arch dam introduced on the construction of the Miatla hydroelectric station is the new method of formation and new design of prefabricated elements for making joints between sections of the dam. The main requirements imposed on these elements are determined by the essence of the tiered technology: concreting of the dam by horizontal tiers from bank to bank; successive concreting of the blocks of adjacent sections separated by a joint between the sections; absence during construction of interruptions necessary for hardening of the concrete, removing the forms from the surface of the joints, and installing cement grouting pipes and outlets, and also sealing of the joints being grouted.

The method of forming section joints by means of reinforced-concrete panels left in the concrete mass conforms to such concreting technology. In Soviet hydrotechnical construction considerable experience has been gained in using precast reinforced-concrete slabs (reinforced panels) incorporated into the design of the structures as load-bearing, reinforcing, or forming elements, or combining these functions (Plyavinyas, Cheboksary, Tashkumyr, and other hydrostations; Zagorsk and Kaisiadorys pumped-storage stations; Toktogul and Kurpsai gravity dams, Andizhan buttress dam, Inguri arch dam). The experience of these construction projects showed that the use of reinforced panels reduces the labor intensity of formwork operations, accelerates preparation of the blocks, and markedly reduces the need for lumber.

The reinforced-concrete panels were used with maximum effect as the main element of the "Toktogul method" — the technology of constructing dams by horizontal layers being placed from bank to bank and from pool to pool.

Before the construction of the Miatla hydrostation, the only arch dam constructed with the wide use of precast reinforced concrete was the Inguri dam constructed by the traditional "column" method with leading and lagging sections. The experience of its construction and, in particular, the use of precast reinforced-concrete panels in the section joints revealed, along with positive results, a number of shortcomings related both to the design of the panels used and to the technology of their installation.

As the reports on grouting of the dam indicate, during hydraulic testing and sealing of the section joints many grouting areas were impassable owing to the large number of projections ("lock") on the surface of the joints being grouted. The joining of the precast panels with the grouting and watertight seals with the upstream and downstream faces of the dam did not have a satisfactory solution either, which led to the use of nonreusable wood forms made on the job on a considerable part of the surface of the joints. This also worsened the quality of the surface of the joints and reduced the effect from using reinforced-concrete panels. Tightness of the contour seals of the grouting sections was not provided, which led to large losses of grout during grouting.

A technology combining the advantages of the Toktogul method of concreting with the structural features of an arch dam was developed and realized on the construction of the Miatla hydrostation. During construction of the thin arch (thickness at the bottom 11.5 m and at the top 6.3 m), the provision of a high quality of the works and, in particular, grouting of the section joints acquired special importance. During development of the concreting technology it was necessary to solve the design of the section joints as a whole, including problems of their geometry, sealing, and grouting, as well as the design of the precast elements themselves together with the technology of their manufacture, transport, and installation.

The section or radial joints of an arch dam represent, except the central joint, not a plane but rather a complex, so-called helicoid surface, which is generated by moving a horizontal straight segment along a vertical straight line with its gradual rotation through a certain angle with each meter of rise.

The surface of the section joints has offsets — trapezoidal projections effecting mutual engagement of adjacent sections of the dam. The surface of the joints is separated over the height into segments with a height to 12-15 m — the grouting segments delimited by seals — groutstops; the same such seals limit the grouting segments on the upstream and downstream faces; they prevent flow of the grout being injected into the cavity of the joint beyond the limits of the segment of the joint being grouted.

The offsets are discontinued at places of horizontal seals. Segments of the joint adjoining the upstream and downstream faces of the dam also do not have offsets. As a consequence of the curvature of the faces, these segments have a width variable over the height.

The outlets of the grouting system are located in the cavity of the joints: linear outlets for primary grouting and valve outlets for multiple (repeated) grouting. The joint grouting system includes also pipes leading to the outlets, air-withdrawal offsets, groutstops, and other elements.

All these numerous design and geometric characteristics of the section joints had to be taken into account when making them from reinforced-concrete panels. On the basis of the design requirements, characteristics of the technology, construction conditions, and with consideration of the experience of previous construction projects, the technical requirements imposed on the reinforced-concrete panels were formulated.

The design of the reinforced-concrete panels, their geometric dimensions, forms, and fastenings should provide: preservation of the design sectioning of the dam into sections and concreting blocks; preservation of the geometry of the section joints, division into grouting segments, dimensions and arrangement of the offsets close to the design; installation of the necessary grout fittings with minimum expenditures of labor on their placement and joining in the concreting blocks; high-quality joining of the panels over the height with the formation of a smooth surface at the place of joining; reliable cohesion of the rear side of the panels to the in situ concrete; sealing of the junctions of the panels with the contour seals of the grouting segments; the same type or minimum number of types of slabs with minimum or complete elimination of additional formwork; strength of the panels and their fastenings when taking on the pressure of the concrete mix being placed and compacted by the usual technology, as well as under installation and transport loads.

Two variants of forming the surface of the joint from precast panels were examined during development.

First: from rectangular panels of one or two types placed in the middle, offset part of the joint, and additional (add-on) panels of variable width placed on segments of the joints connecting the main panels with the faces of the dam.