EXPERIENCE WITH OPERATION OF HYDRAULIC STRUCTURES
AT THE 50TH ANNIVERSARY OF THE GREAT OCTOBER
BRATSK HYDROELECTRIC PLANT

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Construction of the Bratsk hydroelectric plant marked an important stage in the development of Soviet hydro-

power. Its large concrete structures, with a total volume of about 5 million m³, constructed under the severe climatic

conditions of eastern Siberia, presented the designers and constructors with many complex problems, some of which

were unique. A criterion of correctness of the adopted solutions is the state of the structures under the operating

conditions. The writers present in this article dam on experience with operation of the hydraulic structures during

the first years. The water-retaining structure of the hydroelectric plant, with a total length of 5140 m, is formed by

a concrete dam 1430 m long and earth dams with a combined length of 3710 m. The gravity concrete dam (Fig. 1),

with a vertical upstream face and 0.8 downstream slope, of lightened construction with widened joints, consists of

a 924-m long river-channel portion with a maximum height of 125 m, and of 32-64 m high bank portions. The
dam is divided by transverse joints into 22-m-long sections in the river-channel portion, and 11-m long sections

in the bank portions. The widened joints between the sections are 7 and 4 m wide, respectively. Every 13.8 m,
the dam is divided by longitudinal joints into pillar units.

The foundation of the river-channel dam consists of diabases underlain by sandstone with aleurolite

seams. In the middle and right-bank portion of the river channel there is a 70-80-m deep grout curtain which reaches into

the impervious aleurolites. In the remaining portion, contact grouting was applied to a depth of 10 m. The drainage

system for the foundation consists of deep wells 110 mm in diameter at 3-m spacings, which discharge into two

drainage galleries (Fig. 1).

The left-bank earth dam, 723 m long and maximum height of 40 m, was built on aleurolites and sandstones with

an extremely nonuniform permeability. Its most heavily jointed portion is intersected by the lower part of the loam

core of the dam, with a concrete cutoff and a 15-m deep grout curtain. Local soils were used for the dam fills. The

upstream shell between the diabase rock toe and the loam core consists of a gravel mass, and the downstream shell

consists of sandstone eluvium, sand, and gravel (Fig. 2a).

The drainage system for the dam was joined with the deep drainage system for the switchyard and consists of a drainage

gallery and three tunnels, in which 250-mm-diameter holes were drilled at 10-m spacings into the ledge rock.

The right-bank earth dam, 2987 m long and 36 m high, consists of fine-grained sands and sandy loam placed by

the hydraulic-fill method, and has a sandy loam facing on its upstream side (Fig. 2b). In the foundation of this
dam, at a distance of 700 m from the concrete dam, there are diabases covered with a 0.5-1.0 m thick alluvial layer
consisting of gravel and rubble with loam filler. In the remaining portion of the foundation there are loams under-

lain by sandy loams, under which there are diabases. The

Fig. 1. Typical section of river-channel dam.
a) Cross section; b) plan. 1) inspection galleries;
2) drainage galleries; 3) drainage wells; 4) widened
joint; 5a and 5b) places of measurement of
joint openings, according to Fig. 3a and b.

Fig. 2. Cross sections of earth dams. a) Left-bank dam. 1) Diabase rock fill; 2) rolled sandstone eluvium; 3) loam core; 4) concrete cutoff; 5) grouted zone; 6) reinforced-concrete slabs; 7) axis of deep drainage. b) Right-bank dam. 1) Reinforced-concrete slabs placed on gravel mass; 2) sandy-loam facing; 3) fine sand placed by hydraulic-fill method; 4) gravel; 5) axis of drainage conduit.

drainage system consists of a 2.9-km long gallery made from reinforced-concrete sections and several vertical drainage wells at the downstream side.

The inspection group at the hydraulic shop, which consists of about 30 persons, carries out the operation control on the state of the structures with the help of a large system of control-measurement instruments installed in the structures [1, 3].

Condition of the Concrete Dam. The widened joints of the dam remained open until 1967 and gave rise to an unfavorable temperature regimen, with large temperature drops in the internal zone of the structure, with through freezing of the pillars over a period of five to seven months each year. A consequence of this regimen was the development of many vertical superficial cracks in the internal pillars and in the inspection galleries, which extended into the widened joint in each section. Over 200 cracks were detected on the upstream walls of these galleries; leakage through one half of the cracks was observed.

Grouting of the joints between the pillars lagged behind the reservoir filling schedule, and by the time of placing in operation of the first stage of the hydroelectric plant the grouting was completed only in the right-bank portion of the dam. A significant number of the joints between the pillars, grouted when the temperature of the concrete exceeded the allowable value, were opened and closed subsequently during seasonal variations of the center-face temperature. After the closure of the widened joints, the temperature distribution became almost uniform and freezing of the concrete elements ceased.

The decrease in the center-face temperature drops reduced the amplitude of the annual variations in the opening of the joints between the pillars. Their middle openings were gradually reduced also under the effect of the hydrostatic load, and they became practically stabilized in due time after the normal pool level was reached (Fig. 3a). Small variations in the openings are observed in part of the joints located close to the downstream face (Fig. 3b), especially at the upper elevations. At the same time, the average openings of the superficial cracks decreased in the pillars in the internal zone of the dam. Observations conducted in 1969 revealed the presence of 1700 measurable cracks. In about two thirds of these cracks the openings did not exceed 0.2 mm. The number of pervious cracks on the upstream walls of the inspection galleries was reduced to 12. The total quantity of seepage discharged through the drainage wells in the first pillars, which included seepage through the cracks in the galleries and between them, varied, for example, within the range 10–25 liters/sec during 1971.

Strain-gage measurements indicated that in certain horizontal areas at the upstream face of the dam there are normal compressive stresses which exceed the normative ones (0.25 γH). An important component of these

*The observations were conducted by V. P. Shkarin (Scientific-Research Department of the Orgénergostroi).