EXPERIENCE IN THE OPERATION OF THE GUMATI No. 1 HYDROELECTRIC STATION RESERVOIR

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The Gumati hydroelectric station cascade is being built on the Rioni River above Kutaisi in the Georgian SSR (Fig. 1). The Gumati No. 2 hydroelectric station is the second stage in the cascade, taking the form of a bypass installation, the approach channel to which takes the water leaving the turbines of the Gumati No. 1 hydroelectric station. The hydroelectric stations are situated in a humid area with a temperate climate (maximum air temperature +40°C and minimum −15°C). Until 1961 the hydrologic characteristics of the Rioni River reflected its natural state, but from August 1961 the river regimen has been varied by the discharge utilized by the Ladzhanur hydroelectric station, for which water is taken from the Tskhenis-Tskhali River at an average rate of approximately 35 m³/sec. The following discharges are typical of the Rioni over several years, in m³/sec: mean over several years 127 (mean annual varying from 74.8 in 1962 to 169 in 1922), minimum (absolute) 15.5, maximum (observed) 1440. Normal flood discharges vary over the range 400 to 800 m³/sec. In the 58-year period during which readings were taken, discharges greater than 1000 m³/sec were recorded on only 5 occasions. Flooding is characterized by a quick rise and slower fall. The spring flood starts roughly in the middle of March, reaching maximum during May to June, while floods occur in August and November. The theoretical discharges with a probability exceeding once in 100 and 1000 years are respectively 1950 and 2700 m³/sec.

The foundation at the dam of the Gumati No. 1 hydroelectric station is made up of a thick layer of alluvium with a particle size of 20 to 80 mm, underlain in the middle section of the stream bed with native diabases, on which the dam and generator building are situated.

The Gumati No. 1 hydroelectric station is built into the dam and has a capacity of 44 MW. The Rioni River is confined by retaining structures 281.5 m long; the hydroelectric station unit is 70 m long, the spillway dam 71 m, and the connecting sections 74.8 m on the right bank and 65.9 m on the left bank. The spillway section, designed to a no-vacuum profile, is divided into four spans each 14 m clear width; the piers are 3.5 m thick. At normal flood level the discharge capacity of the spillway is 2550 m³/sec. The spans are bridged by twin gates.

The hydroelectric station unit has four water intakes (Q= 914 m³/sec) with sills 8 m below the normal flood level, and four submerged flushing galleries (Q= 256 m³/sec) with sills 20 m below the normal flood level. Hence, at normal flood level, a discharge can be passed through the dam spillway, intakes, and submerged flushing galleries of more than 3000 m³/sec.

Electricity generation in an average water year has been reckoned at 328 million kWh. Following transfer of water from the Tskhenis-Tskhali to the Rioni River, the generating capacity should rise to 394 million kWh/year. However, during joint operation of both stations, electric generation averaged 366 million kWh/year, which is below the project figure on account of the hydrologic features of the period, certain other factors, and because the transfer tunnel passed 50.4 m³/sec (design discharge 60 m³/sec). Following overhaul in 1967, the discharge capacity of the tunnel reached the project figure. Transfer of water from the Tskhenis-Tskhali to the Rioni Basin raised the generating capacity of the Rioni and both Gumati stations, provided a water supply to Kutaisi, improved the health and hygiene conditions, and extended the irrigated land below the town.

There is a combined energy dispersion basin in the tailrace of the spillway. It is a three-stage structure against the left and two middle spans. The first stage of the basin, on which the piers are situated, is 10 m below the outlet sill, and the second 4 m below. The submerged gallery openings have outlets on the plane of the second stage. Very strong diabases were uncovered when excavating the trench in the area of the right span. Following further

*See the paper by the authors in "Gidrotekhničeskoe Stroitel'stvo," No. 10 (1966).

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Fig. 1. Schematic plan of the Gumati hydroelectric station cascade structures. 1) Left bank connection section of the dam; 2) intake and No. 1 hydroelectric station building; 3) spillway section; 4) end spillway; 5) abutment containing the bypass gallery; 6) discharge lock; 7) canal lock; 8) bypass canal; 9) standby spillway section; 10) No. 2 hydroelectric station building; 11) takeoff channel.

Laboratory investigations it was decided to reduce the depth of the basin by 5 m; walls were constructed below the basin and bordering the tailrace over a length of 50 m.

In order to start up the Gumati No. 2 hydroelectric station \((N=3 \times 7.5 = 22.5 \text{ MW})\) before the Gumati No. 1 hydroelectric station, a bypass gallery \((Q=140 \text{ m}^3/\text{sec})\) was built in its right section and the right wall of the connecting section \((Q=140 \text{ m}^3/\text{sec})\), in the form of a rectangular pipe of variable cross-section, of the inverted siphon type. The end section of the pipe took the form of a constricted gallery, in the left wall of which there are 15 outlets 2 x 1 m along a front of 40 m, breaking up the discharge. Silt entering the gallery was carried off to the connecting section, whence it was discharged through the end lock to the tailrace.

For protection against large floating objects there is a screen at the gallery inlet. Large objects accidentally entering the gallery could be removed only by hand and only after taking the gallery out of service. The Gumati No. 2 hydroelectric station generated more than 100 million kWh of electricity prior to bringing in No. 1 station.

Full-scale investigations over several years on hydroelectric station headwaters, tailraces, and reservoirs on mountain rivers, carried out by the V. Vinter TINSGI (Tbilisi Scientific Research Institute for Construction and Hydraulic Engineering), have indicated that the main cause of siltation and suspensions and sediments is the low storage capacity due to the relatively restricted capacity combined with the high solids rate of mountain streams. A big discrepancy in the sediment rate determination was clearly brought out by investigations on the Gumati No. 1 station reservoir. The initial total volume at normal flood level was 39.2 million m³ and the effective volume (with available depth 4 m) 13 million m³. The reservoir is usually employed at normal flood level with fluctuations ±0.2 to 0.3 m. Investigations on this reservoir over a number of years have indicated the following: four years after starting service (1962) the total volume of the reservoir fell to 19 million m³ due to silting and to 10.4 million m³ after 6 years (1964) and again to 6.5 million m³ after 9 years (1967). Hence, the volume of sediment in the reservoir amounted to 32.7 million m³. The effective volume was reduced by 8.55 million m³ and the available volume amounted only to 4.45 million m³. There were big variations in height on the longitudinal profile of the bottom of the reservoir (Figs. 2 and 3).

During the period 1958 to 1962, 5.1 million m³ sediment was deposited on the average annually, and during the period 1962 to 1964, 4.3, and again in the period 1964-1967, 1.3, i.e., as the reservoir fills up the deposition of silt progressively diminishes and an increasing proportion is carried off to the tailrace. In the immediate vicinity of the