USE OF HYDRAULIC MECHANIZATION FOR CLEARING AWAY
THE GORGE SLOPES AT THE CONSTRUCTION SITE
OF THE TOKTOGUL HYDROELECTRIC STATION

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The excavation of foundation pits of hydro developments in mountain gorges requires the removal of large volumes of earth and rock on steep slopes with difficult accesses to the working sites. This hampers the use of systems of large-scale mechanization of these operations which are usually employed in hydraulic engineering construction.

It is necessary to find new optimal solutions to providing the required rate of work on preparing the slopes of foundation pits. Obviously it is necessary to use maximally the characteristics of the local conditions: first, the considerable steepness of the slopes, the presence of which allows excavation by caving natural or artificially created overhangs and hang-ups; and second, the fissures in the rocks, which can often be used for placing explosive charges instead of specially drilled blast holes, or for replacing holes in the case of smooth blasting. All this facilitates the bulk of earth and rock excavation but does not allow clearing away the rock surface of the sides of a pit to the design marks.

At the construction site of the Toktogul hydroelectric station the work of clearing away the slopes in the region of the future structures can be divided into two stages: a) clearing away the sides of the pit above the dam crest, where the slopes were considerably more gentle (40-60°) and clearing by bulldozers, blasting, and partially by hand was possible; and b) clearing of the sides of the pit from the dam crest to the base and preparation of the foundation for placing concrete with a steepness of the slopes of more than 60°.

Under these conditions the use of the conventional machines proved to be impossible, owing to the steepness of the slopes, and was uneconomical in view of the dispersion of comparatively small volumes of rocks over a large area. The only workable method of excavation that remained was manual excavation and trimming the slopes by means of hydraulic devices utilizing high-pressure jets. We used extensively the GM-250 monitors and mobile carriages (Fig. 1), which, in addition, made it possible to meet the sanitary requirements with respect to dust elimination at the work site, since dry excavation of the sides with dumping of the rock from a height as much as 400 m had created very severe dust pollution of the air over an appreciable length of the canyon. Trimming of the slopes after blasting was done by hydraulic monitors (Fig. 2), which lessened the manual work of the rock climbers and reduced expenditures for constructing approaches and for the organization of safe working conditions, which generally amount to more than 60% of the total expenditures when excavating rock manually. The use of monitors could also facilitate the descent of rock waste down the steep slopes.

The builders outlined and implemented a program which made it possible to master rather quickly the procedure of excavation on steep slopes with the use of hydraulic devices and to determine the approximate limits of effective use of various pieces of equipment. The water-supply system provided for the use of the pipes present on the slopes instead of using special high-pressure pipes.

The greatest difficulties arose for the following reasons: a) the need to provide beforehand a prescribed pressure at the monitors at each level of excavation up to 400 m from the water's edge in the river; b) the great difficulty and sometimes impossibility of setting up pumping plants on the slopes owing to the absence of approaches and to troubles in the supply of electric power; c) the possibility of appreciable water hammer in the pipe systems following sudden disconnection of the electric power, failure of the valves, or surges in the pipes; and d) the need to operate the monitors both on the ascending and descending branches of the pressure pipes.

The results of the work performed (Table 3) show that: a) an increase of the flow rate of the water used by the nozzle makes it possible to excavate ground with a high content of large fractions; b) all types of nozzles operate less efficiently as the size of the fractions increases, owing to acceleration of the formation of unscourable dry areas, which require manual finishing and cause interruptions in the operation of the monitor; c) heavy monitors are less maneuverable, and therefore the volume of finishing work increases with increase of the power of the nozzle (with optimal arrangement of the monitor placement manual finishing operations are markedly reduced); d) the efficiency of the monitors increases with increase of the steepness of the slope (objects 3 and 4) and with increase of the working pressure (objects 2 and 10), and depends on the thickness of the layers being excavated (object 1).