DAM OF ARGILLITES AND SILTSTONES

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To create a river reservoir for water supply of a resort region and irrigation of lands in arid places in Crimea, a dam was constructed with a loam core and shoulders of low-strength argillites and siltstones. A spillway and intake structure were constructed next to the dam (Figs. 1 and 2). The design was developed by the Ukrainian Planning, Surveying, and Scientific-Research Institute for Water-Management Construction (Ukrgiprovodkhoz) and construction was accomplished by the Ministry of Reclamation and Water Management of the Ukrainian SSR in 1981.

The reservoir is located in a river valley on the north slope of the Crimean mountains composed of the Taurian Series [Upper Triassic-Lower Jurassic], which consists of flysch intercalating argillites, siltstones, and thin layers of sandstone. The design seismic activity of the region is intensity 8.

The parameters of the dam (Fig. 3): $h_{\text{max}} = 50$ m, $B_{\text{base}} = 330$ m, $m_u = 3.5$, $m_I = 2.5-3.5$, $L = 760$ m.

The foundation of the dam is composed of deluvial loams 4 m thick and alluvial deposits up to 8 m thick underlaid by flysch.

Rocks of Upper Triassic and deposits of Quaternary age are developed in the stretch of the dam, spillway, and intake structures and also in the reservoir basin. The Upper Triassic is represented by flysch. The Quaternary deposits consist of deluvial gravelly loams with a sand content (fraction greater than 2 mm) up to 30% and gravel-pebble deposits of the river.

The basin of the reservoir is located in the region of occurrence of flysch, here and there covered with a layer of deluvial loams (on the valley sides) up to 5 m thick or with flysch covered by gravel-pebble deposits (river terrace) up to 8 m thick.

In the valley floor and in the abutments of the dam to the sides bedrocks occur under strata of unconsolidated rocks of Quaternary age and flysch eluvium. The eluvial formations of the weathering zone are represented by clays with rock fragments. The thickness of the layer is 2-11 m (Fig. 4).

In addition to weathering, processes related to the action of surface waters - sheetflood erosion, lateral and deep erosion of gully and ravine streams - and to gravitation - talus and debris slides - are also intensely developed in the stretch of the dam foundation. The flysch strata are dislocated.

Within the limits of the reservoir basin and dam foundation the alluvial deposits belong to pebble and gravel soils; the deluvial formations belong to loams with grus, gravel, and pebbles. The particle size distribution is given in Table 1.

The entire reservoir basin under the Quaternary deposits has an impervious bed of flysch rocks.

The flysch is distributed in the stretch of the dam and reservoir basin, with the exception of tectonic crush zones. The eluvium is represented by strongly fractured alternating layers of argillites and sandstones with thin layers of sandstone. The argillites (amounting to about 75% of the flysch strata) have a uniaxial compressive strength of 4-6 MPa.

Seepage investigations of the soils of the dam foundation were carried out in the alluvial deposits of the valley floor by single and group pumping tests and in the deluvial deposits of the slopes by Boldyrev's pit intake test; permeability was determined by the water intake test.

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The on-site seepage investigations of the soils of the dam foundation showed that the alluvial deposits of the river terrace have the maximum permeability coefficients, in which $K_p = 1.25-30$ m/day. In the deluvial deposits $K_p = 0.50-0.64$ m/day. In the weathered Taurian rocks $K_p = 0.20$ m/day, and for the Taurian bedrocks $K_p = 0.001-0.03$ m/day.

Experience in the design and construction of hydraulic structures in Crimea showed that earth dams are the most economical here. In the mountainous region of Crimea where the given reservoir is located the problem of constructing the dam was related to the search for borrow pits. The reservoir was created under the condition that the borrow pits would be excavated in the flood zone or on lands unsuitable for agricultural use. The supply of clay soils in the reservoir basin was about 1 million m³. Noncohesive soils were still less. Clay soils occur in the construction region with a small thickness on arable lands or in forest land located 8-10 km from the dam site.

Construction of a dam with a volume of more than 4.5 million m³ was possible provided low-strength soft rocks of the flysch strata were used as the main construction material.

The use of this soil material for constructing a dam required the conduction of a series of research works, which included: laboratory investigation of the strength and seepage characteristics of the rock mass of the argillites and siltstones; investigation of the same characteristics of the soils in the body of the dam; experimental compaction of the soils at the construction site; development of the specifications for placing the soils in the dam; study of weathering of the soils under natural conditions during and after construction.

The strength properties of the rock mass of argillites and siltstones were determined by the All-Union Scientific Research Institute of Water Supply, Sewerage, Hydraulic Structures, and Engineering Hydrogeology (VNII VODGEO) on a triaxial compression instrument. The effect of the particle-size distribution, initial value of the density of dry soil, and hydrostatic compression on the value of the angle of internal friction was investigated. Various experiments to determine the angle of internal friction $\varphi$, Poisson's ratio $\nu$, and modulus of deformation $E$ were conducted for the flysch soils. In the first series of experiments soil of uniform fraction 40-60 mm in the loosest possible state was tested, and then a model mixture of the average particle-size distribution of the downstream shoulder of the Izobil'nyi dam was investigated.