Monitoring of building the dam of Rezaksay water storage from the point of view of engineering geology

Monitoring éngenieure géologique de la construction du reservoir de Rézaksay

N.G. Mavlyanov
State Committee on Geology, Tashkent, Uzbekistan

Sh.Kh. Abdullaev
Institute of hydrogeology and engineer geology, Tashkent, Uzbekistan

ABSTRACT
Complicated geological and geomorphological conditions, uniqueness of the construction and high rates of building the Rezaksay water storage dam made necessary of accurate holding engineering-geological monitoring of quality control of construction works during its building. Monitoring carried out by implementation during stacking and compactions of the ground in a body of the dam the audit engineering-geological tryouts, lab tests and seismic measuring using modern express methods. The next basic indexes were controlled: volumetric weight of skeleton, humidity, particle-size distribution, filtration factor, plasticity, shearing resistance, angle of internal friction, velocity of propagation seismic waves, head resistance of the ground. That has allowed, not slashing rate of the building to carry out qualitative and reliable control and in time to reveal and eliminate degraded construction works.

RĖSUMĖ
Les difficiles conditions géologiques et géomorphologiques, l'originalité de l'ouvrage et les hautes cadences de la construction du barrage réservoir de Rézaksay ont excité la nécessité de la gestion méticuleuse du monitoring géologique et engineering pour contrôler la qualité des travaux de bâtiment de son érection. Le monitoring s'est réalisé par voie d'exécution de test contrôle géologique et engineering, d'essai de laboratoire et de mesure séismique en mettant à profit les méthodes accélérées modernes au cours de l'emballage et de la compression du sol au corps du barrage. Les suivants indications du sol étaient contrôlées : le poids volumétrique de la matrice, l'humidité, la composition granulométrique, le coefficient de filtration, la ductilité, la résistance au cisaillement, l'angle de frottement interne, la vitesse de propagation des ondes séismiques, la résistance à l'avancement du sol. Cela a permis sans l' abaissement du rythme de la construction réaliser le contrôle qualitatif, exact et révéler à temps et éliminer l'accomplissement de mauvaise qualité des travaux de bâtiment.

Keywords: dam, building, monitoring, control, methods, density, humidity.

Building the Rezaksay water storage which situated in the Namangan region of the Republic of Uzbekistan has been carried out with the purpose of creation the conditions for accumulation a part of excessive autumn-winter disposals of Toktogul water storage (Kyrgyzstan) with their subsequent overshoot and using during the summer period for increasing water supply of irrigating systems. Accumulation the water storage in bulk 200 million m^3 will be provided with gravity flow due to water delivery on the existing Big Namangan Channel (BNC) during winter time from Naryn river (Fig. 1).

The basic indexes of a starting complex are:

- Type of the dam – a poured dam from local material with a slanting loamy core, persistent prisms are combined by gravel-shingle soil.

- Bulk – 200 million m^3, altitude of the dam – 80 m, length of the dam on a ridge – 2650 m, bulk of excavation on the dam – 19,8 million m^3, including a bank of shingle – 17,9 million m^3, a bank of loam (core) – 1,9 million m^3.

The axis of the dam crosses the Valley of Rezaksay River. The territory is characterized by a difficult geologic structure. From the surface it is combined by quaternary deposits. In the high-water bed quaternary deposits are presented by alluvial shingle rocks with thickness 10 m. On boards occur gravel-shingle deposits with inclusion of loam and lenses of sand. Their general thickness makes 20-30 m. Quaternary deposits are underlayed by Neogene's rocks.

They are presented by interstratified stratum of siltstones, clays, sandstones. And near the bed part is observed prevalence of siltstones and clays, and on boards – sandstones. The general Neogene's thickness makes 120-150 m (Fig. 2).

Beads of Rezaksay River in a zone of dam building are chased by channels of shallow rivers and ravines.

The dam basis is placed on Neogene's siltstones. Preliminary analyses of formations of the dam basis have demonstrated that the loadings created after completion of building could cause sediment of the basis of the order on 0.7 m.

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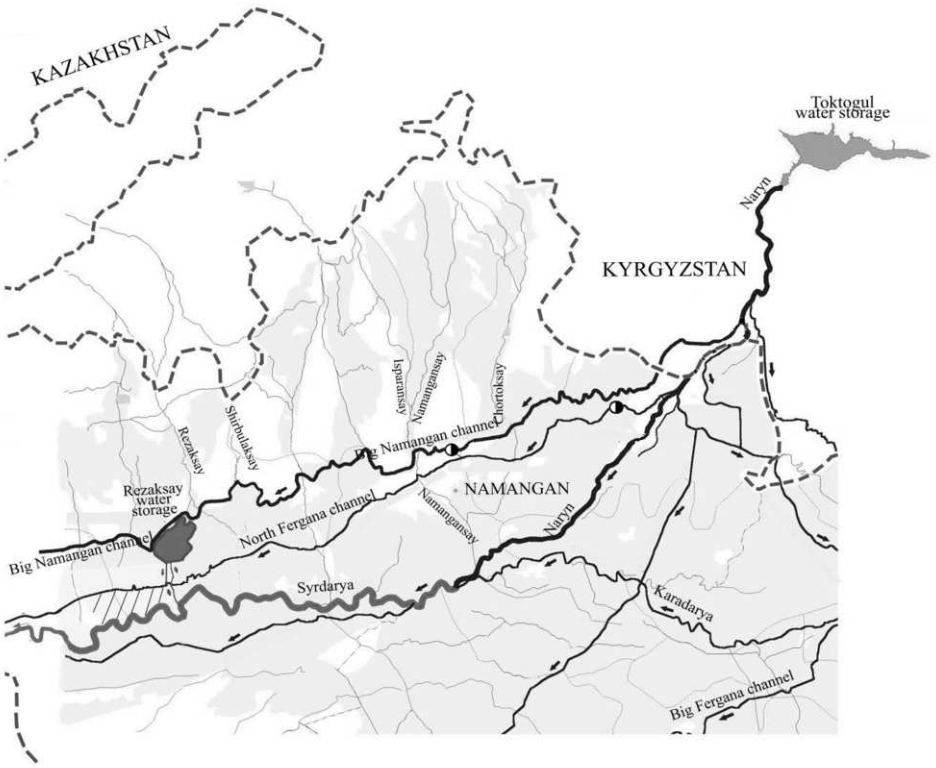

Figure 1. Schematic map of middle course of Syrdarya river.

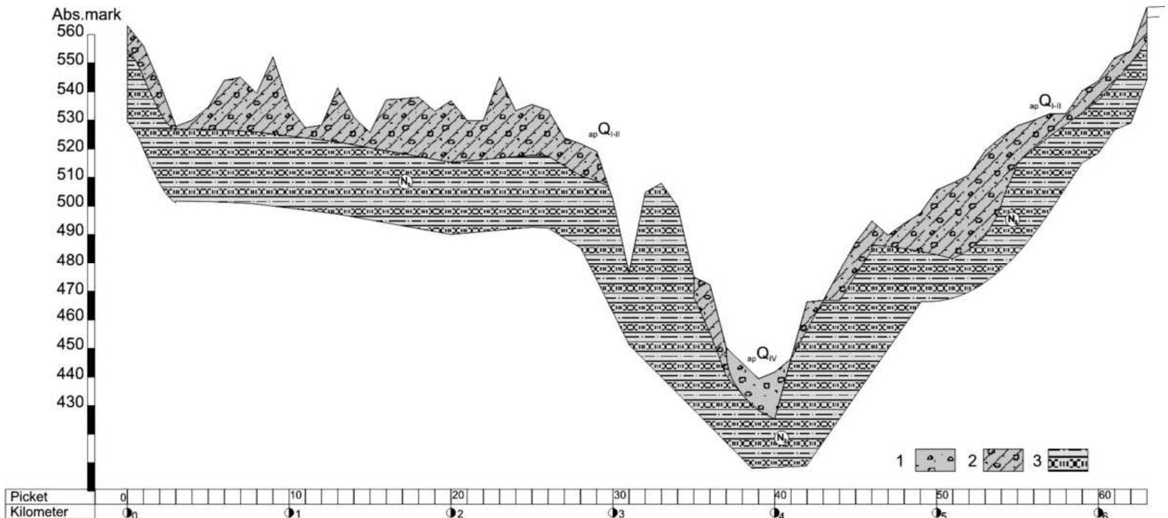

Figure 2. Geological cross-section along the dam axis. 1 - gravel-shingle deposits (Q_{IV}); 2 - gravel-shingle deposits with loamy filler (Q_{I-II}); 3 - siltstones, Neogene's sandstone (N).siltstones, Neogene's sandstone (N).

In conditions of a difficult geologic structure of the dam basis with possible outflanking and impossibility of building the tunnel culvert in these soils was accepted the decision, confirmed by calculations of construction the metal pipe of culvert through the dam body which has been taken in concrete.

The design of the dam consists of several elements. These are the top and bottom retaining prisms which are constructed from shingle by a method level-by-level filling with a thickness 0.4 m and are compacted with rolls in weight 40 ton. According to specifications after compaction the shingle soils should correspond to following estimated characteristics: volumetric weight of skeleton – 2.10 ton/m^3, humidity – 8-10%, filtration factor – 8-10 m/day. The dam core consists of loam. Considering limitation of loam was accepted the decision confirmed by calculations of construction the pressed out loamy kernel, passing in a high side to the baffle that is novelty in hydraulic engineering construction (Fig. 3). Construction of the kernel also was carried out by a method level-by-level filling with a thickness 0.3-0.35 m. For compaction of the loamy soil were used rolls on pneumatic tyre with weight 42 ton. Estimated performances of the soil after compaction have made: volumetric weight of skeleton – 1.70 ton/m^3, humidity – 15-16%, filtration factor – 0.01 m/day.

All these factors have predetermined, first, severe conditions of the dam building, secondly, necessity of conducting accurate engineering-geological monitoring of conducting the construction work. As a result the service of independent quality control works by the dam building has been created

Into tasks of the group entered:

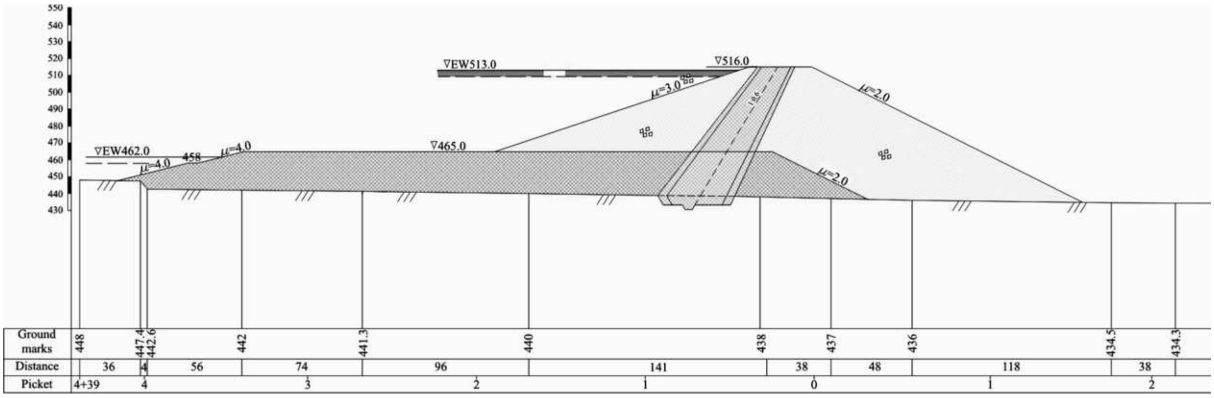

Figure 3. Section by dam.

- Implementation the control on excavation and observance the technical conditions on opening-up of the basis of the dam, water-discharge and other constructions entering into a complex.
- Implementation during stacking and compactions of the ground in a body of the dam the audit engineering-geological tryouts, lab tests and seismic-prospecting measuring.
- Methodical management and operational analysis of groups of geologic supervision and building lab of a contract organization.

Monitoring works were conducted in two directions: by conducting operative and monitoring control.

Operative control was carried out after filling and rolling each next stratum of earth. During operative control the basic indexes were determined: volumetric weight of skeleton (σ_{sk}), humidity (W, %), filtration factor (K_f). High paces of construction work, and also necessity of increasing the quantity of dots of tryouts have predetermined wide using modern express methods of definition the engineering-geological indexes. So, for definition σ_{sk} of earths, besides traditional methods have been used a field densitometer of Kovalev system. The essence of method in testing the density of skeleton of connected soils (loam, loamy sand) by a float method. It much more reduces time of carrying out the tests and reception the results whereas standard methods of definitions demand more time expenditures of the order 4-5 hours. It, in turn, has allowed sharply increase quantity of approbations points and finish their quantity at the rate of one sample on 100-150 m^3 the laid soil at thickness of the layer 0.3 m. Advantage of using field densitometer of Kovalev system was the opportunity of testing the density of skeleton of the soil by accelerated way, i.e. without works by definition the humidity of the soil by a standard method.

For quality control of compaction the gravel-shingle soils of retaining prisms has been widely applied densitometer of water-bottled type which has allowed to reduce time of definition the volumetric weight up to 5-6 minutes Direct measurements of volumetric weight of loamy soils in the dam core were combined with measurements by digital penetrologer of Ejkelkamp firm. The produced device measured head resistance of the soil on depth of 0.35-0.4 m. Results of measurements collected in memory of the device in the form of chart curves (Fig. 4).

By results of pair definitions by the direct method and the penetrologer has been revealed correlation dependence between values of head resistance and volumetric weight of soil skeleton (Fig. 5).

Results of field measurements were entered in field laptop and with using the installed dependence were operatively determined the volumetric weight of skeleton. For quality control of soils compaction between points of direct definitions, and also for reception the information on all filled areas after filling and rolling the 2-3 layers were spent measurements by method of seismic profiling using longitudinal waves. It is known, that for not water-filled friable rocks (loam, gravel-shingle deposits) is observed precise dependence of speed of the propagation of seismic waves (Vp) and volumetric weight (σ).

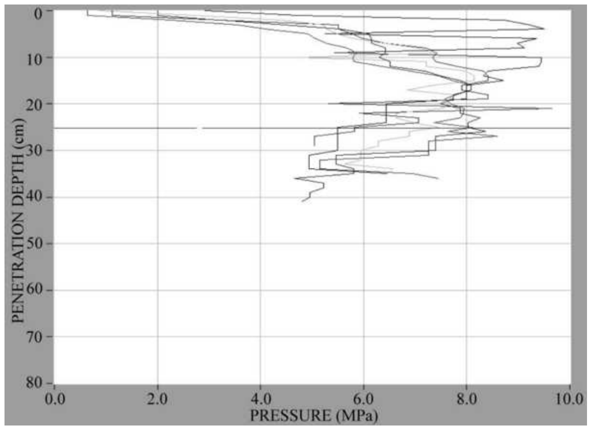

Figure 4. Diagram of head resistance curves.

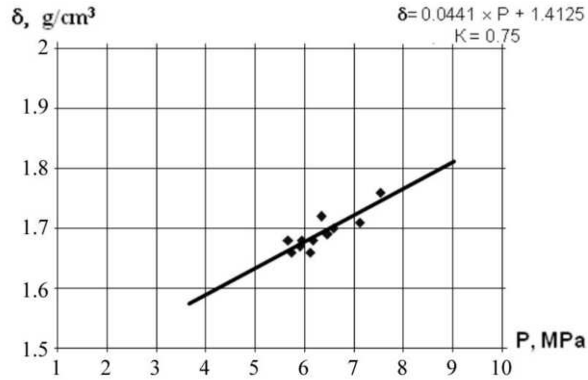

Figure 5. Dependence between volumetric weight of skeleton and head resistance of penetrologer under dampness 15-16%.

However its kind for rocks of various structure different. Therefore for the soils, filled in body of Rezaksay dam has been made the equations of dependence between Vp and σ, using the method of pair correlation. The received dependences looked like:

For loam $\sigma = 0.001Vp + 1.4253$ g/sm^3.

For shingle $\sigma = 2.43Vp^{0.2}$ g/sm^3.

Results of measurements and definitions were represented in the form of the seismogeological sections executed on profiles, located in a body of the dam (Fig. 6). Results of seismic definitions were supervised by direct measurements of soil density.

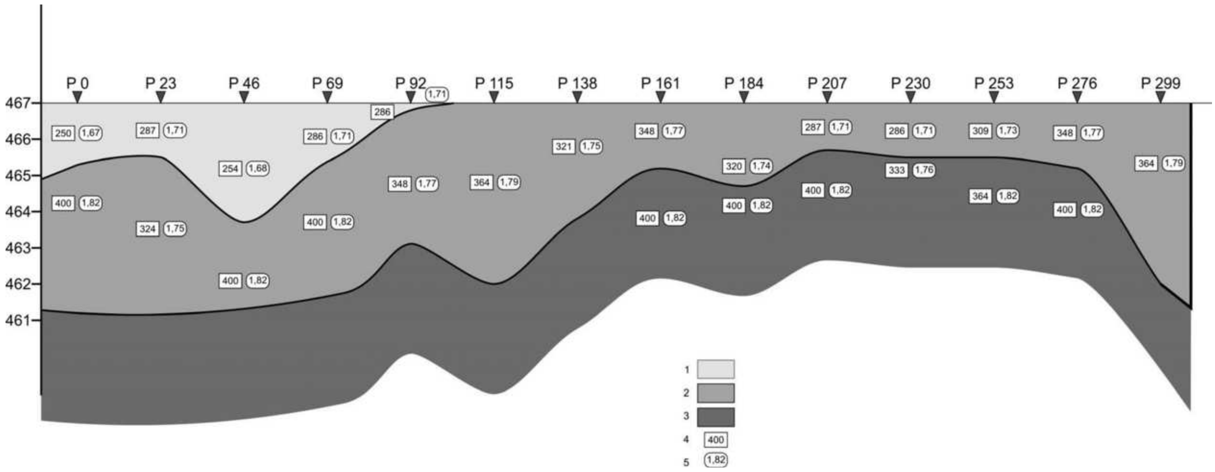

Figure 6. Seismological section by profile II (nucleus, Rezaksay). 1 - zone of satisfactory compaction; 2 - zone of good compaction; 3 - zone of influence overlying rocks pressure; 4 - velocity of the seismic wave origin; 5 - volumetric weight of skeleton.

For definition the filtration factor of shingle earths has been used field filtrometer with a dual ring of Nesterov system.

Monitoring was carried out by drifting audit bore pits by depth up to 1.2 m and culling the monoliths for conducting engineering-geological tryouts and lab tests. During these works granular structure, porosity, angles of internal friction, adhesion, plasticity were determined.

Executed monitoring engineering-geological works during the dam building have allowed, not slashing pace of construction work to carry out control of their quality and in due time to reveal and eliminate all the detected lacks.

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