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Characteristics of the Arzangarzan Dam's Non-Destructive Testing Strategy to Prevent Siltation

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Abstract: The study addresses non-destructive testing strategies for preventing the Arzangarzan dam from silting up in future. The results of the solution to the Arzangarzan dam's silting issue are shown in this article, allowing runoff regions to manage their water resources more sensibly. Future sediment changes are predicted taking into account the dam's increased overgrowth, additional channel processing, a decline in afforestation, and an increase in cultivated land in the downstream regions. The primary strategies for enhancing the flow of sediment into the dead volume bowl are examined, and methods for resolving the siltation issue by clearing the flooded channels are suggested. This method is employed in dams (reservoirs) with flow because its fundamental principle is that suspended sediments are carried into the bowl of the "dead" volume of the dam by the water flow, while silt sediments are agitated with the assistance of a floating dredger equipped with water jets, preventing pulp from being drawn into the dredger. It should be mentioned that the primary factor used to identify boundaries in georadar studies of clay and loam soils is moisture content. In our situation, the electrical resistance of the soils was much decreased by the slightly mineralized water and filtration; as a result, the lithological composition can only be separated on the major lithological differences. With soil moisture levels above 30–45% and high mineralization in soils that have a low resistance, the study was conducted at a maximum depth of 4-6 meters.
Keywords: Arzangarzan dam, Siltation, sediments, erosion , runoff

I. INTRODUCTION

Holocene and Upper Pleistocene alluvial deposits are deposited in the area of the Arzangarzan earthen dam on the Upper Pliocene clays down to a depth of 8 to 20 feet. These deposits are primarily composed of sands with varying sizes and a layer of gravel or pebbles at the base; all over, sand is covered in a layer of clay and loam that ranges in thickness from 1.5 to 16 feet.

The intense runoff represents the Arzangarzan dam, where the lower Pleistocene clay sediments, represented in the lower part by sand and gravel-pebble, with a total thickness of 8 to 12 feet, and in the upper layer of clay with a thickness of 6 to 14 feet, lie down to a depth of 12 to 28 feet. These sediments are representative of the Holocene – Upper Pleistocene aeolian – deluvial sediments, represented by loess-like loamy, macroporous thicknesses from 4 to 10 ft.

Structures are situated inside the floodplain and partially on the first floodplain terraces of the channels and its left-side tributaries on the left side of the Arzangarzan dam. In general, the geological structure is uniform. Alluvial deposits from the Holocene to Upper Pleistocene era are widely distributed on the upper Pliocene clays. The deposits are made up of a layer of lenticular sandy loam and clay and loam that is 4 to 10 feet thick in the higher section and mostly big sands, gravel, and gravel-pebbles with a total thickness of 6 to 14 feet in the lower half.

The Arzangarzan dam's position dictates the hydrogeological conditions in its vicinity. Many aquifers located in the sand and gravel-pebble interbeds of the upper section of the dam. The aquifers are hydraulically coupled down to a depth of 180–230 feet (active water exchange zone). They are protected by estuary-clay clays, which have a thickness of roughly 40 feet. The first aquifer from the surface, which is limited to the Quaternary strata and occurs at depths of 8 to 24 feet, affects the flooding of the areas near the Arzangarzan dam.

With a two-layer structure that has a poorly permeable layer at the top and a well permeable layer below, the non-pressure aquifer in the vicinity of the earthen dam, spillway, lock, and on the left side is limited to the thickness of the alluvial deposits from the Holocene and upper Pleistocene. The range of the aquifer's total water conductivity coefficient is 80 ft2 per day to 430 ft2 per day. With a three-layer structure consisting of a well-permeable layer of macroporous loam at the top, a low-permeable layer of clay in the middle, and a well-permeable layer of sand base, the non-pressure aquifer is restricted to the aeolian-deluvial and alluvial deposits of the upper and middle Pleistocene on the right side.

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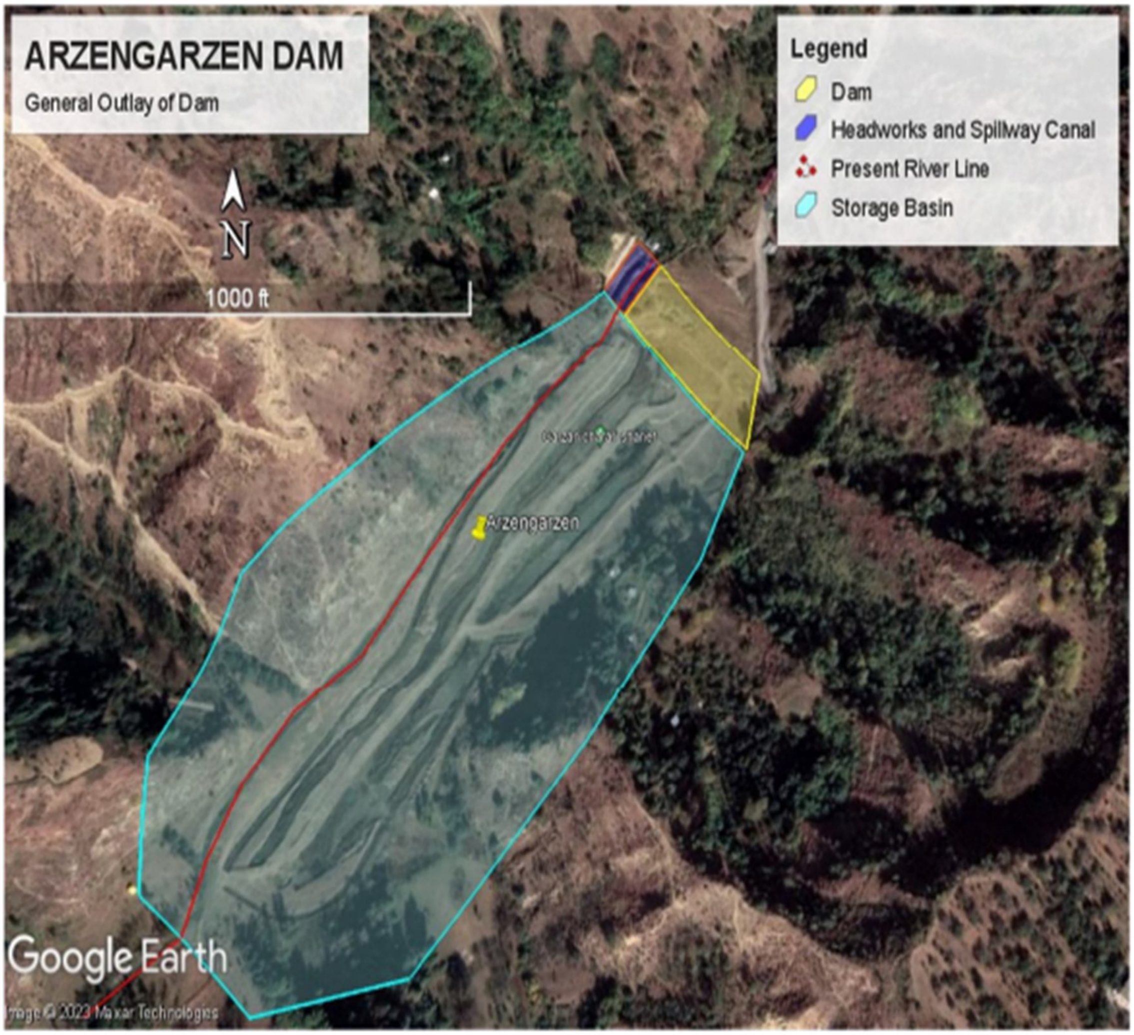
Simultaneously, the findings of the engineering-geological and hydrogeological investigations conducted during the design phase and following the completion of the Arzangarzan dam's construction demonstrate the inherent foundations of concrete structures: Distinct water-saturated sandy soils ranging in composition from loose to dense, as well as partially the plaz ary clayey soils and earthworks stacked alluvial and bulk, preferably water-saturated sand and clay soils, represent an earth dam's water intake and water outlet at PK 20 + 40.

The hydrogeological conditions at the hydraulic structure sites and the surrounding areas have drastically changed over the years that the Arzangarzan dam has been in operation. Groundwater levels have increased as a result of backwater and additional supply, and their current regime is dependent on the level regime in the dam and downstream.

All of these unresolved issues are pertinent and point to the necessity of providing evidence for solutions to the Arzangarzan dam's silting issue in order to support the sensible use of floodplain areas' water resources in contemporary water management.

II. METHODOLOGY



Right now, the Arzangarzan dam's actual use aligns with its intended function. Water erosion controls the sediment runoff in the nearby waterways. Large channel slopes and the relief of the mountain-valleys contribute to the particularly noticeable water erosion in the hilly and foothill regions. Rainfall that falls on the underlying surface, especially intense downpours and snowmelt, as well as debris that enters the channels from the catchment area and forms sediment runoff. The makeup of the rocks that make up the catchment, as well as the afforestation, agrotechnical practices, and water management techniques implemented on the catchment region, all play a significant part in this.

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Regarding stock sediment runoff in the channels, no observations were made. Assuming a runoff modulus of the bottom sediments of the channels near Arzangarzan, the sediment load runoff modulus is calculated analytically using the balance technique. Based on data from 1987,

The debris in the sections of the water area covered in aquatic vegetation causes the volume of sediment to grow by 0.6 million feet every year. When all the sediment from outside the reservoir is included and forms in the bowl, the total annual growth of sediment is 4.12 million feet. Future sediment changes are predicted based on the Arzangarzan dam's increased expansion, a decline in afforestation, and an increase in cultivated land in the areas downstream. In light of these variables, the annual increase in silt quantities along the dam's alignment will be 0.8%.

III. RESULTS

The Arzangarzan dam's design was completed with fixed water levels: the main operational horizon's normal retaining level, marked by a mark of 13.15 mBs, and the maximum allowable level of water in the dam's forced retaining level, marked by a mark of 10.mBs.

These horizons were taken into consideration while determining the watercourse's capacity to convey suspended and entrained sediments. The amount of sediment that entered the bowl annually at the start of the Arzangarzan dam operation was 1.5 million ft3, or 2.0 million ft.

A total of 21.0 million ft3 of sediment were deposited in the reservoir bowl over the course of the operation period, compared to an expected annual volume of 0.02 million ft3. The ratio of the actual to expected volume of sediment is 88.7% of suspended and entrained sediments in the reservoir bowl.

If immediate action is not taken, the Arzangarzan dam's siltation will continue to cause an annual rise in sediment, which is why it was estimated that 80 million ft3 of suspended particles will settle in the dam's bowl between 1977 and 1992. Furthermore, by 1992, the reservoir's average depth had dropped from 9.0 meters in 1975 to 3.5 meters. An increase in sediment quantities is a result of the reservoir's depth changes, which also cause a drop in the standard retention level.

Up until 1992, when things were operating normally, the annual sediment volume was 1.1 million ft3. Based on a comparison of the results, we conclude that 26 years would be needed for siltation to reach a normal level of 90 cm. The majority of the suspended and entrained silt reaches the bowl by channel runoff that entered the Arzangarzan dam.

For work, a radio engineering device with surface sensing was utilized. It is intended to identify point and extended media interfaces, presenting the sensing data in real time on the recording device's screen before storing the data in a file for further processing and printing.

The reflected signal was measured as the antennas were moved in a predetermined step along the profile of the surrounding dam base. RadExplorer 1.4 and GeoScan 32 processing software were utilized for processing and interpretation.

Layers were discovered as a result of processing and interpretation: the upper section, which had a thickness of up to 20 cm and an E = 4 dielectric constant. This layer is a slightly moistened layer of soil and vegetables; it can be as thick as three feet and have a dielectric constant of E = 7.

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Loams with natural moisture make up this layer; moist clay can be as thick as 3.5 feet and have a dielectric constant of E = 18, as can clay at depths greater than nine feet that is moistened by more than 20% and has a dielectric constant of E> 28. The primary factor used to identify boundaries in GPR experiments on clay and loam soils is moisture content.

Since filtration greatly decreased the electrical resistance of the soils in our case and the water is slightly mineralized, it is only possible to separate the lithological composition on the major lithological differences. Additionally, because the depth of the study is limited to 2-3 meters due to high salinity and soil moisture content.

It is suggested that the stirring method be used to clean the runoff in channels. This method is applied to dams that have flow because, in essence, suspended sediments are carried into the bowl of the dead volume of the Arzangarzan dam by the water flow, while silt sediments are disturbed with the assistance of a floating dredger equipped with water jets. The pulp is not drawn into the dredger. Since this approach is 2.4 times less expensive than cleaning with pulp removal, it is advised to adopt it for financial reasons.

Typically, the Arzangarzan dam's siltation assessment is done during low level, making it unable to evaluate safety indicators in a realistic manner. Conclusions are typically derived from visual and instrumental measurements.

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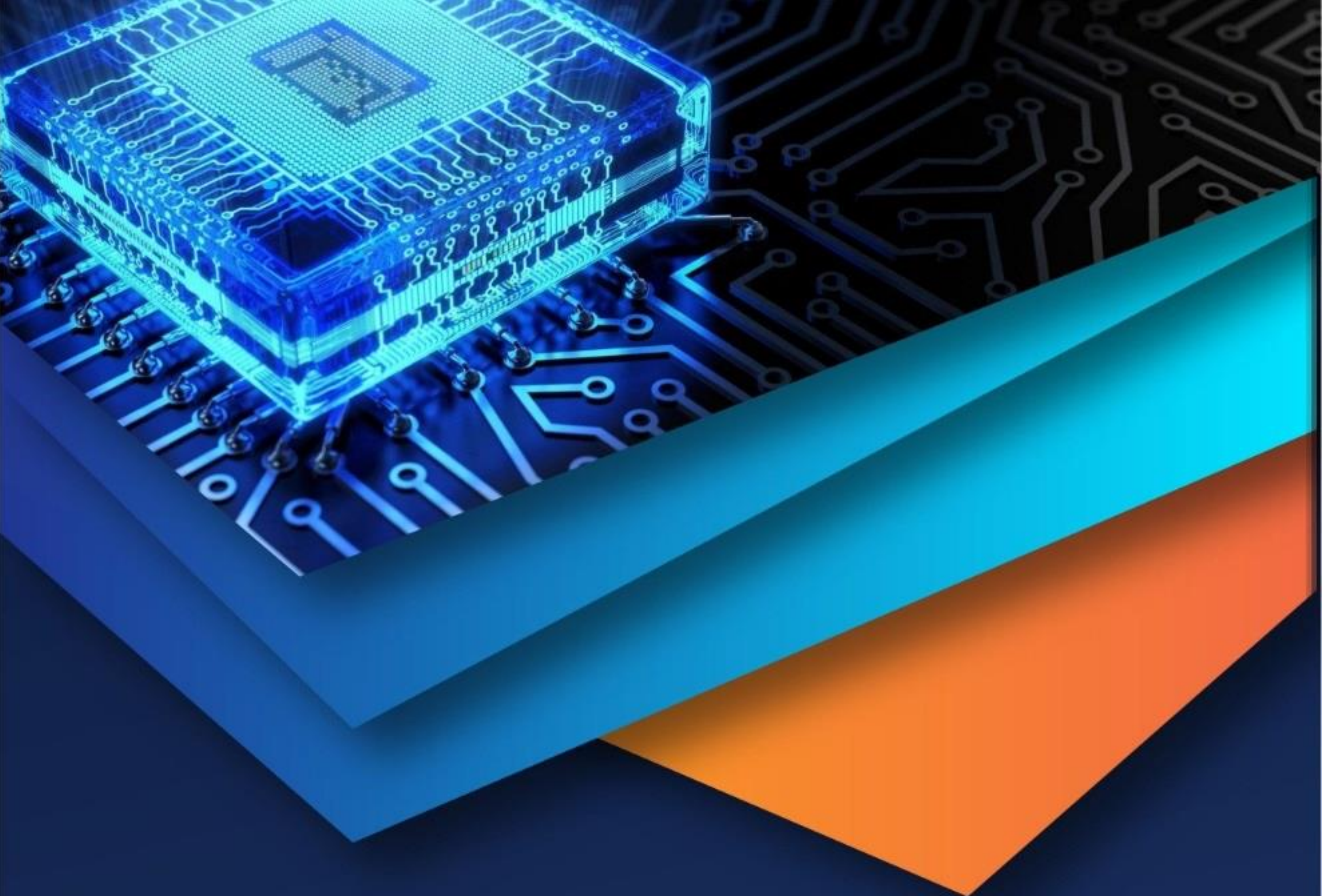

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