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EXTENDED ABSTRACT

Assessment of the Cohesive Sediments Fall Velocity in Karkheh Dam Reservoir

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Introduction

In reservoir of dams, especially near the dam body, the cohesive fine sediments are deposited mainly. The mechanical behavior of these sediments is largely controlled by the interparticle attraction caused by electrostatic and physiochemical forces. these properties cause the stickiness and accumulation of clay particles and formation of dense masses called flocs, which is sometimes referred to as flocculation. flocculation is influenced by several factors including salinity, flow regime, sediment concentration and organic matter. Flocculation is the most important factor that makes the settling, fall velocity and transfer of cohesive sediment considerably more complex and dynamic than non-cohesive sediments. In order to determine the relations governing cohesive sediments, the physical characteristics and behavior of these sediments should be identified. The terminal settling velocity of sedimentary particles in liquids, called particle fall velocity, is one of the most important properties in determining the physical properties of sediments caused transfer, deposition and consolidation. The fall velocity of cohesive sediments is influenced by many factors, including salinity, initial particle size, turbulence, temperature of water, and suspended sediment concentration.

McLaughlin (1959) provided a method for measuring the fall velocity of particle ($\overline{\omega}$) in stillwater, using a settling cylinder with 10 cm diameter and less than 1 meter height and established a differential formula based on its research as follows:

$$\frac{\partial(\overline{\omega}\,C)}{\partial z} + \frac{\partial C}{\partial t} = 0 \qquad (1)$$

Fathi Moghadam et al (2011) studied the settling properties of the cohesive sediments in the Dez Dam reservoir. They concluded that particles for all concentrated samples and in all depths reached to their maximum fall velocity approximately at the same time (15 minutes after starting the test). The lower concentration samples appeared to have higher maximum fall velocities than the higher concentration samples, but for a shorter duration.

Investigating the sources showed that environmental conditions play a significant role in physical properties of cohesive sediments. Therefore, in this research the effect of the concentration of sediments entering the reservoir of Karkheh dam on the fall velocity of particles was studied.

Materials and Methods

The Karkheh River originates from the middle and southwest areas of the Zagros Mountains in the west and northwest of Iran, and the Seymareh, Kashkan, Ghareso, Gamasiab and Chardavol rivers are the main water sources. the Probability of flooding and its dangers is one of the natural characteristics of the Karkhe river. In order to prevent the downstream flooding and supplying water for irrigation of more than 340 thousand hectares of lands and the production of hydroelectric power the Karkheh reservoir dam has been constructed, 22 km northwest of Andimeshk in the province of Khuzestan (southwest of Iran). This structure is located at 48 degrees and 7.8 minutes east and 32 degrees and 29.6 minutes north in the Karkheh area. It is made of soil and has a clay core. It has a height of 127 meters with a crown length of 3030 meters and the total volume of dam reservoir is about 5.6 billion cubic meters in the operation level of 220 meters. Also, the total sediment content is estimated to be around 1730.5 million tons for a normal elevation of 220 meters above sea level, over a period of 50 years.

In order to conduct the present research, the deposited sediment samples at the bottom of the Karkheh dam reservoir and adjacent to the dam body were prepared using a grip sampler. Then the sorting sediment was determined by laser diffraction (Malvern Mastersizer Micro). In order to measure the fall velocity in still conditions, in this study using a settling cylinder with 2 meters height and 25 cm diameter. Conducting the experiments, mixture of water and sediment was prepared with initial concentrations of 4, 6, 8, 10, 15, 20 and 25 g/l in a 200 liter reservoir, firstly. Then samples were taken with using the valves mounted on the cylinder body at the levels of 20, 40, 60, 80, 100, 120 and 140 relative to the upper level of column at times of 5, 10, 15, 20, 30, 45, 60, 90, 120, 150, 180 and 240 minutes. At the end of the test, for measuring the concentrations, samples were weighed using a digital balance and they were placed in an oven at 110 ° C for 24 hours. Ultimately, the concentration of each sample was measured. In the next step, method of McLaughlin (1959) was used to determine the settling velocity in each of the scenarios.

Experimental Results

The findings of this research were studied under different scenarios with two different approaches: one of them is the variation of sediment concentration relative to height of settling column and another is the variation of concentration relative to time. Observations indicated that the concentration of sediments increases with depth. As an example, Fig. 1 shows the vertical distribution of concentration for a dry matter of 4 g/l in the first scenario. According to this figure, the highest concentration variation gradient occurred at approximately 20 minutes after beginning the test. This can be due to the flocculation properties of clay particles. This means that clay particles reached to the maximum diameter due to the flocculation property during the first 20 minutes of the first scenario, As a result, the velocity gradient increases with depth. Also, a similar study for the minimum gradient shows that the lowest gradient occurred at 120 minutes. In the second step of the study, the time variation of settling velocity was investigated at concentrations of 4, 8, 15 and 25 g/l. As an example, the process of time variation of settling velocity is shown for a dry matter of 4 g/l in the first scenario in Fig. 2. The figure shows that the average settling velocity of particles has a positive gradient firstly, then it decreases after 15 minutes from the starting of the test. This can be due to the entering of small flocs into hindered settling zone.

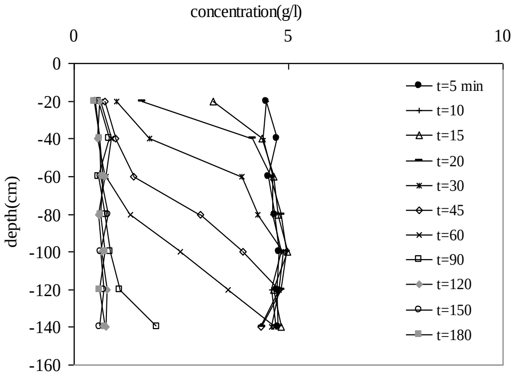

Fig 1-vertical distribution of concentration for a dry matter of 4 g/l in the first scenario

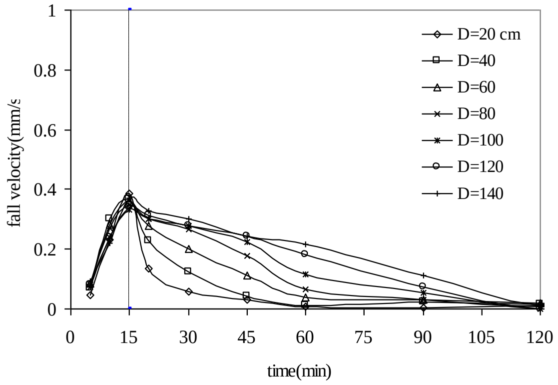

Fig 2- time variation of settling velocity for a dry matter of 4 g/l in the first scenario

Conclusion

The results of this study showed that the particle settling velocity reaches to its maximum due to the formation of flocs at the intervals of 10 to 15 minutes after starting the experiment, then the settling velocity of particles decreased after entering the hindered settling zone. Studies showed that the gradient variation of the maximum settling velocity depends on the initial concentration of the tested mixture. From the quantitative point of view, the results of this study showed that the value of maximum settling velocity of particles are different with the results of previous researchers. The main root of this difference can be considered due to the difference between the reservoirs of the studied dams, as well as the type and size of the sediment particles in the catchment area of the studied areas.

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