Investigation of Velocity and Concentration Profiles of Turbidity Flow in River Bends

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1. Introduction

Basically, a turbidity or dense flow is a two-phase flow that occurs due to the movement of a fluid in a different fluid with a different density, occurring in many natural environments and engineering applications. The turbidity flow in mobile bed conditions consists of three regions: clear water of the perimeter, cloudy water, and sediments (bed loads). The complex interaction of cloudy flow with two other regions makes it difficult to analyze these flows. It can be noted that there are cases such as the effect of floating force, the interaction of particles with the current and the turbulences in the common surface of the environmental fluid with the currents flow. Since in reservoirs of dams, the roughness of the bed changes with the formation of a thick stream, its effect on the flow characteristic is of great importance. In the context of a mobile bed, increasing the velocity or power of the current in the surface area create different bed forms. On the other hand, in analyzing the flow profiles of a fluid in a mobile bed, it is important that the flow resistance consists of two parts: the first part of the roughness due to the particle size and the second part of the roughness is due to the shape of the bed. Some have described gravel bed forms emplaced by the bed-load component of turbidity currents flowing in a confined channel in the Cerro Toro formation of southern Chile. At field scale, some others have measured vertical velocity profiles within the Monterey Submarine Canyon. In the laboratory, previous experimental studies have documented the vertical structure of the body of gravity flows. Only some studies have been performed over mobile beds, and even when bed forms developed, their influence on the flow was not evaluated. Bed forms have feedback mechanisms and, in turn, affect the flows that originally created them.

2. Experimental Program

This research was carried out at the Laboratory of Physical and Hydraulic Models of the Faculty of water Sciences Engineering of Shahid Chamran University of Ahwaz. To conduct the experiments, this study has a flume length of 8.5m, depth of 70cm, width 20cm and slope of the 0.001, including three consecutive 90° curves with a curvature radius of 40, 80 and 120 cm (Figure 1). The experiments were carried out in the form of saline flow and at four concentrations of 0.7, 1, 1.5 and 2 liters per second at concentrations of 10, 15, 20 and 25 grams per liter. In order to provide a mobile bed in the flume floor, due to the special conditions of the currents (very low velocity in small laboratory flumes), comprehensive research has to be carried out on the material characteristics and their use as corrosive substrate materials. Moreover, the tests for this purpose are designed and implemented. The most important points in choosing these materials are, type of materials, specific gravity, density, ease of use. The most important feature for substrate sediments is density Particles, which make it very difficult because of the low velocities of the thick streams for the movement of these sediments, and especially the formation of bed forms, so for particles with a low specific density (in the study of Sequeiros, particles with density Specially for1.53, and in the Rutlox research) particles with a specific density of 1.06 were used. Thus, going through above steps and attempts and errors with very different materials, deposits of polymer (expanded polystyrene) were used.

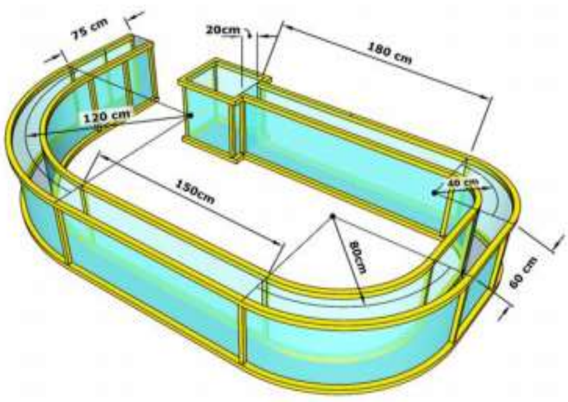

Figure 1. A schematic picture of experimental flume

3. Results and Discussion

The results showed that at all concentrations in the first bend and cross section the maximum flow velocity was at the maximum in the inner wall. With the flow into the bend due to the sudden change in the curvature and the effect of centrifugal force along the internal wall, the pressure drops and along the outer wall increases the pressure. The shear stress variations were also based on changes in the velocity profile, in other words, the greatest tension occurred in the inner wall of the bend, and then it was drawn to the outer wall of the bend. In the context of mobile bed conditions, generally increasing concentrations and thus increasing the flow velocity, the flow power also increased and the bed roughness changed to the extent that, by washing the form of the substrate, the roughness and shear stress begin to decrease. In concentrated stream, the secondary flow results in the maximum velocity approaching to the outer

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wall and the maximum velocity is transferred to the outer wall. This is seen in the transverse velocity profiles in the second and third bends. In general, on the mobile bed, the velocity of the condensate flow increases as the concentration of the incoming flow increases. The important point in the flow rate profiles is that the rate of increase in speed depends on the changes in the form of the bed, as the concentration increases. As the concentration of concentrated flow increases, the shear stress of the bed increases. In the context of the mobile bed conditions, the particles of the active agent act as a resistive force against the inflow current. Regarding the results in the context of mobile bed conditions, concentration generally increased due to increased flow velocity, and increased flow power has also been shown to change the bed roughness.

4. Conclusion

Generally, with increasing concentrations, the shear stress of the substrate increased and the bottom of the substrate, the roughness and shear stress begin to decrease as well. Increasing the speed and formation of bed forms increases the roughness and flow resistance of the substrate, so that the substrate particles act as a force against the inflow current. With regard to the results in the context of mobile bed conditions, concentration generally increased due to increased flow velocity, and increased flow power has also been shown to change the bed roughness, and the importance of generating a bed form for creating resistance to flow. Because at the beginning of the current flow, the bed form is not yet formed, and the agent of the resistivity and roughness of the bed is negligible, and as a result, there is no resistance and decrease effect against the forehead velocity. Results of experiments on the mobile bed showed that by increasing the concentration of the incoming flow, the flow velocity of the fluid is also increases. The important point in the flow rate profiles is that the rate of increase in velocity depends on changes in the form of the bed due to the increase in concentration. By increasing concentrations of turbidity flow, the shear stress of the bed increased. When the bed form is generated, as a result showed in experiment with 25g / l concentration, the rate of velocity increase, by increasing, shear stress decreased (from 34% to 15%). Therefore, the rate of velocity will increase by removing the bed forms and reducing the roughness and shear stress of the bed.