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AIP Conf. Proc. 3256, 020002 (2025)
https://doi.org/10.1063/5.0266918

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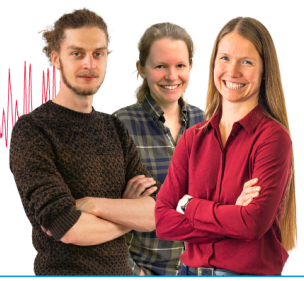
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Experimental Studies of Sharply Changing Movements of a Saturated Turbidity Flow

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Abstract. In this paper, the results of experimental studies on the sharply changing movement of a turbulent flow with intense turbidity, specific to the rivers of Algeria, fed by rain, are presented. The results of experimental studies have established that with an increase in the turbidity of the flow to a certain value, an increase in the average velocity is observed; within a certain value of turbidity, the flow rate remains almost unchanged; with a further increase from this turbidity value, a decrease in the value of the average flow velocity is observed. It was established that when a suspended flow moved along channels, three stages of velocity were observed in the experiments: A stage of increasing flow velocity with increasing turbidity. This stage in experiments extends to a turbidity of 130 g/l; Stage B is a decrease in flow rate with an increase in turbidity of more than 230 g/l; Stage B is a decrease in flow rate with an increase in flow turbidity of more than 230 g/l. Experiments have obtained data on the movement of suspended flows with turbidity from 50 to 450 g/l. These data make it possible to develop calculated dependencies for the hydraulic characteristics of a sharply changing turbulent flow of suspended turbidity and use them to compare calculated dependencies.

Keywords: Experiment, research, sharply changing, movement, hydraulic parameters, flow, increased turbidity.

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INTRODUCTION

The object of the study is the sharply changing movement of a turbulent flow of increased turbidity, characteristic of the Algerian River. The main forms of harmful effects are sharply changing movements of a turbulent flow of increased turbidity - destruction or damage to buildings and structures along the path of the descent and the drift of areas with mud and stone mass. Cities and populated areas, railways and highways, power and communication lines, oil and gas pipelines, canals, agricultural lands, and recreation centers suffer from the sharply changing movement of a turbulent flow of increased turbidity. In order to reduce this threat, methods are being developed for assessing the characteristics of sharply changing movements of turbulent flows of increased turbidity and risk, forecasting their dynamics, methods of protecting against such flows and reducing the activity of this process. These factors characterize the relevance of the problem under study [1-6].

Experimental studies of the dynamics of sharply changing movements of saturated turbidity flow were carried out in various scientific institutions [1-11]. The research of these scientific institutions was aimed at studying the sharply changing movements of the flow of saturated turbidity, as well as turbulent flows transporting granular soils. As noted in the territory of the Algerian People's Democratic Republic, turbulent flows of saturated turbidity are mainly formed with loam content, sandy loam soils up to 60% of the total composition of transported sediment flow. Experiments to study the sharply changing movements of a turbulent flow of increased turbidity were carried out for a long period [13-16]. The author studied the change in velocity depending on the turbidity of the flow.

Experimental studies were carried out on sharply changing movements of a flow of saturated turbidity similar to the foothill regions of Central Asia and Algeria. The main goal of the study was the dynamics of the main

Water, Energy and Food Security in the Context of Global Climate Change and Water Scarcity
AIP Conf. Proc. 3256, 020002-1–020002-6; https://doi.org/10.1063/5.0266918
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hydrodynamic parameters of sharply changing movements of a turbulent flow of increased turbidity. To achieve the goal of the study, the following research tasks were set:

- distribution of turbidity and sediment size in depth, sharply changing turbulent flow of increased turbidity;
- effect of turbidity, at average velocity and hydraulic resistance of the flow.
- the nature of the change in flow rate, average velocity and turbidity of the flow.

RESEARCH METHOD

Experimental studies of sharply changing movements of a turbulent flow of increased turbidity, processing of data obtained in experiments and establishing the main patterns between the hydrodynamic parameters of the flow

RESULTS AND DISCUSSIONS

The experiments were carried out on the experimental setup shown in Figure 1.

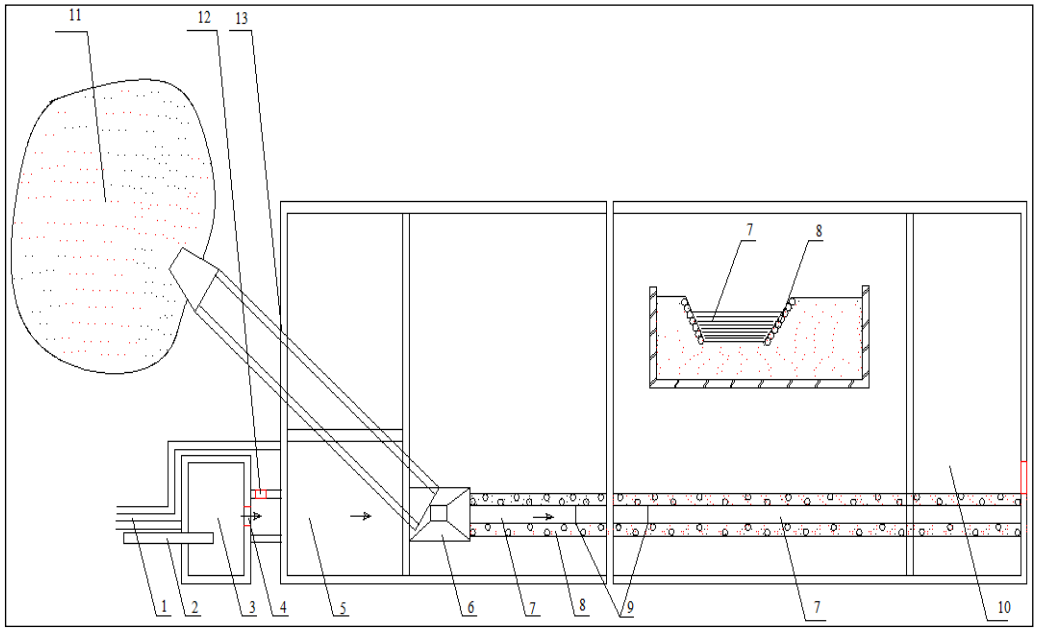


FIGURE 1. Scheme of the experimental setup. 1-reset; 2-pipeline; 3-water intake; 4- trapezoidal weir; 5-absorber; 6-hopper for supplying sediment; 7-channel; 8-stone patching for stablizing slopes; 9-measurement sections; 10-sump; 11-sediment storage; 12-reset shield; 13 belt conveyor.



FIGURE 2. Trapezoidal weir in an experimental setup.

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The water in the experimental setup was supplied from the pressure pool through a trapezoidal weir. The water supplied to the model at the inlet section was continuously saturated with sediment, which was supplied by a conveyor belt and, at a velocity of 1.5-2.0 m/sec, from the sediment storage to the bunker installed at the beginning of the model. The bunker was a metal tank measuring 80x80x50cm. The supply of sediment into the tray from the dispenser was regulated by a valve [14].

To study the movement of sharply changing movements of the flow of saturated turbidity, the distribution of flow turbidity and sediment size in depth, as well as the effect of turbidity on flow velocitys along the prepared model channel, flow rates of 10, 15, 20 and 30 l/sec were passed, successively increasing the flow saturation with sediments in the following order : 50,100,150,200,250,300 and 400 g/l. Each saturation was maintained on the model for up to 10 minutes, during which visual observations of the flow and velocities were measured at selected verticals in the middle part of the channel. Velocity measurements were carried out using a rotator at three points of each vertical: near the surface of the flow, in the middle of the flow at a depth of 0.5 and near the bottom of the channel at a depth of 0.05 h. At the same time, samples were taken with a glass vacuum tube at the same points of the vertical to determine turbidity and fractional sediment composition.

In total, 19 experiments were carried out to study the movement of sharply changing movements of the flow of saturated turbidity along the channels, of which 9 experiments (1-9 experiments) with a flow rate of 10 l/sec, 7 experiments (10-16 experiments) with a water flow rate of up to 15 l/sec ,2 experiments (16-17 experiments) with a water flow rate of up to 20 l/sec and the last 19th experiment with a flow rate of 30 l/sec. The results of experimental studies showed that when the flow moves on an eroded channel, the saturation of the flow with suspended sediment has a significant effect on the movement and the physical and mechanical state of the flow. With an increase in the turbidity of the flow, the following changes were observed: the average flow velocity, the distribution of velocity along the depth of the flow, the width and depth of the channel, the distribution of turbidity along the depth of the flow, viscosity and density of the flow [11].

Figure 3 shows changes in average velocities, flow depth and flow turbidity in the experiments.

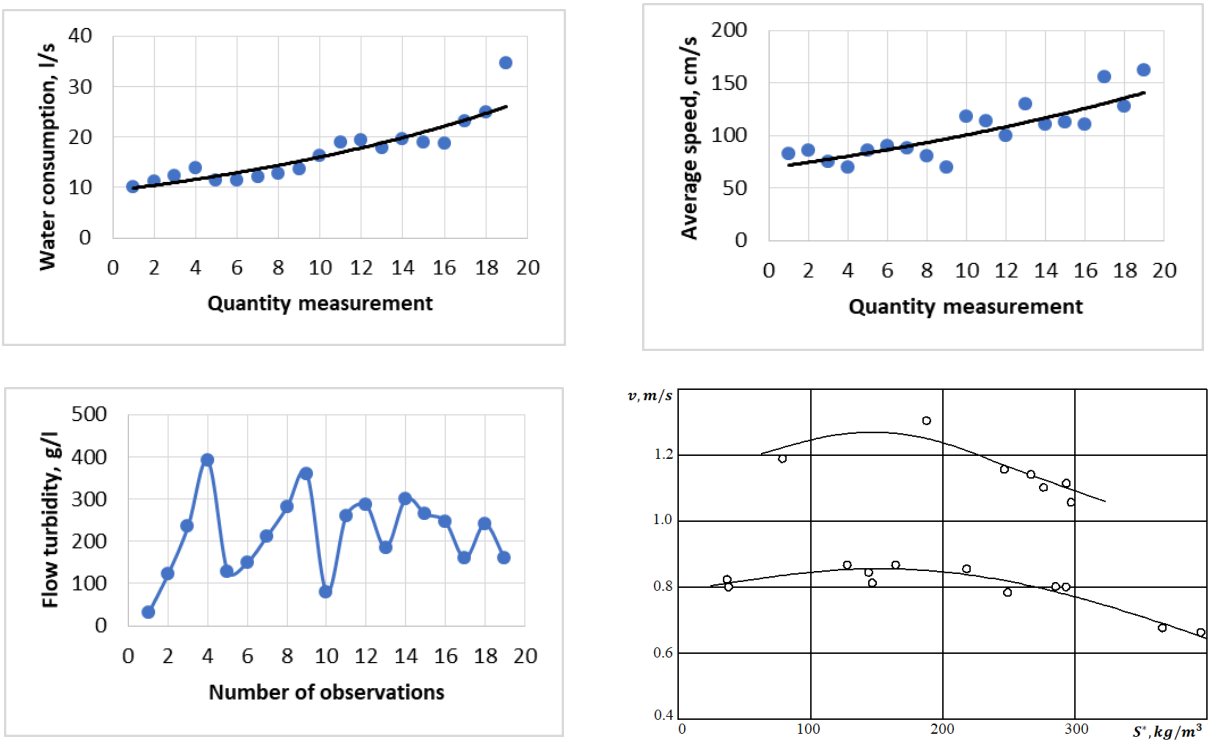


FIGURE 3. Main flow characteristics in experiments.

As the results of experimental studies have shown, with an increase in the turbidity of the flow to a certain value, an increase in the average velocity is observed; within a certain value of turbidity, the flow velocity remains almost unchanged; with a further increase from this turbidity value, a decrease in the value of the average flow velocity is observed. This is well illustrated in Figure 3, which shows curves of changes in average flow rates depending on

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flow turbidity.

In experiments carried out with a water flow rate of 10-15 l/sec. The flow rate in experiments with increasing turbidity to values of 120-130 g/l increases, within the turbidity range of 130-230 g/l, it remains unchanged and decreases with increasing turbidity from 230 g/l or more. Thus, when a suspension-carrying flow moves along channels, three stages of velocity change were observed in experiments:

- Stage 1 - increasing flow rate with increasing turbidity. This article in experiments extends to a turbidity of 130 g/l;
- Stage 2 - decrease in flow rate with an increase in turbidity of more than 230 g/l;
- Stage 3 - decrease in flow rate with an increase in flow turbidity of more than 230 g/l.

In connection with the change in turbidity in the experiments, the change in the average depth and width of the flow is also given. With increasing turbidity, a decrease in the average flow depth and an increase in channel width were observed. The highest value of flow depths corresponds to experiments conducted with the lowest flow turbidity. If in experiments with water flow up to 10 l/sec (10th experiment) the initial depth was 7 cm, then in the subsequent (13th experiment) it decreased to 5 cm, that is, by 28%

Accordingly, with a decrease in the average depth, an increase in the width of the channel was observed in the experiments. If in experiment 10 the width of the channel along the bottom was 13 cm, then in experiment 13 it increased to 23 cm, that is, by 80%.

A decrease in the depth of the channel and an increase in its width was accompanied by a rise in the bottom of the channel due to clogging and the introduction of sediment transported by the flow. Table 3.10 shows data on changes in local flow velocity and turbidity, and the average diameter of suspended sediment in depth. These data are presented in figure 4 -5 in the form of dimensionless profiles of local flow velocities and turbidity in depth.

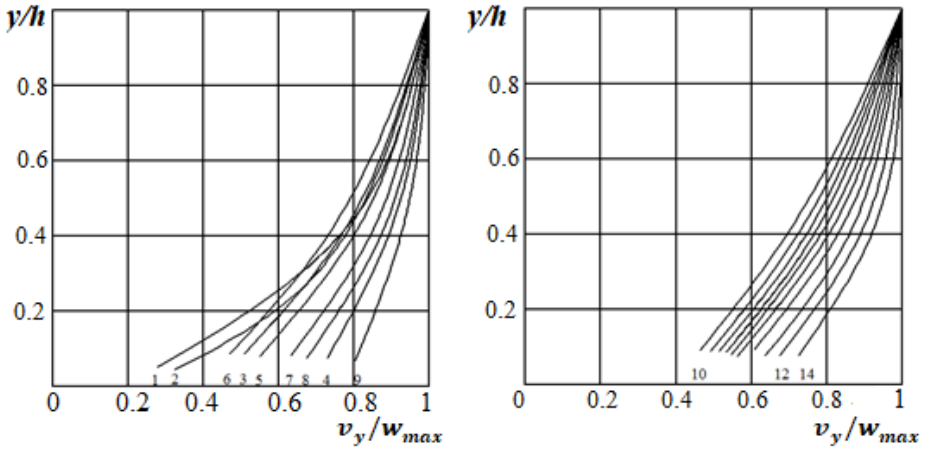


FIGURE 4. Profiles of local flow velocities in experiments.

When the flow is saturated with sediment at different velocities v_{max}, the experimental points formed different velocity profile curves, each of them corresponds to a different degree of saturation of the flow with sediment. The lowest turbidity value in the flow corresponds to curves 2, 10, 13. The largest are curves 4, 9 and 14. Consequently, an increase Elimination of turbidity in the flow leads to alignment of the local velocity profile.

The turbidity profiles also formed different curves depending on the suspension capacity of the stream v/ω and the sediment content in the stream, the greater the suspension capacity of the stream and sediment content, the less curvature of the turbidity profile, i.e. with an increase in the suspension capacity and turbidity of the stream, a leveling of the turbidity profile is observed in depth (Fig. 5).

It is known that an increase in the saturation of a flow with suspended sediment leads to an increase in the kinematic viscosity coefficient. Therefore, 7 experiments were carried out to determine the kinematic viscosity coefficient of the passed mixture during laboratory experiments in riverbeds. Experiments to determine viscosity were carried out at the following turbidity values: 0, 100, 150, 200, 300, 400 and 500 g/l.

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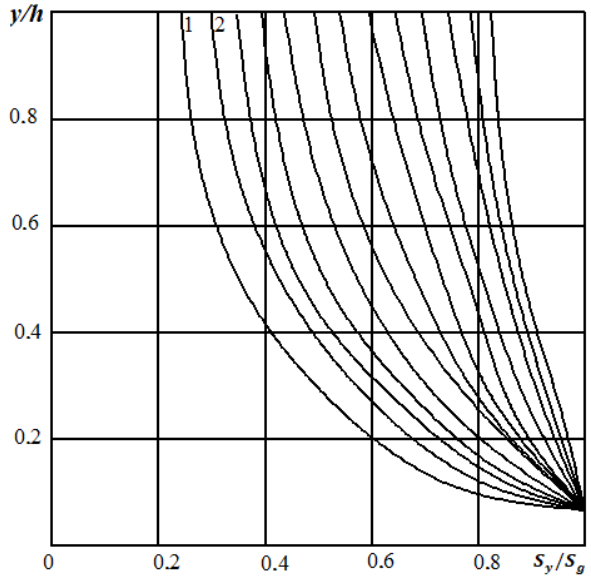


FIGURE 5. Turbidity profiles in experiments.

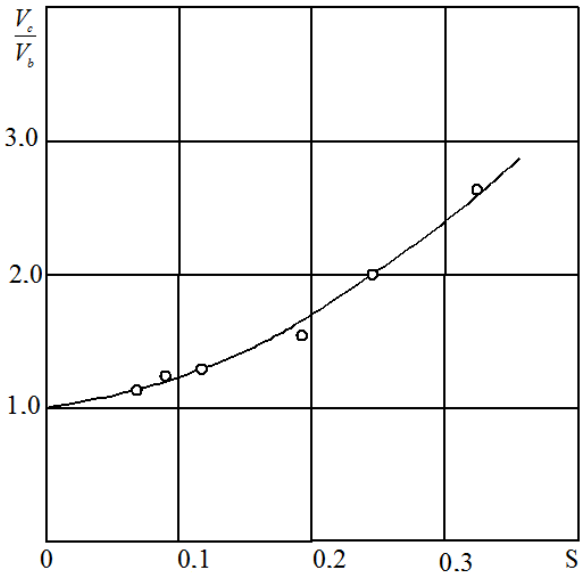


FIGURE 6. Dependency graph $V_c/V_b = f(S)$

In figure 6 the results of the experiments are presented in the form of a curve of the ratio of the kinematic coefficient of the mixture to the kinematic viscosity of water depending on the volumetric concentration of the mixture, determined by the ratio of the weight turbidity (g/l) to the volumetric weight of sediment (g/l):

$$s_{vw} = \frac{S^*}{\gamma}$$

The greater the increase in the kinematic viscosity coefficient, the greater is the saturation of the flow with sediment in the experiments. With the volumetric turbidity increase up to 0.15, a slight increase in viscosity was observed, then in experiments with a volumetric turbidity of more than 0.15 the value of that coefficient increased sharply.

CONCLUSIONS

In conclusion, it can be noted that additional experiments carried out obtained data on the movement of suspended flows with turbidity from 50 to 450 g/l. These data make it possible to develop calculated dependencies for the hydraulic characteristics of sharply changing turbulent flow of elevated turbidity and use them to compare calculated dependencies

1. The results of studies have established that with an increase in the turbidity of the flow to a certain value, an increase in the average velocity is observed; within a certain turbidity value, the flow velocity remains almost unchanged; with a further increase from this turbidity value, a decrease in the value of the average flow velocity is observed;

2. When a suspension-carrying flow moves along channels, three stages of velocity change were observed in experiments:

- Stage 1 - increasing flow rate with increasing turbidity. This stage in experiments extends to a turbidity of 130 g/l;
- Stage 2 - decrease in flow rate with an increase in turbidity more than 230 g/l;
- Stage 3 - decrease in flow rate with an increase in flow turbidity to more than 230 g/l;

3. Experiments obtained data on the movement of suspended flows with turbidity from 50 to 450 g/l. These data make it possible to develop calculated dependencies for the hydraulic characteristics of sharply changing turbulent flow of suspended turbidity and use them to compare the calculated dependencies.

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