



## Experimental Study on the Effect of Triangular Plate Barrier Height on Flow Velocity Distribution in Open Channels

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### Article Info

#### Article history:

Received 12 April 2021

Received in revised form 00

May 2021

Accepted 02 June 2021

#### Keywords:

Triangular Plate

Flow Velocity

Open Channel

### Abstract

Open and closed channel flow flows are distinct, the flow in the channels will constantly change. The flow will also be altered if the water level or flow velocity changes. It was found that employing the Pitot Tube Portable yielded findings identical to those calculated by other methods. A water transfer system is made up of natural or artificial structures via which water is moved from one site to another. The carrier building may be open or closed, depending on whether you want to utilize it as a shipping or receiving location. An open channel with a relatively narrow opening at the top is known as an open conduit. The speed data collection technique is carried out vertically, with a review point as illustrated above. The velocity of the flow was measured using a Pitot Tube Portable Automatic tool. The results are entered into the Froude number ( $fr$ ) after each review point to determine the type of velocity flow at each Review point. The normal flow velocity distribution pattern emerges at the measurement sites of 450 cm, 500 cm, and 550 cm.

## Introduction

As a general rule, in open or closed channel flow, the flow condition in all channels will vary. The channel's form may change owing to a change in the cross-sectional form, or it may change owing to a change in the form of the channel. When this happens, for example when the water level or flow velocity varies, the flow conditions will also be affected. When connected to an open channel, its properties such as channel latitude, roughness, bottom slope, turns, resistance, and flow rate and so on all allow for a change in flow velocity.

Carrier structures are natural or man-made structures through which water is transferred from one location to another. The carrier building may be open or closed, depending on how you want to use it. A channel which is open at the top is known as an open conduit, whereas a channel which is closed at the top is termed a closed conduit (Nezu, 2005). For open channels, rivers, irrigation canals, ditches, and estuaries are open channels, whereas tunnels, pipelines, aqueducts, and culverts are closed channels. Also, the ship canal is a closed waterway.

The shape of the free-flowing surface can be classified into several criteria, each of which applies based on whether the depth or velocity of the fluid has changed and/or on whether the fluid is moving steadily or rapidly after a fixed time interval (Mujumdar & Menon, 2020). In contrast, based on the spatial application, the flow is classed as either regular or non-regular.

If you're dealing with a non-permanent flow, you may be able to change the flow into a permanent one by referring to the moving reference coordinates. The visual simplification provides various benefits, such as an increase in visualizing capability, more convenience in

creating related equations, and the like. A simpler way of putting it is if the waveform doesn't change as it propagates. In contrast to this, in a channel with smooth, gradual transitions, the shape of the shock wave (also known as a surge) does not change, and as a result, a non-permanent shock wave flow can be converted into a permanent flow with reference coordinates that keep up with the absolute velocity of the shock wave. In this case, a person would have to be positioned next to the shock wave in order for the viewer to believe that the shock wave is at rest. This is known as a perpetual flow, and it may be regarded this way. If the shape of the wave varies throughout its transmission, then it is not feasible to translate the wave motion into a permanent flow. For instance, a flood wave that is able to propagate naturally inside a river cannot be converted into a permanent flow because the wave shape is changed throughout the flood wave's voyage on the river flow.

When the velocity of the flow at a particular point in time does not vary, the flow is uniform flow; however, if the velocity of the flow fluctuates over time, the flow is non-uniform flow or variable flow. It depends on the rate of change in velocity with distance: if that rate of change remains constant, the flow may be classed as a graded constant flow, whereas if that rate of change varies, the flow is defined as quickly variable flow.

If the fluid particles move along a certain route and the flow looks to be as if there were sheets or fibers separating the particles, the flow is referred to as laminar flow (Buetehorn et al., 2011). While turbulence may happen if particles have a route that is random in space and time, it is also possible for the flow to be turbulent if the particles' journey follows an irregular pattern. The key determinant of the current state of flow is the relative magnitude of the viscous and inertial forces (Hathcock, 2006). In the event that the viscosity is more powerful, the flow is in laminar. Inertial forces dominate in this case, since the flow is turbulent. In this formula, viscous force is the force on the fluid (i.e. the friction), and inertia is how much the fluid resists this force (i.e. its resistance) ( $Re$ ).

Due to the open channel's free surface and the friction on the channel's walls, the velocity of fluid in the channel varies greatly throughout the cross section. Underwater, the velocity on the wall or bottom of the channel is zero, while the maximum velocity does not occur on the free surface, but occurs beneath the free surface as deep as  $0.05h$  to  $0.25h$ . Besides the channel's cross-sectional form and the channel's roughness, the flow rate relies on numerous other elements, namely the geometry of the channel. On the free surface, the fastest velocity occurs in channels that have a rapid current and a shallow bottom, and in channels that have a slippery bottom. Forcing the flow in the channel to be more turbulent results in an increase in the flow curvature in the vertical velocity division (Engel & Rhoads, 2012; Parsons et al., 2005; Miori et al., 2012; Shen et al., 2003).

The theoretical research projects to identify a mathematical equation for the spread of the average speed include dividing the domain into two halves, the inner area and the outside area (Chen et al., 2012). For values of  $z/H \leq 0.2$ , the velocity difference is much larger in the inner area. Flow velocity is influenced by shear stress, flow characteristics, bed hardness, and the depth of the channel bottom. When it comes to the velocity difference outside of the outer boundary, the magnitude is just 0.2 but is hardly noticeable and the velocity value is based on the maximum velocity, flow depth, and velocity gradient, but it does not factor in viscosity and basic hardness. In general, the flow velocity in a channel will differ substantially from the surrounding places. This is owing to the presence of shear strains at the bottom and on the wall of the channel, as well as the existence of a free surface. Changes in distribution of data speeds across different channel geometries.

Density currents are crucial from several angles. For instance, they greatly affect the sediment transfer on land, in lakes, oceans, and even the deep ocean. Consequently, their management is essential. The concentration of turbidity currents impacts the quantity of sedimentation, for example in reservoirs, and results in decreased storage capacity. In order to limit the density current, a variety of approaches are utilized, including the usage of resistance. When investigating the surroundings in the field, structures such as the Gronsil, Krib, and Sabodam are almost always square in form. This leads to a lower-than-normal chance of finding a triangle-shaped control building.

Thus, this study is aimed to exhibit and exhibit a phenomena by constructing a flow model in the laboratory using a flume and doing tests to observe the changing circumstances of the flow pattern of a fluid that flows past a triangular plate-shaped barrier that varies in height.

### Methods

This research is an experimental research, and this test was conducted out with three different discharge, two different triangular plate height configurations, as well as a plate height of 6 cm and 9 cm. This investigation also implements a variant of the slope, which has the goal of measuring flow distribution patterns both before and after the triangular plate in the open channel.

### Results and Discussion

Table 1. Inlet Discharge Calibration with Thompson

Faucet Aperture	Water Volume (cm <sup>3</sup> )	Time (seconds)				Water level y (mm)			
		t <sub>1</sub>	t <sub>2</sub>	t <sub>3</sub>	t <sub>average</sub> -2	1	2	3	average -2
30°	15422,4	2,11	2,07	2,14	2,11	400,00	400,00	400,00	400,00
	27798,4	3,96	3,82	3,88	3,89	400,00	400,00	400,00	400,00
	38460,8	5,28	5,20	5,13	5,20	400,00	400,00	400,00	400,00
90°	15422,4	1,52	1,48	1,39	1,46	415,00	415,00	415,00	415,00
	27798,4	2,65	2,70	2,78	2,71	415,00	415,00	415,00	415,00
	38460,8	3,79	3,82	3,84	3,82	415,00	415,00	415,00	415,00
90° + 30°	15422,4	1,14	1,02	1,14	1,10	430,00	430,00	430,00	430,00
	27798,4	1,90	2,03	1,97	1,97	430,00	430,00	430,00	430,00
	38460,8	2,83	2,83	2,72	2,79	430,00	430,00	430,00	430,00

Faucet Aperture	V	t	Qa	y	Hw	Qt	Cd	Q	Q rata2
	(cm <sup>3</sup> )	(sec)	cm <sup>3</sup> /det	(cm)	(cm)	cm <sup>3</sup> /sec		cm <sup>3</sup> /sec	m <sup>3</sup> /sec
	15422,4	2,11	7320,76	40,00	10,00	7470,48	0,980	7320,76	
30°	27798,4	3,89	7152,25	40,00	10,00	7470,48	0,957	7152,25	0,0073
	38460,8	5,20	7391,57	40,00	10,00	7470,48	0,989	7391,57	
	15422,4	1,46	10539,23	41,50	11,50	10594,80	0,995	10539,23	
90°	27798,4	2,71	10257,71	41,50	11,50	10594,80	0,968	10257,71	0,0103
	38460,8	3,82	10077,07	41,50	11,50	10594,80	0,951	10077,07	

	15422,4	1,10	14020,36	43,00	13,00	14394,83	0,974	14020,36	
90° + 30°	27798,4	1,97	14134,78	43,00	13,00	14394,83	0,982	14134,78	0,0140
	38460,8	2,79	13768,78	43,00	13,00	14394,83	0,957	13768,78	

To get the average velocity, divide the cross-sectional width into three segments (B) and take three depth measurement points, which are points of depth equal to 0.2 d, 0.6 d, and 0.8 d. These measurements are done with a Pitot Tube Portable Automatic measuring instrument, which is a tool that measures flow pressure at a point of depth and then converts the value of the high-pressure difference into flow velocity. Pressure measurements and speed conversion results show up in the tables included in the sections titled "Table 4", "Table 5", "Table 6", and "Table 7". This tells us that in LQ1S0, the average speed is 23,338 cm/s, in LQ2S0, it is 26.048 cm/s, and in LQ3S0, it is 28,905 cm/s. This validation was done using the Manning and Chezy empirical equations, and the results of this validation may be seen in tables 10, 11, and 12. These findings from monitoring the tool's speed are same in all variations, hence the discharge speed validation in each one produced the same findings. A Manning validation method includes a basic roughness coefficient of 0.01, which is obtained by going through the Manning coefficient table (n).

Table 2. Validation of Flow Rate (Q3)

LQ1S0						
	Manning				Chazy Manning	
b	40,00	cm		b	40,00	cm
D	12,80	cm		D	12,80	cm
A	512,00	cm <sup>2</sup>		A	512,00	cm <sup>2</sup>
R	7,80	cm		R	7,80	cm
n	0,01			n	0,01	
V	28,90547	cm/sec		C	140,8405	
Q	14799,60	cm <sup>3</sup> /sec		V	28,90547	cm/sec
	0,0148	m <sup>3</sup> /sec		Q	14799,6	cm <sup>3</sup> /sec
					0,0148	m <sup>3</sup> /secs

From the calculation results using the Pitot Tube Portable Automatic measuring instrument with empirical formula validation, it shows the average velocity value for each flow rate, proving that the empirical formula results are almost the same as the velocity obtained from the conversion of the Pitot equation.

An equation derived from the study data indicates that the Fr number (Fr) flow rate may be estimated using the equation (2). Flow measurements are computed at each location of measurement. In order to compute the vertical depth, Froude number calculations are made for each specific point of view (fr). By seeing the changes in flow characteristics after passing through a 6 cm and 9 cm high triangular plate, the Q2 and the point 425 cm become a comparison of differences in flow characteristics before and after the resistance and a comparison of differences in flow characteristics after the flow has passed through a 6 cm and 9 cm high triangular plate.

The speed data gathering procedure is carried out vertically, with a review point located in the flow velocity computation table as shown above. The flow velocity was measured using a Pitot Tube Portable Automatic tool, and then the data were converted to pressure and pressure difference to determine the velocity and the resulting velocity change at each review point at the depth of flow. After each review point, the velocity results are entered into the Froude

number ( $fr$ ) in order to get the type of velocity flow at each review point, the Froude value ( $fr$ ) can be found in tables 14, 15, and 16 which lists the prior flow type before the obstacle is subcritical with a value of the average Froude ( $fr$ ) = 0.27 and after the presence of a 6 cm high triangular plate resistance Froude value = 0.28 and a 9 cm high triangular plate resistance has a Froude ( $fr$ ) = 0.33 value.

Before the resistance plate was added, velocity measurements were taken, and these data revealed that the flow pattern created at each measurement point was the same with the highest velocity happening at a depth of 0.6  $d$  below the measurement site. The velocity pattern indicates an average of 23,338 cm/s, which LQ1S0 has reached at 23,339 cm/s, LQ2S0 has reached at 23,838 cm/s, and LQ3S0 has reached at 25,804 cm/s. Additionally, the velocity pattern at each measurement point shows the same pattern.

The velocity distribution pattern on the 6 cm high plate depicts the declining flow velocity distribution pattern at a depth of 0.2  $d$  and the typical flow velocity distribution pattern appears at the measurement locations of 450 cm, 500 cm, and 550 cm. A downward flow velocity distribution pattern on the 9 cm high plate is seen. It seems that it's an exponential distribution pattern that starts low and becomes taller. The return to normal seems to occur when the measurement locations, 500 cm and 550 cm, are reached.

## Conclusion

A preliminary look at the flow velocity distribution in the region between the triangular plate resistance shows that the highest flow velocity pattern occurs on the surface of the flow, which reduces to the bottom of the channel at the 9 cm high triangular plate resistance. The flow velocity pattern between the 6 cm high plate resistance and the bottom of the channel gradually diminishes, ending at the low triangular plate resistance, which has a depth of less than the height of the high triangular plate. an increase of 9 centimeters When the flow meets the obstruction, the flow is in a subcritical state, where there is little or no viscous flow (viscosity has been almost eliminated in the flow, and viscosity measures the presence of viscous flow).

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