FLOW CHANNEL APPARATUS

INSTRUCTION MANUAL

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Ambros

VISUALISATION OF STREAMLINES IN OPEN CHANNEL

AIM:

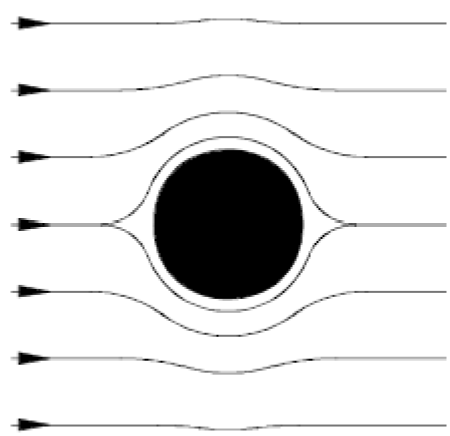
- Visualization of streamlines when flowing around through various drag bodies.

THEORY

The flow of fluid (such as water) around a body can be observed by making the streamlines visible. In the case of stationary flow, the streamlines coincide with the flow lines, i.e. the paths of motion of the individual fluids.The closer the proximity of the streamlines, the greater the flow velocity.

Flow configuration – Cylinder

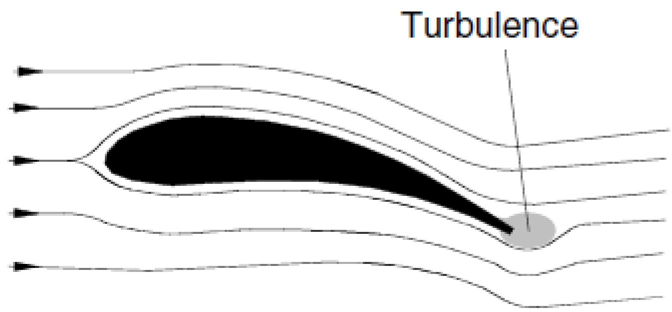
Fig. illustrates the circulation around the cylinder. It is apparent that the flow around the body is smooth. The pattern of the streamlines is symmetrical and shows no turbulence or stalling. The approximation of the streamlines indicates the areas with higher velocities.



Flow configuration around an aero foil

The circulation of fluid around an aero foil (Fig.) clearly shows that the flow configuration is relatively small. However, the turbulence will increase as the Reynold's number *Re* decreases:

$$Re = W\ I \frac{\rho}{\eta}$$



- Re : Reynold's number
- W : Flow velocity in m/s
- L : Length of aerofoil in m
- ρ : Density of water in kg/m3(at 20°C ρ=890kg/m3)
- η : Dynamic viscosity in kg/ms (η=1.002 · 10-3 kg/ms)

The approximation of streamlines on the top of the profile and the contrasting larger intervals on the bottom demonstrate the differences in pressure.

Like these drag bodies other bodies of different shapes are also supplied and can be investigated as well.

DESCRIPTION OF THE UNIT

- The unit can be used to visualize flow around drag bodies and flow phenomena in open channels.
- Either a drag body or weir is fixed in the experimental flume. The streamlines are made visible by injecting a contrast medium. The experimental flume is made of transparent material so that the streamlines and the formation of vortices can easily be observed. The water level in the experimental flume can be adjusted via a gate at the outlet.
- There are two weirs and four different drag bodies available for the experiments.
- The experimental unit is positioned easily and securely on the work surface of the Hydraulic bench module. The water is supplied by Hydraulic bench. Alternatively, the experimental unit can be operated by the laboratory supply.

The unit consists of following parts:

- Tank for constant head
- Overflow
- Experimental flume
- Drag bodies and weirs (sharp and broad crested weir), cylinder, streamline body, guide vane
- Tank for contrast medium
- Distributor for contrast medium

PROCEDURE

- Place the unit on the hydraulic bench
- Adjust the height of the dye tank
- Place the syringes at the inlet of the experimental flume section
- Fill the dye tank with diluted tank. Don't make the dye thick as it may block the syringes
- Place the desired drag body or weir to be investigated in the experimental flume
- Connect the hose connection from hydraulic bench to the inlet of the tank and fill the tank
- Adjust the gate at the outlet of the experimental flume
- slowly open the metric valve of the dye tank and allow the dye to flow through water channel
- Adjust the flow of water and make it laminar so that straight lines can be observed
- Observe the streamlines through weirs or drag bodies and evaluate the result

EXPERIMENT – FLOW OVER WEIRS

OBJECTIVE:

- To study the flow over weirs in a flume channel.

AIM:

- To find the value of co-efficient of discharge of broad-crested weir, sharp crested weir & ogee weir.

THEORY:

A weir having a broad-crest is known as a broad-crested weir. In this case, the sheet of water flowing over the crest is supported by the surface of the crest. Experimental studies have shown that if the width of the weir crest, $B \geq 2.5H$ but $\leq 10H$, the weir will behave as a broad crested weir (where H is the maximum head under which the weir is supposed to operate). Further, as water approaches weir, its surface becomes curved with convexity upwards and the wider width of the crest ensures that streamlines are parallel to the crest. Due to the height of weir, streamlines upstream of weir are displaced outward resulting in deviation from hydrostatic pressure distribution.

A broad crested weir is generally used for the measurement of discharge in large open channels and is generally referred to as a critical depth meter. In this case, the flow depth at the crest adjusts itself (equal to the critical depth) so as to have maximum discharge for a given value of the total head.

- Discharge over a broad-crested weir can be calculated using the following expression:

$Q = C_d 1.705 LH^{(3/2)} m^3/s$ .... **(eq1)**

where L is the effective length of the weir crest, H is the head acting on the weir (neglecting velocity head) and Cd is the coefficient of the discharge.

- Equation (1) can be expressed in general form as:

$Q = C_d CH^{(3/2)} = KH^{(3/2)} m^3/s$ .... (eq2)

Where $K = C_d C$ and $C = 1.705L$ and is constant for the weir.

OBSERVATION & CALCULATIONS:

DATA:

- Broad crested weir (L =0.5m, B=0.240m)
- Sharp crested weir **(L** =0.5m, B=0.240m**)**

OBSERVATION:

OBSERVATION TABLE:

S.No	y_i	y_f	Q
1.			
2.			
3.			

CALCULATIONS:

$$h = \frac{h_1 - h_2}{100}, \text{ m} = \text{-----------------m}$$

$$Q_{act} = \frac{Q}{1000}, \text{ m}^3\text{/sec} = \text{------------------ m}^3\text{/sec}$$

BROAD CRESTED WEIR

$$H_1 = (y_f - y_i), \text{ m} = \text{-----------------m}$$

$$Q_{th} = 1.705 L H_1^{\left(\frac{3}{2}\right)}, \text{ m}^3\text{/sec} = \text{------------------ m}^3\text{/sec}$$

$$C_d = \frac{Q_{act}}{Q_{th}}$$

Sharp Crested Weir

$H_3 = (y_f - y_i)$, m = -----------------m

$$Q_{th} = 53.92 L H_3^{\left(\frac{3}{2}\right)}$$, m^3/sec = ------------------ m^3/sec

$$C_d = \frac{Q_{act}}{Q_{th}}$$

NOMENCLATURE:

g	=	Acceleration due to gravity, m/sec
L	**=**	Length of the broad-crested weir
B	=	Width of the broad-crested weir
H	=	Head
y_i	=	Initial pointer gauge reading at the flume bed
y_f	=	Final pointer gauge reading at the flume bed
Q_{act}	=	Actual Discharge
Q_{th}	=	Theoretical Discharge

NOTE: FOR THE VISUALIZATION OF FLOW THE DISCHAGRE SHOULD BE MINIMUM.