IMPACT OF JET TEST RIG

AIM

The objective of this experiment is to verify the momentum conservation law.

EXPERIMENTAL SETUP

The setup mainly consists of a nozzle of about 10 mm in diameter fitted to a pipe of 50mm diameter. The jet of water issuing from nozzle strike a flat plate of about 100mm diameter placed at some distance to a nozzle (Figure 1). A force acts on the plate by which the shaft moves up. A weight W is placed on the pan P to counter-act the force F due to momentum transfer, on the plate. The plate again comes back to its original position. The force F acted by the jet on the flat plate is equal to the weight W.

The discharger, which falls in the tank after striking the flat plate, is used to measure the discharge by volumetric method

THEORY

Whenever the velocity of a stream is changed either in magnitude or in direction, a force is required to bring this change.

The law of momentum conservation states that the summation of all the externally applied force on a given volume is equal to the rate of change of momentum brought in the direction of forces. In order to calculate the force caused by impact of jet onto a flat plate, principle of change in momentum is applies, i.e.,

$$\sum F_x = \rho Q (V_{in} - V_{out})$$

Where $\sum F_x$ is the summation of all the forces acting in X-direction, similar equations also be written in Y and Z direction.
ρ is the density of water (= 1000 Kg/m^3)
Q is the volumetric flow rate of fluid, m^3/s.

Volumetric flow rate in the above equation is calculated by taking the volume of fluid within a specified time.

$$Q = \frac{v}{t}$$

V_{in} is calculated based on the velocity at the nozzle which is determined using the volumetric flow rate and the diameter of nozzle (dia = 10 mm):

$V_{nozzle} = \frac{Q}{A};$

$V_{in}^2 = V_{nozzle}^2 - 2gS,$

Where;
g: the gravitational acceleration (9.81 m/s^2);

S: the distance between the jet and the plates.

V_{out} generally equals $V_{in} \cos \theta$, where θ represents the change in direction of the jet. Since the jet of the fluid turns by right angle when striking a flat plate
For the flat plat $\theta = 90\circ$, so that $V_{out} = 0.0$

The predicted values for the force is thus given as

$$\Sigma F_x = \rho Q V_{in}$$

PROCEDURE

1. Switch on the power and start the motor.
2. Mark the position of vertical lever and horizontal arm when there is no weight on the pan.
3. Open the inlet valve so that jet of water strikes the flat plate at its center. The lever is deflected to one side.
4. Put a weight W on the pan so as to bring the lever in its original position as marked in step1.
5. Measure the discharge Q by volumetric method.
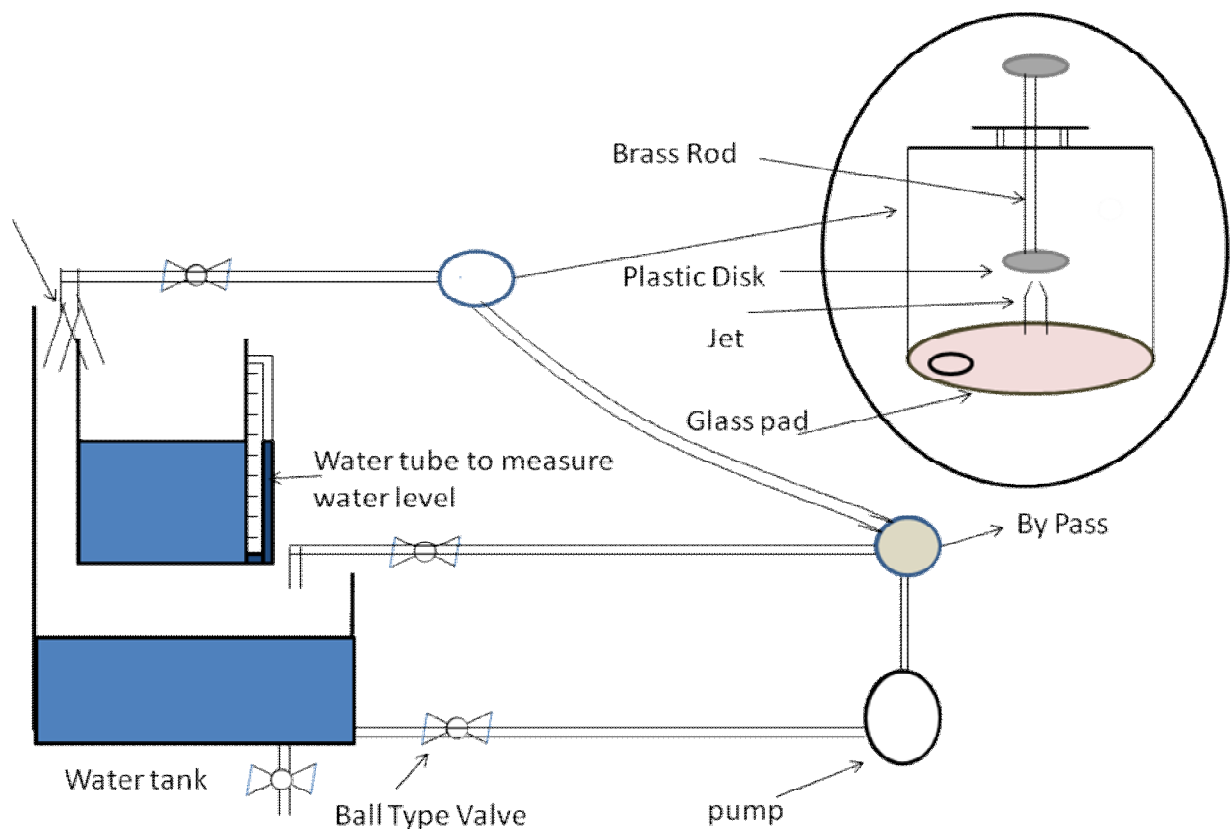6. Repeat step 2 and 4 for various other discharges.

Figure 1: IMPACT OF JET TEST RIG

OBSERVATION TABLE

Sr No.	Distance moved	Weight on pan	Volume (liters)	Time (sec)	Q, m³/s	V_nozzle, m/s	V_in , m/s
1.							
2.							
3.							
4.							
5.							
Average							

S no.	Inlet Area (A)	F1, Theoretical (N)	F1 actual (N)	% error
1				
2				
3				
4				
5				
Average				

FORMULAE USED

$$F_{th} = \rho * AV^2$$

$$V = \frac{Q}{A}$$

ρ = specific weight of water, where A is inlet area.

$$F_{th} = \rho * A * \frac{Q^2}{A^2}$$

$$F_{th} = \rho * \frac{Q^2}{A}$$

$$F_{act} = (weight of pan + weight on pan) * 981$$

$$\%error = \frac{F_{act} - F_{th}}{F_{th}} * 100$$

OBSERVATIONS

- Diameter of nozzle = 10 mm
- Area of nozzle = $7.8 \times 10^{-5}\ m^2$
- Sump tank = $(0.3 \times 0.3 \times 0.9)\ m^3$
- Area of tank = $0.09\ m^2$
- Weight of plate flat w1 = 0.06 kg
- Weight of curve w1 = 0.05 kg
- Weight of pan with rod w2 = 0.44 kg

CONCLUSION/DISCUSSION ON THE RESULT:

1. Write down the observations.

2. Try to explain the results from theory studied earlier

FURTHER READING

1. Introduction to Fluid Mechanics 8th Edition, by *Fox*, Robert W. and *McDonald*, Alan T. Chapter 4.

TEACHING ASSISTANT: