EXPERIMENTAL STUDY ON SINGLE AND DOUBLE SCREEN TYPE ENERGY DISSIPATOR FOR HYDRAULIC STRUCTURE

A DISSERTATION

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I UJJAWAL KUMAR SINGH, ROLL NO 2K16/HFE/19 of M.Tech(Hydraulic And Water Resources Engineering) hereby declare that the project Dissertation titled" **EXPERIMENTAL STUDY ON SINGLE AND DOUBLE SCREEN-TYPE ENERGY DISSIPATOR FOR HYDRAULIC STRUCTURE**" which is submitted by me to the Department of Civil Engineering, Delhi Technological University in the partial fulfilment of the requirement for the award of the degree of "Master of Technology" is original and not copied from any sources without proper citation. This work has not previously formed the basis for the award any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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CERTIFICATE

I hereby certify that the Project Dissertation titled ”EXPERIMENTAL STUDY ON SINGLE AN DOUBLE SCREEN TYPE ENERGY DISSIPATOR FOR HYDRAULIC STRUCTURE” which is submitted by Ujjawal Kumar Singh, Roll No 2K16/HFE/19 Department of Civil Engineering,Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology is record of the project work carried out by the student under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

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ABSTRACT

Laboratory experiments have shown that screens or porous baffles with a porosity of about 50-60% can be used as effective energy dissipators below small hydraulic structures, either in a single wall, a double wall with the different angles at 45º, 90º and 135º. The experiments were carried out for a range of unstable flow Froude numbers (F_1) from about 1.5 to 6, and the relative energy dissipation is comparatively larger than that produced by the hydraulic jumps. The iron sheet screens or porous baffles creates free hydraulic jumps, imposed hydraulic jumps, and in some cases submerged jumps. The downstream flow was found to be supercritical flow and tail water depth after leaving the screen is equal to the .79 times to y_2.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Symbol	Title
a	Gate opening
F	Froude Number
y_1	Depth of supercritical flow before jump
y_2	Depth of subcritical flow after the jump
Q	Discharge
V_1	Mean velocity before jump
V_2	Mean velocity after the jump
g	Acceleration due to gravity
L_j	Length of jump
ΔE	Energy loss
V_d	Mean velocity
S-90º	Single screen at 90º
S-45º	Single Screen at 45º
S-135º	Single Screen at 135º
D-90º	Double screen at 90º
D-45	Double Screen at 45º
D-135	Double screen at 135º

CHAPTER 1

INTRODUCTION

1.1 General

The hydraulic jump is defined as that it is a phenomenon that happens when supercritical flow is imposed to change to subcritical flow by an obstacle to the flow. This immediate change in flow condition is companied by considerable amount turbulence and loss of energy. It has drawn wide attraction for many years not only in its importance to of its design in stilling basins and other hydraulic engineering works but also because of its attractive difficulty. By many years of research work many of its hydraulic design and feature are well know and can understand.

In the classical jump the water depth starts rising suddenly at the beginning of the stream, or downstream of the jump, which rotates about an average position, and it continues to go up to a section further which it is necessary to level. This section denotes the end of the jump. For having a jump, there should be a flow hindrance at the downstream. A weir, a bridge abutment, a dam or simply channel friction are being made on downstream impediment. Water depth rises at the time of a hydraulic jump and energy is a loss or dissipated as turbulence. Often, there is always install impediments in channels in order to force jumps to occur by the engineers. Some chemicals coagulant is being mixed in water treatment plants is often aided by hydraulic jumps. At the downstream channel in the spillway, the concrete blocks might be installed in order to force a jump for reducing the velocity and the energy of the water. Flow will go from supercritical flow when Froude number is bigger than 1 to subcritical flow where Froude number is lesser than 1on a jump. At the beginning of the jump, turbulent eddies of large sizes are formed which extract energy form the mean flow. The bigger sized eddies are split up into the smaller ones and the energy is transferred from the larger eddied into the smaller ones. The smaller eddies are responsible for the dissipation of turbulence energy to the heat energy.

Nowadays, triple and double screens have been used to prevent form soil erosion alongside roads drain and on sloped surfaces. In the triangular screen device, a very hard and stiff screen with a porosity of approximately about 60% is bent to create the two sloping sides of a triangle with an included angle of about 60º this screen is placed perpendicular across the super-critical flow in which the ditch and surfaces are present. As the water in the supercritical state flows passes from the iron sheet screen, a pool of water forms inside the triangle, that force the formation of a free or impose hydraulic jump upstream of the screen and creates relatively energy loss. This device seems to be work with the tail water depth. The same experimental study is also done on the double screen, in that representation two iron sheet screens are placed together at space of about 5 mm between them. Perhaps laboratory work with these iron sheet screens suggested that these devices, with proper changes or modification, might be useful for energy dissipation below small hydraulic structures. Hence, some exploratory experiments were performed to understand the nature of energy dissipation provided and the effect of the supercritical Froude number and tail water depth.

Contrary to the belief that the use of stepped channels for energy dissipation purposes is a new concept (developed along with the introduction of new construction techniques, e.g., roller compacted concrete, gabions), stepped chutes have been used since antiquity. Stepped channels were designed to contribute to the stability of structures (e.g. overflow weir) and to dissipate flow energy. In fact, the technique of stepped channels was developed independently by several ancient civilizations.

The main series of experiments were performed in a horizontal rectangular channel 0.31 m wide, 0.40 m deep, and 8 m long. The flow was provided by a head tank with a sharp-edged sluice gate, and the tailwater depth could be controlled by a tailgate provided at the downstream end of the flume. The flow rate was measured with a magnetic flow meter provided in the supply line feeding the head tank A hard plastic screen with approximately square holes (of 5 mm sides) and an areal porosity of 50-60% was used to make the single, double, and triangular screens. The screen device was mounted perpendicularly across the flume at a distance of 1.5 m from the gate. In these experiments, the tailgate was not used to control the downstream or tail-water depth.

1.2 Objectives of the Study:

The objectives for the present study are:

- **i.** To develop an experimental setup and conduct the study for analysis of hydraulic jump.
- **ii.** To investigate experimentally the relative energy dissipation between classical hydraulic jump and forced hydraulic jump produced by the screen type energy dissipator either in single or double wall mode.
- **iii.** To compare the tailwater depth in downstream after the classical hydraulic jump with the forced hydraulic jump.

1.3 Energy Dissipation

A hydraulic jump is produced upon impact of an upstream flow free falling from a weir into a downstream stilling basin. A large amount of kinetic energy is consumed in a hydraulic jump when the upstream flow impacts upon the downstream channel. Hence, energy dissipation is characteristic of a hydraulic jump.

1.4 Energy loss

Although momentum is conserved throughout the hydraulic jump, the energy is not. When the flow jumps from supercritical to subcritical depths there is an initial loss of energy. This loss of energy is equal to the change in specific energy across the hydraulic jump and this is given by the equation for delta E.

1.5 Energy Dissipator

To prevent scour and erosion of the toe of a dam, as well as the downstream channel, energy dissipaters are provided to dissipate sufficient amount of energy before water enters the downstream channel. The flow velocity at the toe of a high-head spillway is usually around 32-35 m/sec. This high velocity may cause serious scour and erosion of the downstream channel if proper precautions are not taken. The common types of energy dissipators which are used as outlet structures in spillway design are:

1.7 Stilling basin

The stilling basin structure comes in several forms and is designed to dissipate the energy of the flow by utilizing the development and enhancement of the hydraulic jump within the basin. This is a solution for dams up to 60-70 m high. The location of the hydraulic jump is important for determining the length of channel requiring protection.

1.8 Screen type energy dissipator

A permeable or porous baffles used as an energy dissipator for hydraulic structure. In this experiment we used an iron sheet with the porosity of 50-60% that means only 50-60% water can pass through the screen, which dissipates the energy because of energy loss due to the screen.

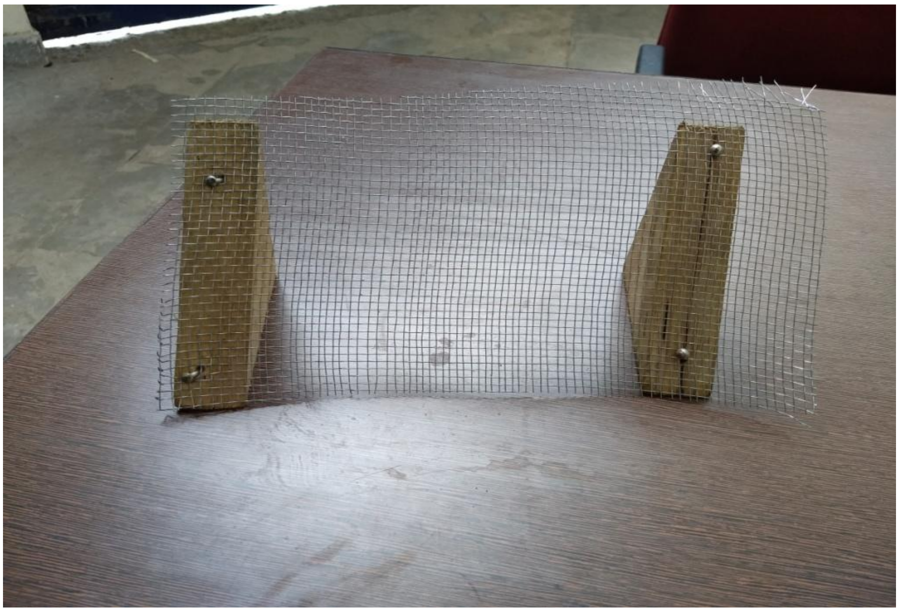


Fig. 1 Screen type Energy Dissipator

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the field of hydraulic engineering hydraulic jump has broadly been studied. It is a fascinating and interesting phenomenon that has caught the views of many researchers gone into the study of this subject. The results of the analytical treatment by Belanger in 1828 are still valid. The literature on this topic is vast and ever-expanding. The main reason for such continued interest in this topic is its immense practical utility in hydraulic engineering and allied fields.

N.Rajaratnam And M.R Chamnai (2010) presented a view on energy loss at the drops which is very critical view on energy loss. They gave the view that when there is a mixing of the fast flow with the pool behind the flow This work has also indicated that the loss at a drop is mainly due to the mixing of the jet with the pool behind the jet.

Jen-Yan Chen, Shi -l Liu and Yuan-Ya Liau (2012) they studied and derived equations for calculating the energy loss or amount of energy dissipation of a hydraulic jump in a free fall. And further their equations and formula is used in this field to examine the energy loss in hydraulic jump.

Sandip P.Tatewar & N.Ingle M.Ish(2012) gave the conclusion that in when there is a reduction of the stilling basin size which is provided in the Stepped spillways, and they studied about the manufacturing cost for the cost and estimation purpose that to reduce the manufacturing cost of the spillway and the energy dissipation devices.

N.Rajaratnam, Zahid Islam, Hasan Zobeyer(2010) there were a experiment conducted to measure the turbulence characteristics at the end of the jump to open channel flow or in a rectangular channel. And in this experiment an acoustic Doppler velocimeter was used to measure mean velocities, turbulent intensities, Reynolds stress and kinetic energy of maximum two Froude Number. The range of the supercritical Froude Number is from 4 to 8.

Talib Mansoor(2014) explained the discharge through irrigation canals is commonly controlled by means of sluice gates. In order to increase the efficiency of sluice gate, it can be placed obliquely to the flow .

N.Rajaratnam & K.I Hurting (2000) performed and examined Laboratory experiments to show that plastic screens or holes baffles with with a porosity of about 40% which means only 40% flow of water can be passed from the screen and it helps to dissipate the energy under the small hydraulic structure and used as effective energy dissipator and they used as single and double wal mode. They performed the experiments for the supercritical flow Froude number at the range of 3 to 10.

Youngkyu Kim, Gyewoon Choi, Hyoseon Park and Seongjoon Byeon(2009) they explained the control of flow which can generated by a sluice gate, for the investigation they exmined the energy dissipaters for there power in some relation with the different locations where they can placed and there height.

Dr.Thulfikar Razzak Al- Husseini(2015) in this research paper in way to find the specified efficiency of energy which dissipating from flow and after that they trying upgrade it for a new and novel strory.

Bozkus Zafar,Cakir Pinar & Ger Matin(2002) in this research paper the downstream flow is stimulating the water flowing below the gate and it is an alternate option or device for energy dissipation. As we known that the major parameters like the porosity, thickness, and the location of the screens are together with the upstream flow Froude number. The experiments study was studied in a range of Froude numbers between 3 and 15, porosities between 21% and 65%, and the placements of screen up to 100 times of the undisturbed upstream flow depth .

George C.Christodoulou(1993) in this study they had done potentially high energy dissipation on stepped overflow spillways would imply a significant reduction of the size of downstream stilling basins .

Johannes Oelerich and Hans-Henning Dette(2016) They study on dissipation was computed using several analytical and empirical approaches and compared with prototype measurements in the Big Wave Flume (GWK) in Hannover as well as with field measurements from the west coast, of the Island of North Sea .

N.Rajaratnam & David Z.Zhu(2016) Energy dissipation is one of the main considerations in the design of drop manholes and is closely related to the flow regimes observed. Four flow regimes in a drop manhole are classified according to different flow conditions at the inlet and outlet: free over fall flow, orifice flow, pressurized outflow, and fully submerged manhole condition .

Donatella Cannizzaro and Giuseppe Pezzinga(2000) their aim is rectify that they can imputed to thermal exchange of gas bubbles between the nearby liquid or to gas release and mixed process and also examine the non friction less energy dissipation in transient flow.

Stefan Felder and Hubert Chanson(2011) in this research paper there is that conclusion that the most of the stepped spillway design are modified for a uniform step height and for non uniform spillway designed may be a practical alternate in some cases. A physical study was conducted in a moderate slope-stepped chute (1V:2H) and five stepped configurations were tested for $0.6<dc/h<1.8$ .There is a proper detailed air and water flow measurements which is performed for each specification and the given result were these compared in the terms of flow patterns, energy dissipation, and flow resistance

Aslankara and Bozkus (2016) they investigated in this research paper that Froude number range from 4 to 20 has an effect of the tail water depth on energy dissipation. And they proved that in energy dissipation there is no role of tail water depth. However, they also explained in their paper that number of screen dissipator has more energy loss as compared to single screen.

Bashir Tanimu(2010) in this research paper the study of energy dissipation takes place in different geometries of stepped spillway**.** For the experiment he made models which is made from woods and having a chute angle of 45,its height is 24 cm, step height 4cm and there are six number of steps. Varied flow discharge were applied to the each model of geometry and Calculated the energy dissipation by the hydraulic parameter and compared. And this result gives the details about effect of steps geometry on energy dissipation stepped chute is significant as as the energy loss ration to upstream energy varies from 48% to 69%.

2.2 Applications of Hydraulic Jump

To prevent the objectionable scour in the downstream channel from the hydraulic jump to dissipate the energy below sluiceways, weirs, gates, etc. The high energy loss that occurs in hydraulic jump has led to its acquiring as a part of the energy dissipator system below a hydraulic structure. Where the energy dissipation is intentionally allowed to occur by which the outgoing stream at the downstream part of the hydraulic structure can safely be conducted to the channel below is called as a stilling basin. It is a fully cover channel and may have additional appurtenances, such as baffle blocks and sills to aid in the efficient performance over a wide range of operating conditions.

2.3 formation of Hydraulic Jump

The hydraulic jump is defined as that it is a phenomenon that happens when supercritical flow is imposed to change to subcritical flow by an obstacle to the flow. As we know that at tail water or downstream we can regulate the Subcritical and as well as by upstream we can regulate the supercritical flow. By this handling of control fixes there depth and discharge relationship in this own way. It also fixes the behaviour of upstream and downstream flow at the certain distance. So that by which subcritical flow is produced by the upstream and super critical produced by the downstream. There is a different kind of opinion can be solved when the upstream is going to deal with supercritical flow and downstream can regulate the subcritical.

2.4 Classical Hydraulic Jump

Hydraulic jump in a rectangular channel, also known as classical jump, is a natural phenomenon that occurs whenever flow changes from supercritical to subcritical flow.There are common hydraulic jumps that occur in everyday situations such as during the use of a household sink.And the main characterstics of classical hydraulic jump are given below.

2.4.1 Main Characteristics

In the classical jump the water surface starts rising suddenly at the beginning, or toe, of the jump, which fluctuates about a mean position, and it continues to rise up to a section beyond which it is essentially level. This section denotes the end of the jump. The supercritical depth at the beginning is called represented as y_1 which is termed as initial depth and the subcritical depth at the end is represented as y_2 which is termed as sequent depth.

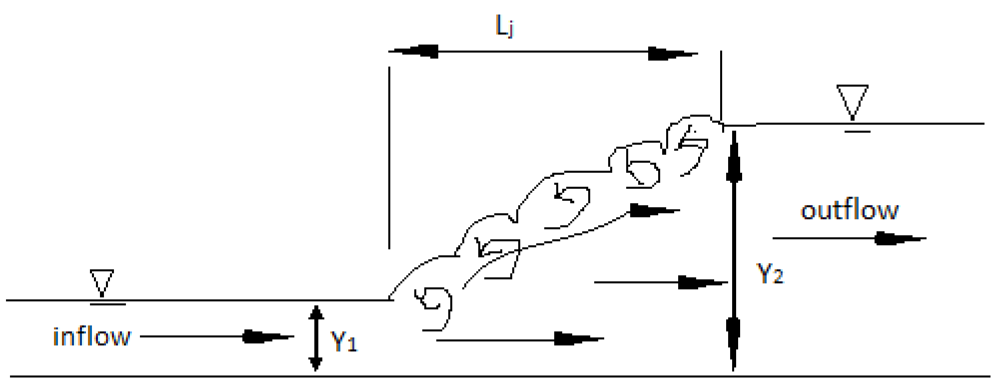


Figure 2.1 Length characteristics of a classical jump

At the toe of jump (section 1 in the figure 2.1) the flow depth is y_1, and the average velocity, $U_1 = Q/(by_1)$ with Q = discharge and b = channel width. At the end of the jump (section 2 in the figure 2.1) the depth is y_2 and the velocity, $U_2 = Q/(by_2)$. The supercritical Froude number is given by:

$$F = \frac{V}{\sqrt{gD}}$$

V= velocity in m/s

g= gravity(9.8 m/s^2)

D=Depth in m

With the Froude number larger than one and the depth called supercritical at the upstream condition of the hydraulic jump, which is lower than critical depth and the Froude number smaller than one and the depth higher than the critical depth at the downstream condition. So, the specific energy at the upstream of jump is larger than that at the downstream, the difference is called as the energy loss in hydraulic jump.

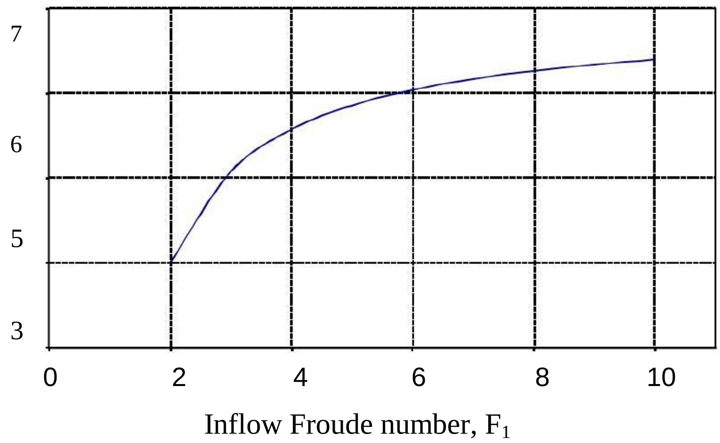


Figure 2.2: Length of hydraulic jump on horizontal floor

CHAPTER THREE

THEORETICAL FORMULATION

3.1 Introduction

We know the fact that the jump formation in horizontal channel is considerably more than in irregular ones like sloping channel or channel with quick drop, the latter ones are often preferred for energy dissipation or other purposes. The nature of the hydraulic jump in a sloping channel with screen type energy dissipator is a complex and poorly understood problem. In the recent study the particular attention is focused on free jump in the sloping channel. Considering the complexity and scope of the problem, several assumptions and restrictions were made in order to make the problem simple. These are discussed in the following section.

3.2 Assumptions

The given assumptions have been considered in formulating the theoretical equation describing the relationship between the sequent depth ratio with upstream Froude number and other associated variables and the assumptions are:

- Analysed the One dimensional steady flow.
- The channel is sloping, rectangular and straight.
- The fluid is incompressible.
- Velocity distribution over the upstream and downstream section is not uniform.
- Channel banks are fixed.

- At the beginning and at the end of the jump, the pressure distribution is hydrostatic.

- Turbulence effects and air entrainment are not included in the analysis.

- The sidewalls frictional resistance and bed of the flume is neglected.

3.3 Governing Equations

To Determine Froude Number it can calculate by velocity and upstream depth.

$$F = \frac{V}{\sqrt{gD}}$$

V= velocity in m/s

g= gravity(9.8 m/s^2)

D=Depth in m

3.4 Calculation of Energy loss($\Delta E/E_1$)

To evaluate the performance of these screens for energy dissipation, the writers calculated first the relative loss of energy produced by the screens. If E1 is the specific energy downstream of the gate or just before the hydraulic jump and Ed is the specific energy of the flow just downstream of the screens, the energy loss ΔE is equal to (E1 -Ed). The relative energy loss may be written as

$$\frac{\Delta E}{E_1} = \frac{\left[y_1 + \left(\frac{V_1^2}{2g}\right)\right] - \left[y_d + \left(\frac{V_d^2}{2g}\right)\right]}{\left[y_1 + \left(\frac{V_1^2}{2g}\right)\right]}$$

y_d = the tail water depth (in m)

y_1 = the depth at section 1 (in m)

V_d = mean velocity downstream (in m/s)

V_1 = upstream velocity (in m/s)

CHAPTER FOUR

EXPERIMENTAL SETUP

The experimental study was conducted at the Hydraulics and Fluid mechanics Laboratory of the Department of Hydraulics and Water Resources Engineering of Delhi Technological University (DTU). The experimental setup as well as the measuring techniques used in the experimental process, is discussed in the following articles.

4.1 Design of Sloping Channel with Drop

A drop structure, also known as a grade control, sill, or weir, is a manmade structure, typically small and built on minor streams, or as part of a dam's spillway, to pass water to a lower elevation while controlling the energy and velocity of the water as it passes over.

4.1.1 Introduction

The hydraulic jump is being used for energy dissipation is usually partly or completely to a channel. The particular attention of this present study is focused on jumps formed in the flume this jump is called classical hydraulic jump. The most essential part of the present study was the design and fabrication of a hydraulic jump and energy dissipation between classical and forced hydraulic jump.

4.1.2 Design

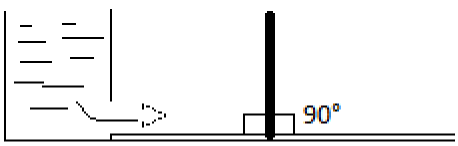
The experiments were performed in the 8m long tilting flume in the laboratory. Tilting facility of the flume was used to make it to a sloping channel. It was possible to create only light slopes in the flume channel. Three different slopes of 0.0041, 0.0081 and 0.0123 were maintained in the flume. To produce a hydraulic jump in the channel it is necessary to install a sluice gate in the channel. A considerable period of time was spent in the design, construction and installation of a new sluice gate in the flume.

4.1.3 Constriction Elements in the flume

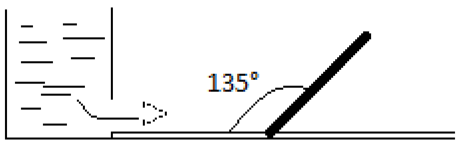
For obtaining the relative energy dissipation between classical and forced hydraulic jump placed screen type energy dissipator in three following cases.

a) At 90 degree with respect to flow.
b) At an angle of 45 degree against the flow.
c) At an angle of 135 degree against the flow.

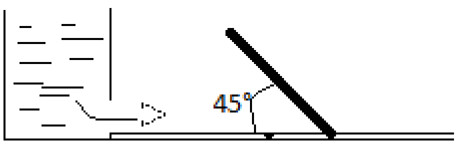
And there respective layout are shown in the figure given below:-



(a) At an angle of 90°



(b) At an angle of 135°



(c) At an angle of 45°

Figure 4.1 shown different screen layout

4.2 Experimental Facilities

The experimental setup associated with the use of a laboratory tilting flume having an adjustable sluice gate and an adjustable tail water gate, water tank, pump, water meter and various constriction elements. A brief description of the apparatus and auxiliary equipment used in the experiments is given in the subsequent articles.

4.2.1 Laboratory Flume

Experiments were performed in a 8m long channel of a uniform rectangular cross section with glass sidewalls and painted steel bed, performed in the Hydraulics and River Engineering Laboratory of the Water Resources Engineering.

Fig 4.2 8 meter long Tilting flume

The channel width is 0.3048m (1-ft) and the sidewall height is approximately 0.3048 m (1-ft). It is supported on an elevated steel truss that spans the main supports. The channel slope could be adjusted by using a geared lifting mechanism.

The whole flume consists of an upstream reservoir and a stilling chamber with contraction reach. The original channel depth was reduced by various constrictions. All constriction elements were made of wood that was located in the bed of the channel. The flume has a modifiable sluice gate by this we can control the upstream flow and an modifiable tail water gate located where we can control downstream flow of the expansion geometry. Water issuing through an opening of the sluice gate, located downstream from the reservoir, formed the supercritical stream. During the experiments, the location of the hydraulic jump was being controlled by the downstream tail water gate and discharge.

The circulation of the water within the flume is a closed system. From the storage reservoir the water is transported by means of the pipeline to the upstream reservoir. There are two types of pipelines viz. suction and delivery pipeline. Suction pipe sucks the water from the storage reservoir and at the same time passes that water through the pump. The water is delivered to the channel through the delivery pipe and returns to the storage reservoir.

4.2.2 Pump

A centrifugal pump with maximum discharge draws water from tank through valve and supplies it to the channel. The pump was calibrated so that the water discharge could be set to the desired quantity. The pump used for water circulation can be run for 8 hours at a stretch. No stand by pump is available.

Fig 4.3 Representation of Pump in the Experiment

4.2.3 Motor

The capacity of the motor, which drives the pump, is 2.5 HP. The motor uses the electrical energy by a shaft attached to it to drive the pump.

Fig 4.4 Position of Motor in Tilting flume

4.3 Measuring Devices

The device measures the velocity,discharge, depth pressure of the flow. With the help of devices we calculated Froude number, by this we calculated the energy loss between the screen.

4.3.1Water Meter

Two electromagnetic water meters are placed in the delivery pipes. The gate valve just upstream of the meter in the pipeline can control the discharge through the meter. The discharge measurements are made with the help of these water meters.

4.3.2 Miniature Propeller Current Meter

The miniature propeller current meter consists of propellers rotating about a horizontal axis. The propeller is fixed at one end of the shaft while the other end of the shaft is connected with the help of a wire. The revolution of the propeller is displayed in the counter, which is operated by batteries.

The calibration of the present current meter was done by mounting the meter on a carriage that runs on rails along a straight channel and moves the propeller of the current meter through still water. The speed of the carriage was determined by the time required to travel a known distance. With several runs at various speeds the relation between revolution of the propeller per unit time and water speed was determined. The calibrated results are given below:

1) For $0 < n < 1.31$

$$U = 0.2344n + 0.0313$$

2) For $n \geq 1.31$

$$1. = 0.2460n + 0.0161$$

Where n is the revolution per sec displayed in the current meter and U is the velocity of the flowing water in meter per second.

4.3.3 Point Gauge

The water level and the bed level are measured with the help of a point gauge (Figure 4.5). The point gauge is suitable for swiftly flowing liquids without causing appreciable local disturbances. The gauge is mounted on a frame laid across the width of the channel. The point gauge is accurate within 0.1 mm.

Fig 4.5 Measuring the Reading by using Point gauge

4.4 Measurements

Six experiments were conducted at the hydraulic laboratory of Department of Water Resources and Engineering to determine the Flow rate. The values are given in tables.

4.4.1 Discharge

Discharge, Q in the flowing channel is measured with the help of water meter. The flow-circulating pipe is equipped with two electromagnetic flow meters that enable to measure the discharge through the channel very precisely by digital measuring scale.

4.4.2 Water Surface Elevation

Measurements of water surface elevation were taken both at the upstream and downstream of the jump. Measurements were taken by the point gauge. The gauge reading at the bed was set to zero so when the reading of water surface elevation was taken it gave directly the water depth data. In this way both the initial and sequent depth were taken. At both sections three readings were taken and then the average of these three was used for the analysis.

CHAPTER FIVE

EXPERIMENTAL PROCEDURE

5.1 Introduction

The experimental procedure of the study was divided into two parts: i) preparation of the flume as per requirement of the experiment and ii) running of experiments. Considerable time is required for arrangement of the experimental facilities for this study. Running the experiment and collecting the required data require not only a great deal of physical works but also a careful observation. For conducting the experiment the following procedure was followed :

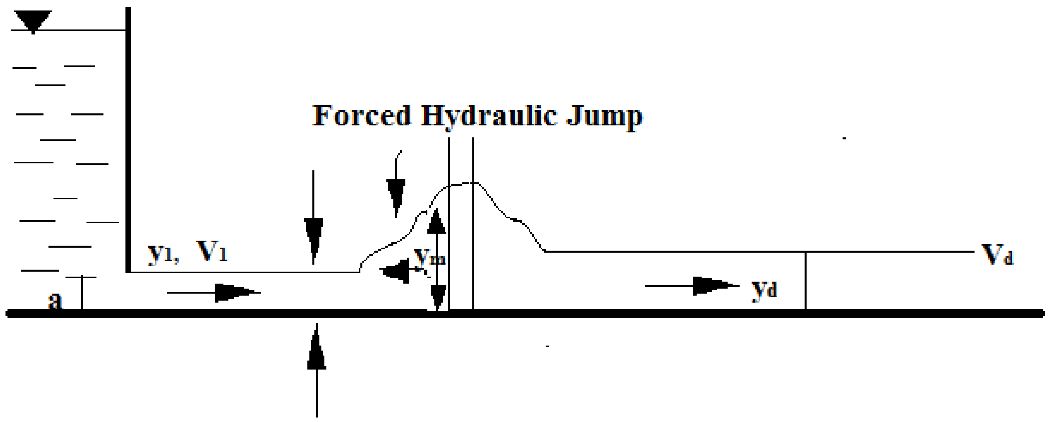
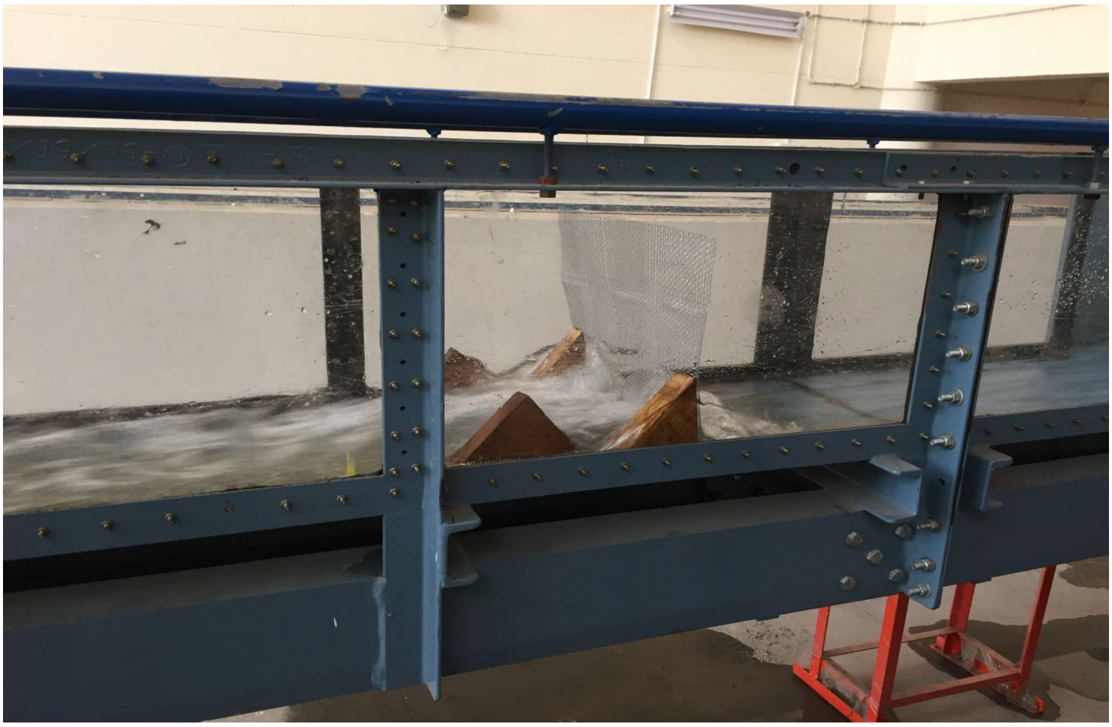


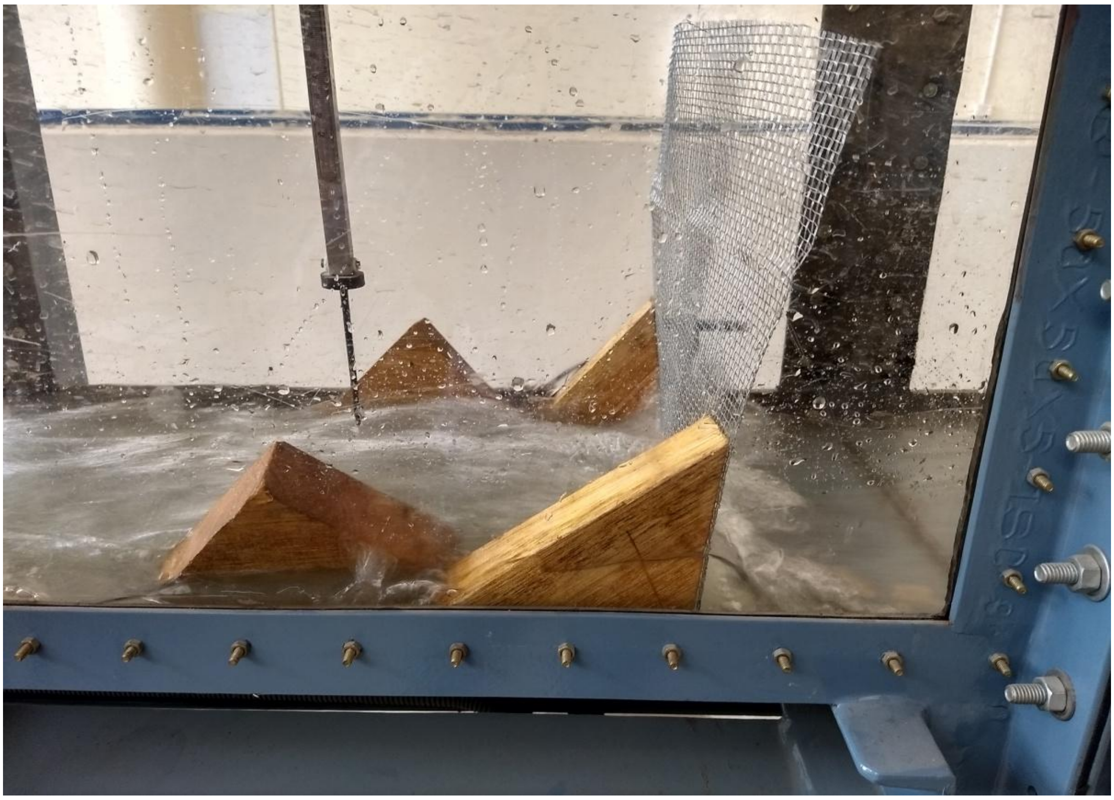
Fig 5.1 Layout description of Experiment

1. The main series of experiment were performed in a horizontal rectangular channel 0.30m wide,0.30 m deep, and 8 m long. The flow was provided by a head tank with a sharp edged sluice gate.
2. The flow rate was measured with a magnetic flow meter provided in the supply line feeding the head tank.

3. An iron sheet with approximately square holes (of 5 mm sides) was used to make screens.
4. The iron sheet screen was placed perpendicularly across the flume at a distance of 1.5 m from the gate.
5. In any particular experiment, the gate produced a supercritical flow which, on approaching the iron sheet screen, collided with it and produced either a free hydraulic jump, a forced hydraulic jump, or in some cases a submerged hydraulic jump. The flow left the screen as a supercritical stream, with a reduced Froude number as compared with that produced by the gate.
6. In the case of the double and triangular screens, there was considerable mixing and turbulence in the pools in between the iron sheet screens. The iron sheet screens acted like thin plates.
7. The flow downstream of the screens was uniform, since it was produced by a multitude of turbulent jets.
8. In the case of the double and triangular screens, there was considerable mixing and turbulence in the pools in between the iron sheet screens. The iron sheet screens acted like thin plates.
9. The flow downstream of the screens was uniform, since it was produced by a multitude of turbulent jets.
10. Let y1 and V1 be the depth and mean velocity of the super-critical stream just before the jump, and let F1 be the corresponding Froude number. In the first series of experiments with single the gate opening, a, was fixed at 25 mm and F1 was varied from about 1 to 13.
11. When the flow below the gate was free, the supercritical depth was measured with a point gauge; when it was submerged, it was calculated using the results available from the literature.



(a)



(b)

Fig 5.2 Forced Hydraulic jump at Screen (a) & (b)

Repeat these steps with other two screen with an angle of 45 and 135 degree. Do the same thing with those two screen and analyse the forced hydraulic jump, tail water depth, velocity at both upstream and downstream.

Main parameters to be measured during the present experiment are velocity, depth of flow at different location along the flume length. The measurement procedure of these parameters is briefly described in this section. Depth of the flow is measured by using a point gauge fixed into the travelling bridge and operated manually.

5.2 Data collection

Table 5.1 When single screen placed at an angle of 90º

Gate opening(cm)	y_1(m)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(m)	$\frac{\Delta E}{E_1}$
10	0.015	0.810	2.7	0.456	0.045	0.59
15	0.020	0.781	2.1	0.421	0.056	0.56
20	0.024	0.767	1.6	0.419	0.061	0.53

Table 5.2 When double screen placed at an angle of 90º

Gate opening(cm)	y_1(m)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(m)	$\frac{\Delta E}{E_1}$
10	0.016	0.80	2.7	0.40	0.050	0.61
15	0.022	0.79	2	0.391	0.061	0.59
20	0.026	0.77	1.5	0.384	0.065	0.56

Table 5.3 When single screen placed at an angle of 45º

Gate opening(cm)	y_1(m)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(m)	$\frac{\Delta E}{E_1}$
10	0.015	0.812	2.3	0.52	0.048	0.45
15	0.021	0.78	1.8	0.512	0.056	0.40
20	0.025	0.71	1.5	0.49	0.061	0.38

Table 5.4 When double screen placed at an angle of 45º

Gate opening(cm)	y_1(m)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(m)	$\frac{\Delta E}{E_1}$
10	0.016	0.80	2.0	0.42	0.072	0.60
15	0.022	0.75	1.6	0.391	0.080	0.58
20	0.026	0.72	1.4	0.384	0.081	0.53

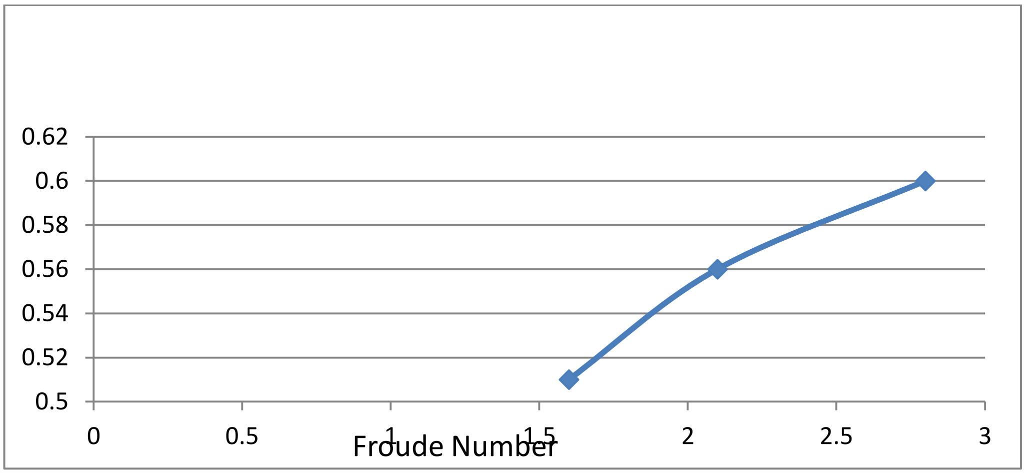
Table 5.5 When single screen placed at an angle of 135º

Gate opening(cm)	y_1(mm)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(mm)	$\frac{\Delta E}{E_1}$
10	0.010	0.87	3	0.421	0.055	0.63
15	0.015	0.78	2.2	0.381	0.060	0.60
20	0.025	0.71	1.5	0.352	0.069	0.55

Table 5.6 When double screen placed at an angle of 135º

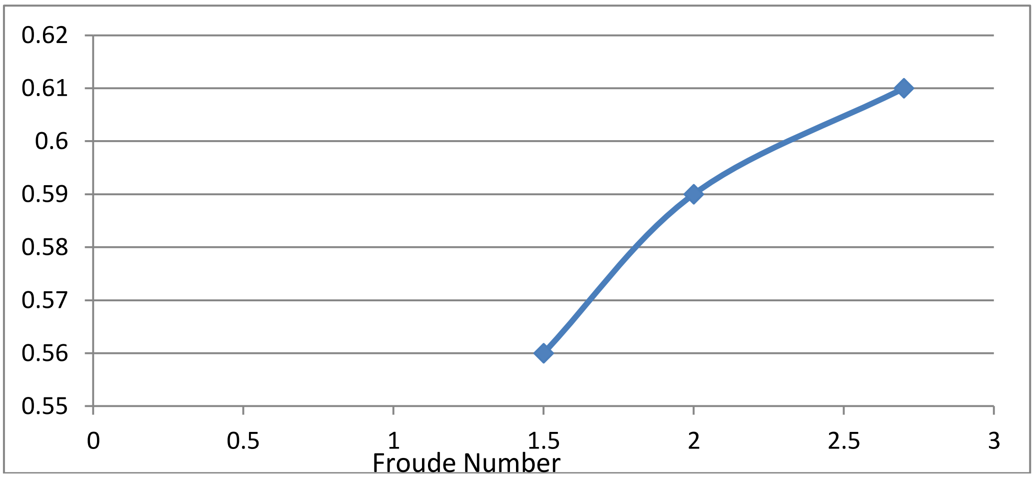
Gate opening(cm)	y_1(mm)	V_1(m/s)	Froude No.	V_2(m/s)	y_2(mm)	$\frac{\Delta E}{E_1}$
10	0.011	.85	2.5	0.401	0.060	0.63
15	0.018	.75	1.7	0.351	0.064	0.58
20	0.026	.72	1.5	0.340	0.070	0.52

5.3 Graphical Representation



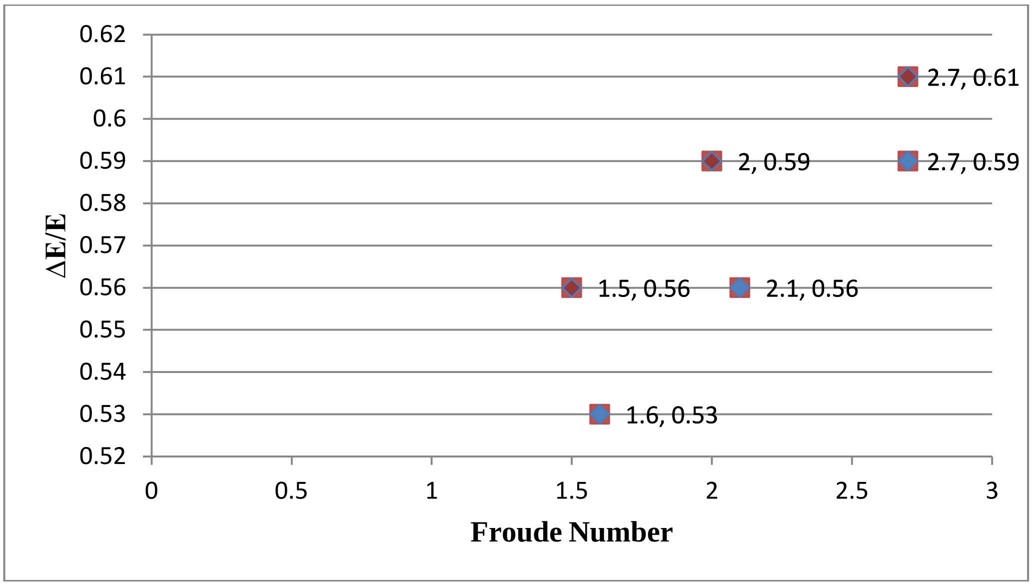
(a)

Graph.5.1 Graphical representation of Energy Loss with F for Jumps Produced by single Screens at 90º



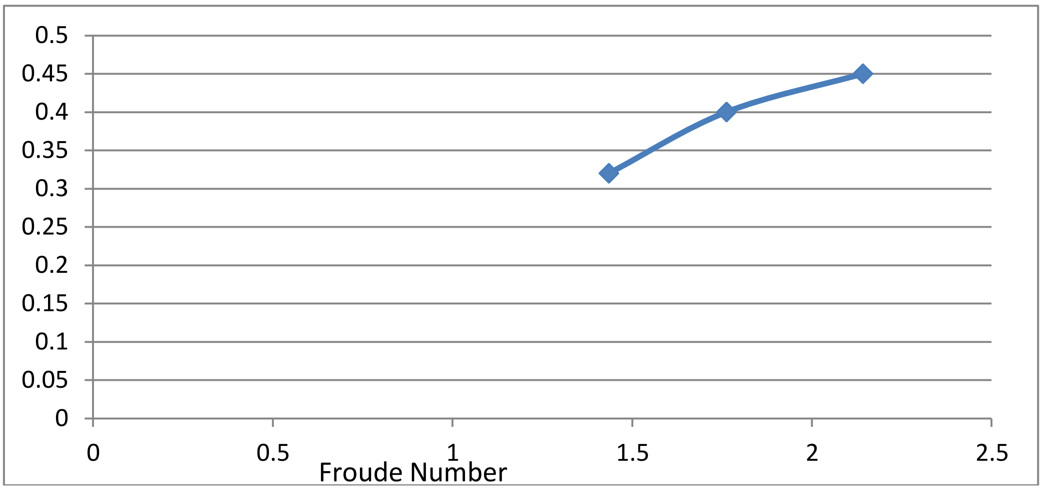
(b)

Graph.5.2 Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 90º

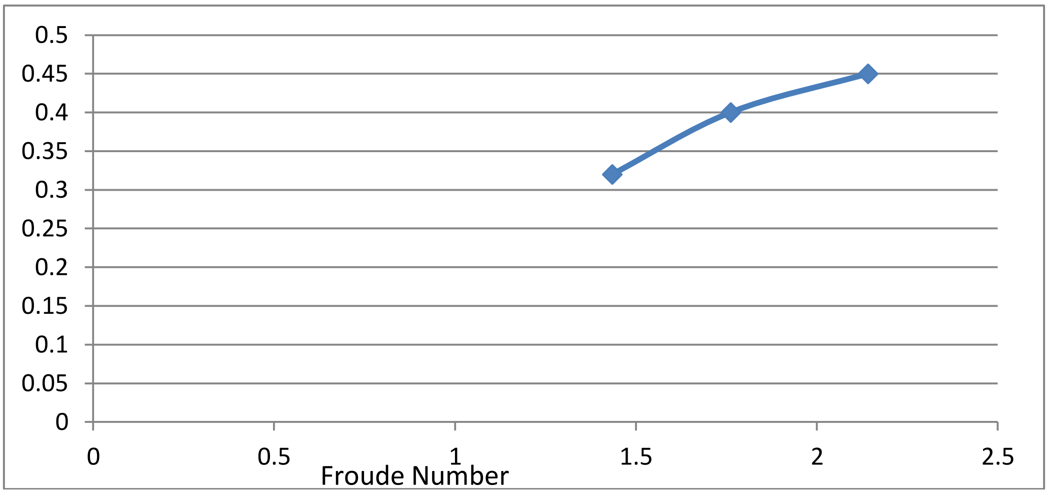


Graph 5.3 Graphical representation of Energy Loss with F for Jumps Produced by single and double Screens at 90º

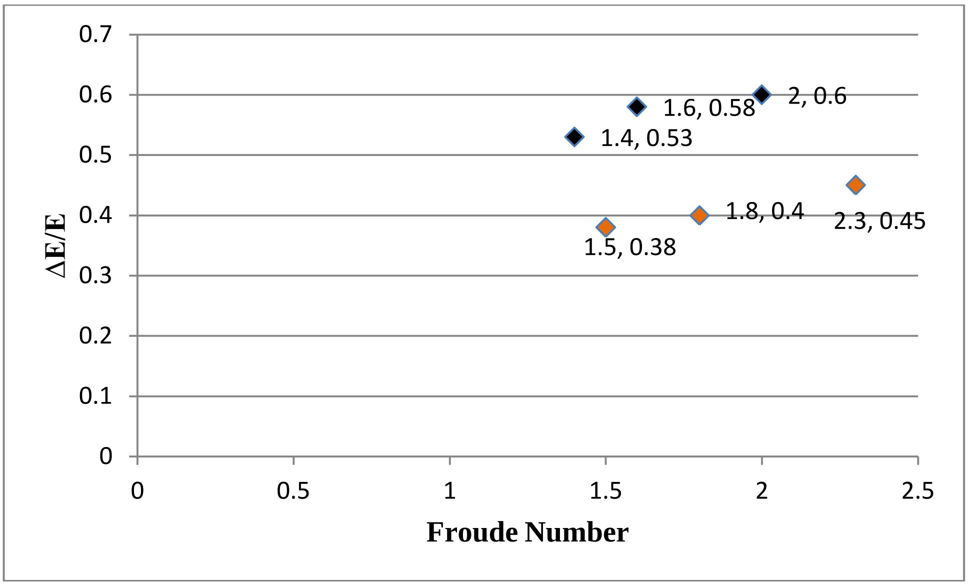
These graph representation of Energy loos with various Froude number F for the jump produced by the single and double screens at 90º. This means that the in double screen mode energy loss is little larger than the energy loss in the single screen. That means forced hydraulic jump produced by the double screen is more efficient than the single screen. Also in Upstream depth in second case slightly larger than the upstream depth in single screen. As we know that the when the area of obstruction is maximum so there is more probability of maximum energy loss. Because the larger the area so the obstruction area would be larger. In this experiment we are examining that at which given angle 90º , 45º, 135º the energy dissipate more. In this arrangement in single wall mode the porosity of flow is slightly higher than the double wall mode because of double wall arrangement it causes more obstruction between flow and the screen.



Graph 5.4 Graphical representation of Energy Loss with F for Jumps Produced by single Screens at 45º

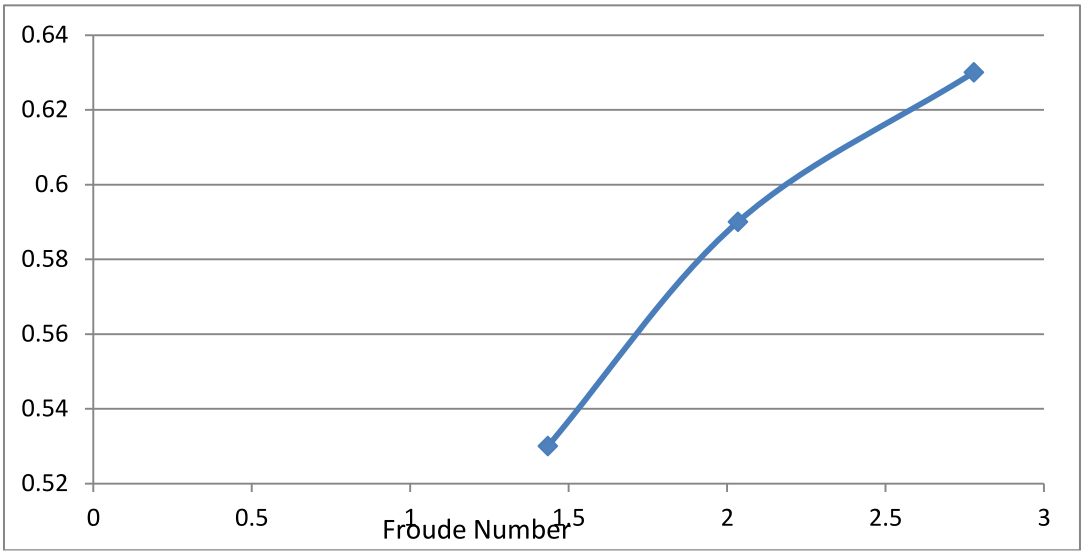


Graph 5.5 Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 45º



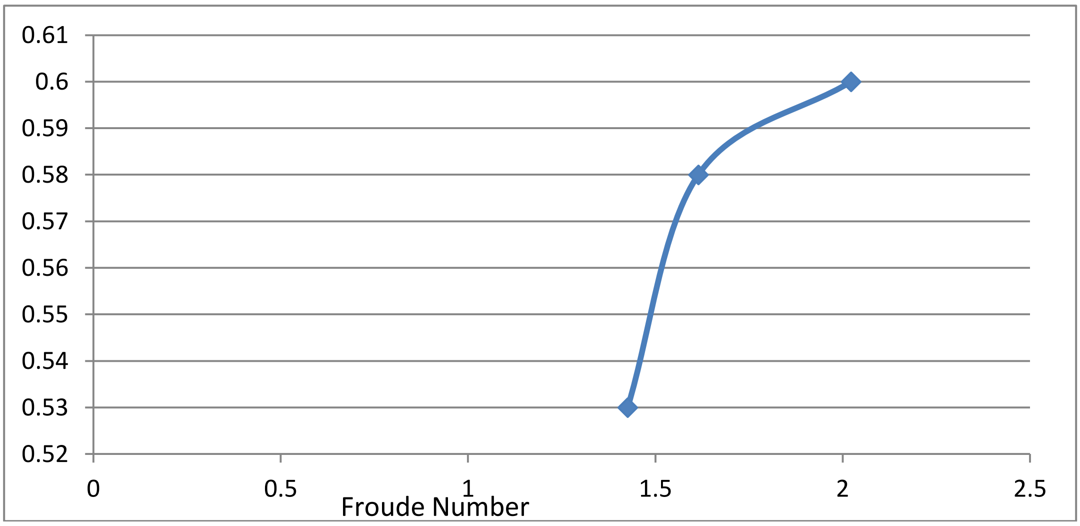
Graph 5.6 Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 45º

These graph representation of Energy loos with various Froude number F for the jump produced by the single and double screens at 45º. This means that the in double screen mode energy loss is little larger than the energy loss in the single screen. That means forced hydraulic jump produced by the double screen is more efficient than the single screen. Also in Upstream depth in second case slightly larger than the upstream depth in single screen. As we know that the when the area of obstruction is maximum so there is more probability of maximum energy loss. Because the larger the area so the obstruction area would be larger. In this experiment we are examining that at which given angle 90º , 45º, 135º the energy dissipate more. In this arrangement in single wall mode the porosity of flow is slightly higher than the double wall mode because of double wall arrangement it causes more obstruction between flow and the screen. But in this case even in double wall mode the energy loss is lesser than energy loss in where the screen placed at 90 degree. If we compare both cases energy loss in vertical position the energy loss as compare to the slant height placement.



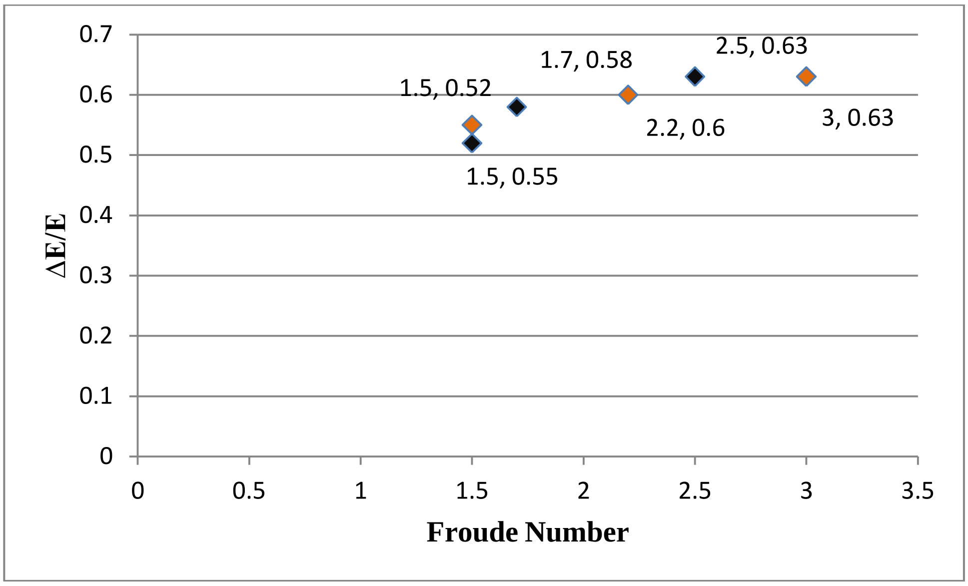
(a)

Graph 5.7 Graphical representation of Energy Loss with F for Jumps Produced by single Screens at 135º



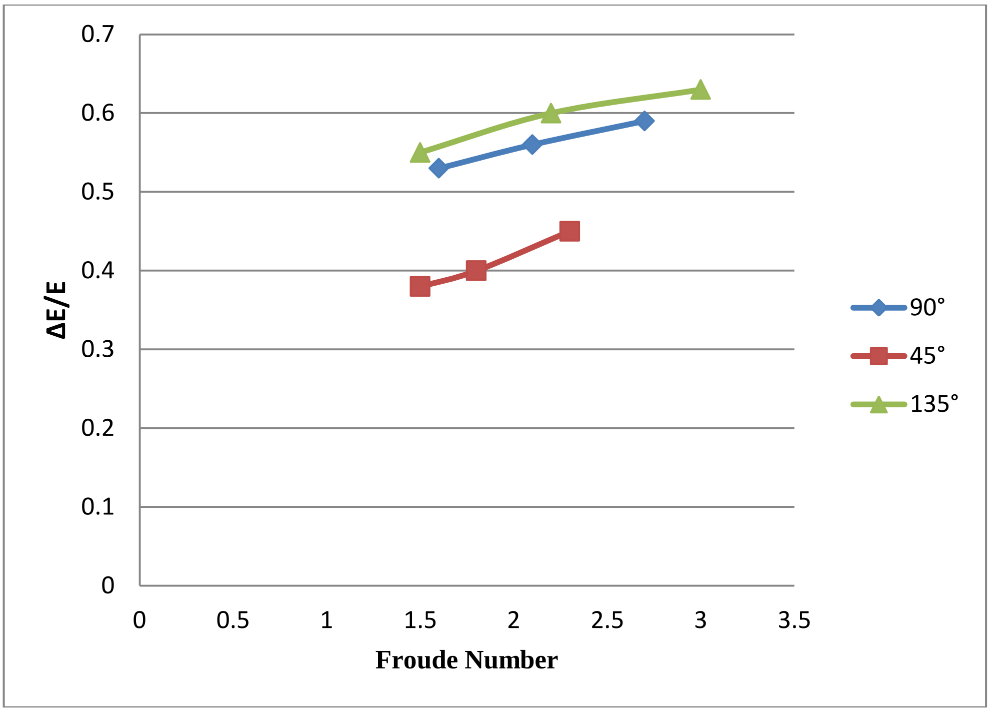
(b)

Graph 5.8. Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 135º



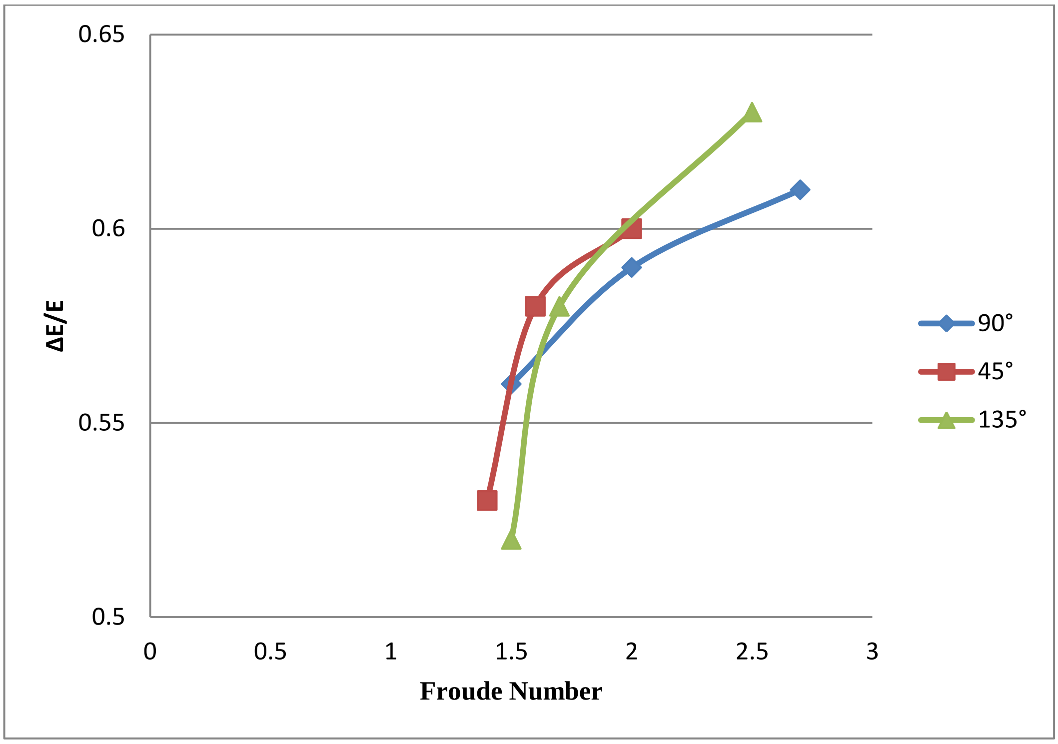
Graph 5.8. Graphical representation of Energy Loss with F for Jumps Produced by single and double Screens at 135º

These graph representation of Energy loos with various Froude number F for the jump produced by the single and double screens at 135º. This means that the in double screen mode energy loss is little larger than the energy loss in the single screen. That means forced hydraulic jump produced by the double screen is more efficient than the single screen. Also in Upstream depth in second case slightly larger than the upstream depth in single screen. And at the Downstream depth the tail water depth is lager in double wall mode than single wall mode. As we know that the when the area of obstruction is maximum so there is more probability of maximum energy loss due to angle given to the screen of 135 degree with flow so area of the obstruction is larger as compare to other two case. Because the larger the area so the obstruction area would be larger. In this experiment we are examining that at which given angle 90º , 45º, 135º the energy dissipate more. In this arrangement in single wall mode the porosity of flow is slightly higher than the double wall mode because of double wall arrangement it causes more obstruction between flow and the screen.



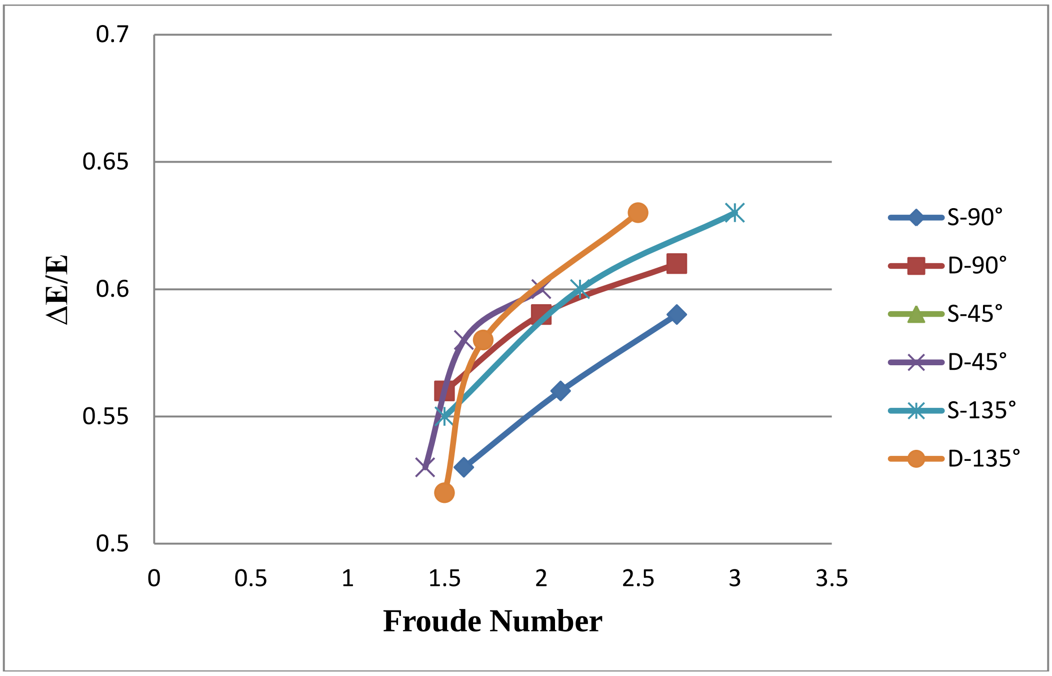
Graph.5.9 Graphical representation of Energy Loss with F for Jumps Produced by single Screens at 90º, 45º and 135º

In this graph representation of Energy loos with various Froude number F for the jump produced by the single screens at 90º, 45º,135º. This means that the energy loss in screen placed at 135º is little larger than the energy loss in the single screens at 90º, 45º. That means forced hydraulic jump produced by the screen placed at 135º is more efficient than the screen placed at 90º, 45º. Also in Upstream depth in S-135 degree case slightly larger than the upstream depth in single screen at 90º, 45º. And at the Downstream depth the tail water depth is lager in S-135 wall mode than S-90 and S-45. As we know that the when the area of obstruction is maximum so there is more probability of chance of maximum energy loss, Due to angle given to the screen of 135 degree with the flow so the area of the obstruction is larger as compare to other two case. Because the larger the area so the obstruction area would be larger. In this experiment we are examining that at which given angle 90º , 45º, 135º the energy dissipate more. In this arrangement in single wall mode the porosity of flow is slightly higher than the double wall mode because of double wall arrangement it causes more obstruction between flow and the screen.



Graph.5.10 Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 90º, 45º and 135º

In this graph representation of Energy loos with various Froude number F for the jump produced by the Double screens at 90º, 45º,135º. This means that the energy loss in screen placed at 135º is little larger than the energy loss in the double screens at 90º, 45º. That means forced hydraulic jump produced by the screen placed at 135º is more efficient than the screen placed at 90º, 45º. Also in Upstream depth in D-135 degree case slightly larger than the upstream depth in double screen at D-90º, 45º. And at the Downstream depth the tail water depth is higher in D-135 wall mode than D-90 and D-45. As we know that the when the area of obstruction is maximum so there is more probability of chance of maximum energy loss, Due to angle given to the screen of 135 degree with the flow so the area of the obstruction is larger as compare to other two case. Because the larger the area so the obstruction area would be larger. In this experiment we are examining that at which given angle 90º , 45º, 135º the energy dissipate more. In this arrangement in single wall mode the porosity of flow is slightly higher than the double wall mode because of double wall arrangement it causes more obstruction between flow and the screen. After the comparing all the data is shows that in D-135 energy dissipate more than the all the cases. If we compare all the data and shown in graphical representation as given below we conclude that in D-135 energy dissipate more. In D-135 area of obstruction is larger as compare to other cases, due to this discharge of the flow increases and the process of energy dissipate in this form is larger as compare. And we found and the tail water depth in the classical jump is smaller as compare to the forced hydraulic jump. In given graphical representation it shows that in D-135 and S-135 energy loss is larger than other four cases with different supercritical Froude number F. In this porosity is also varies because of the single and double wall mode criteria. At the gate water opening at 10mm mean velocity is maximum as compare to gate opened at 15 mm and 20 mm.



Graph.5.10 Graphical representation of Energy Loss with F for Jumps Produced by double Screens at 90º, 45º and 135º

It was observed that some of the data for the forced jumps in the first series are located somewhat above the rest of the observations. A mean curve is drawn through most of the experimental points, leaving out a few data points corresponding to mostly forced hydraulic jumps. This mean curve indicates that the relative energy loss produced by these screens is appreciably greater than that produced by the classical hydraulic jump.

CHAPTER 6

CONCLUSION

Experiments were commenced in open channels on a tilting hydraulic flume at the Fluid Mechanics Laboratory of DELHI TECHNOLOGICAL UNIVERSITY, Shahbad Daulatpur, Bawana Road New Delhi (India) for calculate the loss in energy from screen dissipate. When forced hydraulic jump produced by screen there is energy loss. After reviewed the research paper and gone through it a laboratory experiment done with screens or filter with a porosity of about 50-60% could be used as effective energy dissipators. The experiment were carried out by placing the screen at different angle at 45º, 90º and 135º either in single or double wall mode wall under hydraulic structures for making forced hydraulic jump and calculate the energy loss. The experiments were carried out for a range of supercritical Froude numbers from about 1.5 to 6, and the relative energy dissipation was appreciably larger than that produced by the corresponding classical hydraulic jump. These screens or permeable obstruct produced free hydraulic jumps, forced hydraulic jumps. There is a energy loss between free jump jump and jump produced by screen. Tail water depth of forced hydraulic jump y_2 is equal to 0.79 times the depth of the classical jump with some Froude number.

CHAPTER 7

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