EFFECTS ON THE HYDRAULIC COEFFICIENTS FOR DIFFERENT CASES OF SLUICE GATE OVER DIFFERENT CASES OF SILLS

Submitted in partial fulfillment of the requirements of the degree of

Master of Technology

In Hydraulics and Flood Control Engineering

BY

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CERTIFICATE

This is to certify that the major project report entitled "**EFFECTS ON THE HYDRAULIC COEFFICIENTS FOR DIFFERENT CASES SLUICE GATES OVER DIFFERENT CASES OF SILLS**" being submitted by me is a Bonafide record of my own work carried by me under the guidance of Dr. MUNENDRA KUMAR in the partial fulfillment of the requirement for the award of the degree of Master of Technology in Civil Enginneering with specialization in HYDRAULICS AND FLOOD CONTROL ENGINEERING, DELHI TECHNOLOGICAL UNIVERSITY, DELHI-110042.

The matter embodied in this project has not been submitted for the award of any other degree.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

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DECLARATION

I certify that

a) The work contained in the dissertation is original and has been done by myself under the general supervision of my supervisors.

b) The work has not been submitted to any other Institute for any degree or diploma.

c) I have followed the guidelines provided by the Institute in writing the report.

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Name of the Student: VAIBHAV NAGAR

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Finally, I am thankful and grateful to God the Almighty for ushering His blessings on me.

Signature

Name: VAIBHAV NAGAR

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Abstract

The sluice gates are used in controlling the flow of water through the canals and irrigational structures. Humps/sills are installed in canals and channels for reducing the height of gates and they are also used for energy dissipation.

Sluice gates are mainly used in irrigation structure, humps/prismatic sills under gates has positive effect on flow performance under the gate and reduce its height. An experimental study in a laboratory flume of delhi technological university (delhi) is carried out to study submerged flow passing the opening between the hump and the gate. Three different heights of humps are used for this project. The basic principles of analysis are employed to correlate between the hydraulic and geometric dimensionless parameters with the discharge coefficient.

This project is to study the effect on the hydraulic coefficients which have been made in a rectangular flume with two gate opening of 3 cm and 4 cm, for each opening of gate and sill 3 runs of discharges are carried out and five different gate cases (vertical and inclined vertically) by angle (45)° with and opposite flow direction with sharp lower lip under the three cases of different height of humps 7.5 cm, 10.0 cm & 11.5cm and one case without sill.

Different cases of sluice gates are taken in consideration to study the effects on coefficient of discharge,coefficient of velocity & coefficient of contraction by three different humps of different heights are installed under the sluice gates. The opening between the humps and sluice gate is kept 3 cm and 4 cm for every case,three runs of discharge are carried out in each opening. Total of about 120 cases of run of discharge are done in this experimental project.

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Chapter 1

Introduction

1.1 SLUICE:

A sluice is a channel, natural or man made, controlled with a gate which is called sluice gate and it is used to direct water to the desired locations. Sluice can be used for the purpoe of water control,materials procesing and energy generation.

The sluice consists of a long channel, allowing the water to flow in a given direction when the gate is opened. The gate can be controlled on site or remotely and may be designed in a number of different ways to control the flow of water through the channel.

One important use for a sluice is in controlling the flow of water to prevent flooding and supplying water to the irrigation fields. Dams and reservoirs commonly uses sluicies and they can also be seen around areas prone to sudden floods of water. The sluices can be used for various purposes as to hold and redirect water.

1.2 SLUICE GATES:

A sluice gate is a mechanism used to control and the rise the water flow. Sluice gates are commonly used in water treatment plants, mining, dams, rice fields and at many other places. The sluice gates are typically made of wood or metal and mainly slide vertically on the frame of gate to open or close, allowing the water to flow in and out of a space/opening or to be contained in it. For this purpose, they can also be said as the sluice valve.

Sluice gate design are not only restricted to the vertical sliding system, they can be inclined according to the needs. some sluice gate acts like a flap and are moved by water pressure,which is being greater on one side than the other side of the gate.

The word sluice indicates the manmade channel or modified natural waterway that carries water. This kind of gate regulates on how and where that water is moved in the channel. This is especially useful for controlling the flooding or water levels in irrigation/farming and other purposes.

Many sluice gates are moved by means of a rod system. when these gates are used in applications with a huge amount of water pressure, such as dams, they are raised and lowered or moved with the help of hydraulic systems to control the sluice gate flow in the channel. Sometimes in minor uses, the gates are raised and lowered or moved manually. At other times, electrically-driven system are used to control the movement of sluice gates.

The Discharge through the canals is commonly controlled by means of gates. Gates may be free or submerged according to the extent of the water depth downstream the gate related to the gate opening.

1.3 SILLS:

Sills reduce the height of the gates and consequently the pressure forces acting on it, then the height decrease the weight of the gate, operation force and costs. Sills/humps are also effective in dissipating the energy below gates.

1.4 HYDRAULIC COEFFICIENTS:

The hydraulic coefficients are categorised into three types:

- **coefficient of discharge :** The ratio of actual discharge through an orifice/venturi to the theoretical discharge, is known as coefficient of discharge. The value of coefficient of discharge varies with the value of coefficient of contraction and coefficient of velocity.

- **coefficient of velocity :** The ratio of actual velocity of jet at vena contacta, to the theoretical velocity is known as the coefficient of velocity. The difference occurs between the velocities due to friction.

- **Coefficient of contraction :** The ratio of coefficient of discharge and coefficient of velocity is known as the coefficient of contraction.

1.5 OBJECTIVE:

The sluice gates are used in controlling the flow through the canals and irrigational structures. Gates are mainly used in irrigation structure, humps/sills under gates has positive effect on flow performance under the gate and reduce its height. The Discharge through the canals is commonly controlled by means of gates. Gates may be free or submerged according to the extent of the water depth downstream the gate relative to the gate opening.

Sills/humps reduce the height of the gates and consequently the pressure forces acting on it, then the height decrease the weight of the gate, operation force and costs. Sills/humps are also effective in dissipating the energy below gates.

The main objective of this research is to study the effect on hydraulic coefficients in various cases of sluice gates over the different cases of humps/sills.

We will study the effects on the hydraulic coefficients : coefficient of discharge , coefficient of velocity and coefficient of contraction in the different cases of humps of different heights (6cm, 11.5 cm & 13.5 cm) under the sluice gates of different types (inclined in direction of flow , inclined in opposite direction of flow , with sharp edge lip).

1.6 OVERVIEW:

Chapter 2 summarizes some of the literature work that describes the effects on hydraulic coefficients in different cases of sluice gates and different cases of sills.

Chapter 3 deals with theoretical background that elaborates about the hydraulic coefficients.

Chapter 4 explains the experimental setup which arranged in the hydraulics laboratory of Delhi technological University.

Chapter 5 deals with experimental results that are explained in the form of tables and graphs.

Chapter 6 contains the results for different cases of sluice gates with the different cases of sills on the hydraulic coefficients.

Chapter 7 deals with the conclusion of the work.

Chapter 2

Literature review

This thesis work is mainly concentrated on finding the effects on hydraulic coefficients under different cases of sluice gates and different sills. For the better understanding on the effects of different sluice gates and sill on hydraulic coefficients: coefficient of discharge, coeefficient of velocity & coefficient of contraction, we are performing a experiment in the hydraulics laboratory of Delhi Technological University. We are using a rectangular flume of 4 meter length, 30.5 cm width and 35 cm depth and wooden sluice gates and sills. Some of the early researchers have done work and researches to understand the flow hydraulics for vertical gates but with a huge development since then and wide use of gates in more of hydraulic structures. so, it is very important to study another cases such as the inclined gates. various studies and researches have been done to study free and submerged flow discharge through the sluice gate, some of these investigations and researches deals with the discharge characteristics of the sluice gate. Few of the studies have been taken in consideration before doing an experiment, which helped a lot to study the effects of different cases of gates over the sills, these are the few studies:

In year 2013 Mr. Ahmed Y. Mohammed and Moayed S. Khaleel of university of mosul,iraq studied the Gate Lip Hydraulics under Sluice Gate, there study showed that the gate lip has a positive effect on the flow performance of water under the sluice gates. They concluded that the sharp edge lip has a varying effect on the flow proeperties depending upon the position of sluice gates which can be vertical , inclined in the direction of flow and inclined in the opposite direction of flow.

Prof.Masliyah in year 1985 & mr. Finni and Jeppson in year 1991 carried out a experiment to study the characteristics of flow under vertical sluice gate theoretically using numerical and finite elements methods. They has done study on the flow characteristics under the sluice gates.

Mr. Jung-Fu Yen in year 2001 has done the study on the flow movement through a sluice gate opening for both free and submerged flow conditions experimentally using laboratory channels/flumes and M. Bijankhan in year 2012 has done the same study. Both of them developed stage discharge relationship from these studies to study the effects on the discharge. Where as Prof. H. Khalili Shayan & prof. J. Farhoudi in year 2013 studied the energy loss of free flow under sluice gate; they present an equation for estimating energy loss factor and then the effect of this parameter on increasing discharge coefficient's accuracy.

various studies and researches have been conducted till now to study the effect of sills/humps in the free and submerged flow characteristics under sluice gates by many researchers. Sills under the sluice gates have a positive effect on the coefficient of discharges, coefficient of velocity and coefficient of contraction.

Prof.Salem in year 1990 studied the gate with the sill of flat top and curved top with different heights under the different flow conditions. The result concluded from that study was that the curved top sill increases the value of discharge coefficient Cd.

Prof A.M Negm head of water resources at E-just have done various case study on the effects of hydraulic jumps and sills. Few of his studies are stated below:

1. In year 1993, he investigated the effect of crest shape sill on the length of the free hydraulic jump and on the discharge coefficient Cd for the case of supercritical free flow conditions.

2. In year 1998 he investigated the effect of the sill parameters on flow below submerged gate through the opening of gate, he found that the sill under the gate increases the coefficient of discharge of the gate and the rate of increase depends up on the configuration of both the sill and the gate as well as on both the sill and flow parameters in the channels.

3. In year 2000 he compared the performance of rectangular and radial stilling basins on the discharge characteristics and hydraulic jump. The study concluded that the radial basin is more efficient regarding the whole characteristics.

4. In year 2000 he extended the study of Ibrahim by analyzing and observing the experimental data of subcritical flow below gate in radial basin with sill under the gate, he used the same experimental procedure of Ibrahim and suggested an equation for estimating the discharge coefficient.

5. In year 2001 he studied the characteristics of submerged flow below vertical gate with sill upstream of horizontal diverging channel reach, they carried their experimental study in a channel of 10cm wide and 31 cm deep and 3m long. He observed that the presence of sill under the gate has a remarkable effect on the discharge coefficient of the gate, and the observed variations in the discharge coefficients are depended on the under-gate Froude number and the differential head ratio.

Prof. Saad have also done various case studies and research work in the field of hydraulics and water engineering. Prof. saad in year 1991 studied the effect of a sill under the gate for submerged flow conditions using trapezoidal flat top sills with different downstream slopes and different heights, his study showed that the Coefficient of discharge increases by increasing the d/s downstream slope of sill. And Prof. saad in year 2007 also studied the effect of circular-crested sill shapes under sluice gate on supercritical free flow characteristics. From the study it was found that, the main factor which affects coefficient of discharge Cd value is the geometric shape of the sill.

Prof.Ibrahim in year 2000 analyze and calculated the experimental data of supercritical submerged flows at fixed Froude number FG (1.806, 1.462, 1.255 and 1.018).
He has also given the equation for discharge coefficient Cd in terms of Froude number, gate opening D and the differential head on the gate ΔH. Ibrahim also concluded that the discharge coefficient get its maximum values when the lateral sill is constructed at a distance of ¾ of the basin length from the sluice gate.

The study on the effect of the relative height of sill under gate with downstream slope of 1:5 was done by prof A.M negm in year 1994 & 1995, where as prof. saad in year 2001 also studied the effect of the circular-crested sills. The study was carried out in a flume with 250 cm length, 15 cm width and 30 cm depth, the experimental study was carried for seven models of fixed slops upstream and downstream with a constant height. By the study they found that the main factor affecting the coefficient of discharge is B/Z (where Z=sill height, B=bottom width of the sill), and the circular crested sill produces a greater discharge coefficient than the flat-crested sill only if B/Z of the circular-crested sill is equal or smaller than that of the flat-crested one.

A study by Mr. Sarhan Abdulsatar of iraq to analyse the effects of prismatic sill under the sluice gates concluded that the sills under gates have effects on the coefficient of discharge depending upon the physical and geometric paramters of the sill and flow of water in the channel.

The objective of the present study is to study the effect on hydraulic coefficients in different cases of sluice gates with different cases of humps/sills.

Chapter 3

THEORETICAL BACKGROUND

coefficient of discharge(Cd) :

The ratio of the actual discharge flowing through an orifice/venturi to the theoretical discharge of experiment calculated by the head, is known as the coefficient of discharge. The value of coefficient of discharge varies with the value of coefficient of contraction and coefficient of velocity.

The flow of water under the submerged sluice gate is a flow passing through the opening between the gate and the hump/sill, the discharge depends on the difference in the depths between the upstream flow and downstream flow, the difference between the upstream flow and downstream flow is the head that should over come all the resistance between the two sections.

Equation (1) gives the formula to calculate the discharge theoretically, and Figure-1 shows the representation of sketch of sill under the gate.

$$Q_{th} = W \cdot d\sqrt{2gH} \qquad (1)$$

Where
Qth = the theoretical discharge passing under gate
W = width of channel
d = the gate opening
H = difference in head
g = gravitational acceleration

$$C_d = \frac{Q_{act}}{Q_{th}} \qquad (2)$$

Where
Cd = coefficient of discharge
Qact = the actual discharge passing under gate

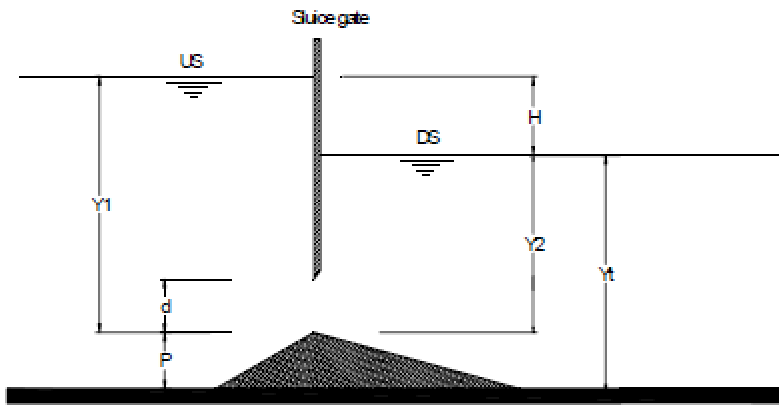


Figure 1: representation of sketch of sill with a total length (B) and one opening height (P) affects the performance of gate.

The actual discharge though the orifice is calculated by this formula

Q ac = V / t = (A.ΔH) / t

where
V = (A.ΔH) i.e. Volume of water collected in collecting tank
A = Cross section area of collecting tank.
ΔH = (H2 – H1) i.e. Depth of water collected in collecting tank.
t = Time required to collect the water up to a height ΔH in the collecting tank.

coefficient of velocity:

The ratio of actual velocity of jet at vena contacta, to the theoretical velocity is known as the coefficient of velocity. The difference occurs between the velocities due to friction.

Coefficient of velocity = $\frac{Vac}{Vth}$

Where,

Theoretical velocity , Vth =$\sqrt{2 \times g \times h}$

 # coefficient of contraction: The ratio of coefficient of discharge and coefficient of velocity is known as the coefficient of contraction.

Coeffcient of contraction = $\frac{Cd}{Cv}$

Where,

Cd = coefficient of discharge

Cv = coefficient of velocity

Chapter 4

EXPERIMENTAL SETUP

This experimental program was performed at the Hydraulic Laboratory Delhi Technological University Delhi. A re-circulating flume of 4m long, 0.305m wide and 0.45m deep was used. A horizontal scale with accuracy of 1.0mm was fixed along the flume for measuring the horizontal distances. A point gauge with a harp edged end and with a venire scale, was installed on a manually carriage running along the flume to measure the bed elevation, the water depth and the upstream & downstream level.. The flume is provided with centrifugal pump to re-circulate the water from ground tank to feed the flume with the required flow discharge.

To achieve the research objectives, five different cases of sluice gates were taken over three cases of different humps of different heights and one case without sill. Two gate opening of 3 cm and 4 cm for vary discharge in each run is carried out though the experiment. Three runs of discharge are carried out for each opening of 3 cm & 4 cm for each case of sluice gate and prismatic sill.

Figure-2. Representation of the sill model and sluice gate in the flume.

This experiment is carried out with different cases of sluice gates over the humps of different heights. The objective of the present study is to investigate the effect of different heights of hump, and different downstream and upstream slopes of the
model, with different gate opening of different sluice gate cases on the hydraulic coefficients in case of submerged flow condition.

The different cases of sluice gates over the humps are:

1. When a rectangular sluice gate with horziontal edge is placed vertically in the following cases:-

   i. When no sill is used,but when
      - Opening between the gate and channel is of 3 cm.
      - Opening between the gate and channel is of 4 cm.

   ii. When a sill of 7.5 cm is used,but when
      - Opening between the gate and sill is of 3 cm.
      - Opening between the gate and sill is of 4 cm.

   iii. When a sill of 10 cm is used,but when
      - Opening between the gate and sill is of 3 cm.
      - Opening between the gate and sill is of 4 cm.

   iv. When a sill of 11.5 cm is used.
      - Opening between the gate and sill is of 3 cm.
      - Opening between the gate and sill is of 4 cm.

2. When a rectangular sluice gate with horizontal edge is inclined in the direction of flow in following cases:

   i. When no sill is used,but when
      - Opening between the gate and channel is of 3 cm.
      - Opening between the gate and channel is of 4 cm.

   ii. When a sill of 7.5 cm is used,but when
      - Opening between the gate and sill is of 3 cm.
      - Opening between the gate and sill is of 4 cm.

iii. When a sill of 10 cm is used,but when
    - Opening between the gate and sill is of 3 cm.
    - Opening between the gate and sill is of 4 cm.

iv. When a sill of 11.5 cm is used.
    - Opening between the gate and sill is of 3 cm.
    - Opening between the gate and sill is of 4 cm.

3. When a rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow in following cases :

i. When no sill is used,but when
- Opening between the gate and channel is of 3 cm.
- Opening between the gate and channel is of 4 cm.

ii. When a sill of 7.5 cm is used,but when
    - Opening between the gate and sill is of 3 cm.
    - Opening between the gate and sill is of 4 cm.

iii. When a sill of 10 cm is used,but when
    - Opening between the gate and sill is of 3 cm.
    - Opening between the gate and sill is of 4 cm.

iv. When a sill of 11.5 cm is used.
    - Opening between the gate and sill is of 3 cm.
    - Opening between the gate and sill is of 4 cm.

4. When a suice gate with sharp edge lip is inclined in the direction of flow in the following cases :

i. When no sill is used,but when
- Opening between the gate and channel is of 3 cm.
- Opening between the gate and channel is of 4 cm.

ii. When a sill of 7.5 cm is used,but when

- Opening between the gate and sill is of 3 cm.
- Opening between the gate and sill is of 4 cm.

iii. When a sill of 10 cm is used,but when
  - Opening between the gate and sill is of 3 cm.
  - Opening between the gate and sill is of 4 cm.

iv. When a sill of 11.5 cm is used.
  - Opening between the gate and sill is of 3 cm.
  - Opening between the gate and sill is of 4 cm.

5. When a suice gate with sharp edge lip is inclined in the opposite direction of flow in the following cases :

i. When no sill is used,but when
  - Opening between the gate and channel is of 3 cm.
  - Opening between the gate and channel is of 4 cm.

ii. When a sill of 7.5 cm is used,but when
  - Opening between the gate and sill is of 3 cm.
  - Opening between the gate and sill is of 4 cm.

iii. When a sill of 10 cm is used,but when
  - Opening between the gate and sill is of 3 cm.
  - Opening between the gate and sill is of 4 cm.

iv. When a sill of 11.5 cm is used.
  - Opening between the gate and sill is of 3 cm.
  - Opening between the gate and sill is of 4 cm.

And we are running three discharges in each opening of the gate. So, total of around 120 runs of discharges are carried out to study the effects on hydraulic coefficients from these various cases of sluice gates and the sills of different heights.

TEST PROCEDURE:

1. Sluice gate was installed at the distance of 1 m from the inlet of water.
2. The diameter of the orifice, dimension of the measuring tank and diameter of pipeline were noted.
3. The opening between the hump/sill and sluice gate is kept 3 cm & 4 cm each through out the experiment for every case.
4. The discharge is varying in each case of sluice gate and opening of gate.
5. Keep on increasing the discharge through the flume in each case of opening for 3 times.
6. The inlet controlled valve was opened. The inlet tank was allowed to fill the over flow started.
7. After that the actual velocity was measured.
8. The upstream and downstream heads of flow around the gate over the hump were measured.
9. The actual discharge was measured, which is changing with the opening.
10. The difference between the upstream flow and downstream flow is calculated, the head is calculated..
11. The procedure was repeated for a five sluice gate cases with four prismatic sills of different heights for 3 cm & 4 cm openings, and around 3 runs for each case of opening was carried out , total of 120 cases of discharge run were taken.
12. Then calculations and observations are noted down carefully, to study the effect on hydraulic coefficients for different cases of sluice gates and sills.

EXPERIMENT:

CASE 1 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS PLACED VERTICALLY ON THE DIFFERENT SILLS

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED.

Figure 3: when a sluice gate with horizontal edge is is installed vertically without a sill/hump.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

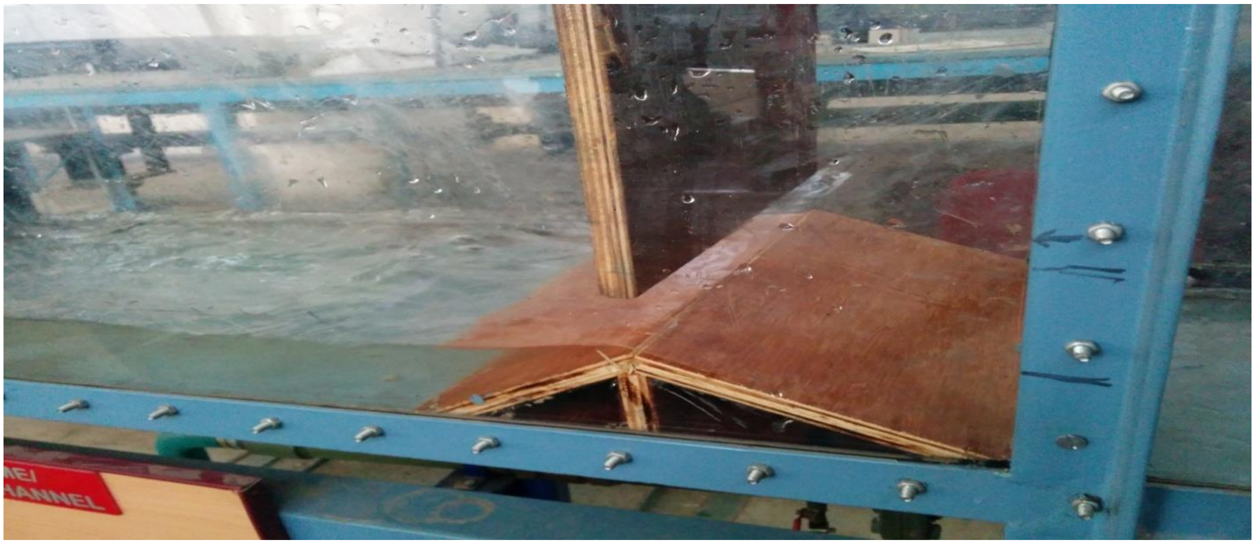


figure 4: when a rectangular sluice gate with horizontal edge is placed vertically on the sill of 7.5 cm.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

Figure 5: when a sluice gate with horizontal edge is placed vertically on the the sill of 10 cm.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

Figure 6: when a sluice gate with horizontal edge is placed vertically on the the sill of 11.5 cm.

In this case, a rectangular sluice gate with horizontal edge is placed vertically in the channel or flume over a prismatic sill/hump of height 7.5,10 & 11.5 cm and one case of no sill. Opening of about 3 cm & 4 cm between the gate and sill/hump are taken, three discharges are passed through the each opening of sluice gate and sill/hump to study the effects on the hydraulic coefficients in this case.

We have to measure the upstream and downstream flows to calculate the head difference between them.

CASE 2 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

Figure 7: when a sluice gate with horizontal edge is inclined in the direction of flow without a sill/hump.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

Figure 8: when a sluice gate with horizontal edge is inclined in the direction of flow with a sill/hump of 7.5 cm.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW .

Figure 9: when a sluice gate with horizontal edge is inclined in the direction of flow on the the sill of 10 cm.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

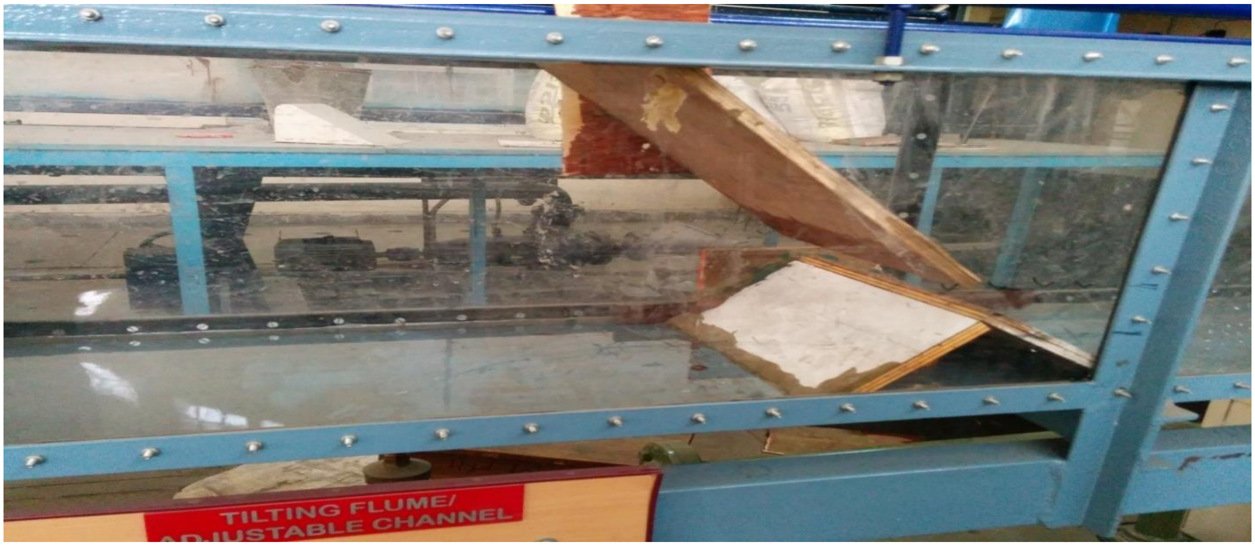


Figure 10: when a sluice gate with horizontal edge is inclined in the direction of flow on the the sill of 11.5 cm.

In this case, a rectangular sluice gate with horizontal edge is inclined in the direction of flow in the channel or flume over a prismatic sill/hump of height 7.5,10 & 11.5 cm and one case with no sill. Opening of about 3 cm & 4 cm between the gate and sill/hump are taken, three discharges are passed through the each opening of sluice gate and sill/hump to study the effects on the hydraulic coefficients in this case.

We have to measure the upstream and downstream flows to calculate the head difference between them.

CASE 3 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 11: when a sluice gate with horizontal edge is inclined in the opposite direction of flow without a sill/hump.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

Figure 12: when a sluice gate with horizontal edge is inclined in the opposite direction of flow with a sill/hump of 7.5 cm.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 13: when a sluice gate with horizontal edge is inclined in the opposite direction of flow on the the sill of 10 cm.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

Figure 14: when a sluice gate with horizontal edge is inclined in the opposite direction of flow on the the sill of 11.5 cm.

In this case, a rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow in the channel or flume over a prismatic sill/hump of height 7.5, 10 & 11.5 cm and one case of no sill. Opening of about 3 cm & 4 cm between the gate and sill/hump are taken, three discharges are passed through the each opening of sluice gate and sill/hump to study the effects on the hydraulic coefficients in this case.

We have to measure the upstream and downstream flows to calculate the head difference between them.

<u>CASE 4</u> :

<u>WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.</u>

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

Figure 15: when a sluice gate with sharp edge lip is inclined in the direction of flow without a sill/hump.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

Figure 16: when a sluice gate with sharp edge lip is inclined in the direction of flow with a sill/hump of 7.5 cm.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

Figure 17: when a sluice gate with sharp edge is inclined in the direction of flow on the the sill of 10 cm.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

Figure 18: when a sluice gate with sharp edge is inclined in the direction of flow on the the sill of 11.5 cm.

In this case, a rectangular sluice gate with sharp edge is inclined in the direction of flow in the channel or flume over a prismatic sill/hump of height 7.5 , 10 & 11.5 cm and one case of no sill. Opening of about 3 cm & 4 cm between the gate and sill/hump are taken, three discharges are passed through the each opening of sluice gate and sill/hump to study the effects on the hydraulic coefficients in this case.

We have to measure the upstream and downstream flows to calculate the head difference between them.

CASE 5 :

WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 19: when a sluice gate with sharp edge lip is inclined in the opposite direction of flow without a sill/hump.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 20: when a sluice gate with sharp edge lip is inclined in the opposite direction of flow with a sill/hump of 7.5 cm.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 21: when a sluice gate with sharp edge is inclined in the opposite direction of flow on the the sill of 10 cm.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

Figure 22: when a sluice gate with sharp edge is inclined in the opposite direction of flow on the the sill of 11.5 cm.

In this case, a rectangular sluice gate with sharp edge is inclined in the opposite direction of flow in the channel or flume over a prismatic sill/hump of height 7.5, 10 & 11.5 cm and one case of no sill. Opening of about 3 cm & 4 cm between the gate and sill/hump are taken, three discharges are passed through the each opening of sluice gate and sill/hump to study the effects on the hydraulic coefficients in this case. We have to measure the upstream and downstream flows to calculate the head difference between them.

CHAPTER 5

Calculations & observations

Now, we will study the effects on hydraulic coefficients of different cases of sluice gates over the different cases of humps/sills of different heights on the coefficient of discharge (Cd), coefficient of velocity (Cv) & coefficient of contraction (Cc).

Coefficient of discharge (Cd) :-

First we have to calculate the actual discharge through the flume, which can be calculated by this formula :

$$Q\ ac = V / t = (A.\Delta H) / t$$

where
V = (A.ΔH) i.e. Volume of water collected in collecting tank
A = Cross section area of collecting tank.
ΔH = (H2 – H1) i.e. Depth of water collected in collecting tank.
t = Time required to collect the water up to a height ΔH in the collecting tank.

Qac = (A.ΔH)/ t

Now, we will calculate the theoretical discharge in each case :

$$Q_{th} = W \cdot d\sqrt{2gH} \qquad (1)$$

Where

Qth = the theoretical discharge passing under gate
W = width of channel
d = the gate opening
H = difference in head
g = gravitational acceleration

CASE 1 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS PLACED VERTICALLY ON THE DIFFERENT SILLS

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.1: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

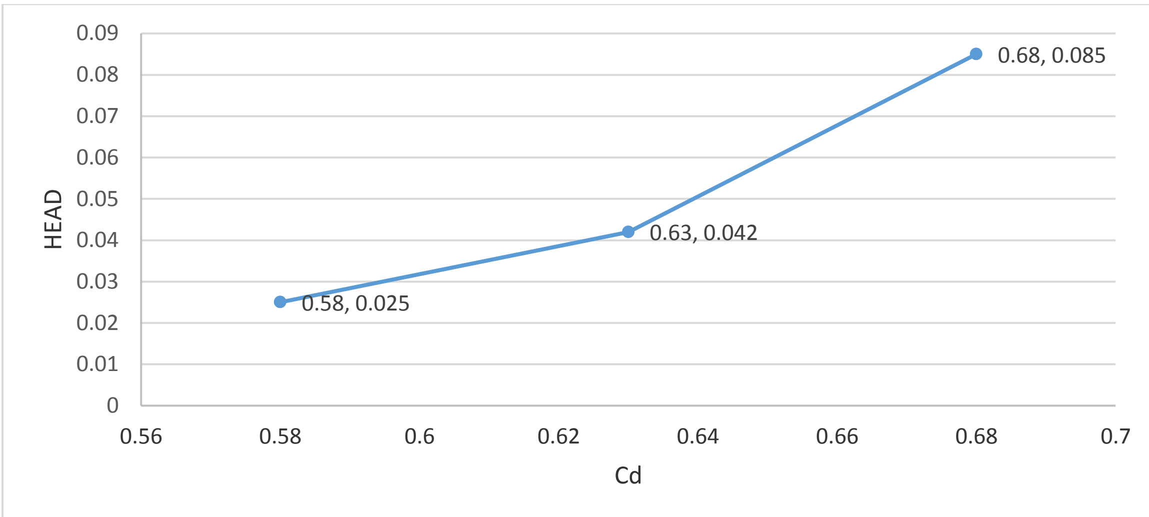
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.055	0.030	0.025	0.833	0.03	0.00371606	0.006407	0.58
2.	0.067	0.025	0.042	1.4	0.03	0.00523282	0.00830606	0.63
3.	0.105	0.020	0.085	2.83	0.03	0.00803216	0.011812	0.68

TABLE NO. 5.2: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.050	0.035	0.015	0.375	0.04	0.00390131	0.0066124	0.59
2.	0.068	0.034	0.034	0.85	0.04	0.00639708	0.0099643	0.64
3.	0.075	0.025	0.050	1.25	0.04	0.00836143	0.0120835	0.69

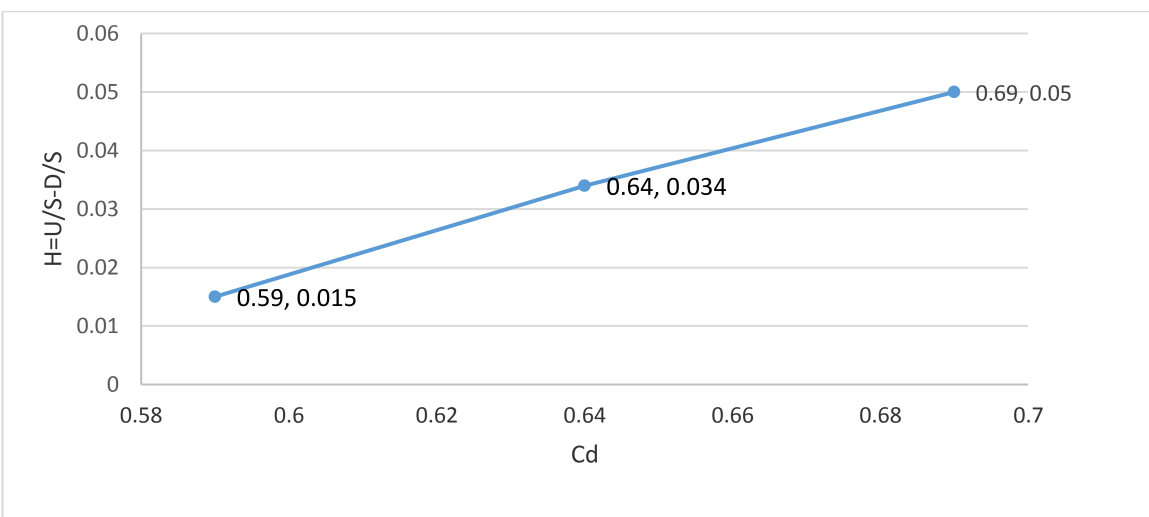
I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED.

- WHEN AN OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 1: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED WITHOUT A SILL.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 2: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED WITHOUT A SILL.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.3: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

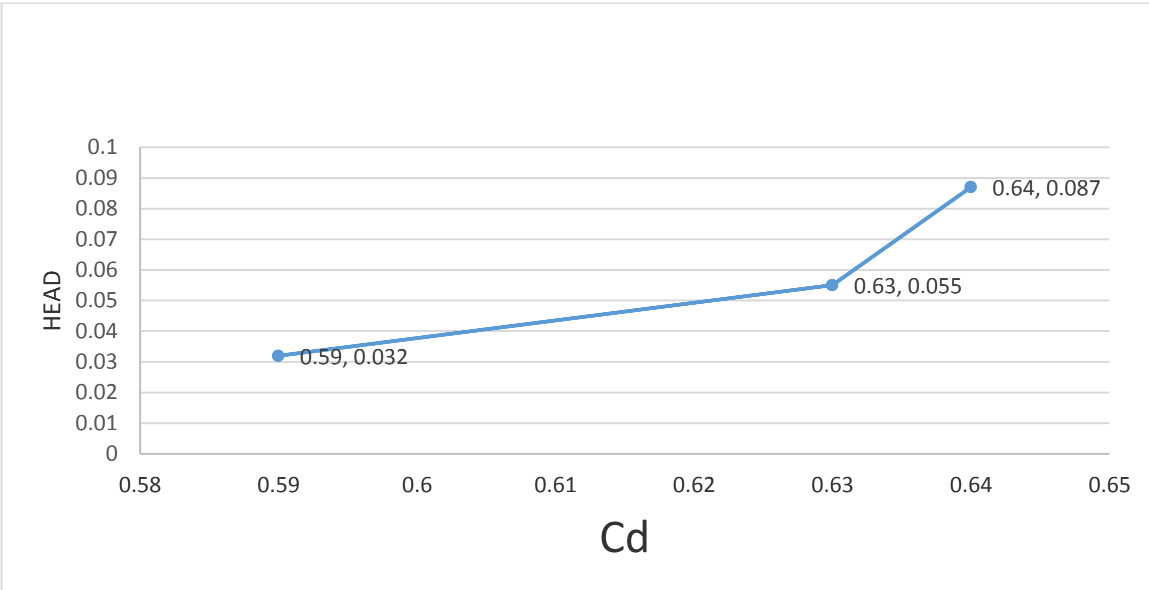
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.227	0.195	0.032	1.06	0.03	0.00427757	0.0072501	0.59
2.	0.240	0.185	0.055	1.83	0.03	0.00598814	0.0095049	0.63
3.	0.320	0.233	0.087	2.90	0.03	0.007901	0.0119543	0.66

TABLE NO. 5.4: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.196	0.180	0.016	0.4	0.04	0.0042938	0.006835	0.63
2.	0.272	0.220	0.052	1.3	0.04	0.0078984	0.0123228	0.64
3.	0.385	0.321	0.064	1.6	0.04	0.0091590	0.0136703	0.67

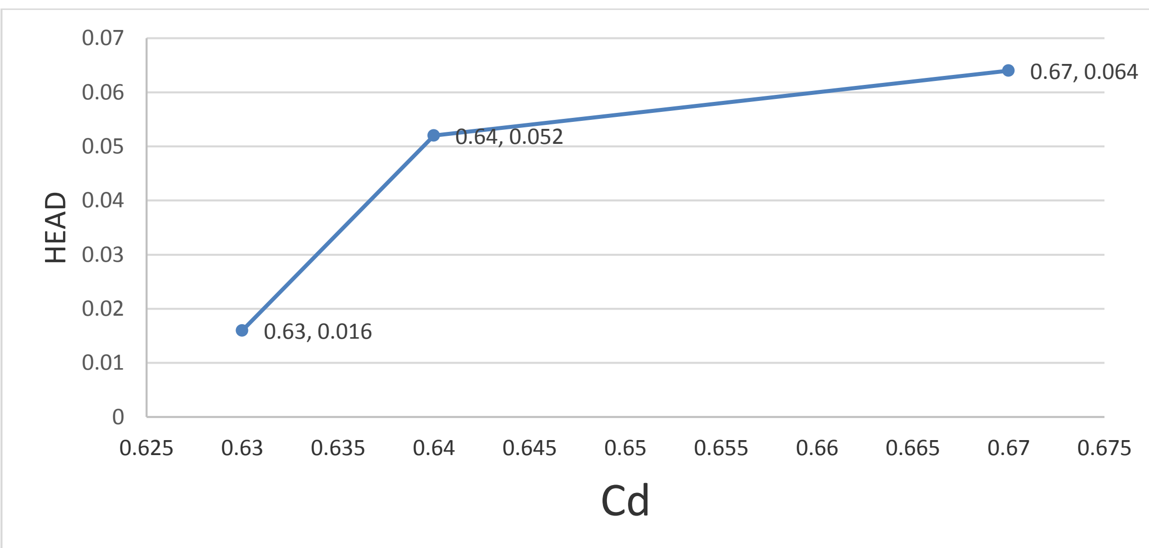
II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 3: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED A SILL OF 7.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 4: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED OVER A SILL OF 7.5 CM.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.5: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

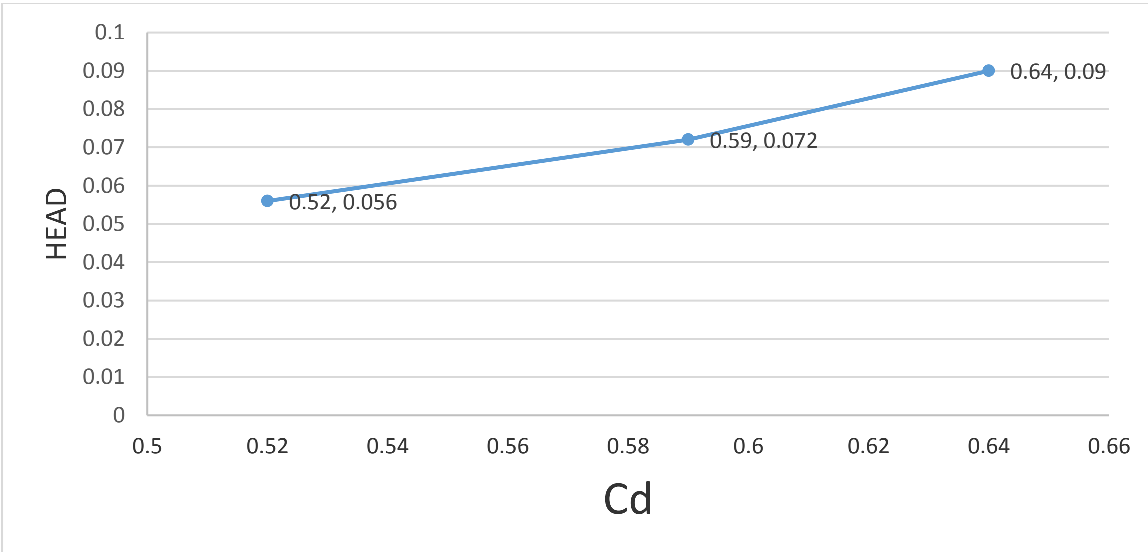
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.178	0.122	0.056	1.86	0.03	0.0049868	0.009590	0.52
2.	0.202	0.130	0.072	2.4	0.03	0.0064163	0.0108751	0.59
3.	0.255	0.165	0.090	3	0.03	0.0076600	0.0121588	0.64

TABLE NO. 5.6: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.158	0.134	0.024	0.6	0.04	0.00502302	0.0083717	0.60
2.	0.218	0.162	0.056	1.4	0.04	0.00792851	0.0127880	0.62
3.	0.261	0.189	0.072	1.8	0.04	0.0094251	0.0145002	0.65

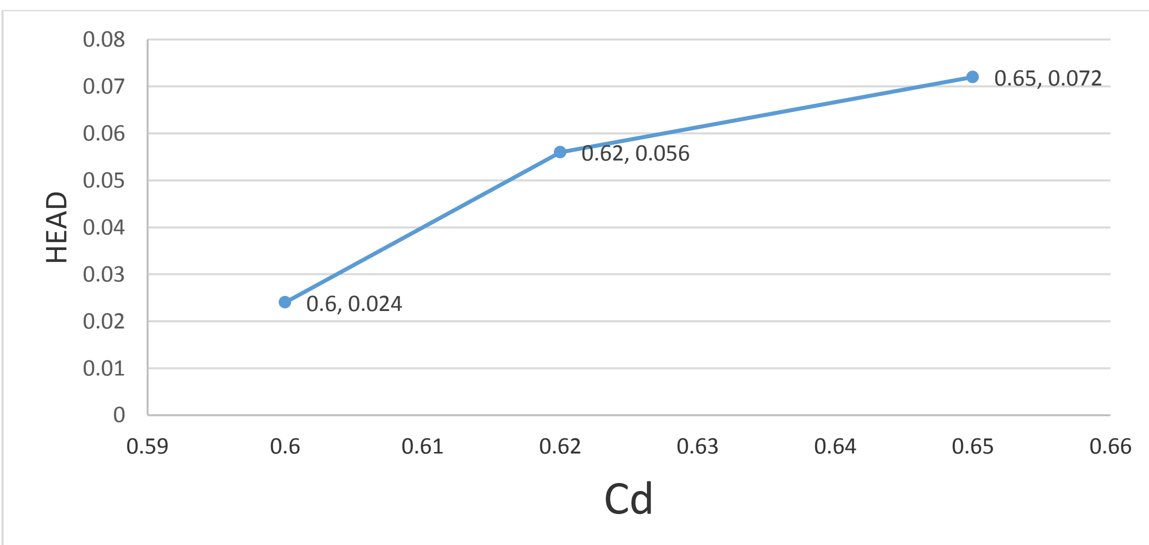
III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 5: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED OVER A SILL OF 10 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 6: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED OVER A SILL OF 10 CM.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.7: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

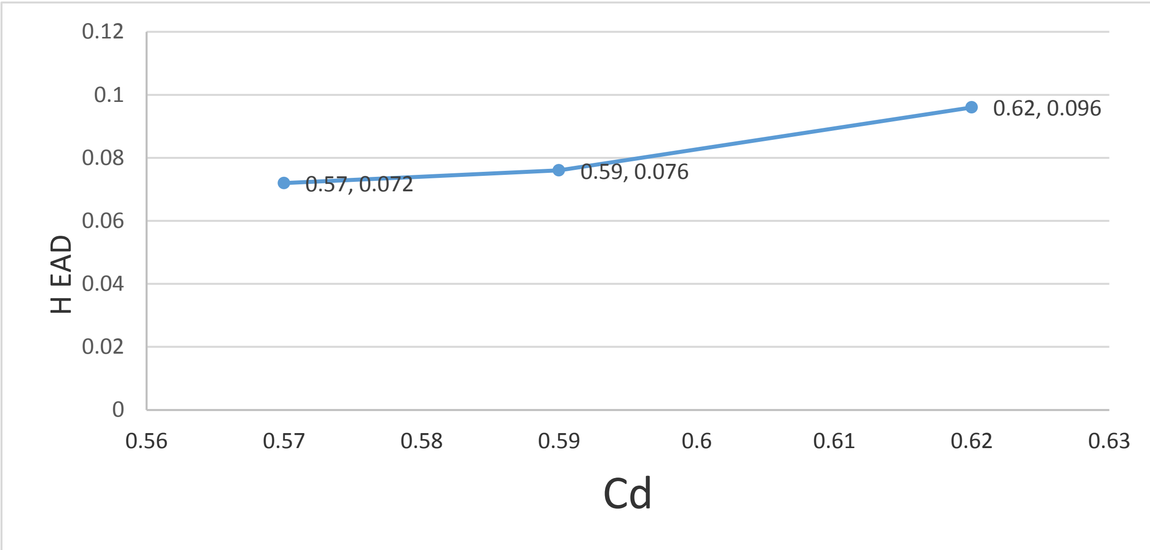
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.210	0.138	0.072	2.4	0.03	0.0062047	0.0108751	0.57
2.	0.228	0.152	0.076	2.53	0.03	0.0066145	0.0111732	0.59
3.	0.264	0.168	0.096	3.2	0.03	0.0077857	0.0125575	0.62

TABLE NO. 5.8: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.183	0.141	0.042	1.05	0.04	0.0064235	0.0110747	0.58
2.	0.227	0.166	0.061	1.52	0.04	0.0082681	0.01334671	0.61
3.	0.269	0.185	0.084	2.1	0.04	0.0098670	0.0156621	0.63

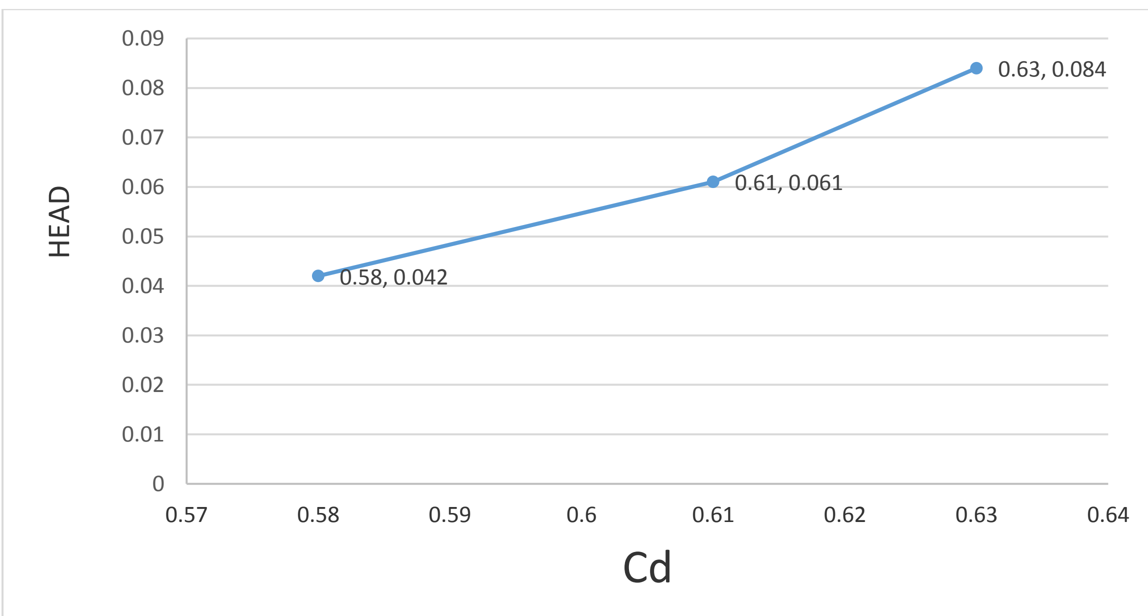
IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 7: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED OVER A SILL OF 11.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 8: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED OVER A SILL OF 11.5 CM.

CASE 2 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.9: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

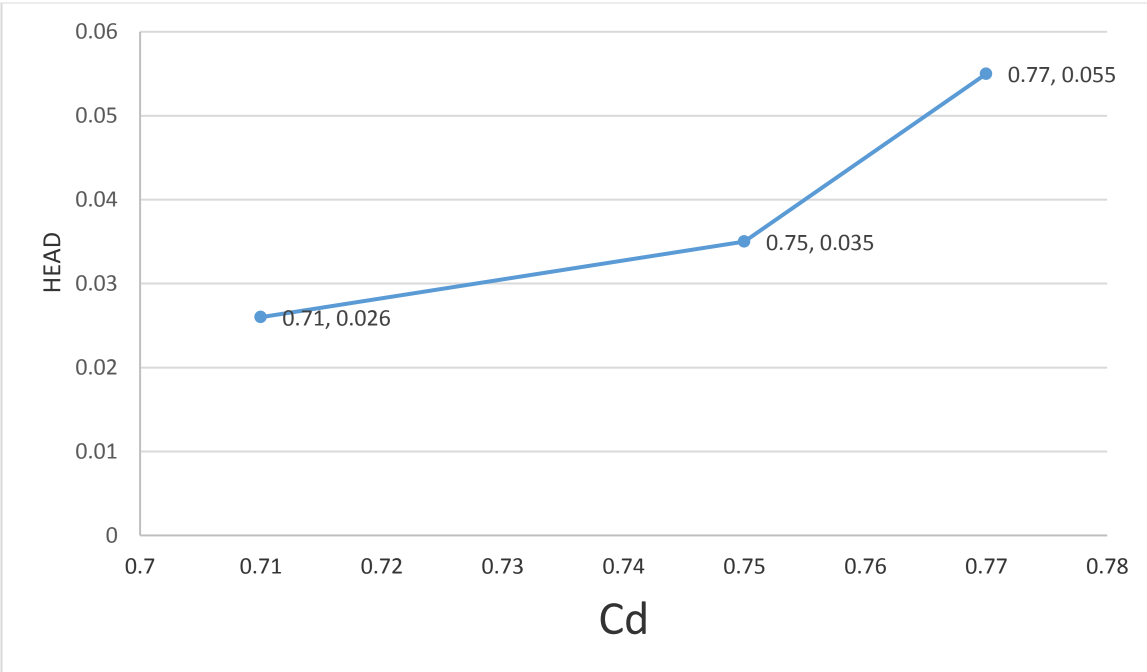
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.055	0.029	0.026	0.86	0.03	0.0046399	0.0065371	0.71
2.	0.065	0.030	0.035	1.16	0.03	0.0056867	0.0075823	0.75
3.	0.078	0.023	0.055	1.83	0.03	0.0073188	0.0095049	0.77

TABLE NO. 5.10: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.045	0.030	0.015	0.375	0.04	0.0047652	0.0066184	0.72
2.	0.055	0.034	0.021	0.5	0.04	0.0059508	0.0078301	0.76
3.	0.065	0.030	0.035	0.875	0.04	0.0079861	0.010109	0.79

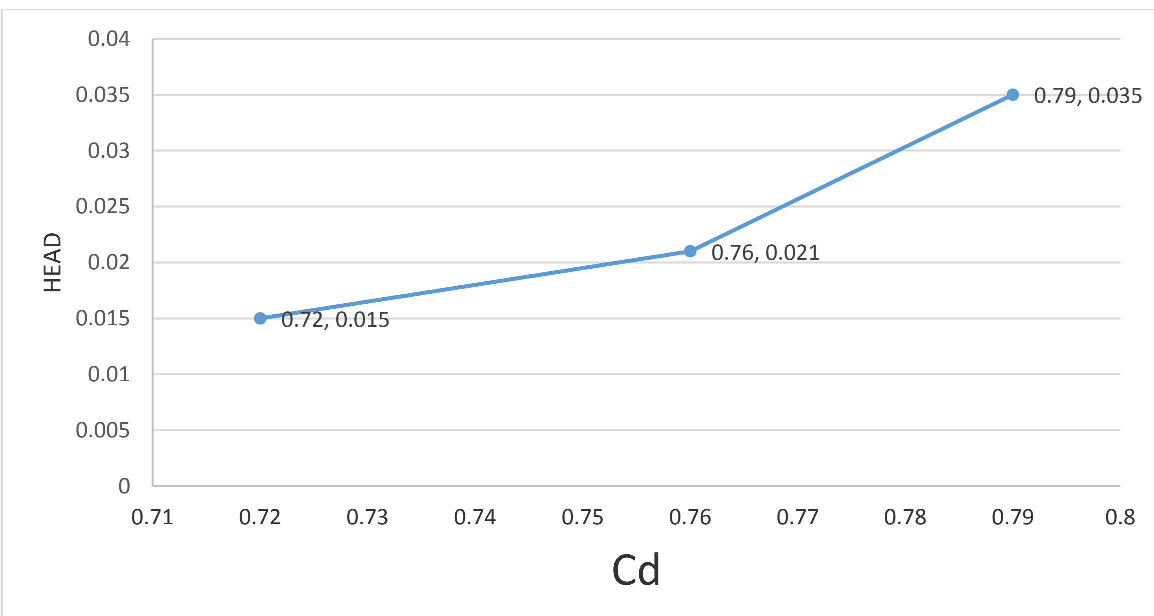
I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 9: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW WITH OUT A SILL.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 10: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW WITHOUT A SILL.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.11: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

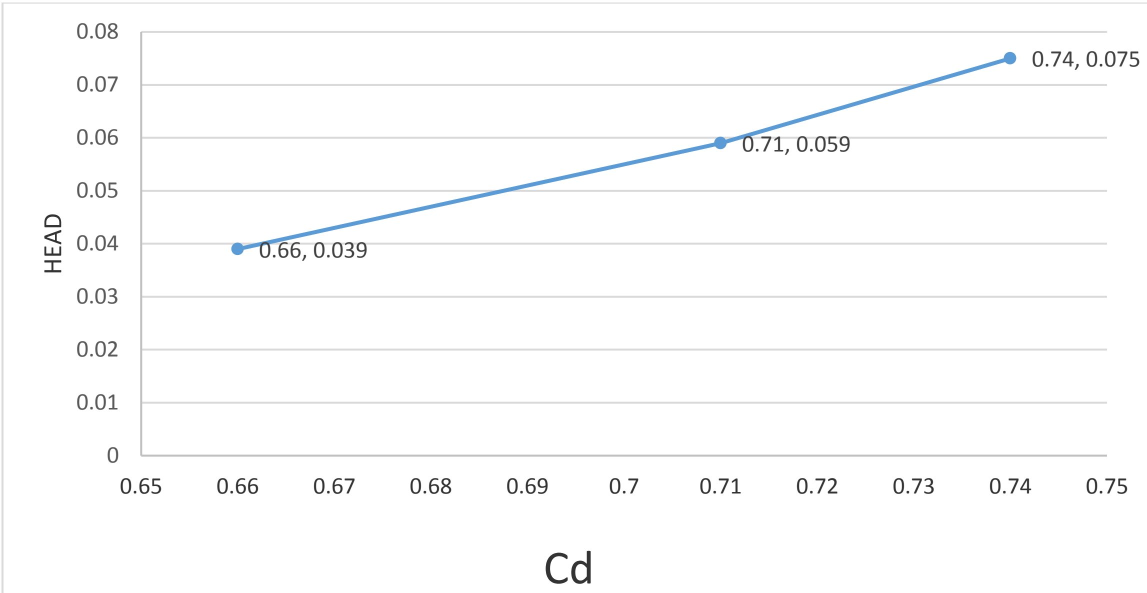
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.132	0.093	0.039	1.3	0.03	0.0052819	0.008003	0.66
2.	0.209	0.150	0.059	1.96	0.03	0.006989	0.009845	0.71
3.	0.280	0.205	0.075	2.5	0.03	0.0082132	0.011099	0.74

TABLE NO. 5.12: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.125	0.107	0.018	0.45	0.04	0.0050019	0.00724924	0.69
2.	0.172	0.138	0.034	0.85	0.04	0.007233	0.0099631	0.73
3.	0.216	0.165	0.051	1.27	0.04	0.0091528	0.0122036	0.75

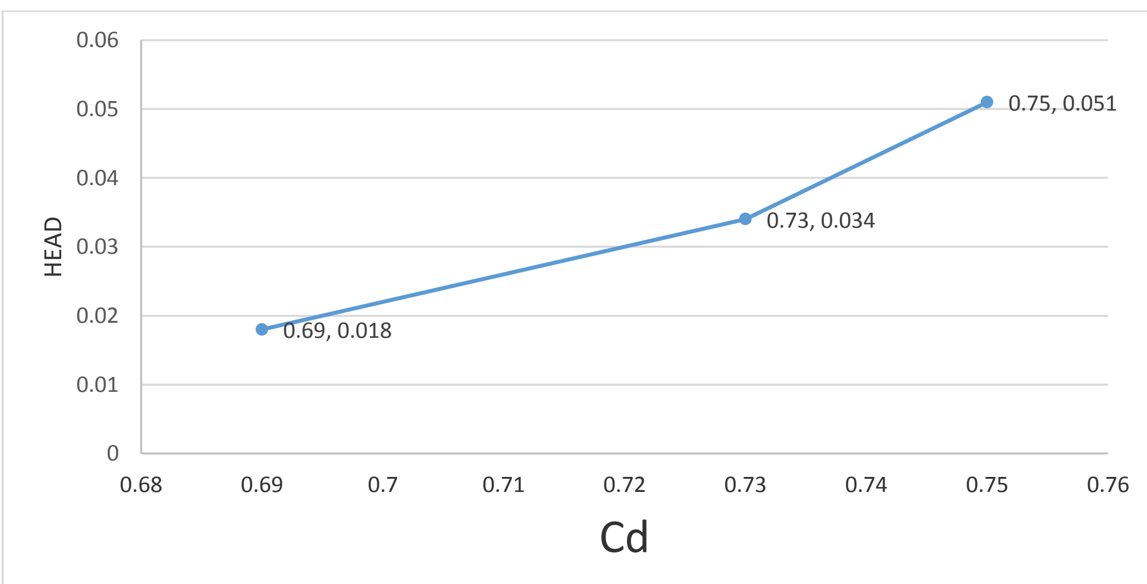
II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 11: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 12: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 10 CM.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.13: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

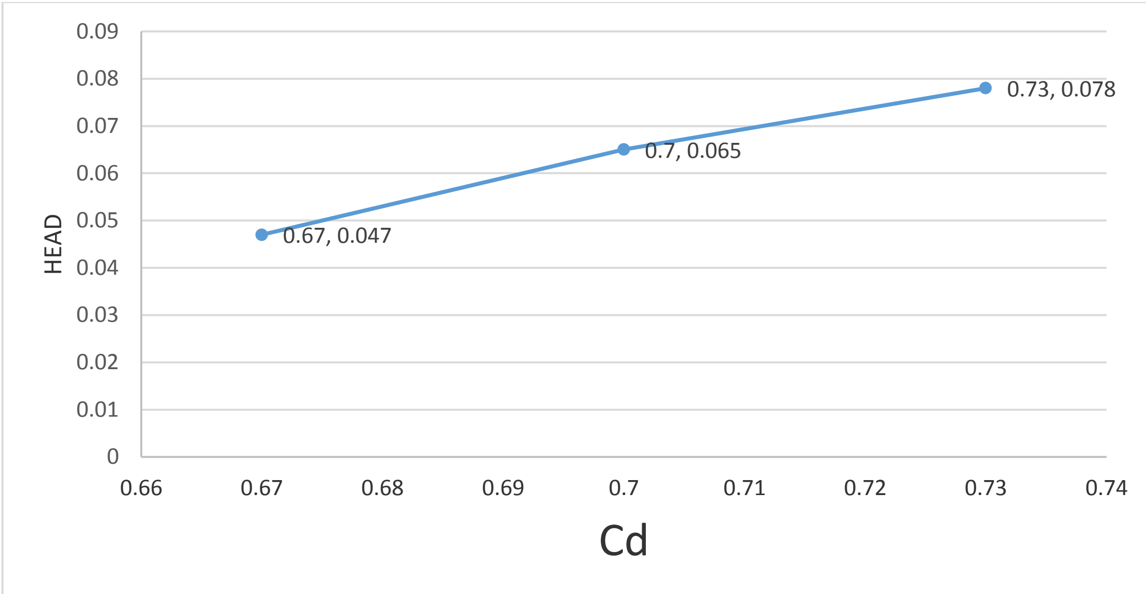
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.160	0.113	0.047	1.56	0.03	0.0058869	0.00878657	0.67
2.	0.215	0.150	0.065	2.16	0.03	0.0072331	0.0103330	0.70
3.	0.238	0.160	0.078	2.6	0.03	0.0082628	0.0113190	0.73

TABLE NO. 5.14: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.156	0.127	0.029	0.725	0.04	0.0063037	0.0092025	0.68
2.	0.208	0.173	0.035	0.875	0.04	0.0073593	0.010109	0.73
3.	0.220	0.165	0.055	1.37	0.04	0.0093780	0.012673	0.74

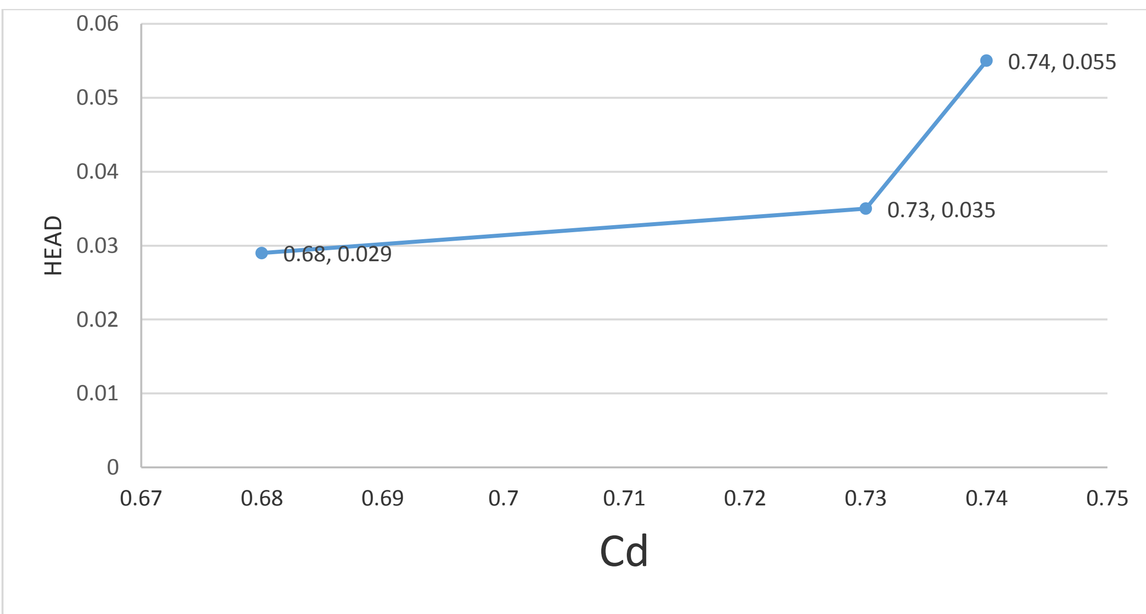
III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 13: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 10 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 14: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 10 CM.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.15: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

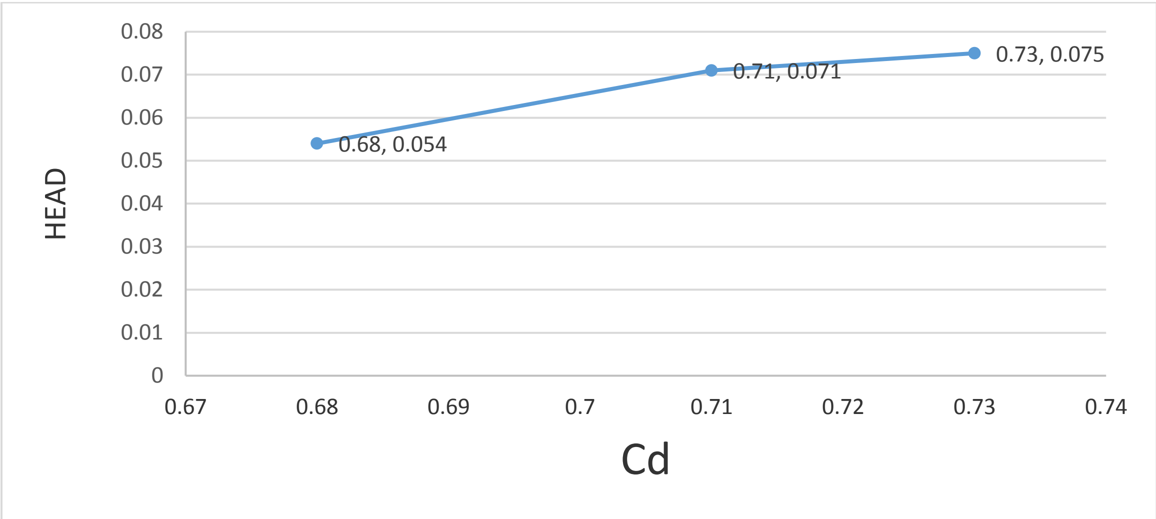
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.185	0.131	0.054	1.8	0.03	0.0064420	0.0094181	0.68
2.	0.237	0.166	0.071	2.36	0.03	0.0076675	0.0107994	0.71
3.	0.252	0.172	0.080	2.66	0.03	0.008336	0.0114634	0.73

TABLE NO. 5.16: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.169	0.133	0.036	0.9	0.04	0.0070747	0.0102532	0.69
2.	0.227	0.175	0.052	1.3	0.04	0.0088723	0.0123227	0.72
3.	0.242	0.181	0.061	1.52	0.04	0.00987655	0.0133467	0.74

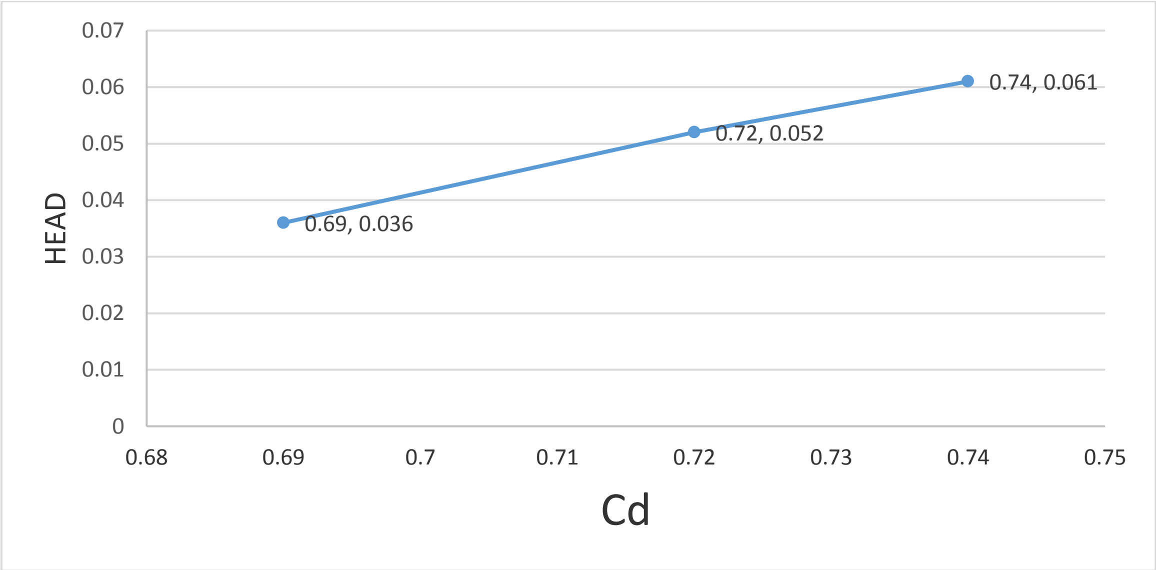
IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 15: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 16: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

<u>CASE 3</u> :

<u>WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.</u>

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.17: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

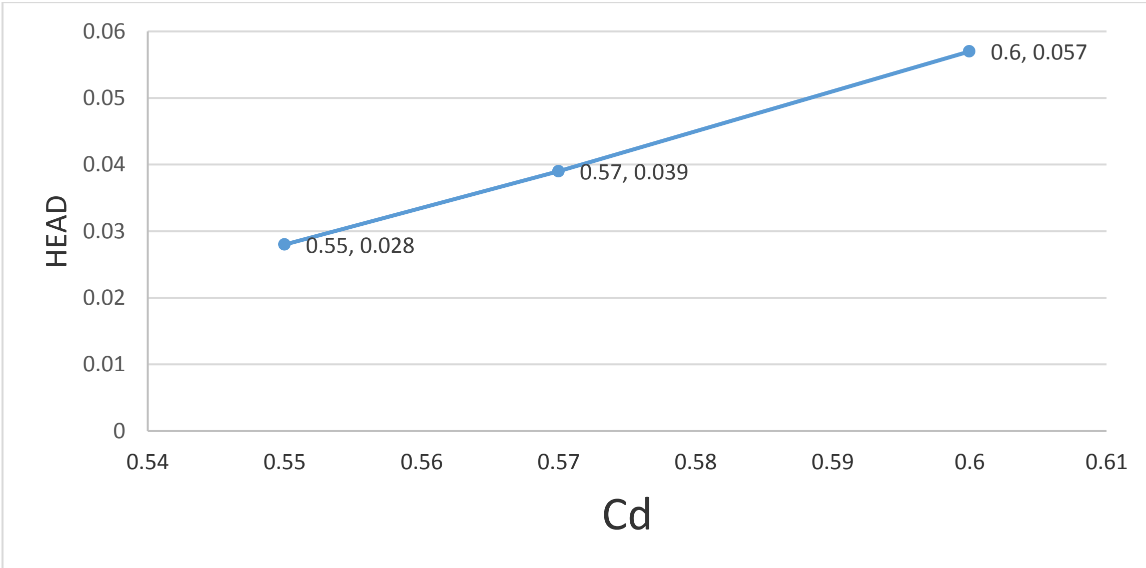
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.058	0.030	0.028	0.93	0.03	0.0037003	0.006781	0.55
2.	0.069	0.030	0.039	1.3	0.03	0.0045622	0.0080392	0.57
3.	0.085	0.028	0.057	1.9	0.03	0.0058057	0.0096762	0.60

TABLE NO. 5.18: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.055	0.030	0.025	0.625	0.04	0.0047891	0.0085442	0.56
2.	0.070	0.033	0.037	0.925	0.04	0.0051361	0.0088559	0.58
3.	0.085	0.032	0.053	1.32	0.04	0.0075920	0.012446	0.61

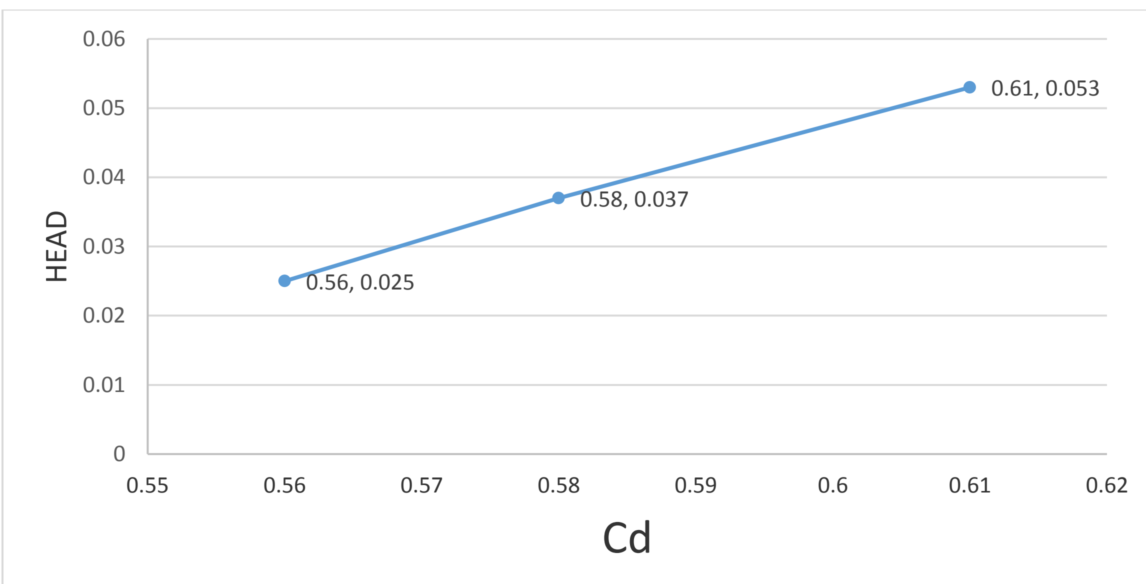
I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 17: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF FLOW WITHOUT A SILL.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 18: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF FLOW WITHOUT A SILL.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

TABLE NO. 5.19: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

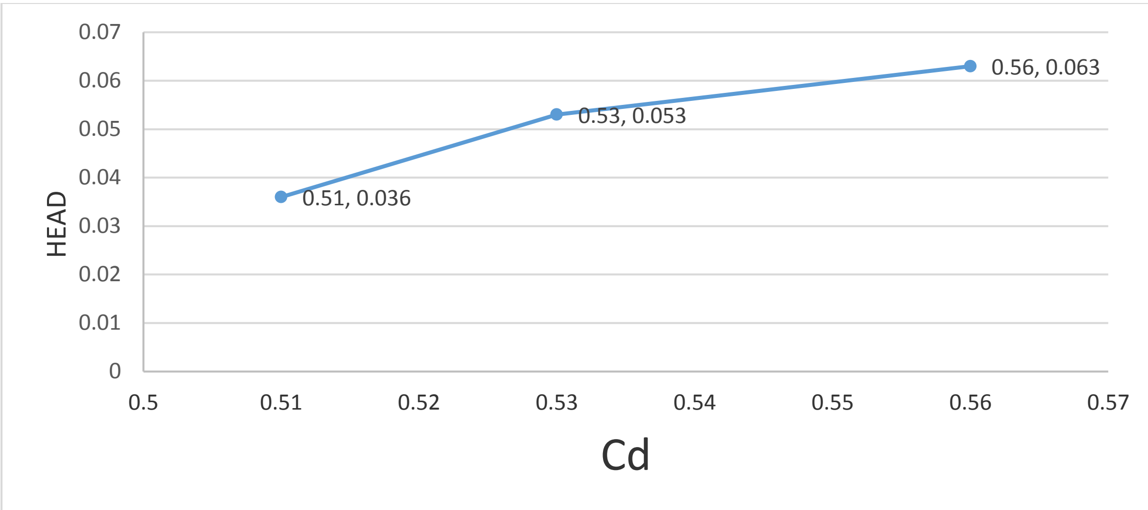
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.185	0.149	0.036	1.2	0.03	0.0039213	0.007689	0.51
2.	0.243	0.190	0.053	1.76	0.03	0.0049452	0.0093305	0.53
3.	0.308	0.245	0.063	2.1	0.03	0.0057473	0.0101728	0.56

TABLE NO. 5.20: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.180	0.148	0.032	0.8	0.04	0.00512342	0.0096668	0.53
2.	0.265	0.214	0.051	1.275	0.04	0.00671207	0.0122037	0.55
3.	0.278	0.219	0.059	1.47	0.04	0.00761385	0.01312734	0.58

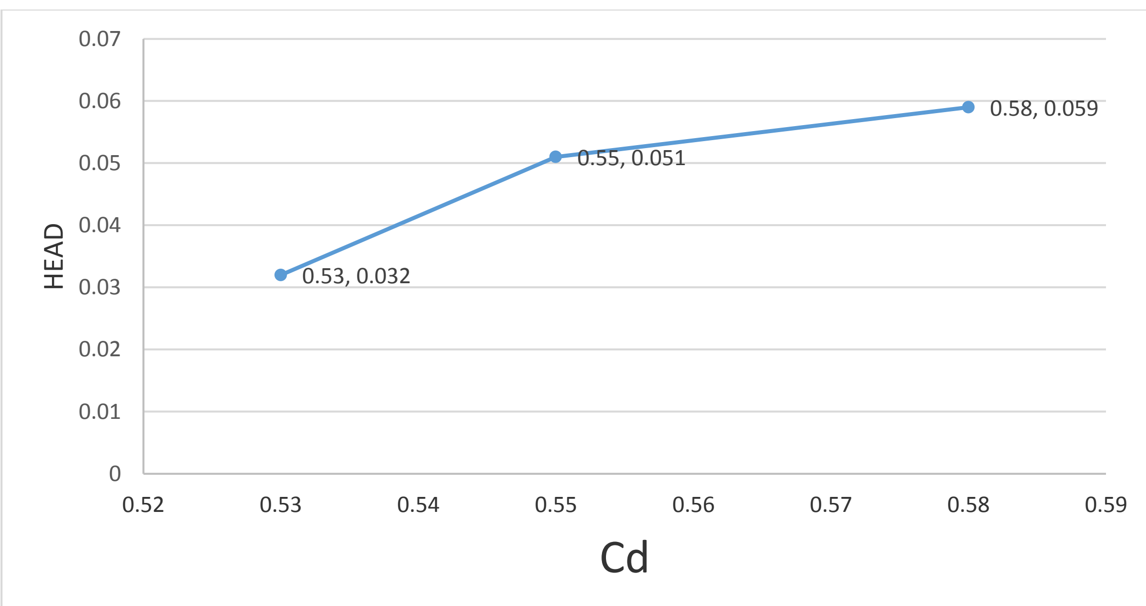
II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 19: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 20: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF OVER A SILL OF 7.5 CM.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.21: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

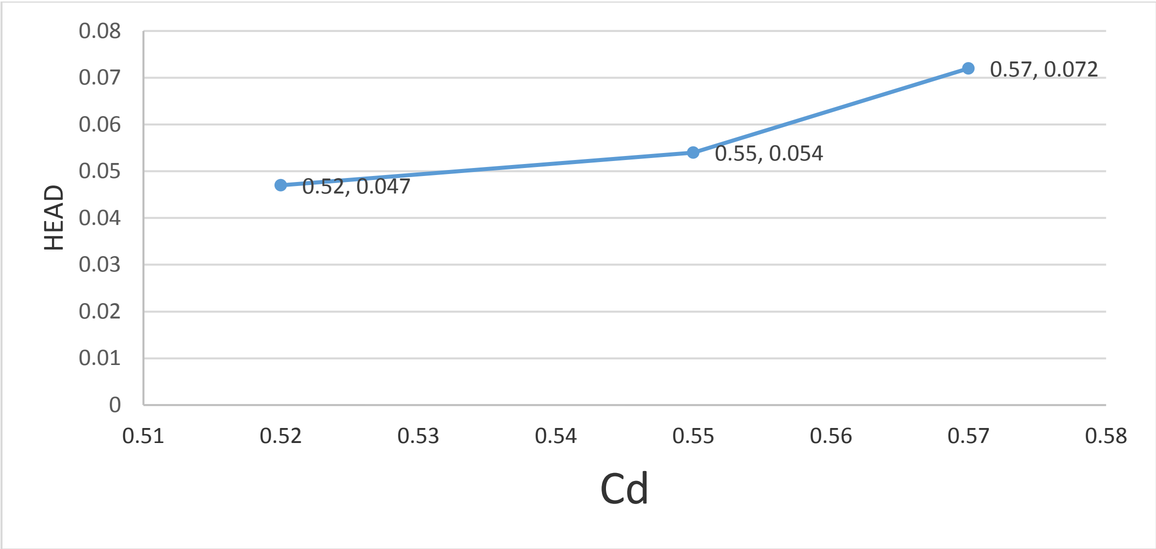
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.160	0.113	0.047	1.56	0.03	0.00456901	0.00878657	0.52
2.	0.198	0.144	0.054	1.8	0.03	0.00518003	0.00941819	0.55
3.	0.255	0.183	0.072	2.4	0.03	0.00619883	0.01087514	0.57

TABLE NO. 5.22: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.229	0.187	0.042	1.05	0.04	0.0059799	0.011074	0.54
2.	0.241	0.188	0.053	1.32	0.04	0.0069668	0.0124407	0.56
3.	0.260	0.190	0.070	1.75	0.04	0.0083063	0.0142974	0.58

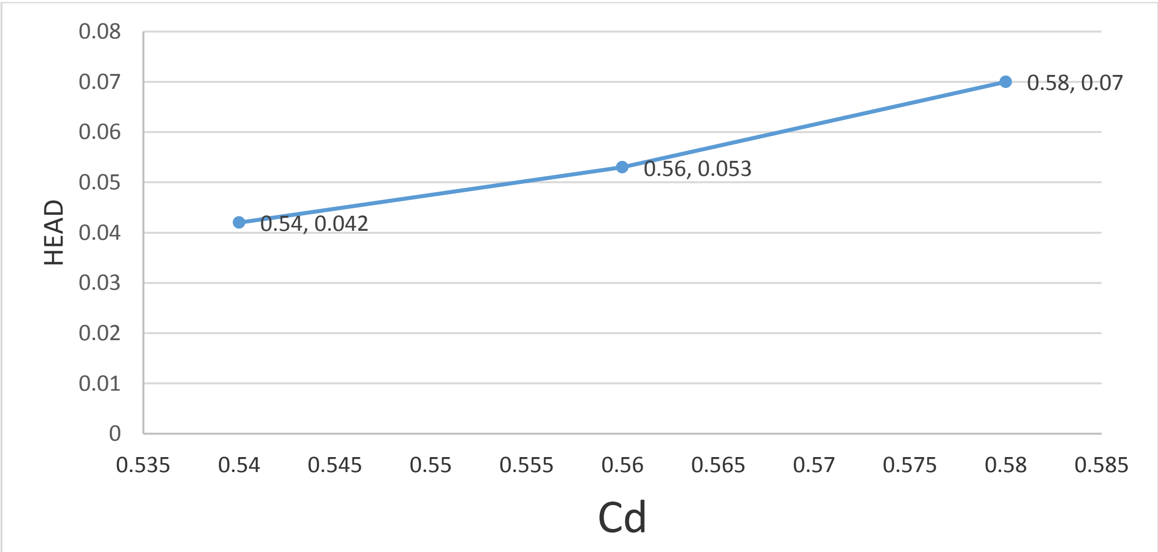
III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 21: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF OVER A SILL OF 10 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 22: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF OVER A SILL OF 10 CM.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

TABLE NO. 5.23: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

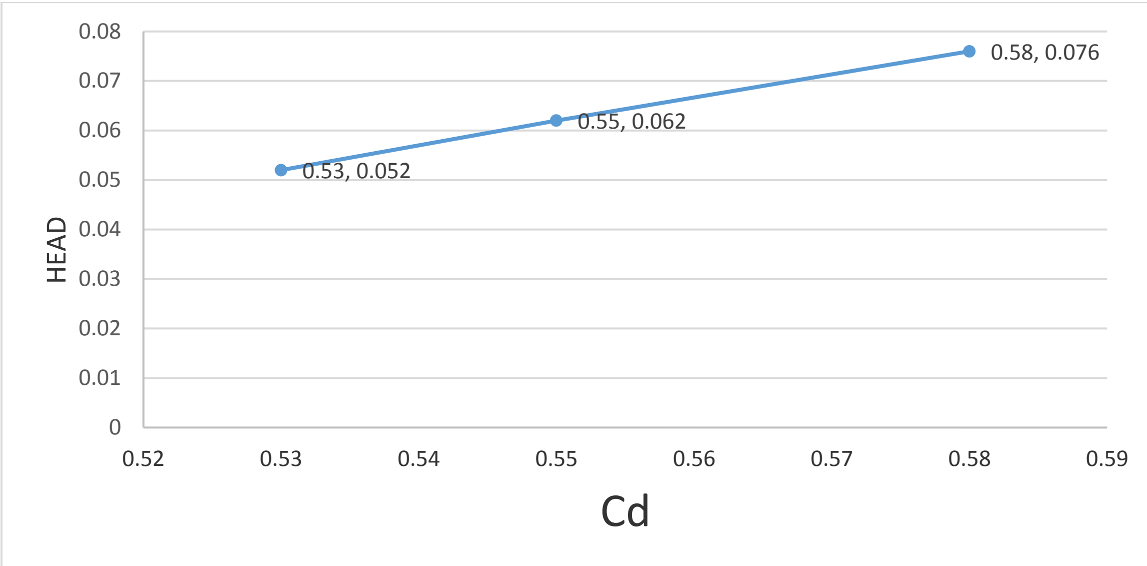
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.184	0.132	0.052	1.73	0.03	0.004906	0.0092420	0.53
2.	0.209	0.147	0.062	2.06	0.03	0.005550	0.0100917	0.55
3.	0.256	0.180	0.076	2.53	0.03	0.006491	0.0111732	0.58

TABLE NO. 5.24: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.213	0.167	0.046	1.15	0.04	0.0062818	0.0115900	0.54
2.	0.246	0.191	0.055	1.37	0.04	0.0071984	0.0126733	0.57
3.	0.266	0.194	0.072	1.8	0.04	0.0085551	0.0145002	0.59

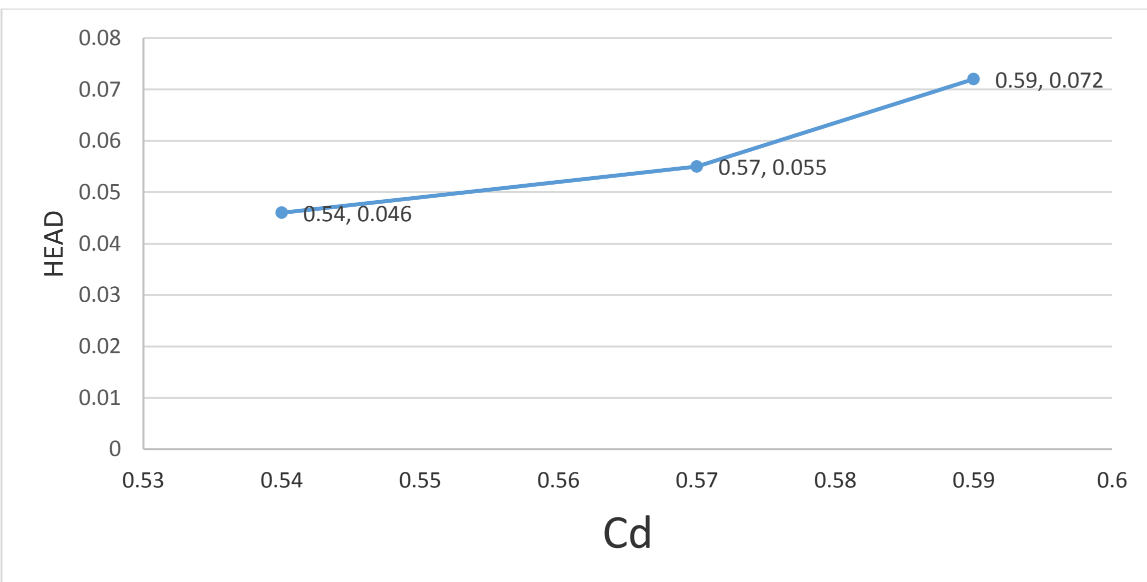
IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 23: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF OVER A SILL OF 11.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 24: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE DIRECTION OF OVER A SILL OF 11.5 CM.

CASE 4 :

WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.25: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

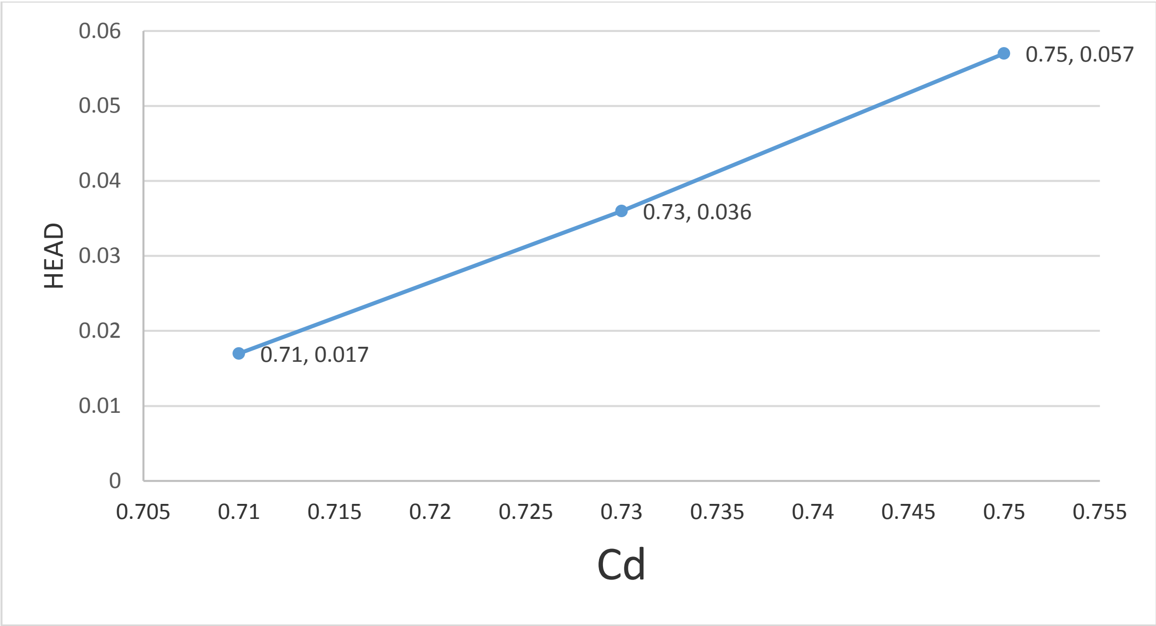
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.055	0.028	0.027	0.9	0.03	0.004761	0.006659	0.71
2.	0.065	0.029	0.036	1.2	0.03	0.005613	0.007689	0.73
3.	0.085	0.028	0.057	1.9	0.03	0.007257	0.009676	0.75

TABLE NO. 5.26: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.050	0.029	0.021	0.52	0.04	0.005636	0.007829	0.72
2.	0.063	0.030	0.033	0.82	0.04	0.005845	0.0078990	0.74
3.	0.088	0.030	0.058	1.45	0.04	0.009890	0.0130143	0.76

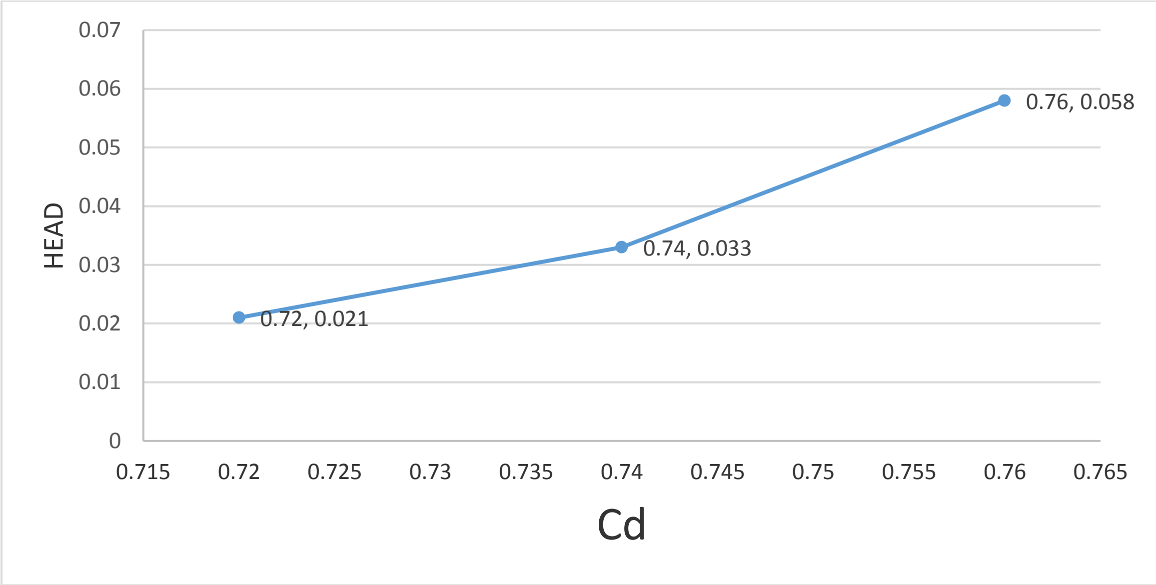
I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 25: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW WITHOUT A SILL.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 26: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW WITHOUT A SILL.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.27: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

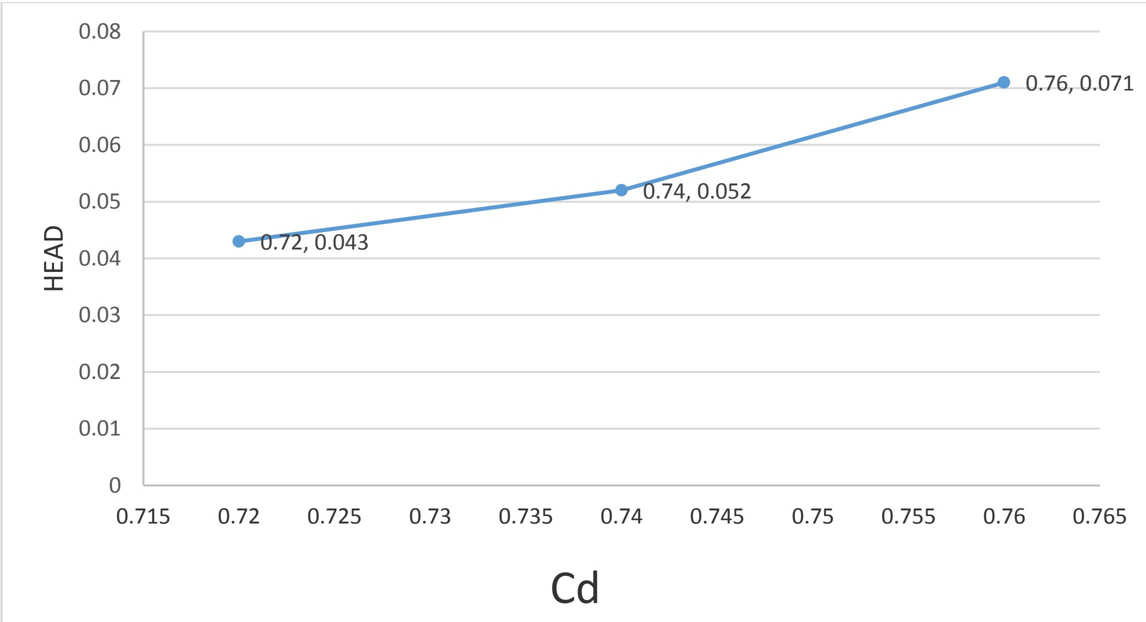
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.148	0.105	0.043	1.43	0.03	0.006051	0.0084043	0.72
2.	0.165	0.113	0.052	1.73	0.03	0.006839	0.0092421	0.74
3.	0.215	0.134	0.071	2.36	0.03	0.008224	0.010799	0.76

TABLE NO. 5.28: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.180	0.154	0.026	0.65	0.04	0.006360	0.008713	0.73
2.	0.213	0.177	0.036	0.97	0.04	0.007689	0.0105323	0.75
3.	0.246	0.187	0.059	1.47	0.04	0.010107	0.0131259	0.77

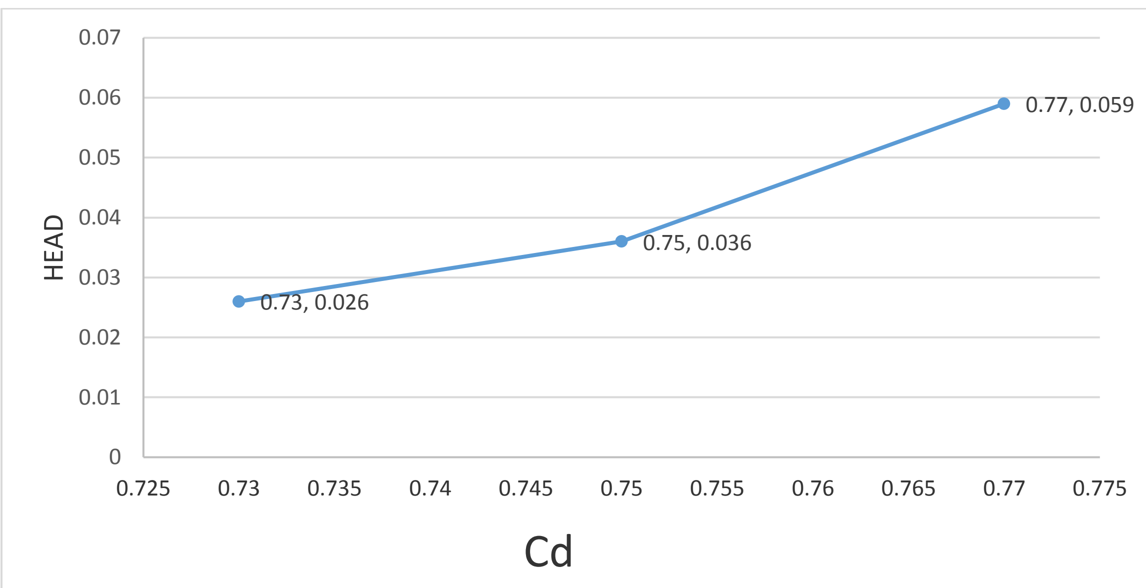
II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 27: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 28: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.29: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

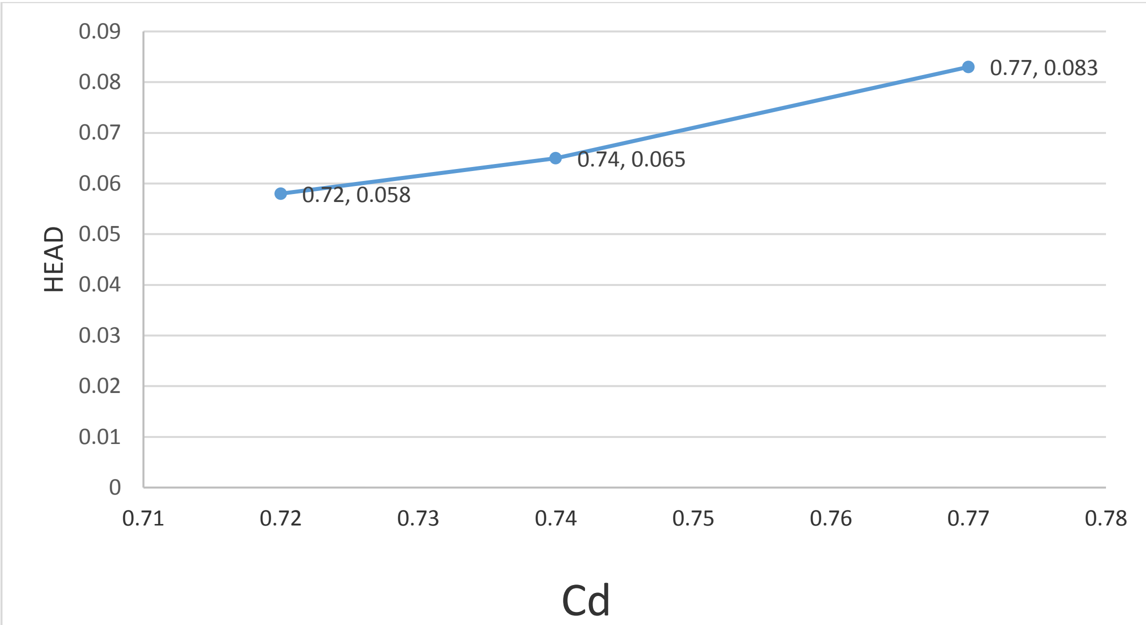
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.167	0.105	0.058	1.93	0.03	0.00702776	0.0097607	0.72
2.	0.192	0.132	0.065	2.16	0.03	0.0075287	0.0101728	0.74
3.	0.235	0.152	0.083	2.76	0.03	0.0089908	0.0116764	0.77

TABLE NO. 5.30: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.180	0.148	0.032	0.8	0.04	0.0071534	0.009666	0.74
2.	0.212	0.173	0.039	0.97	0.04	0.0081106	0.0106719	0.76
3.	0.238	0.175	0.063	1.57	0.04	0.0105796	0.0135637	0.78

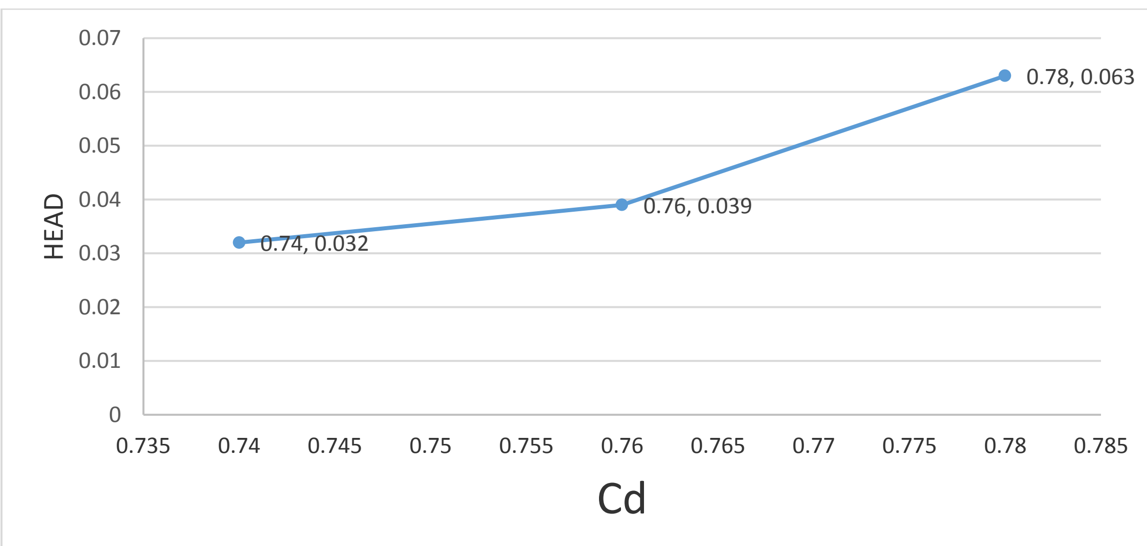
III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 29: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 10 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 30: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 10 CM.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.31: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

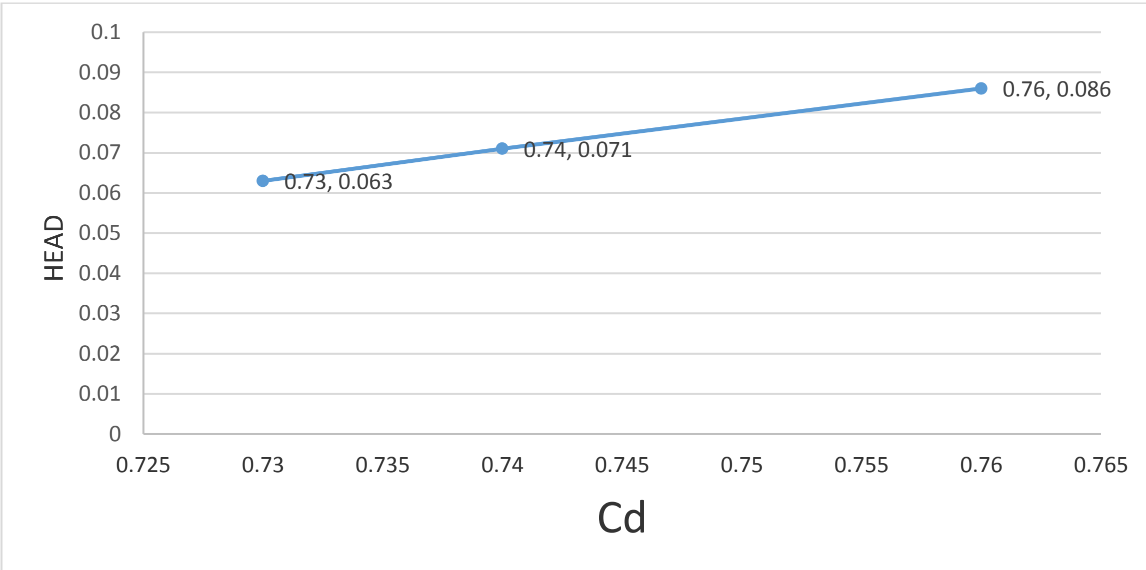
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.181	0.118	0.063	2.1	0.03	0.0074261	0.1017281	0.73
2.	0.205	0.134	0.071	2.36	0.03	0.0080024	0.0107994	0.74
3.	0.241	0.155	0.086	2.86	0.03	0.0090326	0.0118851	0.76

TABLE NO. 5.32: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.187	0.139	0.048	1.2	0.04	0.0087611	0.0118394	0.74
2.	0.200	0.146	0.054	1.35	0.04	0.0095437	0.0125575	0.76
3.	0.241	0.170	0.071	1.77	0.04	0.011202	0.0143992	0.78

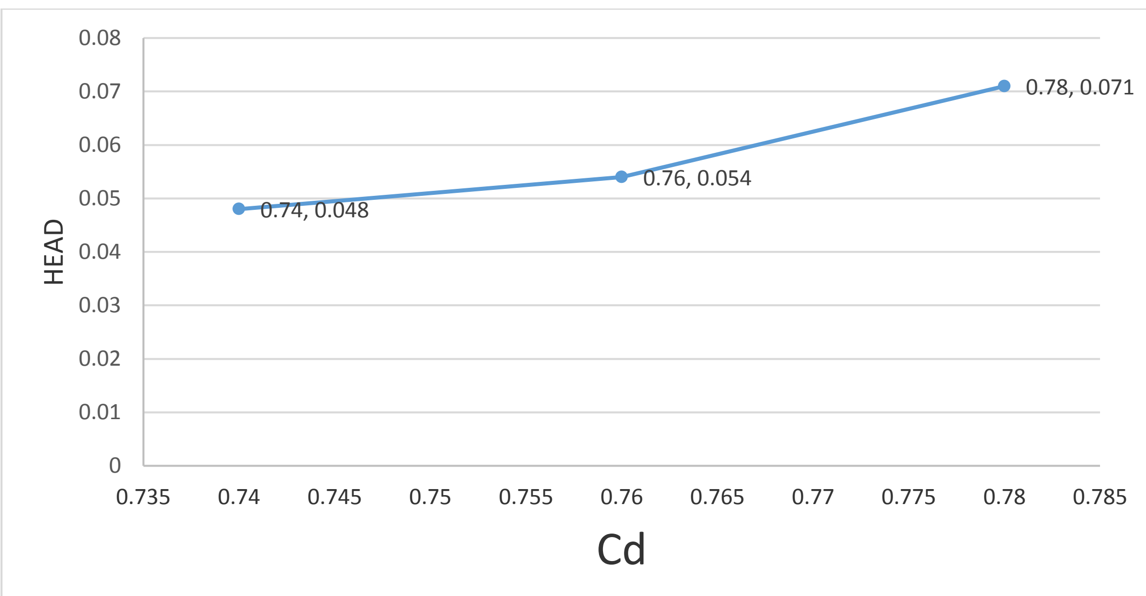
IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 31: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 32: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

<u>**CASE 5**</u> :

<u>WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.</u>

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.33: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

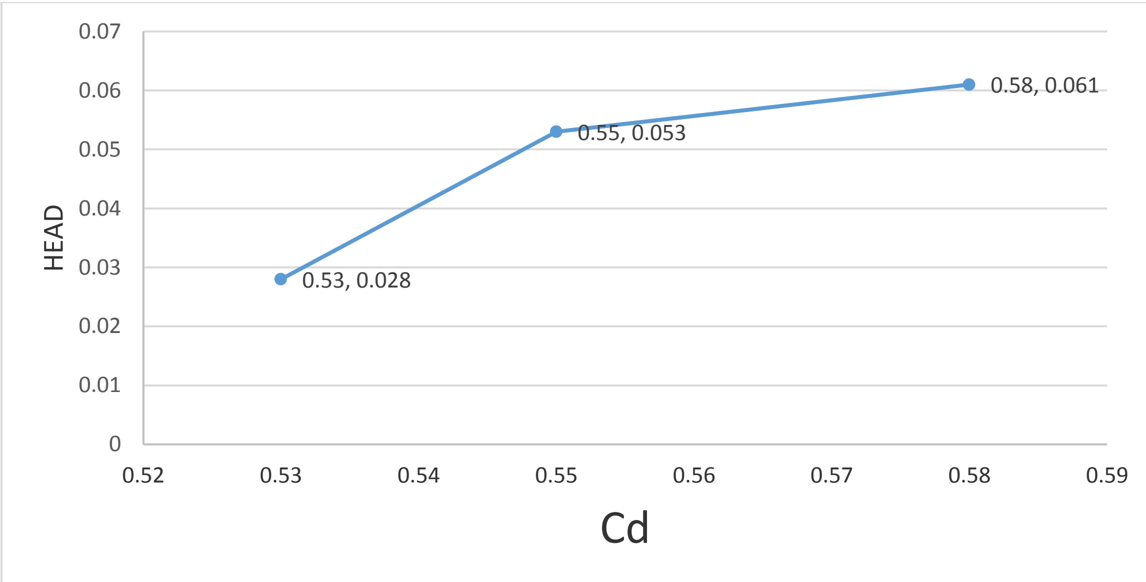
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.050	0.022	0.028	0.93	0.03	0.0035943	0.0067818	0.53
2.	0.077	0.024	0.053	1.76	0.03	0.0051318	0.0093305	0.55
3.	0.088	0.027	0.061	2.03	0.03	0.0058058	0.0100100	0.58

TABLE NO. 5.34: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.048	0.030	0.018	0.45	0.04	0.003929	0.00725012	0.54
2.	0.058	0.031	0.027	0.675	0.04	0.0051503	0.00887955	0.58
3.	0.065	0.032	0.033	0.825	0.04	0.005988	0.0098167	0.61

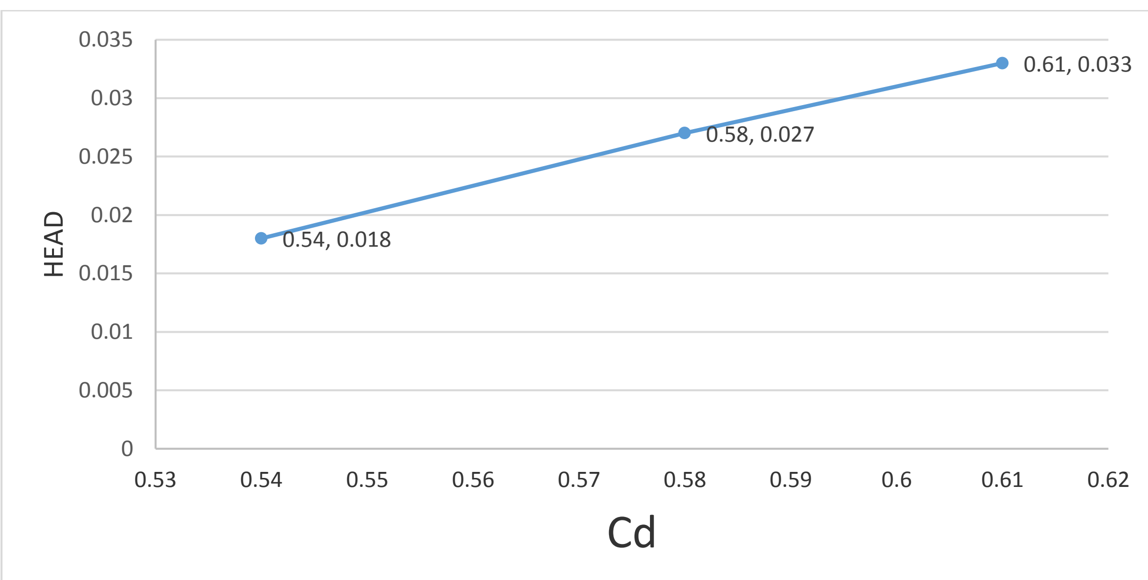
I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 33: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW WITHOUT A SILL.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 34: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW WITHOUT A SILL.

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.35: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

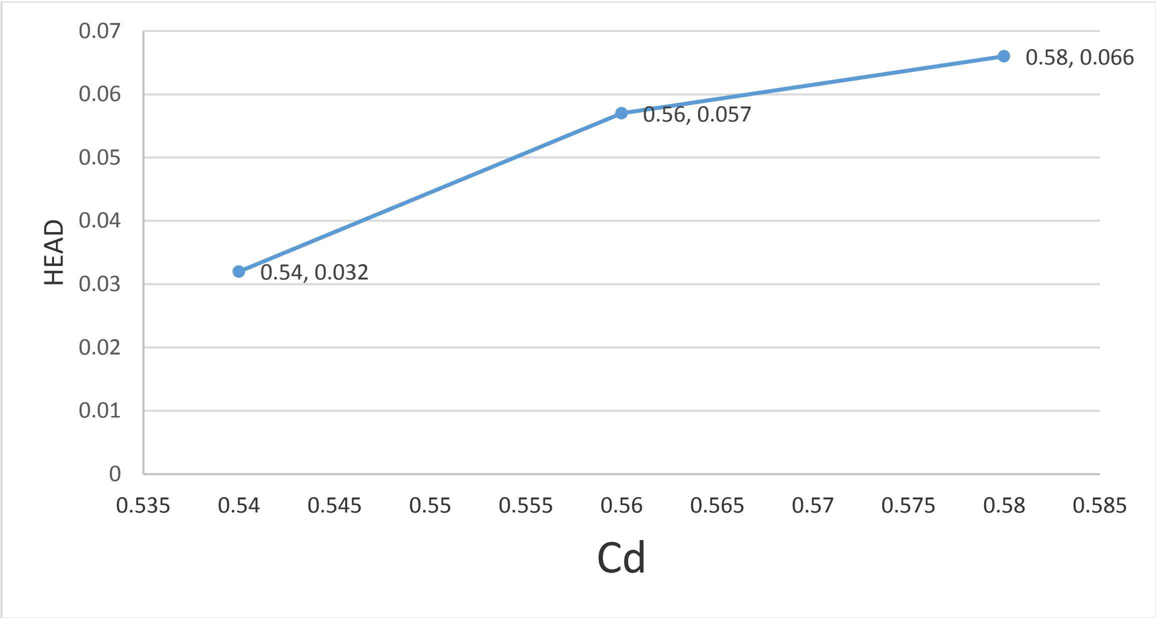
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.135	0.103	0.032	1.06	0.03	0.0039150	0.0072501	0.54
2.	0.226	0.169	0.057	1.9	0.03	0.0054185	0.009676	0.56
3.	0.240	0.174	0.066	2.2	0.03	0.0060390	0.010412	0.58

TABLE NO. 5.36: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.133	0.102	0.031	0.775	0.04	0.0052330	0.0095145	0.55
2.	0.171	0.137	0.034	0.85	0.04	0.0056794	0.009964	0.57
3.	0.222	0.168	0.054	1.35	0.04	0.0074086	0.012557	0.59

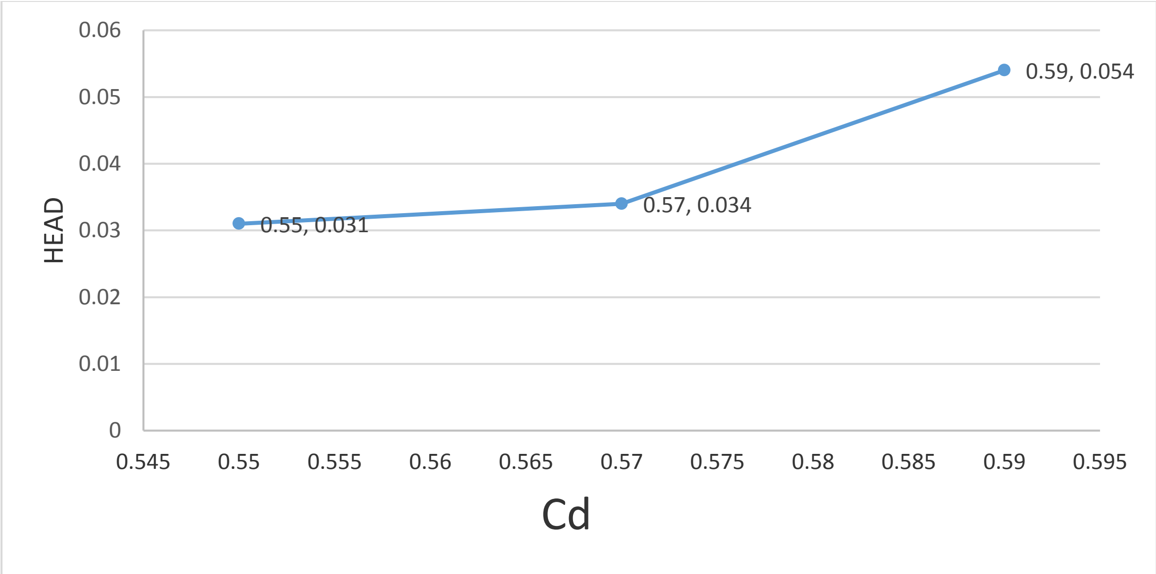
II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 35: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 36: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 7.5 CM.

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.37: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

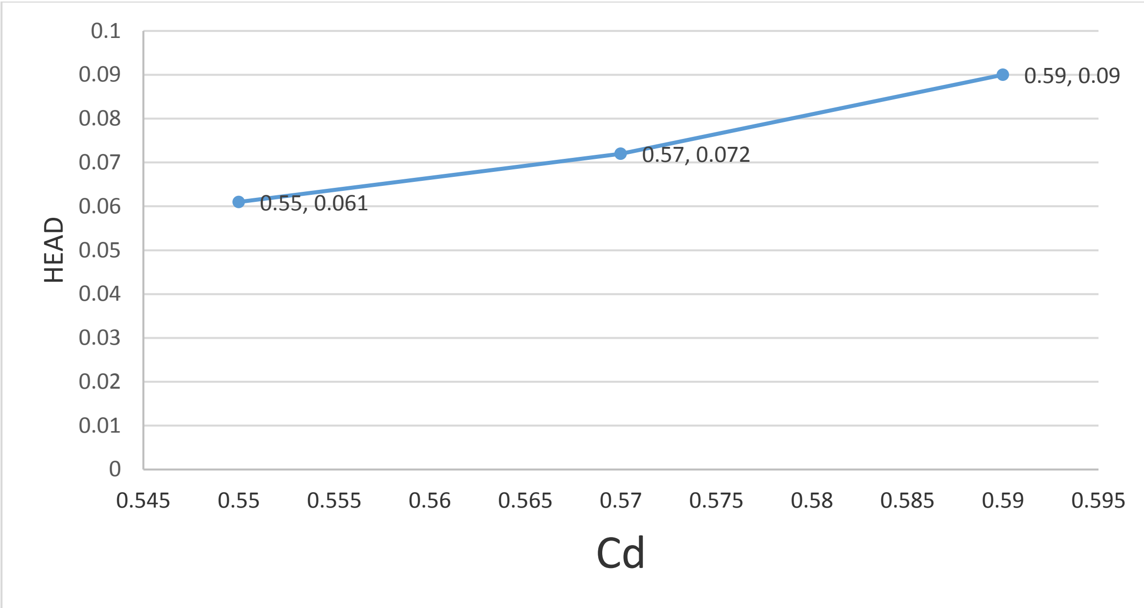
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.170	0.109	0.061	2.03	0.03	0.005505	0.0100100	0.55
2.	0.223	0.151	0.072	2.4	0.03	0.006198	0.0108751	0.57
3.	0.260	0.170	0.090	3	0.03	0.007173	0.0121588	0.59

TABLE NO. 5.38: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.180	0.145	0.035	0.875	0.04	0.0056614	0.0101098	0.56
2.	0.190	0.150	0.040	1	0.04	0.0062901	0.0108078	0.58
3.	0.235	0.179	0.056	1.4	0.04	0.007800	0.0127880	0.61

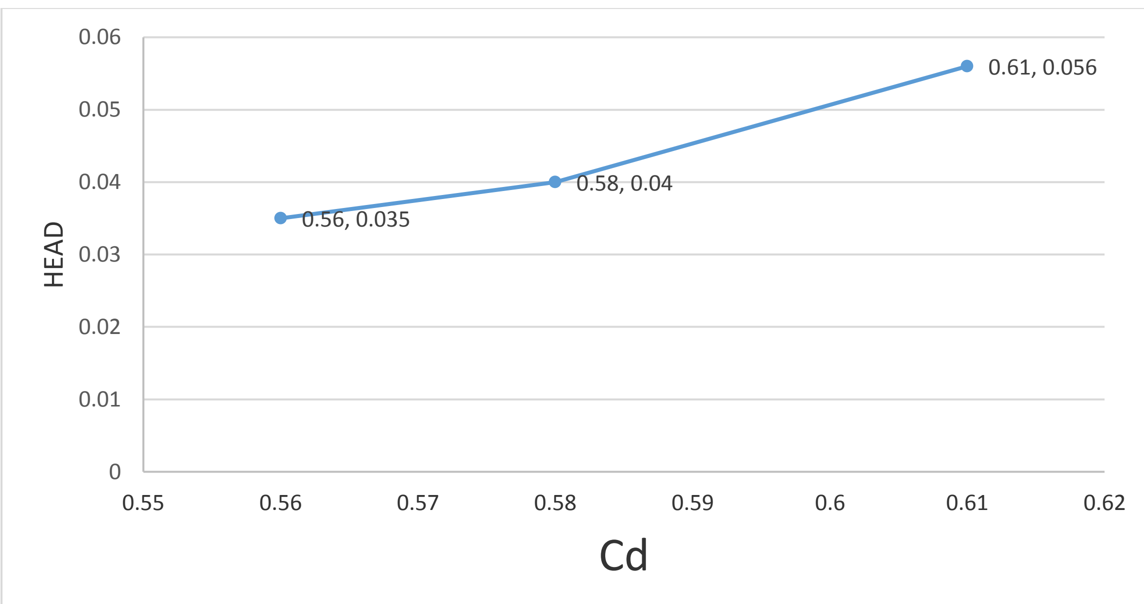
III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 37: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 10 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 38: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 10 CM.

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW.

TABLE NO. 5.39: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

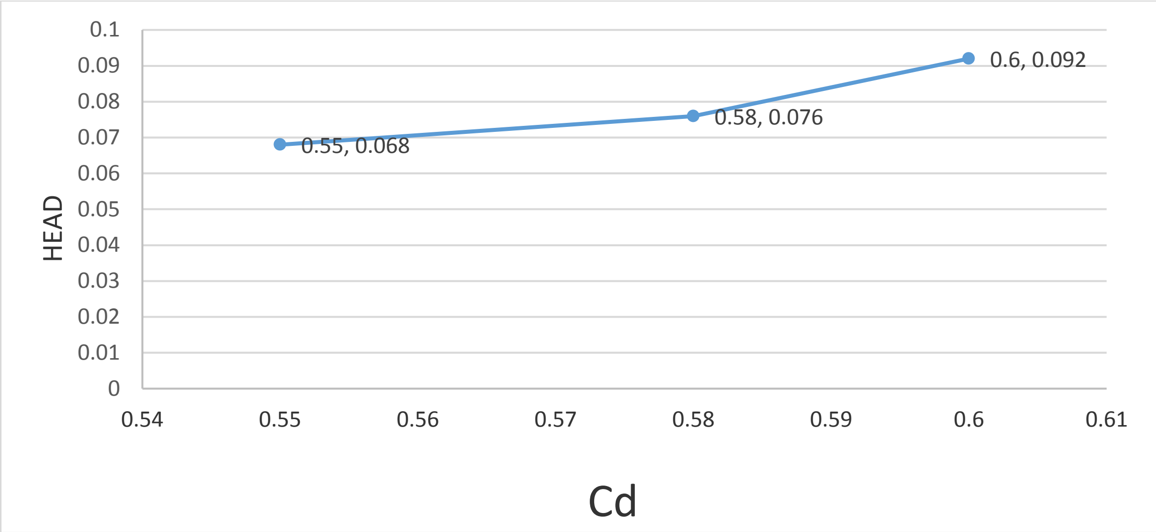
CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.183	0.115	0.068	2.26	0.03	0.005812	0.0105687	0.55
2.	0.231	0.155	0.076	2.53	0.03	0.006491	0.011173	0.58
3.	0.267	0.175	0.092	3.06	0.03	0.0073759	0.012293	0.60

TABLE NO. 5.40: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H1 U/S	H2 D/S	H = U/S – D/S	H/D	D	Qact	Qth	Cd
1.	0.191	0.140	0.051	1.275	0.04	0.006941	0.0122035	0.57
2.	0.210	0.152	0.058	1.45	0.04	0.007678	0.013014	0.59
3.	0.241	0.172	0.069	1.725	0.04	0.008729	0.0141949	0.61

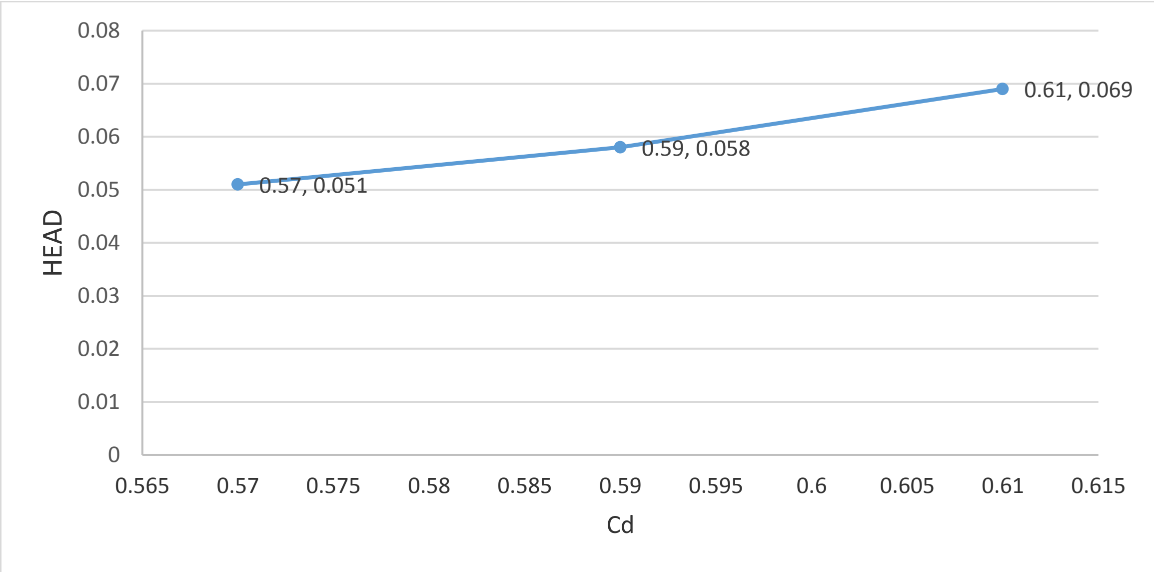
IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 39: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

- WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.



GRAPH 40: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 4 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH SHARP EDGE LIP INCLINED IN OPPOSITE DIRECTION OF FLOW OVER A SILL OF 11.5 CM.

Coefficient of velocity :-

Now we will calculate the coefficient of velocity in each case to study the effects on hydraulic coefficients of different cases of sluice gates over the different cases of humps/sills.

Cv = Vac/Vth

Vac = actual velocity

Vth = theoretical velocity

Where Vth = $\sqrt{2gh}$

Cv = coefficient of velocity

Coefficient of contraction :-

Now, we will also calculate the coefficient of contractionin each case to study the effects on hydraulic coefficients of different cases of sluice gates over the different cases of humps/sills.

Cc = Cd/ Cv

Where Cc = coefficient of contraction

Cd = coefficient of discharge

Cv = coefficient of velocity

CASE 1 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS PLACED VERTICALLY ON THE DIFFERENT SILLS

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.41: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.025	0.6512	0.7003	0.93	0.58	0.62
2.	0.042	0.8678	.9077	0.956	0.63	0.65
3.	0.085	1.275	1.291	0.988	0.68	0.69

TABLE NO. 5.42:WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.015	0.5121	0.5420	0.945	0.59	0.624
2.	0.034	0.8167	0.7848	0.961	0.64	0.663
3.	0.050	O.981	0.990	0.990	0.69	0.698

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.43: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.032	0.74481	0.79236	0.932	0.59	0.633
2.	0.055	0.9920	1.0387	0.95	0.63	0.663
3.	0.087	1.2789	1.3064	0.979	0.66	0.674

TABLE NO. 5.44: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.016	0.5327	0.5602	0.951	0.63	0.660
2.	0.052	0.8909	0.91850	0.962	0.64	0.665
3.	0.064	1.1082	1.1205	0.989	0.67	0.677

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.45: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.056	0.990	1.048	0.945	0.52	0.57
2.	0.072	1.140	1.1885	0.96	0.59	0.614
3.	0.090	1.318	1.3288	0.993	0.64	0.629

TABLE NO. 5.46: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.024	0.6560	0.6862	0.956	0.60	0.596
2.	0.056	0.92340	0.9500	0.972	0.62	0.617
3.	0.072	1.183	1.188	0.996	0.64	0.633

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED .

TABLE NO. 5.47: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.072	1.1196	1.1885	0.942	0.57	0.606
2.	0.076	1.1734	1.2211	0.961	0.59	0.616
3.	0.096	1.360	1.372	0.991	0.62	0.625

TABLE NO. 5.48: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.042	0.8632	0.9077	0.951	0.58	0.609
2.	0.061	1.068	1.0939	0.972	0.61	0.629
3.	0.084	1.281	1.283	0.998	0.63	0.631

CASE 2 :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.49: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.026	0.6585	0.7142	0.922	0.71	0.771
2.	0.035	0.78309	0.8286	0.945	0.75	0.790
3.	0.055	1.0076	1.0387	0.970	0.77	0.793

TABLE NO. 5.50: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.015	0.5055	0.5424	0.932	0.72	0.772
2.	0.021	0.6148	0.6418	0.958	0.76	0.793
3.	0.035	0.8169	0.8286	0.986	0.79	0.801

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW.

TABLE NO. 5.51: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.039	0.8049	0.8747	0.920	0.66	0.717
2.	0.059	1.033	1.076	0.956	0.71	0.742
3.	0.075	1.166	1.213	0.962	0.74	0.769

TABLE NO. 5.52: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.018	0.5502	0.5942	0.926	0.69	0.745
2.	0.034	0.7832	0.8167	0.959	0.73	0.761
3.	0.051	0.9667	1.0003	0.965	0.75	0.776

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.53: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.047	0.8988	0.9602	0.936	0.67	0.715
2.	0.065	1.084	1.129	0.960	0.70	0.73
3.	0.078	1.2123	1.237	0.980	0.73	0.744

TABLE NO. 5.54: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.029	0.7090	0.7543	0.940	0.68	0.723
2.	0.035	0.8046	0.82867	0.971	0.73	0.749
3.	0.055	1.022	1.03879	0.985	0.74	0.751

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.55: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.054	0.9675	1.0293	0.940	0.68	0.727
2.	0.071	1.1401	1.1802	0.966	0.71	0.734
3.	0.075	1.1912	1.2130	0.982	0.73	0.739

TABLE NO. 5.56: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.036	0.7950	0.8404	0.946	0.69	0.729
2.	0.052	0.988	1.0100	0.978	0.72	0.736
3.	0.061	1.0819	1.093	0.989	0.74	0.745

<u>CASE 3</u> :

WHEN A RECTANGULAR SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.57: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.028	0.7070	0.7411	0.954	0.55	0.576
2.	0.039	0.8554	0.8747	0.978	0.57	0.582
3.	0.057	1.054	1.057	0.997	0.60	0.60

TABLE NO. 5.58: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.025	0.6722	0.7003	0.96	0.56	0.583
2.	0.037	0.8689	0.8858	0.981	0.58	0.591
3.	0.053	1.01766	1.0197	0.998	0.61	0.601

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

TABLE NO. 5.59: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.036	0.79165	0.8404	0.942	0.51	0.54
2.	0.053	0.98710	1.0197	0.968	0.53	0.549
3.	0.063	1.2658	1.2731	0.992	0.56	0.570

TABLE NO. 5.60: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.032	0.75512	0.79236	0.953	0.53	0.551
2.	0.051	0.9713	1.00030	0.971	0.55	0.570
3.	0.059	1.07159	1.07590	0.996	0.58	0.588

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.61: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.047	0.91226	0.96028	0.95	0.52	0.547
2.	0.054	0.99328	1.0293	0.965	0.55	0.565
3.	0.072	1.1766	1.18854	0.990	0.57	0.578

TABLE NO. 5.62: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.042	0.8696	0.90776	0.958	0.54	0.559
2.	0.053	0.9952	1.0197	0.976	0.56	0.573
3.	0.070	1.1695	1.1719	0.998	0.58	0.582

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE INCLINED IN OPPOSITE THE DIRECTION OF FLOW .

TABLE NO. 5.63: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.052	0.9494	1.0100	0.94	0.53	0.564
2.	0.062	1.0643	1.1029	0.965	0.55	0.569
3.	0.076	1.2125	1.2211	0.993	0.58	0.585

TABLE NO. 5.64: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.046	0.9044	0.9500	0.952	0.54	0.569
2.	0.055	1.0076	1.0387	0.970	0.57	0.585
3.	0.072	1.1849	1.1885	0.997	0.59	0.591

CASE 4 :

WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW ON THE DIFFERENT SILLS.

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.65: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.027	0.66960	0.72783	0.920	0.71	0.770
2.	0.036	0.79417	0.8404	0.945	0.73	0.772
3.	0.057	1.0204	1.0575	0.965	0.75	0.777

TABLE NO. 5.66: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.021	0.59625	0.6418	0.930	0.72	0.774
2.	0.033	0.7511	0.7899	0.951	0.74	0.778
3.	0.058	1.0577	1.0849	0.975	0.76	0.780

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.67: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.043	0.85971	0.91850	0.936	0.72	0.769
2.	0.052	0.9595	1.01006	0.950	0.74	0.770
3.	0.071	1.1472	1.18026	0.972	0.76	0.781

TABLE NO. 5.68: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.026	0.67350	0.71422	0.943	0.73	0.776
2.	0.036	0.80344	0.84042	0.956	0.75	0.780
3.	0.059	0.90196	0.91850	0.982	0.77	0.784

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.69: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.058	1.0091	1.0667	0.946	0.72	0.761
2.	0.065	1.06419	1.11178	0.957	0.74	0.773
3.	0.083	1.2648	1.2761	0.991	0.77	0.776

TABLE NO. 5.70: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.032	0.7595	0.79236	0.958	0.74	0.770
2.	0.039	0.8450	0.87474	0.966	0.76	0.778
3.	0.063	1.1039	1.11178	0.993	0.78	0.785

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE DIRECTION OF FLOW .

TABLE NO. 5.71:WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.063	1.0561	1.11178	0.95	0.73	0.768
2.	0.071	1.1354	1.1802	0.962	0.74	0.770
3.	0.086	1.2742	1.2989	0.981	0.76	0.776

TABLE NO. 5.72: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.048	0.9325	0.9704	0.961	0.74	0.773
2.	0.054	1.0076	1.0293	0.979	0.76	0.776
3.	0.071	1.17435	1.18026	0.995	0.78	0.781

<u>CASE 5</u> :

<u>WHEN A RECTANGULAR SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW ON THE DIFFERENT SILLS.</u>

I. WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW.

TABLE NO. 5.73: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.028	071375	0.74118	0.963	0.53	0.55
2.	0.053	1.0003	1.0197	0.981	0.55	0.56
3.	0.061	1.090708	1.09399	0.997	0.58	0.58

TABLE NO. 5.74: WHEN A OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.018	0.5775	0.5942	0.972	0.54	0.55
2.	0.027	0.71764	0.72783	0.986	0.58	0.57
3.	0.033	0.80302	0.80464	0.998	0.61	0.61

II. WHEN A PRISMATIC SILL OF 7.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.75: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.032	0.75591	0.79236	0.954	0.54	0.567
2.	0.057	1.0278	1.05751	0.972	0.56	0.573
3.	0.066	1.133	1.1379	0.995	0.58	0.575

TABLE NO. 5.76: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.031	0.75024	0.77988	0.962	0.55	0.571
2.	0.034	0.7995	0.8167	0.979	0.57	0.582
3.	0.054	1.0272	1.02931	0.998	0.59	0.591

III. WHEN A PRISMATIC SILL OF 10 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.77: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.061	1.03929	1.0939	0.950	0.55	0.577
2.	0.072	1.14694	1.1885	0.965	0.57	0.590
3.	0.090	1.31554	1.3288	0.990	0.59	0.595

TABLE NO. 5.78: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.035	0.80152	0.82867	0.967	0.56	0.580
2.	0.040	0.86285	0.88588	0.974	0.58	0.598
3.	0.056	1.03981	1.04819	0.992	0.61	0.615

IV. WHEN A PRISMATIC SILL OF 11.5 CM IS USED UNDER THE SLUICE GATE WITH SHARP EDGE LIP IS INCLINED IN THE OPPOSITE DIRECTION OF FLOW .

TABLE NO. 5.79: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 3 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.068	1.09152	1.15505	0.945	0.55	0.582
2.	0.076	1.1722	1.2211	0.960	0.58	0.605
3.	0.092	1.3287	1.3435	0.989	0.60	0.606

TABLE NO. 5.80: WHEN A OPENING BETWEEN SLUICE GATE AND SILL IS 4 CM.

CASE	H	Vac	Vth	Cv	Cd	Cc
1.	0.051	0.95829	1.0003	0.958	0.57	0.592
2.	0.058	1.0389	1.0667	0.974	0.59	0.606
3.	0.069	1.1565	1.1635	0.994	0.61	0.618

CHAPTER 6

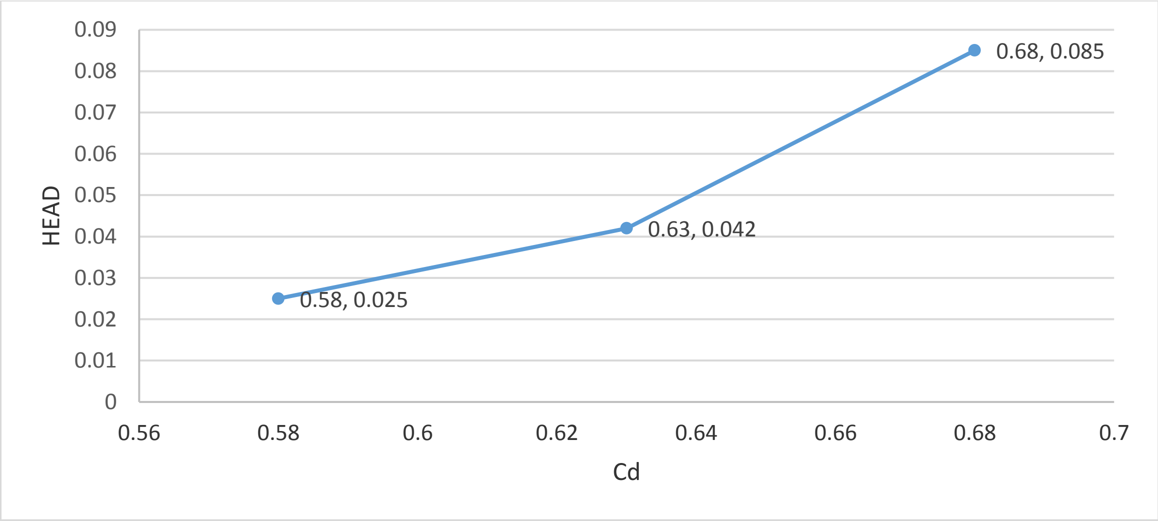
RESULTS

The data collected from this experimental work is given in chapter 5. The data collected is for the five cases of sluice gates (rectangular sluice gate with horizontal edge vertically placed, horizontal edge sluice gate inclined in the direction of flow, horizontal sluice gate inclined in the opposite direction of flow, sluice gate with sharp edge lip inclined in the direction of flow & sluice gate with sharp edge lip inclined in the opposite direction of flow.) under the four different cases of sills (no sill, 7.5cm , 10 cm & 11.5 cm) for two openings of 3 cm and 4 cm for each and every case.

The present study shows that the value of Cd (coefficient of discharge) increases with the increase of head for a same opening in each case of sluice gate. For example, as shown in graph 1 the value of Cd is increasing with the increase of head in a case of rectangular sluice gate vertically placed without a sill.

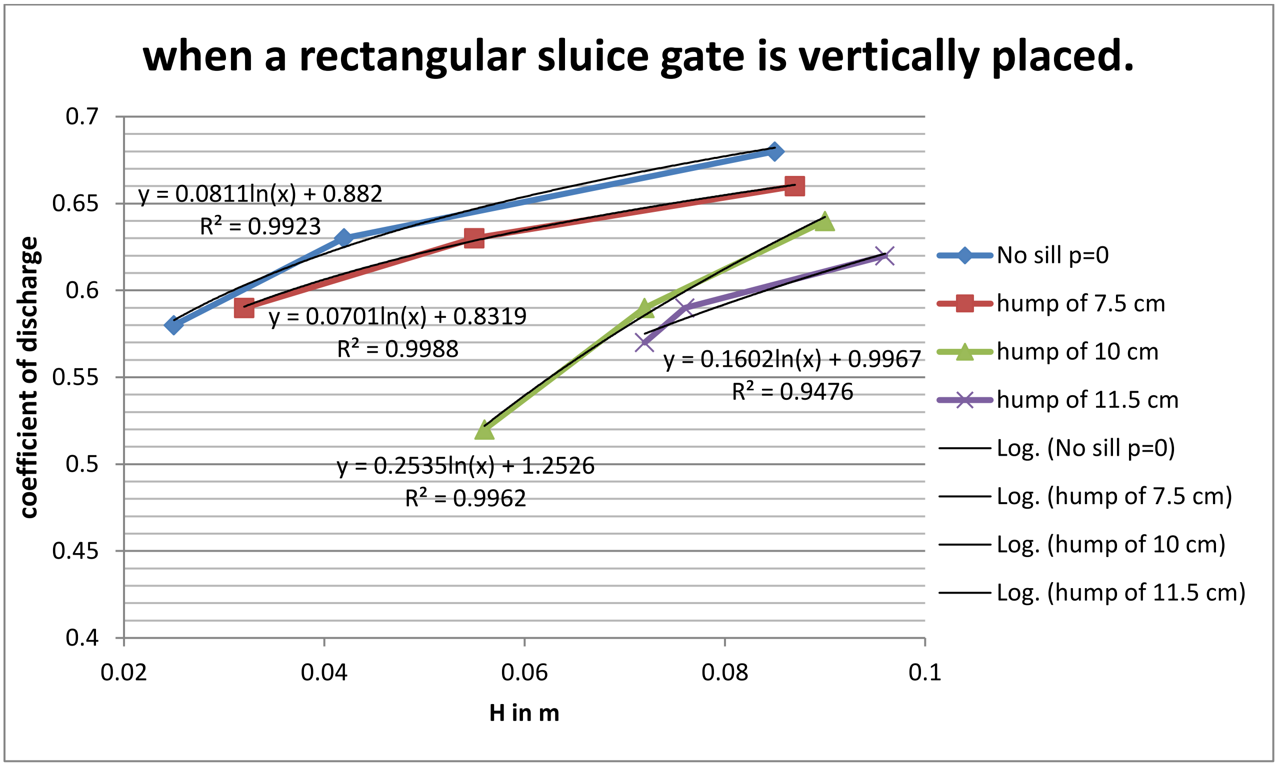
WHEN NO PRISMATIC SILL IS USED UNDER THE SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED.

- WHEN AN OPENING BETWEEN SLUICE GATE AND CHANNEL BED IS 3 CM.



GRAPH 2: RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED WITHOUT A SILL.

It was clear that the actual discharge passing under the gate increases with increase of sill height within the experimental range for each and every case of sluice gate. That is due to the gradually entrance to the gate opening and the gradually exit from the gate.
The value of coefficient of discharge is increasing for each case of sluice gate over different cases of sills for a single opening.



GRAPH 41 : RELATION BETWEEN Cd AND HEAD WHEN A OPENING OF 3 CM IS TAKEN IN THE CASE OF SLUICE GATE WITH HORIZONTAL EDGE VERTICALLY PLACED WITH DIFFERENT CASES OF A SILL.

The value of coefficient of discharge was increasing in a single opening as seen in the chapter 5 with the increase in head.

The graph above is to show the case of a rectangular sluice gate with horizontal edge which is vertically placed on the different cases of sills for a single opening of 3 cm, as we can see that the coefficient of discharge is increasing for each case of hump with the increase in its head for a single opening of 3 cm. Though the value of Cd may vary for each case of hump but it is clear that the Cd increases with the increase of head.

Similarly, all the cases of sluice gates with different cases of sills have a same effect on coefficient of discharge with respect to the head in each and every case for different openings respectively.

And as the opening of the gates was increasing, it was found that the actual discharge entering through the opening was increasing gradually.

The relationship graphs between the heads and coefficient of discharge were shown in chapter 5 with the each and every case of sluice gate and different cases of sills with two gate openings of 3 cm and 4 cm.

The experimental values of coefficient of discharge for each and every case were calculated in chapter 5, the average values of Cd (coefficient of discharge) for each case of sluice gate are given below:

1. The average value of coefficient of discharge for the case 1: when a rectangular sluice gate with horizontal edge was vertically placed over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.618 ranging from about 0.520 to 0.690.

The average value of Cd for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the vertical sluice gate with horizontal edge.
  Average value of coefficient of discharge in this case of no sill was found to be 0.635, Cd ranging from 0.58 to 0.69.

- For the case of sill of 7.5 cm height under the vertical sluice gate with horizontal edge.
  Average value of coefficient of discharge in this case of sill of 7.5 cm was found to be 0.637, Cd ranging from 0.59 to 0.67.

- For the case of sill of 10 cm height under the vertical sluice gate with horizontal edge.
  Average value of coefficient of discharge in this case of sill of 10 cm was found to be 0.603, Cd ranging from 0.52 to 0.65.

- For the case of sill of 11.5 cm height under the vertical sluice gate with horizontal edge.
  Average value of coefficient of discharge in this case of sill of 11.5 cm was found to be 0.600, Cd ranging from 0.57 to 0.63.

2. The average value of coefficient of discharge for the case 2: when a rectangular sluice gate with horizontal edge is inclined in the direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.720 ranging from about 0.670 to 0.790.

The average value of Cd for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the rectangular sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of discharge in this case of no sill was found to be 0.750, Cd ranging from 0.71 to 079.

- For the case of sill of 7.5 cm height under the a rectangular sluice gate with horizontal edge inclined in the direction of flow. Average value of coefficient of discharge in this case of sill of 7.5 cm was found to be 0.713, Cd ranging from 0.66 to 0.75.

- For the case of sill of 10 cm height under the a rectangular sluice gate with horizontal edge inclined in the direction of flow. Average value of coefficient of discharge in this case of sill of 10 cm was found to be 0.708, Cd ranging from 0.67 to 0.74.

- For the case of sill of 11.5 cm height under the a rectangular sluice gate with horizontal edge inclined in the direction of flow. Average value of coefficient of discharge in this case of sill of 11.5 cm was found to be 0.711, Cd ranging from 0.68 to 0.74.

3. The average value of coefficient of discharge for the case 3: when a rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow over the different

cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.558 ranging from about 0.510 to 0.590.

The average value of Cd for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the rectangular sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of no sill was found to be 0.578, Cd ranging from 0.55 to 0.61.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 7.5 cm was found to be 0.543, Cd ranging from 0.51 to 0.58.

- For the case of sill of 10 cm height under the rectangular sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 10 cm was found to be 0.553, Cd ranging from 0.52 to 0.58.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 11.5 cm was found to be 0.560, Cd ranging from 0.53 to 0.59.

4. The average value of coefficient of discharge for the case 4: when a rectangular sluice gate with sharp edge lip is inclined in the direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.745 ranging from about 0.710 to 0.780.

The average value of Cd for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over Average value of coefficient of discharge in this case of no sill was found to be 0.735, Cd ranging from 0.71 to 0.76.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over edge. Average value of coefficient of discharge in this case of sill of 7.5 cm was found to be 0.745, Cd ranging from 0.72 to 0.77.

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of discharge in this case of sill of 10 cm was found to be 0.750, Cd ranging from 0.72 to 0.78.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of discharge in this case of sill of 11.5 cm was found to be 0.751, Cd ranging from 0.73 to 0.78.

5. The average value of coefficient of discharge for the case 5: when a rectangular sluice gate with sharp edge lip is inclined in the opposite direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.572 ranging from about 0.530 to 0.610.

The average value of Cd for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow.Average value of coefficient of discharge in this case of no sill was found to be 0.566, Cd ranging from 0.53 to 0.61.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 7.5 cm was found to be 0.565, Cd ranging from 0.54 to 0.59.

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 10 cm was found to be 0.576, Cd ranging from 0.55 to 0.61.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of discharge in this case of sill of 11.5 cm was found to be 0.583, Cd ranging from 0.55 to 0.61.

The coefficient of velocity was also found to be increasing slightly with the increase in head for a single opening. The experimental values of coefficient of velocity for each and every case were calculated in chapter 5, the average values of Cv (coefficient of velocity) for each case of sluice gate are given below:

1. The average value of coefficient of velocity for the case 1: when a rectangular sluice gate with horizontal edge was vertically placed over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.965 ranging from about 0.930 to 0.998.

The average value of Cv for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the vertical sluice gate with horizontal edge.
  Average value of coefficient of velocity in this case of no sill was found to be 0.961 , Cv ranging from 0.930 to 0.990.

- For the case of sill of 7.5 cm height under the vertical sluice gate with horizontal edge.
  Average value of coefficient of velocity in this case of sill of 7.5 cm was found to be 0.960 , Cv ranging from 0.932 to 0.980

- For the case of sill of 10 cm height under the vertical sluice gate with horizontal edge.
  Average value of coefficient of velocity in this case of sill was found to be 0.970, Cv ranging from 0.945 to 0.993

- For the case of sill of 11.5 cm height under the vertical sluice gate with horizontal edge.Average value of coefficient of velocity in this case of sill of 11.5 cm was found to be 0.969, Cv ranging from 0.942 to 0.998

2. The average value of coefficient of velocity for the case 2: when a rectangular sluice gate with horizontal edge is inclined in the direction of flow over the different cases of sills for

both the openings of 3 cm and 4 cm was found to be around 0.957 ranging from about 0.922 to 0.989 .

The average value of Cv for different cases of sills under the sluice gate with horizontal edge inclined in the direction of flow over it are as follow –

- For the case of no sill under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of velocity in this case of no sill was found to be 0.952 , Cv ranging from 0.922 to 0.986

- For the case of sill of 7.5 cm height under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of velocity in this case of sill of 7.5 cm was found to be 0.948, Cv ranging from 0.920 to 0.965.

- For the case of sill of 10 cm height under the sluice gate with horizontal edge inclined in the direction of flow. Average value of coefficient of velocity in this case of sill was found to be 0.962, Cv ranging from 0.936 to 0.985 .

- For the case of sill of 11.5 cm height under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of velocity in this case of sill of 11.5 cm was found to be 0.966 , Cv ranging from 0.940 to 0.989.

3. The average value of coefficient of velocity for the case 3: when a rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.972 ranging from about 0.940 to 0.998 .

The average value of Cv for different cases of sills with the rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow over it are as follow –

- For the case of no sill under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of no sill was found to be 0.978, Cv ranging from 0.954 to 0.998 .

- For the case of sill of 7.5 cm height under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of sill of 7.5 cm was found to be 0.970 , Cv ranging from 0.942 to 0.996 .

- For the case of sill of 10 cm height under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of sill was found to be 0.972, Cv ranging from 0.950 to 0.998.

- For the case of sill of 11.5 cm height under the sluice gate with horizontal edge is inclined in the opposite direction of flow.Average value of coefficient of velocity in this case of sill of 11.5 cm was found to be 0.969, Cv ranging from 0.940 to 0.997

4. The average value of coefficient of velocity for the case 4: when a rectangular sluice gate with sharp edge lip is inclined in the direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.961 ranging from about 0.920 to 0.995.

The average value of Cv for different cases of sills with the sluice gate with sharp edge lip amd inclined in the direction of flow are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of velocity in this case of no sill was found to be 0.947 , Cv ranging from 0.920 to 0.975

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of velocity in this case of sill of 7.5 cm was found to be 0.956 , Cv ranging from 0.936 to 0.982

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of velocity in this case of sill was found to be 0.968, Cv ranging from 0.946 to 0.993

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of velocity in this case of sill of 11.5 cm was found to be 0.971 , Cv ranging from 0.95 to 0.995

5. The average value of coefficient of velocity for the case 5: when a rectangular sluice gate with sharp edge lip is inclined in the opposite direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.975 ranging from about 0.945 to 0.998 .

The average value of Cv for different cases of sills with the rectangular sluice gate with sharp edge lip is inclined in the opposite direction of flow it are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of no sill was found to be 0.982 , Cv ranging from 0.963 to 0.998.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of sill of 7.5 cm was found to be 0.976, Cv ranging from 0.954 to 0.998.

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of sill was found to be 0.973, Cv ranging from 0.950 to 0.992.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of velocity in this case of sill of 11.5 cm was found to be 0.970 , Cv ranging from 0.945 to 0.994.

The experimental values of coefficient of contraction for each and every case were calculated in chapter 5, the average values of Cc (coefficient of contraction) for each case of sluice gate are given below:

1. The average value of coefficient of contraction for the case 1: when a rectangular sluice gate with horizontal edge was vertically placed over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.637 ranging from about 0.570 to 0.698 .

The average value of Cc for different cases of sills with the vertical sluice gate over it are as follow –

- For the case of no sill under the vertical sluice gate with horizontal edge.
  Average value of coefficient of contraction in this case of no sill was found to be 0.657 , Cc ranging from 0.620 to 0.698.

- For the case of sill of 7.5 cm height under the vertical sluice gate with horizontal edge. Average value of coefficient of contraction in this case of sill of 7.5 cm was found to be 0.662 , Cc ranging from 0.633 to 0.677.

- For the case of sill of 10 cm height under the vertical sluice gate with horizontal edge. Average value of coefficient of contraction in this case of sill was found to be 0.609, Cc ranging from 0.570 to 0.633.

- For the case of sill of 11.5 cm height under the vertical sluice gate with horizontal edge. Average value of coefficient of contraction in this case of sill was found to be 0.619, Cc ranging from 0.606 to 0.631.

2. The average value of coefficient of contraction for the case 2: when a rectangular sluice gate with horizontal edge is inclined in the direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.752 ranging from about 0.715 to 0.801 .

The average value of Cc for different cases of sills under the sluice gate with horizontal edge inclined in the direction of flow over it are as follow –

- For the case of no sill under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of contraction in this case of no sill was found to be 0.786 , Cc ranging from 0.771 to 0.801.

- For the case of sill of 7.5 cm height under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of contraction in this case of sill of 7.5 cm was found to be 0.751, Cc ranging from 0.717 to 0.776.

- For the case of sill of 10 cm height under the sluice gate with horizontal edge inclined in the direction of flow. Average value of coefficient of contraction in this case of sill was found to be 0.735, Cc ranging from 0.715 to 0.759 .

- For the case of sill of 11.5 cm height under the sluice gate with horizontal edge inclined in the direction of flow.Average value of coefficient of contraction in this case of sill of 11.5 cm was found to be 0.735 , Cc ranging from 0.727 to 0.745.

3. The average value of coefficient of contraction for the case 3: when a rectangular sluice gate with horizontal edge is inclined in the opposite direction of flow over the different

cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.553 ranging from about 0.540 to 0.601 .

- For the case of no sill under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of no sill was found to be 0.583, Cc ranging from 0.576 to 0.601 .

- For the case of sill of 7.5 cm height under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of sill of 7.5 cm was found to be 0.561 , Cc ranging from 0.540 to 0.588 .

- For the case of sill of 10 cm height under the sluice gate with horizontal edge inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of sill was found to be 0.567, Cc ranging from 0.547 to 0.582.

- For the case of sill of 11.5 cm height under the sluice gate with horizontal edge is inclined in the opposite direction of flow.Average value of coefficient of contraction in this case of sill of 11.5 cm was found to be 0.577, Cc ranging from 0.564 to 0.591.

4. The average value of coefficient of contraction for the case 4: when a rectangular sluice gate with sharp edge lip is inclined in the direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.775 ranging from about 0.761 to 0.785 .

The average value of Cc for different cases of sills with the sluice gate with sharp edge lip amd inclined in the direction of flow are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of contraction in this case of no sill was found to be 0.775 , Cc ranging from 0.770 to 0.780.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of contraction in this case of sill of 7.5 cm was found to be 0.776, Cc ranging from 0.769 to 0.784.

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of contraction in this case of sill was found to be 0.773, Cc ranging from 0.761 to 0.785.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the direction of flow over. Average value of coefficient of contraction in this case of sill of 11.5 cm was found to be 0.774, Cc ranging from 0.768 to 0.781.

5. The average value of coefficient of contraction for the case 5: when a rectangular sluice gate with sharp edge lip is inclined in the opposite direction of flow over the different cases of sills for both the openings of 3 cm and 4 cm was found to be around 0.585 ranging from about 0.551 to 0.618.

The average value of Cc for different cases of sills with the rectangular sluice gate with sharp edge lip is inclined in the opposite direction of flow it are as follow –

- For the case of no sill under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of no sill was found to be 0.570 , Cc ranging from 0.550 to 0.610.

- For the case of sill of 7.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of sill of 7.5 cm was found to be 0.576, Cc ranging from 0.567 to 0.591.

- For the case of sill of 10 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of sill was found to be 0.592, Cc ranging from 0.577 to 0.615.

- For the case of sill of 11.5 cm height under the rectangular sluice gate with sharp edge lip inclined in the opposite direction of flow. Average value of coefficient of contraction in this case of sill of 11.5 cm was found to be 0.601 , Cc ranging from 0.582 to 0.618.

CHAPTER 7

CONCLUSION

In this experimental project work by observing the tables and graphs in chapter five and the results in the chapter six we conclude for the effects on hydraulic coefficient under different cases of sluice gates with different cases of sills, that are given as below:

1. The coefficient of discharge was increasing as the head of water flow was increasing for every single opening in each case of sluice gates under the different cases of sills.

2. From all the results we conclude that head will effect the coefficient of discharge, coefficient of velocity and coefficient of contraction.

3. As the opening of sluice gate was increased from 3 cm to 4 cm, we concluded that the actual discharge will increase where as the head of water flow will decrease slightly.

4. The head of water flow was increasing as the sill height was increased in different cases of sills.

5. The values of coefficient of discharge, coefficient of velocity and coefficient of contraction were varying in every single case of sluice gates over the different cases of sills.

6. The average values of coefficient of discharge of gate inclined with flow direction and horizontal edge increases by 16% in comparison to the case of vertical sluice gate, where as for the sharp edge lip sluice gate in direction of flow it increases almost by 20.5%. And in the case of gate inclined in opposite direction of flow with horizontal edge it decreases by 9.70% in comparison to the case of vertical sluice gate & decreases by 7.4% for the sharp edge lip sluice gate in opposite direction of flow under the different cases of sills.

7. The average values of coefficient of discharge were found to be varying from 0.920 to 0.998, which are almost similar to each other. This means that the actual velocity in the flume and the theoretical velocity of water calculated by the head of flow were almost equal in every case of gate and sill.

8. The average values of coefficient of contraction, for the case of sluice gate with horizontal edge inclined in the direction of flow increases by 18% in comparison to the case of vertical sluice gate with horizontal edge, where as for the sharp edge lip sluice gate in direction of flow it increaes by 21.6%. And in the case of gate inclined in opposite direction of flow with horizontal edge it decreases by 16% in comparison to the vertical sluice gate & decreases almost by 8.1% for the case of sharp edge lip in opposite direction of flow.

9. The coefficient of discharge, coefficient of velocity & coefficient of contraction are also affected by the physical parameters of sill like height of sill in our project. As the height of sill was increasing the head of flow was also increasing.

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