An Experimental Study of a Combined Oblique Cylindrical Weir and Gate Structure

INTRODUCTION

Weirs and gates are the most commonly used and important structures for measuring water flow.

Weirs are structures that regulate water surface and flow control in water conveyance channels and hydraulic structures. One of their disadvantages is that they need to be cleaned of sediment and trash periodically.

Gates are used extensively for flow control and water measurement.

One disadvantage of the gates is that they retain floating materials. In order to maximize their advantages, weirs and gates can be combined together in one device, so that water could pass over the weir and below the gate ,Regarding the form of the combined cylindrical weir-gate structures, it has some advantages including easy design, sediments and floating material flow, higher flow discharge coefficient, lower cost.

The main objective of the current research is to study the impact of various oblique angles and diameters on the hydraulic properties of a combined cylindrical oblique weir and gate structure. Additionally, this study aims to establish relationships for the prediction of flow rate and the coefficient of discharge.

. THEORETICAL DISCHARGE:

The total theoretical discharge through a combined cylindrical weir and gate structure for free flow conditions can be obtained by adding the discharge under the gate to the discharge over the weir.

$$Q_{th} = Q_g + Q_w$$

$$Q_{th} = La\sqrt{2gH} + \frac{2}{3}L\sqrt{\frac{2}{3}g}\,h^{3/2}$$

where Q is the total theoretical discharge, Q is the discharge passing under the gate, Q is the discharge passing over the weir, and H = h + d +a the total head above the flume bed L. The variables used in the dimensional analysis were chosen to represent the experimental conditions,

TABLE I. DETAILS OF THE TESTED CYLINDRICAL WEIR-GATE MODELS

Model No.	Oblique angle (α)	Diameter (cm)
1	90^o	4
2		7.3
3		9
4		11
5	60^o	4
6		7.3
7		9
8		11
9	45^o	4
10		7.3
11		9
12		11
13	30^o	4
14		7.3
15		9
16		11

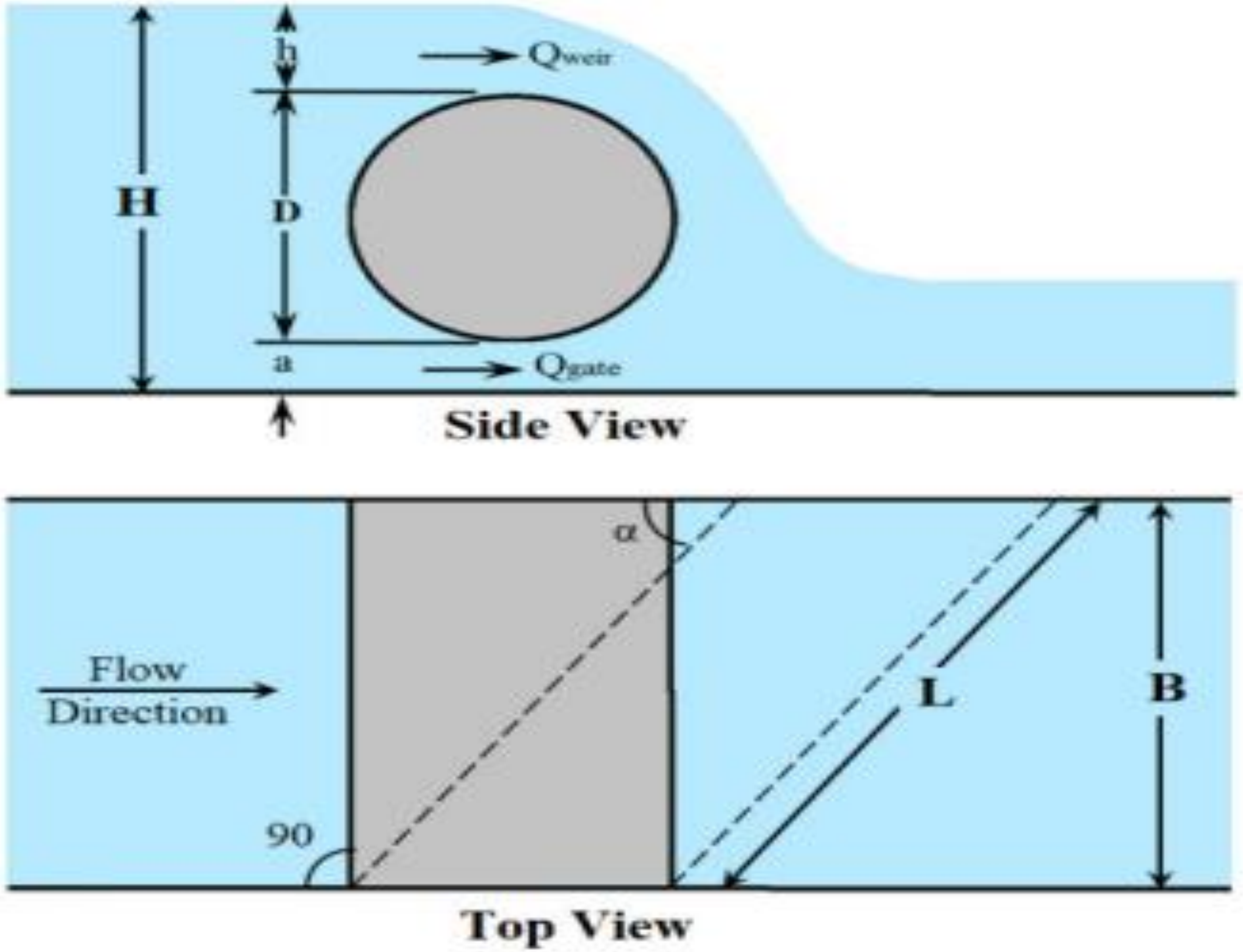


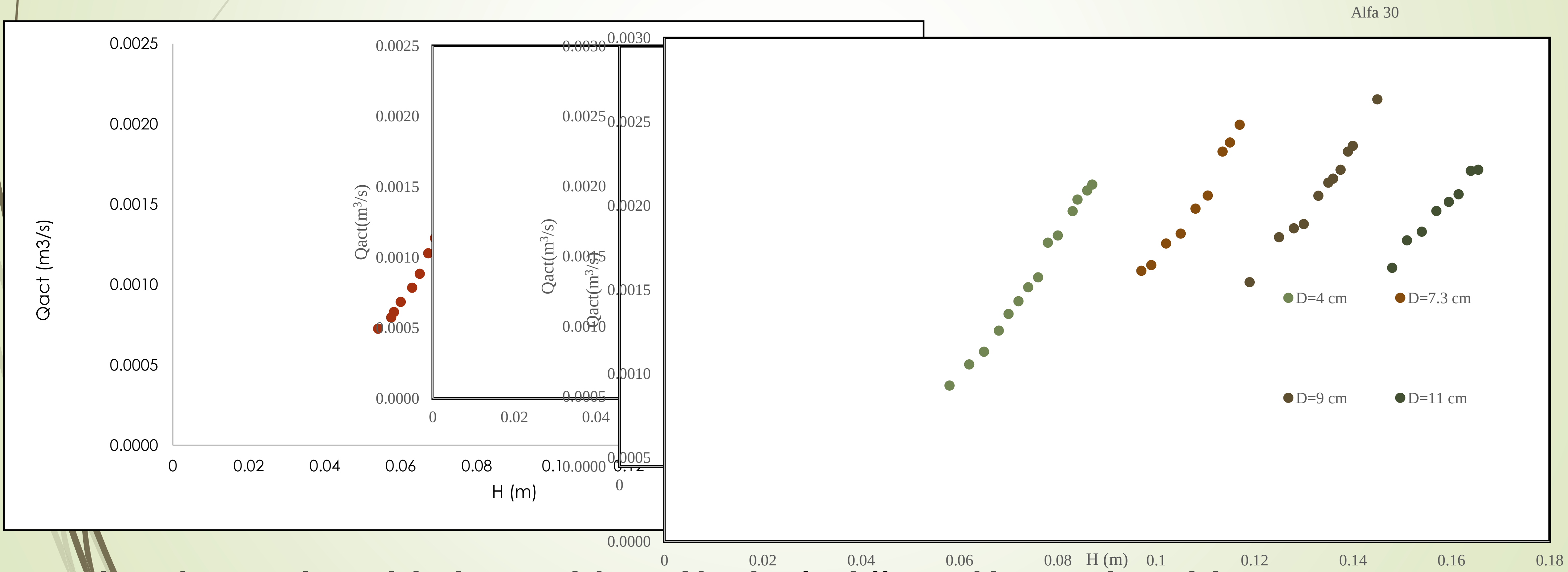
Fig. 1. Combined weir and gate structure.

Fig. 2. A model sample during operation.

I. RESULTS AND DISCUSSION

Variation of (Q_{act}) with (H)

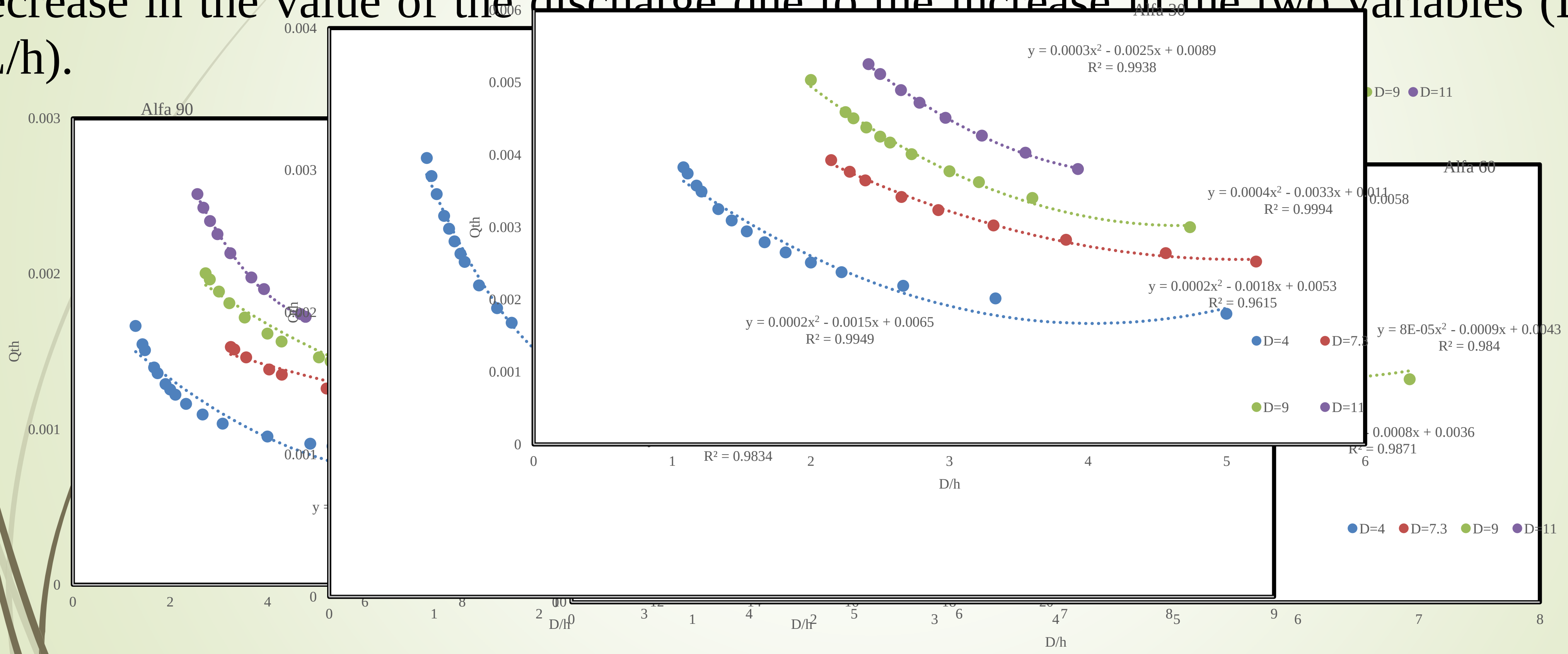
After all models were tested and the data collected the relationships between (Q_{act}) and total upstream head (H) for different oblique angle and diameter are shown in Figure .It is indicated that the discharge passing the cylindrical weir gate increase with increase of total upstream head (H) and decrease the oblique angle.



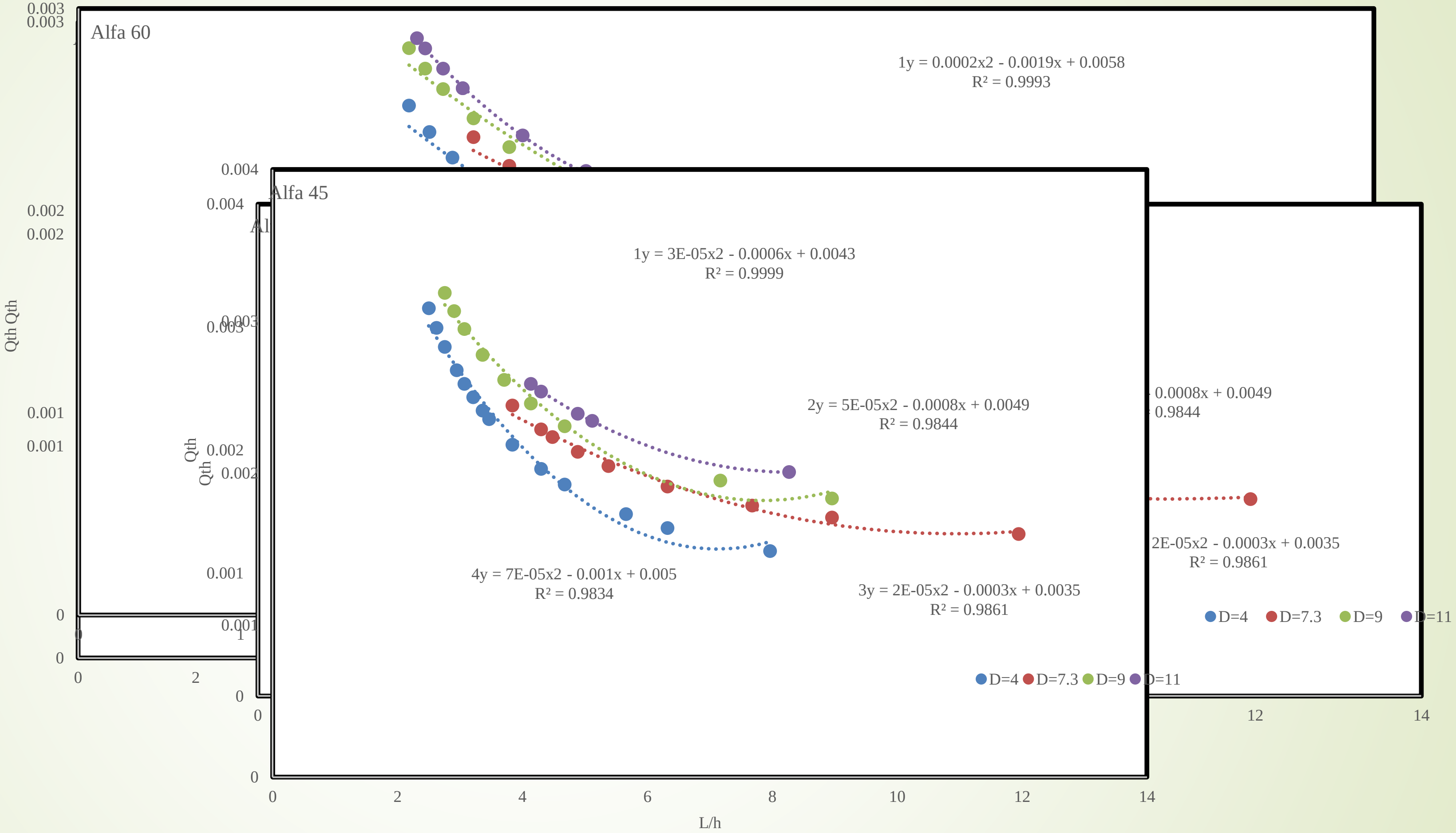
Relation between the total discharge and the total head H for different oblique angles and diameters.

1. *Variation of* $(\boldsymbol{Q_{th}})$ *with* $(\boldsymbol{D/h\ and\ L/h})$

The variation of (Q_{th}) with (D/h and L/h) was studied for all models with different oblique angle (α = 90° , 60° , 45° , and 30°) are plotted .one may observe that the decrease in the value of the discharge due to the increase in the two variables (D/h) and (L/h).



Relation between the $(\boldsymbol{Q_{th}})$ with $(\boldsymbol{D/h})$ for different angles.

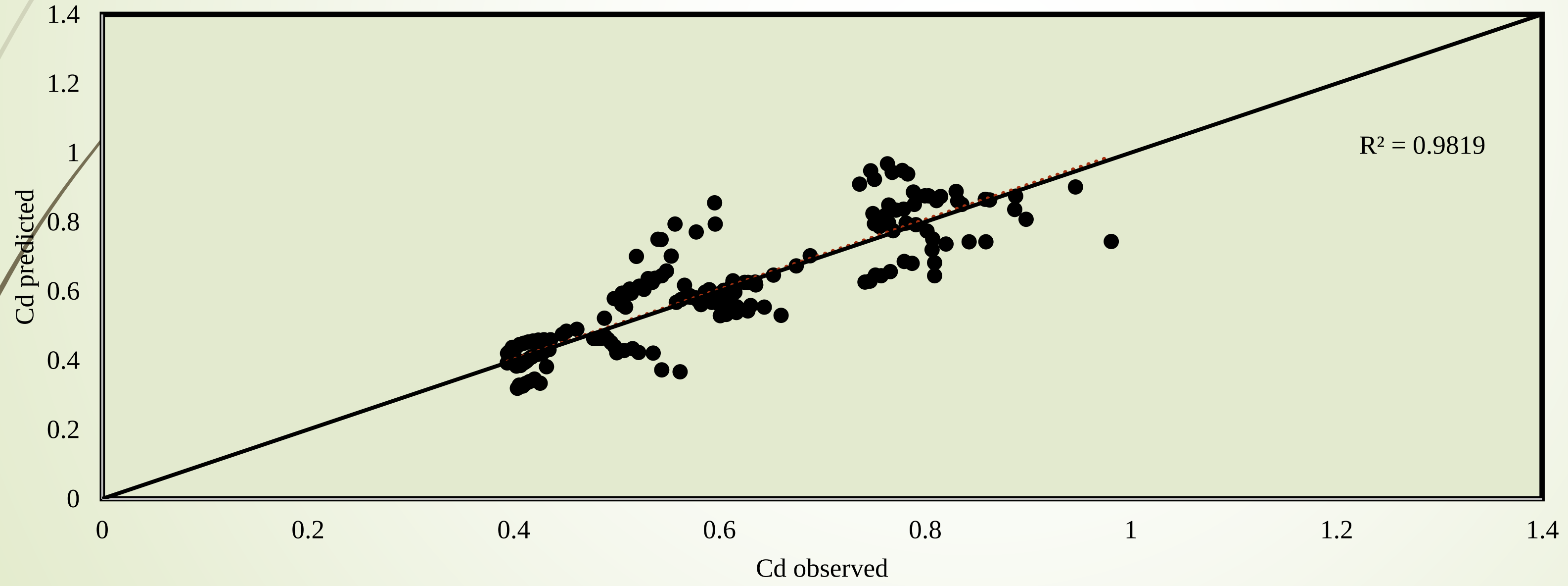


Relation between the (Q_{th}) with (L/h) for different angles

I. CONCLUSION

The current work aims to experimentally study the effect of oblique angle and different diameter on the flows over oblique cylindrical weir-gates. 16 models were designed and tested with angles varied four times from 30° to 90° and diameters varied from 4 to 11 cm. The discharge range was between 0.5 to 2.5 LPM. The results from the study are discussed and the following conclusions can be drawn:

1. The main parameter effect on $\frac{Q_{th}}{\sqrt{g}\,h^{2.5}}$ and Cd were $\left(\frac{D}{h}, \frac{L}{h}, and\ \alpha\right)$.



. Variation of predicted values of CD with experimentally observed ones for all test runs.

1. The theoretical discharge(Q_{th}) decreases with the increase of all parameters (D/h) and (L/h) for different angles and diameters.
2. The actual discharge increases as the diameter of combined weir -gate increase and decrease the oblique angle.
3. As the oblique angle increased, the discharge coefficient decreased, with a range of values from 0.5 to 0.98.
4. The values produced by the developed equation were found to closely match the observed values.
5. Two empirical expressions in the form of a power function were obtained, with a correlation coefficient of 0.998 and 0.88.

$$\frac{\mathrm{Q_{th}}}{\sqrt{\mathrm{g}}\mathrm{h}^{\frac{5}{2}}} = 0.252\left(\frac{\mathrm{D}}{\mathrm{h}}\right)^{0.714}\left(\frac{\mathrm{L}}{\mathrm{h}}\right)^{1.729}$$

and

$$\boldsymbol{C_d} = 0.0448\,(\boldsymbol{\alpha})^{0.602}\left(\frac{D}{h}\right)^{0.052}\left(\frac{L}{h}\right)^{0.088}$$

thanks