A STUDY OF FLOW CHARACTERISTICS
OVER OBLIQUE & V-SHAPED WIERS IN PLAN

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LIST OF SYMBOLS

B = width of flume

l_t = total length of weir in plan

l_o = length of straight oblique weir.

l = length of oblique portion of Z-shape

x = length of normal portion of Z-shape

l_r = length of right branch of V-shape

l_l = length of left branch of V-shape

θ = side wall angle of straight oblique weir

θ^* = angle of secondary skewness

h = head on crest of weir

h_1 = rise of water above crest in D.S.

p = height of weir crest

Q = discharge over weir

Q_o = discharge over oblique weir

Q_M = discharge over normal weir

q = discharge per unit width.

C = coefficient of discharge

V_m = mean velocity

V_a = velocity of approach

y_c = critical depth

g = acceleration of gravity

ρ = mass density of fluid

μ = dynamic viscosity of fluid

ν = kinematic viscosity of fluid

σ = surface tension force.

R_N = Reynold's number

W_N = Weber's number

F_N = Freude's number

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INTRODUCTION

Weirs are hydraulic structures errected across the flow to raise the upstream water level. Generally, from the irrigation point of view, the primary function of weirs is the control of water level for the purpose of irrigation, navigations, flood protection or reducing of bed gradient of a river.

Therefore, the discharge capacity of weirs has been the subject of a great number of experimental and theoritical investigations. For weir construction, there exist a well defined conception of outflow from upstream level (overflow height) representing the control section, from which the quantity of flow could be determined from water level measuring.

Weirs are generally arranged normal to channel axis (overflow length - channel width) due to economical considerations. The flow quantity Q over these weirs can be calculated using Poleni's formula. Q depends therefore, in addition to overflow height, on the cross-section form of the weir.

Beside the mentioned normal weir, there exist oblique weirs, and weirs of broken curved or reounded axis.

An oblique weir is characterized through its inclination in plan with an angle θ to the main direction of flow. Thus, for the same channel width, the flow passes over a longer crest length compared with the case of normal weir. Therefore a certain quantity of flow can be discharged with smaller overflow height.

Oblique weirs are used therefore as the other special forms of weirs, when the max overflow height is limited. Thus, they can be used as overflow structures for reservoirs to increase the storage capacity without excceding the maximum permissible water level.

There exist series of formulas for calculating the discharge over normal, longitudinal, and oblique weirs.

The names of the most important authors which developed these formulas are :-

For normal weirs

Poleni, Weißbaeh, Basin, King, Rehbock, United States Bureau of Reclamation and Nessim Hay-Eric Markland.

For longitudinal weirs

Engels, Schaffernak, Faehheiner, de Mardri and Schrnidt.

Fo oblique weirs

Boileau, Aichel, Istomina, Eseande- Sabathe and Gentilini,

Till now, there is no equation, having a theoritical base, generally valid, and experimentally coroborated for flow over oblique weirs.

The submitted work was carried out with vertical, sharp-edged weirs, due to its great accuracy as measuring devices.

The aim of this work is to clear and continue by its own investigation, the problem of discharge over Z-shaped, and V-shaped sharp-edged weirs, compared to the oblique weir through accurate consideration of the known researches and theoritical dissertations.

This work involves a trial to :

1. Study the effect of variables that have an influence on the flow over these weirs to be taken into consideration in calculating the coefficient of discharge.

2. Calculate values for the coefficient of discharge for these weirs having different shapes and positions for several heads and consequently several discharges. Also finding the percentage increase in discharge in comparison with the oblique weirs under the same conditions.

Our aim is to increase the length of the straight oblique weir by Z-shaping keeping the distance y constant and consequently the length of floor unchanged, thus reducing the costs of construction.

3. Evaluate the coefficients of discharge by using the dimensional analysis and the experimental data.

The experiments were carried out on twenty four models in a rectangular channel representing the various shapes and positions.

These models were tested for both free and submerged conditions of flow.

CHAPTER 2

REVIEW OF LITERATURE

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Review of Literature

2.1 Basic Weir equation

Almost all known flow formulas come from the basic formula of Poleni 1717, see Fig. (1).

$$Q = \frac{2}{3} C\sqrt{2g}\, Bh^{3/2} \quad m^3/s \quad \text{------------------------}(1)$$

This formula was derived by integrating the velocity. The velocity was expressed in terms of the square root of vertical distance below the free surface (Fig 2-a). for unit width.

$$q = \frac{2}{3} C\sqrt{2g}\; h^{3/2} \quad m^3/s/m \quad \text{--------------------------}(2)$$

with $g = 9.81\ m/s^2$, it follows that :-

$$q = 2.953\ Ch^{3/2} \qquad m^3/s/m \quad \text{--------------------}(3)$$

The flow coefficient C compensated all the simplifications included in Poleni's formula Du Buat, sixty years after Poleni, introduced the presentday method of estimating the effect of submergence using the formula

$$Q = \frac{2}{3}\, CB\sqrt{2g}\; h_2^{3/2} + CB\; h_1\sqrt{2gh_2}$$

Where

$h_2 = h - h_1$ represents the net head (Fig.2-b)