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Exprimental Study and Analysis of Labyrinth Weir

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Abstract: - Compound labyrinth weir is a new type of labyrinth weirs that consider a good applicable choice for increasing the capacity of discharge. The flow over a compound labyrinth weir is a complex problem because the flow behavior is three dimension. The present study aims to simulate the flow over the compound labyrinth weir into the critical regions that cannot be observed when using an experimental test. Labyrinth weirs are a type of weir that is folded in plan view to increase the total spillway crest length. This increased crest length results in a higher discharge capacity for a given head than a linear weir of the same width. Labyrinth weirs can be used to increase the discharge capacity of existing spillways or to provide more efficient spillways for new dams.

Keywords: - Circular, Coefficient Discharge, zigzag Labyrinth weir, flood hydraulic Structure.

1. INTRODUCTION

Weir raises the level of water in a river (or stream) on the upstream side, and spills the surplus water over its entire crest length on to the downstream side. Unlike a dam having a small spillway portion, a weir spills over its entire cress length, which is usually the width of the stream itself. For the overall safety of the hydraulic structure, weirs play a predominant role. Also, the weirs contribute a significant portion of the overall project cost. Weirs can be of different types based on the shape of opening, the crest shape, effect of side openings on nappe formation and based on discharge conditions. For example, weir can be a rectangular weir, triangular weir, or a trapezoidal weir, based on the form of the opening in elevation. Also, based on the edge profile of the crest, the weir may be one of the following: a sharp-crested weir, narrow-crested weir and broad-crested weir. A labyrinth weir is a linear weir that is folded in plan-view to increase the crest length for a given channel or spillway width. There are an infinite number of possible labyrinth weir configurations and design variations; however, labyrinth cycles are typically placed in a linear fashion (i.e., upstream apexes align at a common channel cross section; Fig. 1), have a sidewall angle (α) less than30°, and are oriented towards the approaching flow.

A labyrinth weir is able to pass large discharges at relatively low heads compared to traditional linear weir structures of equal width. As a result of their hydraulic performance and geometric versatility, labyrinth weirs have been placed in streams, canals, rivers, ponds, and reservoirs as headwater control structures, energy dissipaters, flow aerators, and spillway.

Objective: -

- The characteristics of flowof labyrinth weir.
- Analysis the flow of labyrinth weir.
- To check the comparison of flow**.**

2. METHODOLOGY:

The flow through a labyrinth weir is complex and depends on a number of factors, including the weir geometry the upstream head, and the downstream tailwater. However, the general methodology for calculating the flow through labyrinth weir can be summarized as follows:
1. Determine the weir geometry. This includesweir height, crest length, and sidewall angles.
2. Calculate the upstream head. This is the difference in elevation between the upstream water surface and the weir crest. Downstreamof the weir.

Previous Study: -
Labyrinth weir head-discharge relationships have been described by various empirical equations. These relationships vary based on different definitions of the discharge coefficient, the characteristic weir length, and the upstream driving head (e.g., the inclusion ofthe velocity head component V2=2g, described in the following).In the present study, a standard form of the weir equation, Eq. (1),was selected with the centerline length of the crest (Lc) as the characteristic weir length: Several earlier labyrinth weir studies resulted in published design methods; a selection is presented and discussed. Hay and Taylor (1970) presented parameter guidelines, based upon research by Taylor (1968), for sharp- crested triangular and trapezoidal labyrinth weirs. Discharge rating curves for h=P < 0.6 were presented in terms of a labyrinth-to- linear weir Fig 2. Boardman labyrinth-crest spillway (Cassidy et al. 1985) Discharge ratio (basedon a common channel width W, and h), requiring discharge information for a linear weir (α ¼ 90°) of equivalent weir height (P), wall thickness (tw), and crest shape. The Bureau of Reclamation(USBR) conducted model studies to aid in the design of Ute Dam(Houston 1982). Discrepancies between their experimental results and the recommendations by Hay and Taylor (1970) were attributed to different definitions of upstream head [h, Hayand Taylor (1970).

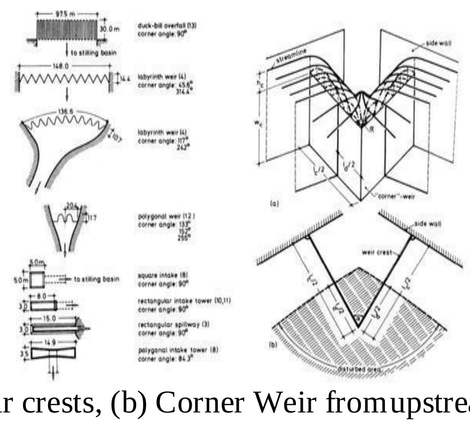


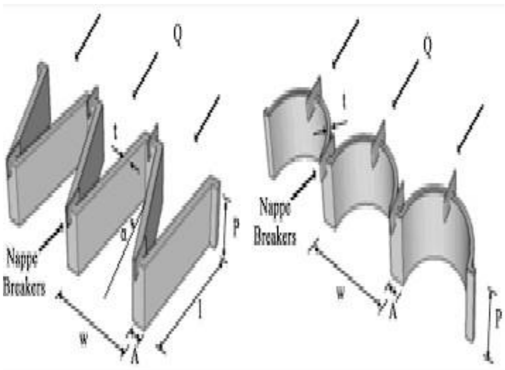
fig 1. (a) Polygonal Weir crests, (b) Corner Weir fromupstream and plan (Indlekofer and Rouve 1975)

(NCISEM -2024)

Experimental Setup and Experiment

Semi-circular labyrinth weir experimentswere conducted at the Hydraulic Laboratory of Firat University, Elazig,Turkey.

Experiments were conducted at stable flow conditions and free overflow conditions. The experimental set-up includes sump, pumping system, discharge tank, rectangular flume, digital flowmeter and labyrinth weir (Fig. 1). Water is recirculated through 250 mm diameter of supply line using two 75 HP pumps. Water for experimental setup is taken from the supply line by means of a pipe with150 mm diameter. The discharge was measured by means of a Siemens electromagnetic flow- meter installed in the supply line. Water was supplied to the main channel (2 m wide and 0.80 m height this channel length is 3.0 m) through a supply pipe from the sump (volume of 15 m3) with flow controlled by a gate valve. For damping the water surface waves and reducing turbulence, baffle wall and wood surface dampener is provided. In the experiments, the upstream elevation was built higher than the downstream elevation so that free flow conditions occur downstream of the weir. Sheet metal materials which have 4 mm thickness (t) were used for labyrinth weirs. Labyrinth weirs designed as three- cycles. Schematic view of circularlabyrinth weir is given in Fig. (2). Each semi-circular labyrinth weir and linear weir models with a sharp crested shape was tested in the experiments.

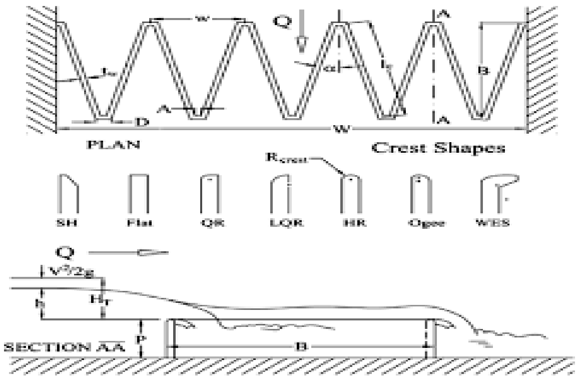


To measure the nappe height, water depth was measured accurately using Mitutoyo digital point gauges (accurate to 0.01 mm) just upstream of the weirs. Level measurements were taken at a distance from the weir equal to five times the nappe height. For flow rate measurements, Nortek brand acousticthree axis velocimeter was used.
In the experiments, the weir heights weretaken as 100 mm, 150 mm and 200 mm and apex width (A) was taken as 80 mm. Sharp crested shapes is provided for all models. All experiments were performedaccording to free flow conditions.
The flow over labyrinth weir is three dimensional and does not readily fit into mathematical description and hence the discharge function is found through experimental studies and analysis. Thecrest coefficient / depends on the total head, weir height, thickness, crest shape, apex configuration and angle of side wall. To simplify the analysis, the effect of viscosity and surface tension could be neglected by electing model and velocity of sufficient magnitude.

3. CONCLUSIONS

The labyrinth spillway was 'invented' a century ago, allowing for a reduced overflow width normally at the spillway crest region. The so-called dischargemagnification factor as the ratio HO between discharges of the labyrinth to the normal weir arrangements is the HMP true measure of the hydraulic performance. This research details the developments of this particular hydraulic structure by accounting for the outstanding research additions up to 1985. It demonstrates that labyrinth weirs apply not for all hydraulic conditions, particularly under high submergence, high relative overflow depth, and poor plan geometry. This structure is a predecessor of the PK and RL weir with the same developed crest lengths, three-dimensional free surface numerical simulations have been performed. The PK weir produced higher discharge capacity than all of the geometrical comparable RL weir, with the exception of small H/P. The PK weir maximum and average discharge efficiencies (quantified by Cd) for $0.3 \leq H/P \leq 0.75$ were respectively from 3,1 to 5,6% larger, in comparison to the RL weir.

Furthermore, using flux surfaces, variation, the discharge per unit length along the crest of the various tested weirs has been calcul- ated, and the percentage contribution on the inlet, outlet and sidewall crest in the discha-rge capacity of the weirs has been determi- ned . based of the results on the numerical simulations, the reduction in discharge cap acity of RL weir(relative to PK weir) is sol- the Piano Key Weir, which currently is popular because of even increased discharge characteristics as compared with the labyrinth weir. The future development of both weir types may be improved with this historical outlook for further progress both in hydraulic and economical features. Experimental data were collected in this study to evaluate the performance of the numerical model. It was found that the numerical model has ability to predict the discharge capability of nonlinear weirs. Its accuracy was even higher than four of the most popular analytical equations used recent studies.
To compare the discharge efficiency ofely attributable to the colliding nappes flow wing over two adjacent sidewall crests.
This phenomenon is attributed to the slopeFloors in the outlet key of the P weir.



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