Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 01, January -2018

DEPTH DISCHAGRE RELATION OF COMPOUNDBROAD CRESTED-WEIR OVER A CURVED PORTION

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ABSTRACT-*Investigatesare done to know the appropriateness of different shapes of broad crested weirs to substitute the predictable method of discharge measurement with the help of weir, notch or other dives on site. The weir used on site also has an independent use as energy dissipater. The properties of the weir crest and step altitude of a broad-crested weir of rectangular cross section and curve portion on the values of depth, discharge coefficient (cd), and the approach velocity was examines by taking series of laboratory investigation. The dependency of theobservations taken on model parameters for discharge was examined and the magnitudes were associated with those of the traditional rectangular broad crested weir and venturiflume.*

Key Words *-Co-efficient of Discharge, Calibration of compound Weir,CompoundBroad crested stepped weir, Discharge measurement in rectangular canal, Depth-Discharge relationship, approach velocity.*

I. INTRODUCTION

A weir is a barrier across a river designed to vary its flow characteristics for discharge measurement and also works like a flow controlling device in open channels, mostly manmade and natural channels like canals and rivers. It is the simplest way to measure the discharge on the weir just by gauging it at the station points (in rivers, canals …) are important. The use of portable instrument like kinds of weirs, flumes, floats, and volumetric tank are common.

Measurement of Discharge capacity is intended to be one of the important purposes of a broad crested weir.Successive observations were done in laboratory and studies were carried out for the implementation of the width at both the levels – i.e. at the lower weir crest and at each step of the broad-crested weirs with rectangular compound cross section and the values of the depth, discharge coefficient (Cd) and the approach velocity coefficient. Problems incurred with the implementation of the weir on the field were about its calculations. Its compare with venture-flume as its better substitute for the complete discharge measurement on site, weir construction was seldom implemented.If a broad crested weir is considered, here in this case as the crest is sufficiently broad enough, it is observed that, critical flow takes place and pressure distribution over the weir is hydro static, and stream lines are parallel to the crest.

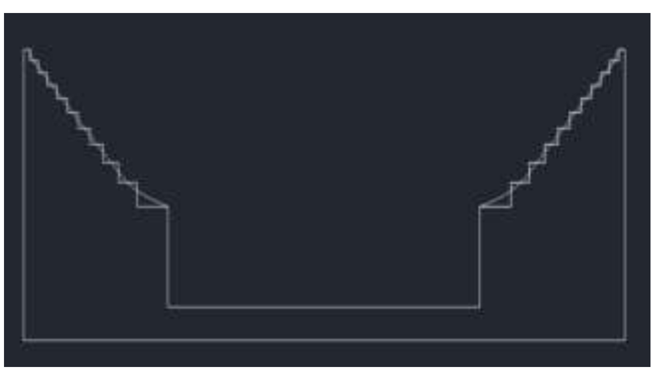

Figure 1: Cross Section of Rectangular Stepped Broad Crested Weir

I have emphasizing on the designing and construction of a Compound Broad Crested Weir (CBC Weir) and its utilization to know the depth discharge relationship according to the submergence ratio (or its total depth of submergence).

A rectangular stepped weir is combined into a curved one to overcome the difficulties and hurdles in stepped weir. Thus the depth discharge correlation is to be derived to know the actual discharge passing through an open channel. The derivation of the depth discharge relationship is carried out by a model study of a deigned weir and testing its suitability on a tilting flume at different discharges.

The depth discharge relationship is to be implemented in knowing the discharge value by a compound broad crested weir. Thus by just knowing the depth at any section of a canal where the weir is to be installed, the discharge value canbe obtained thus making the measurement simple and easy fordifferent uses.

II. LITERATURE SURVEY

Study of physical characteristics of the dischargepassing overa compound broad crested weirs with different throat cross sections is always been the topic of importance and awareness to many investigators.

Chyan Den Jang(1943), carried out experiments on various CBC weirs in comparison with simple weirs and even derived dimensionless discharge equations. M Gogus, concluded that the discharge coefficient values obtained from the experiments performed on CBC rectangular weir are lower than those of simple rectangular broad crested weir having the same crest height and crest length. Hanna Majcherek(1984) carried out the theoretical and experimental investigations of effect of weir submergence whose experiments showed that coefficient of discharge is a function of nappe head. B. P. Tullis, J.C. Young and M.A. Chandler (2007) carried out experimental study to find head discharge relationship for submerged labyrinth weir, in which with the help of Villemonte’s relation they derived the new dimensionless submerged head discharge relationship. G.A. Hinge (2015) carried out study on hydraulic jump type energy dissipater; the design of this weir is in reference with this research.

III. METHODOLOGY

A. EXPERIMENTAL MEASUREMENT OF DISCHARGE

The rate of flow measurement procedure for the computation of the discharge experimentally is described in the following steps. The design discharge range for the weir used was 2lps to 7lps. The discharge is set in the rectangular tilting flume after installation of the weir by trial and error method. The known volume tank is used for measuring the discharge by recording the time required to collect the water of same volume. The research that is carried out is a compound broad crested weir. The dimensions of the said weir can be shown in the following figures

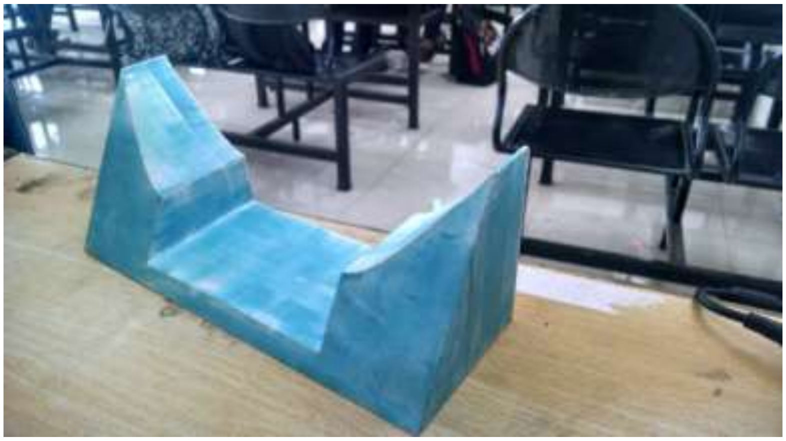

Figure 2: Actual fabricated weir for performance of Experimentation

Our stepped weir is installed in the testing section of tilting flume and water is allowed to pass through and over the weir. Depth is measured at predefined section i.e. the upstream side of the channel before the submergence of weir y_1, the depth at the upstream side of thecurve where water just passes c_1, the depth at the downstream side of the curve where the water just passes c_2 and the depth at the downstream side of the channel is measured y_2.This measurement of depth is done with vernier scale of accuracy 0.1 mm. The water is allowed to flow through the rectangular channel with weir installed and the time required to fill the required volume is recorded. This process is repeated for increment of every 0.2 lps of discharge.

Consequently the rate of flow is measured with the equation (which is called volumetric measurement of Discharge)

Discharge (Q) = (Volume (V)) / (Time(t))

Figure 3: Flow of Water over the Weir

In the next set, the depth at the downstream side is adjusted by plank arrangement. The depth measurements are taken at all four required sections for every 0.2 lps of increment in discharge (unto 6 lps).

Discharge and its time required to fill the tank is noted and accordingly the experimental discharges are calculated for different submergence.

B. THEORITCAL MEASUREMENT OF DISCHARGE

The depthas defined y_1, y_2, c_1.c_2, is measured on both sides of weir i.e. upstream side and downstream side of the installed weir. Equation for discharge measurement for the flow over a rectangular stepped CBC weir is considered to be the most similar to the way done for simple rectangular broad crested weir, but generally having broad crested weir with different Co-efficient of discharge (cd).The theoretical discharge flow equation is calculated by considering the submergence ratio as well.

Submergence ratio =(Downstream Depth-Starting Height)/(Upstream Depth-Starting Height)

Use of Ville-Monte Equation is done in calculation of the theoretical discharge:

$$Q_2 = Q_1 \left[1 - \frac{{h_2}^p}{h_1}\right]^{0.385}$$

Where,
h2 = downstream depth – starting height
h1 = upstream depth – starting height
p = 1.5 for rectangular Weir cross section
Q1 = Free open channel Discharge
Q2 = Submerged Discharge

Calculation of $Q_2$is done with respect to the above equation. Q_1 has to be calculated with respect to the number of submerged steps.

IV.EXPERIMENTAL OBSERVATIONS AND DISCUSSIONS

A. FOR NO PLANK CONDITION

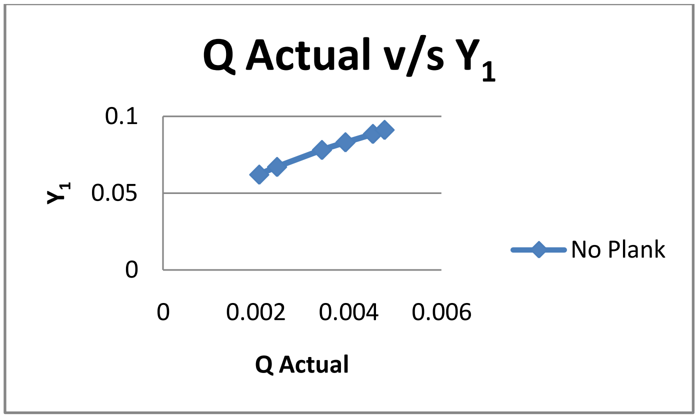

Figure 4: Graph for Q Experimental Vs Upstream Depth for No Plank Condition

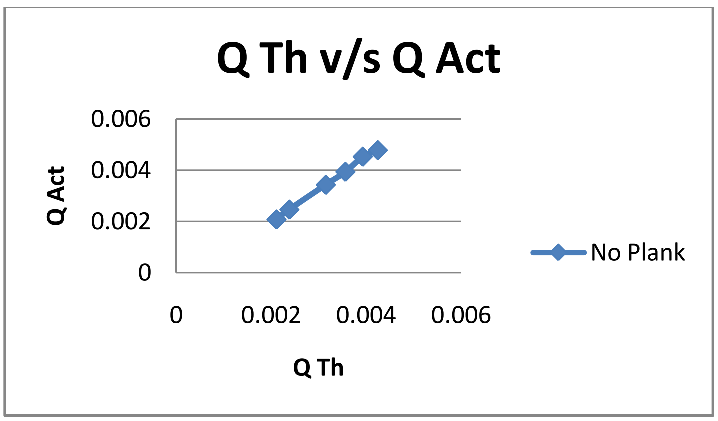

Figure 5: Graph for Q Experimental Vs Q Calculated for No Plank Condition

B. FOR ONE PLANK CONDITION

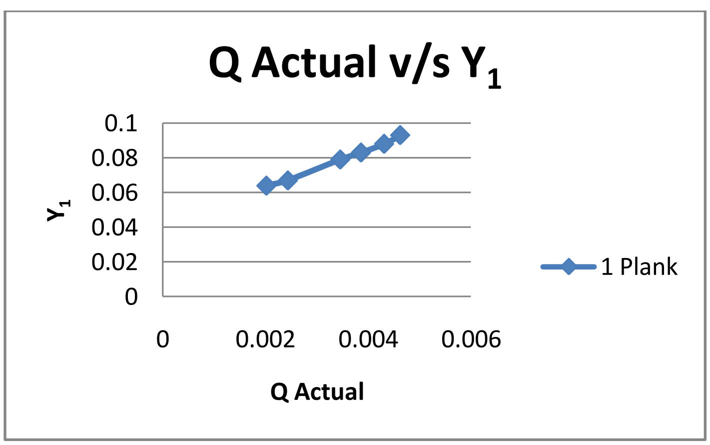

Figure 6: Graph for Q Experimental Vs Upstream Depth for One Plank Condition

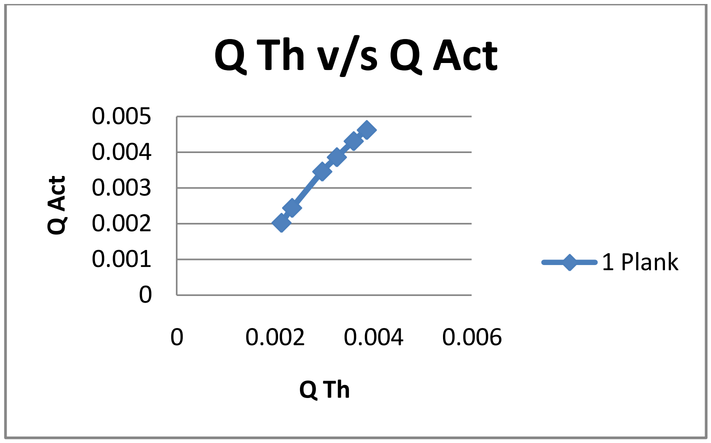

Figure 7: Graph for Q Experimental Vs Q Calculated for One Plank Condition

C. FOR TWO PLANK CONDITION

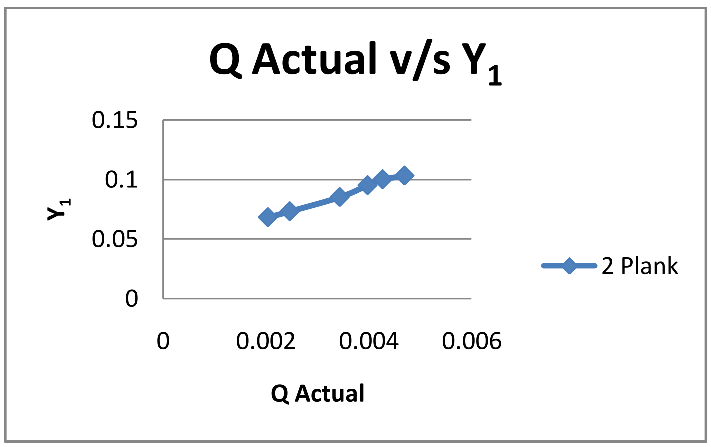

Figure 8: Graph for Q Experimental Vs Upstream Depth for Two Plank Condition

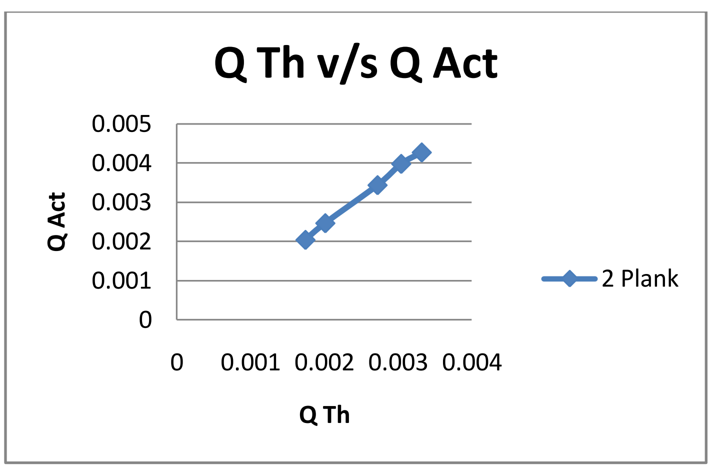

Figure 9: Graph for Q Experimental Vs Q Calculated for Two Plank Condition

The numerical analysis with their graphical representation for each case discussed, suggested that the experimental and theoretical results show analogous graphical profile. This recommended a prospect of originating a connectionrelation between discharge and depth which is as plotted in the above graph.

The analysis of the readings led to development of two different relationships:

$$Q_{EXP} = \frac{Q_{CAL}}{\left[1.57 - \frac{C_2}{C_1}\right]^{1.5}} \quad \text{....No plank condition}$$

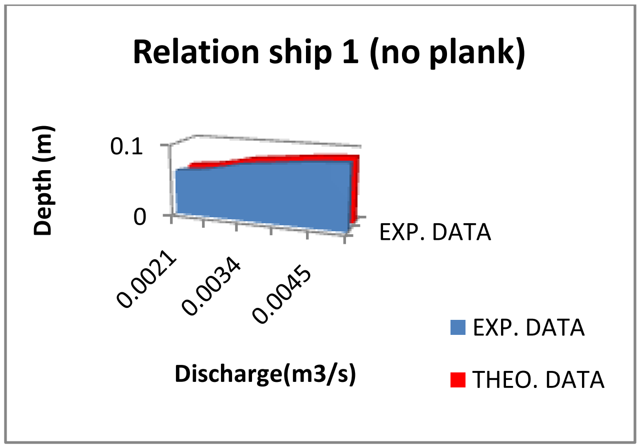

Figure 10: Depth Discharge Relationship for No Plank Condition

$$Q_{EXP} = \frac{Q_{CAL}}{\left[1.55 - \frac{C_2}{C_1}\right]^{1.5}} \text{.... One plank condition}$$

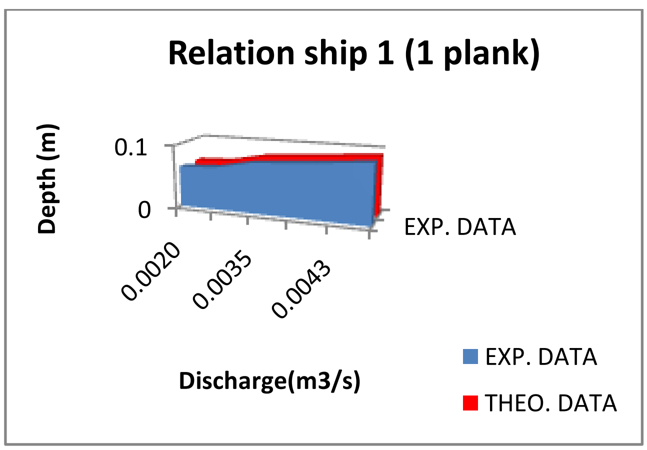

Figure 11: Depth Discharge Relationship for One Plank Condition

V. CONCLUSION

The outcomes of the analysis are presented above in graphical formation and following conclusions were drawn:

- The preliminary set of trials a comparative analysis of data suggests that the experimental and theoretical values have comparatively parallel graphical profile.

- It’s concluded from the trials takenfor the equation, that excluding few evaluations and observations the relation is valid and is within the allowable discrepancy is about 5%.
- It is alsoconfirmed that the economy of weir over rectangular flume in open channel flow has a cost saving of practically 70%, then that of Venturi flume actual construction.
- This weir verifies to be appropriate and easy for measurement of discharge in canals running at 60% to 100% of its discharge value (commonly adopted).
- It is suggested that the suitability of the weir above 2.5lps discharge, as in channel if discharge goes below this the head available will be less also there will be excess percolation and evaporation losses. Hence the calibration suggested proves successful above the mentioned discharge.

VI. ACKNOWLEDGMENT

We are thankful to Dr. G. A. Hinge & the Department of Civil Engineering of TSSM’s Bhivarabai Sawant College of Engineering and Research, Narhe Pune, for guiding and providing facilities for the research work in their Hydraulics lab.

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