# EVALUATION OF THE EFFECTS OF SURFACE ROUGHNESS ON DISCHARGE COEFFICIENTS OF THE BROAD CRESTED WEIR

By

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EVALUATION OF THE EFFECTS OF SURFACE ROUGHNESS ON DISCHARGE COEFFICIENTS OF THE BROAD CRESTED WEIR


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Broad-crested weirs are one of the most widely used hydraulic structures in irrigation and drainage systems in natural streams where it is necessary to measure a wide range of discharges. The use of laboratory materials in hydraulic engineering gives a more accurate estimation of the discharge coefficients for broad-crested weirs with a rough crest surface.

For this research, a rectangular broad crested weir was investigated and studied through three models of length value and three roughness sizes ;5, 10 and 20 cm each with two heights 15cm and 25 cm , within different lengths 30, 60 and 90 cm each. The aim of this study was to determine the effects of the surface roughness sizes and its various heights on the discharge coefficients of the broad crested weir.

The results obtained from each situation show that increase in size of surface roughness lead to decrease of discharge value. Also increase of length and height of weir lead to decrease of discharge value due to the head loss caused by an increased surface resistance force.

There is positive relationship between H/P and discharge coefficients while the relationship between weir height and discharge coefficient is a strong negative relationship, while for the length and size of surface roughness, the relationship is

weak in range of thickness of $0.0169 \leq H/W \leq 0.1004$ and in the large range of weir height (extreme $0.0407 < H/P < 0.401$) while the range of H/Ks was $0.0005 \leq H/Ks \leq 0.0601$. As for the range of H/L, it was $0.011 < H/L < 0.2008$.

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## APPROVAL

This thesis was submitted to Senate of Infrastructure University Kuala Lumpier (IUKL) and has been accepted as partial fulfilment of the requirement for the degree of Master of Science in Water Resources. The members of the thesis Examination Committee were as follows:

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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Infrastructure University Kuala Lumpur or at any other institution.

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| Abbreviation | Description |
|---|---|
| *A* | Flow area in section of weir |
| *B* | Width of the crest of the dam or weir |
| *cf* | Friction coefficient |
| *C* | Chézy coefficient |
| *C1* | Numerical coefficient of broad-crested weir flow |
| *Cd* | Discharge coefficient |
| *C dc* | Discharge coefficient over the crest |
| *d* | Water depth |
| *D* | Hydraulic diameter |
| *f* | friction factor |
| *Fr* | Froude number |
| *g* | Gravitational acceleration |
| *h* | Upstream water level above weir crest |
| L | Water level over weir |
| L | Water level over weir |
| *H* | Total energy head |
| Ks | Roughness size of crest |
| *M* | Weir slope |
| *n* | Manning coefficient |
| *p* | Pressure |
| *P* | Weir height |
| *q* | Discharge per unit width |
| *Q* | Total discharge |
| $Q_{th}$ | Theoretical discharge over the weir |
| Qact | Actual discharge over the weir |
| v | flow velocity |
| w | Width of flume |

# CHAPTER 1

# INTRODUCTION

## 1.1 General

In order to measure the level of water in an upstream, hydraulic structures are usually installed in the rivers and open channels. The level of water in the upstream will then be used in estimating the discharge (Boiten, 1993). Weirs, for example are types of hydraulic structures that act as obstructions in rivers and open channels, and are used to measure the amount of discharge. Two main methods are often used to measure the flow in these hydraulic structures. The first method is known as the velocity areas method and the second one is the hydraulic head method. In the first method, the flow discharge is usually measured by finding the local velocity of the areas that have been affected, while the second method is used to determine the flow discharge by measuring the available difference in the hydraulic head through the use of the flow reach. In order to conclude these methods, empirical equations are usually used between the flow head and discharge. At times, these measurements are dissimilar in value from those obtained in the field.

Weirs are simple devices used to measure discharge and control the flow in open channels, like canals and rivers. They are used as a form of a measurement tool for discharges during the task of monitoring of floods at respective stations (in the rivers and canals). Weirs are small overflow-type dams, commonly, used to raise the water levels of a river or a stream, thus, causing a large change of water levels behind them. Many researchers have studied the head discharge relations for flows over the sharp-crested and broad-crested weirs with a simple cross sectional shape, like a rectangular, triangular, trapezoidal, truncated triangular, and others (Seyed Hooman Hoseini, Shayegan, & Afshar, 2013).

Broad crested weirs are some of the widely used hydraulic structures that individuals use in measuring the rate of flow in irrigations, rivers, open channels and drainage systems.

A broad-crested weir is a structure created with a flat crest in such a way that the length of the crest is larger when compared to the thickness of the flow (Gonzalez &

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