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JUDUL: **COMPARISON BETWEEN METHODS OF STEADY GRADUALLY VARIED FLOW COMPUTATIONS IN PRISMATIC CHANNEL WITH ACTUAL DATA**

SESI PENGAJIAN : 2007/2008

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COMPARISON BETWEEN METHODS OF STEADY GRADUALLY VARIED FLOW COMPUTATIONS IN PRISMATIC CHANNEL WITH ACTUAL DATA

NURUL KASWINA BINTI NIZAM

A report submitted in partial fulfillment of the
requirements for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering
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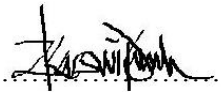
APRIL 2008

I declare that this thesis entitled "*Comparison between Methods of Steady Gradually Varied Flow Computations in Prismatic Channel with Actual Data*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Dedicated to…

My beloved dad and mum,

Nizam Aziz and Sarifah Mat Salleh,

I could have never done it without both of you..

My siblings; sisters and brothers,

My uncle and aunt; Emran Mat Salleh & Rabitah Hanim,

who has so much faith in me..

All my friends, who always stood by me,

Aidil, Amyra, Nurlida & Ikhwan

Thanks for showering me with love, support, and encouragement

Thank you very much

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ABSTRACT

The purpose of the study is to analyze the methods of steady gradually varied flow computations and compare the results with the actual data obtained experimentally in the laboratory. The computational method includes graphical integration method, direct integration method, and numerical method in determining the length, *L* between two sections of known water depths in rectangular channels. The direct integration method is divided into direct integration and numerical integration while direct step method and standard step method are parts of numerical method. Many approaches have been made by the early hydraulicians in order to solve the equations created or improved the existing equations. Since there is a variety of equations and channel cross sectional shapes, methods suggested by Chow V.T.(1959) are used as a solution of this various existing methods. The methodology of this study is divided into two parts; experimental in the laboratory and analyzing data obtained in form of calculations and graphical, which resulted several conclusions in the end. MS Excel software is used to analyzing data obtained and the results will be displayed in terms of table of calculations, and graph plotting based on the equations made. The application of gradually varied flow computations widely used in construction of dams or weir to determine the effect of backwater and the destruction at the upstream resulted from the construction.

ABSTRAK

Kajian ini dilakukan bertujuan untuk menganalisis kaedah-kaedah aliran mantap berubah beransur dan membandingkan keputusan pengiraan kaedah-kaedah tersebut dengan data sebenar yang diperolehi daripada ujikaji makmal. Kaedah-kaedah tersebut termasuklah kaedah kamiran graf, kaedah kamiran langsung dan kaedah kamiran berangka dalam menentukan panjang, *L* di antara dua bahagian yang diketahui kedalamannya pada saluran segiempat. Kaedah kamiran langsung terbahagi kepada kamiran langsung dan kamiran berangka manakala kaedah berperingkat langsung dan kaedah berperingkat berangka merupakan sebahagian dari kaedah berangka. Pelbagai pendekatan telah dibuat oleh pengkaji hidraulik terdahulu dalam menyelesaikan persamaan yang diterbitkan atau menambaikkan persamaan yang telah sedia ada. Memandangkan terdapat pelbagai jenis persamaan dan bentuk keratan rentas saluran, pendekatan yang dicadangkan oleh Chow V.T.(1959) digunapakai bagi menyelesaikan permasalahan ini. Kajian metodologi terbahagi kepada dua bahagian, iaitu ujikaji makmal dan menganalisis data yang diperolehi dalam bentuk kiraan dan graf yang akan membawa kepada beberapa kesimpulan pada akhir kajian. Perisian MS Excel telah digunakan untuk menganalisis data dan hasil kajian dalam bentuk jadual dan plotan graf berdasarkan persamaan yang telah dibuat. Aplikasi pengiraan aliran berubah beransur digunakan secara meluas dalam pembinaan empang untuk menentukan kesan air balik dan mengkaji kesan kemusnahan atau penenggelaman di hulu akibat pembinaan empang berkenaan.

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LIST OF SYMBOLS / ABBREVIATIONS

A	-	Wetted cross sectional area
B	-	Channel Width
E	-	Specific energy
g	-	Gravitational acceleration
GVF	-	Gradually Varied Flow
H	-	Total head
K	-	Conveyance at any depth, y
K_o	-	Conveyance corresponding to normal depth, y_o
L	-	Length / distance
N	-	Number of section
n	-	Manning's coefficient
P	-	Wetted perimeter
Q	-	Flow Rate
q	-	Discharge
R	-	Hydraulic Radius
r^2	-	Coefficient of determination
S_c	-	Critical Slope

S_o	-	Channel bottom slope
S_e	-	Energy slope / friction slope
S_f	-	Energy slope differ from each other
S_w	-	Water surface slope
V	-	Velocity head
x	-	Longitudinal distance
Δx	-	Length of the section
y	-	Flow depth
$\bar{y}$	-	Mean flow depth in each section
y_c	-	Critical Flow depth
Δy	-	Flow depth changes between sections
z	-	Bed elevation / Datum of the channel

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Gradually varied flow (GVF) is a non-uniform flow in open channels where the depth of flow does not change during the time interval under consideration but varies gradually along the length of channel. It has two conditions. First, the steady flow, so that the hydraulics flows remain constant for the time interval under consideration and secondly is the parallel streamlines. A GVF profile also known as a water depth profile, backwater calculation, and non-uniform flow computation for a steady state flows where the discharge remains constant. GVF occurs over long distance such as the water approaching a weir, dam, or flowing through a sluice gate.

The developed theories of gradually varied flow are based on some basic assumptions, which are (1) the head loss within any given section calculation is the same as for uniform flow, (2) the velocity is the same across the entire cross-section, (3) the slope of the channel is less than ten percent, (4) the roughness coefficient is constant in the section and is independent of the flow depth (non-grassed waterway), gradual changes in flow depth starting from controlling boundary condition with no sudden changes and (5) if the section length is long, flow approaches normal depth.

Open channels may be classified into five types depending on the channel slope, the surface conditions, the sectional geometry, and the discharge. There are steep slope channels, critical slope channels, mild slope channels, horizontal slope channels, and adverse slope channels. However, only steep channels and mild channels are considered in this study. If the slope is greater than critical slope (S_c), the normal depth will be less than critical depth and flow will be super-critical flow, the slope is termed as steep slope (S). If the slope is less than critical slope (S_c), the normal depth will be greater than the critical depth and flow will be sub-critical flow, the slope is termed as mild slope (M).

Most of the major activities of hydraulic engineering in free surface flow involve the computation of GVF profiles. Applications of computational and problem analysis of GVF is used in determination of an effect of a hydraulic structure, inundation of lands due to construction of dams and weir, and flood zone estimation.

Its computational involves solution of the dynamic equation and there are three main methods of computations, which are the direct integration method, numerical method and graphical integration method. All these methods represent different equations and they will be analyzed and compared with the actual data obtained experimentally in the laboratory. Each of these methods has a number of particular solution procedures to suit the specific needs of different class of problems.

GVF mechanisms are governed by the Continuity Equation and the Energy Equation, collectively expressed in the Dynamic Equation of GVF. They are solved in conjunction with Manning's, n or Chezy equations.

1.2 Problem Statement

The calculations of gradually varied flow profile involve solution of the dynamic equation. This study is about calculations and comparison between several methods of computation of gradually varied flow to determine the changes of channel distance, Δx and flow depth, y. Two calculations need to be solved, which are; the determination of length or distance, L if depth at two points, lets say y_A and y_B are known and secondly is the determination one of the depth, lets say y_A if length, L and the another depth, y_B are known.

The calculations of length, L in gradually varied flow profile is important for the engineers in construction of dams or weir to know the effect of backwater and the destruction at the upstream resulted from the construction. To achieve it, the relationship between length, L and depth, y needs to be determined. In the other word, this study will help the engineers in choosing the best and most effective methods of steady gradually varied flow computations to be used in the real civil engineering world.

1.3 Purpose of the Study

The purpose of the study is to analyze the methods of steady gradually varied flow computations and compare the methods with the actual data obtained experimentally in the laboratory.

1.4 Objective of the Study

The objective of this study is to determine the length, *L* between two sections of known water depths of steady gradually varied flow in prismatic channel by using:

1. Direct Integration Method
2. Numerical Method and
3. Graphical Integration Method

as compared to the actual data obtained experimentally in the laboratory.

1.5 Scope

The study is focused on the types of computational methods of gradually varied flow in determining the length, *L* of steady flow profile between two sections of different depth in rectangular prismatic open channels and compares the above methods to the actual data.