UNIVERSITI MALAYSIA SARAWAK

fk

BORANG PENGESAHAN STATUS THESIS

Judul: Study Of Flow In A Non-Symmetrical Compound Channel With Rough Flood Plain.

SESI PENGAJIAN: 2000 - 2003

Saya CHARLES BONG HIN JOO
(HURUF BESAR)

mengaku membenarkan tesis ini disimpan di Pusat Khidmat Maklumat Akademik, Universiti Malaysia Sarawak dengan syarat-syarat kegunaan seperti berikut:

1. Hakmilik kertas projek adalah di bawah nama penulis melainkan penulisan sebagai projek bersama dan dibiayai oleh UNIMAS, hakmiliknya adalah kepunyaan UNIMAS.
2. Naskhah salinan di dalam bentuk kertas atau mikro hanya boleh dibuat dengan kebenaran bertulis daripada penulis.
3. Pusat Khidmat Maklumat Akademik, UNIMAS dibenarkan membuat salinan untuk pengajian mereka.
4. Kertas projek hanya boleh diterbitkan dengan kebenaran penulis. Bayaran royalti adalah mengikut kadar yang dipersetujui kelak.
5. * Saya membenarkan/tidak membenarkan Perpustakaan membuat salinan kertas projek ini sebagai bahan pertukaran di antara institusi pengajian tinggi.
6. ** Sila tandakan (√) di kotak yang berkenaan.

☐ SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972).

☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/ badan di mana penyelidikan dijalankan).

☑ TIDAK TERHAD

Disahkan oleh

Charles B (TANDATANGAN PENULIS)	(TANDATANGAN PENYELIA)
Alamat tetap: No. 99, Lorong A5-A, Taman B.D.C Stampin, 93350, Kuching, SARAWAK.	Associate Prof. Dr. NABIL BESSAIH (Nama Penyelia)
Tel : 082-455537	
Tarikh: 24-3-2003	Tarikh: 24-3-2003

CATATAN * **Potong yang tidak berkenaan.**
** **Jika Kertas Projek ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/ organisasi berkenaan dengan menyertakan sekali tempoh kertas projek. Ini perlu dikelaskan sebagai SULIT atau TERHAD.**

This Final Year Project report is as follows:

Title : **Study Of Flow In A Non-Symmetrical Compound Channel With Rough Flood Plain**

Author's Name : **Charles Bong Hin Joo**

Matric No. : **5185**

had been read and confirmed by:

(Associate Prof. Dr. Nabil Bessaih)
Project Supervisor

24-03-03

Date

Study Of Flow In A Non-Symmetrical Compound Channel With Rough Flood Plain

Charles Bong Hin Joo

A Project Report Submitted in Partial Fulfilment for the Bachelor Degree of Engineering (Civil) With Honours in the Faculty of Engineering Universiti Malaysia Sarawak
2003

Specially Dedicated to :
Mum, Dad
&
to all who had guided, helped, taught, advised and motivated me along the way

ACKNOWLEDGEMENT

The author would like to express his profound appreciation and gratitude to the following persons whom either direct or indirectly helped to complete his project.

1. Associate Prof.Dr. Nabil Bessaih, project supervisor, for his guidance, advice and comments, and also encouragement throughout this project.

2. Civil Engineering Program, Faculty of Engineering, Universiti Malaysia Sarawak in providing all laboratory facilities and materials.

3. Tuan Haji Affandi B. Haji Osman, Mohd. Hafiz and Nawawi, (technicians of Civil Engineering Program, Faculty of Engineering) for preparing all the laboratory facilities and materials.

4. To all my friends, especially Albert Lai and Phang Hock Lim who have always been there whenever needed.

ABSTRAK

Kajian tentang aliran air dalam saluran gabungan yang terdiri daripada saluran utama dan dataran banjir di sebelahnya telah menjadi topik utama kajian kebelakangan ini. Minat dalam topik kajian ini timbul akibat daripada keperluan untuk menganggar isipadu aliran air semasa kejadian banjir dan juga untuk mendapatkan hubungan antara aras kedalaman air dengan isipadu untuk tujuan kawalan banjir. Telah didapati bahawa cara hidraulik lama untuk menganggar isipadu di mana saluran gabungan dibahagikan kepada sub-bahagian adalah kurang tepat kerana tidak mengambil kira kesan interaksi di antara aliran air dalam saluran utama dengan aliran pada dataran banjir. Walau bagaimanapun, kebanyakan kajian yang dijalankan setakat ini adalah melibatkan saluran gabungan yang berbentuk simetri. Oleh sebab itu, matlamat utama kajian ini adalah untuk memberi pengenalan tentang ciri-ciri aliran dan anggaran isipadu bagi saluran gabungan yang berbentuk tidak simetri dan mempunyai dataran banjir kasar. Untuk tujuan ini, eksperimen dijalankan ke atas model saluran gabungan tidak bersimetri berskel kecil. Daripada keputusan eksperimen, didapati untuk saluran gabungan tidak bersimetri berskel kecil, cara hidraulik lama masih boleh digunakan untuk menganggar isipadu aliran walaupun kurang tepat.

ABSTRACT

The study of flow in compound channel sections has been the subject of considerable research in recent years. The practical interest in the problem arises from the necessity for accurate discharge predictions during flood events and for a reliable stage-discharge relation for flood control measures and management schemes. It has been long realized that traditional hydraulic methods of channel subdivision are inadequate for discharge calculation due to the significant interaction between main channel and flood plain. However, most of the research work was done for symmetrical compound channel. Therefore, the intention of this project is to study the flow characteristics and the discharge estimation for a non-symmetrical compound channel with rough flood plain. In order to do this, experimental investigations are carried out on a small scale non-symmetrical compound channel model. Results show that for a small scale non-symmetrical compound channel, the traditional hydraulic method can still be used to predict the discharge although less accurate.

CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF NOTATIONS

A	-	cross-section area
B	-	half total width of main channel plus flood plain
b	-	half bed width of main channel
ξ	-	weighting factor for weighted division channel method (WDCM)
fp	-	flood plain
H	-	total flow depth
H_*	-	relative depth (H-h/H)
h	-	depth of main channel below berm level
mc	-	main channel
n	-	Manning's roughness coefficient
Q_{est}	-	estimated discharge using channel division method
Q_{obs}	-	observed discharge
V	-	mean velocity
V_{ave}	-	observed mean velocity for the whole cross-section
$V_{mc\text{-}DCM\text{-}H}$	-	calculated mean velocity in the main channel region using the DCM with horizontal division
$V_{mc\text{-}DCM\text{-}V}$	-	calculated mean velocity in the main channel region using the DCM with vertical division

CHAPTER 1

INTRODUCTION

1.0 GENERAL OVERVIEW

The study of flow in compound channel sections has been the subject of considerable research in recent years. The practical interest in the problem arises from the necessity for accurate discharge predictions during flood events. The term 'compound' or two stage covers channel cross-sections having berm(s) or flood plain(s) that come into action at high flows but which are normally dry (see Fig.1). It has long been realized that traditional hydraulic methods are inadequate for discharge calculation due to the significant interaction between main channel and flood plains.

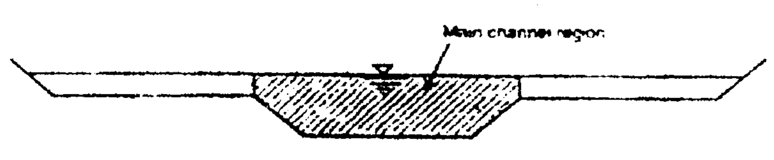


Fig.1. Compound channel section.

Many experimental studies have been carried out addressing various aspects of the problem, ranging from the boundary shear distribution to the structure of turbulence in compound section and various methods as well as empirical formulas have been proposed for discharge calculation. The available studies on flow in compound channels include Myers (1975 & 1978), Knight & Shiono (1990), Wormleaton & Merritt (1990) and Lambert & Myers (1998). Despite the progress achieved so far, no consensus has been reached for the estimation of discharge in compound channel.

1.1 OBJECTIVE OF THIS PROJECT

Since most of the research work was done for symmetrical compound channel, thus, the objective of this project is to study the flow characteristics and the discharge estimation for a non-symmetrical compound channel with rough flood plain.

CHAPTER 2

LITERATURE REVIEW

2.0 BACKGROUND OF RESEARCH

The apparently simple problem of determining the discharge capacity of a compound channel under uniform flow conditions has proved to be difficult. Sellin[1] (1964) first identified the modification of the velocity distribution and the resulting changes in the discharge capacity caused by the turbulent interaction between the main channel and the flood plain. Compound channels have traditionally been analysed by dividing the compound cross-section into relatively large homogeneous sub-areas which are easier to analyse. This approach is termed the divided channel method (DCM). However, this approach assumes no interaction between the subdivided areas despite the existence of mean velocity discontinuities at the assumed internal boundaries.

The main features that affect the interaction and hence loss of discharge capacity when the flow is above bank according to P. Ackers (1992) are :-

a) Relative depth of the flood plain flow to the main channel flow.
b) Roughness of the flood plain compared with the roughness of the main channel.

c) Ratio of the flood plain width to the main channel width.

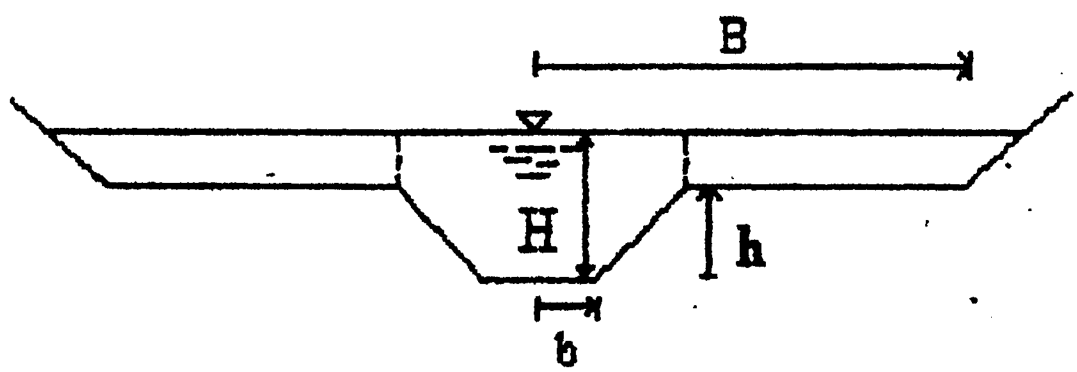
d) The number of flood plains.

e) The side slope of the main channel.

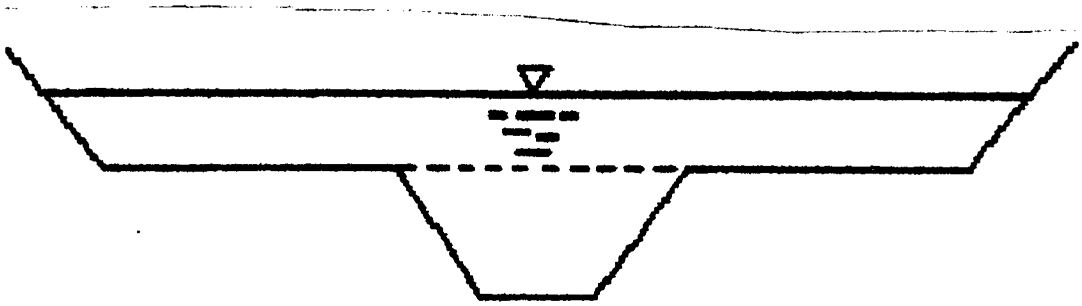
f) The aspect ratio of the main channel.

2.1 CONVENTIONAL METHODS FOR ESTIMATING DISCHARGE.

In 1933, Lotter[2] proposed the 'divided' channel method which is based on the subdivision of the flood plain from the main channel, as shown in Fig. 2.



(a) Vertical divisions.



(b) Horizontal divisions.

Fig. 2. The Divided Channel Method (DCM) with a) vertical division and b) horizontal division.

In the divided channel method (DCM), it is necessary to split the compound channel cross-section into subsections, either by vertical division or horizontal division. Then, Manning's formula ($Q = s^{1/2} AR^{2/3} /n$) will be applied to each subsection and the discharges for all the subsection will be summed to estimate the overall discharge of the compound channel. However, since this approach assumes no interaction between the subdivided areas, where the interaction between the slower moving berm flows and the main channel flow increases head losses significantly, so, the discharge calculated by this method will overestimate significantly the true channel capacity.

Another conventional method for estimating discharge though not as popular as the divided channel method (DCM) is the single channel method (SCM). In this method, the discharge for the compound channel is calculated as a whole using the Manning's formula without any subdivision. However, the single channel method (SCM) tends to underestimates the discharge capacity.

Since the conventional methods used for predicting discharge did not take into account the interaction between the slower moving berm flows and the main channel flow, thus, a more reliable methods of predicting the discharge for compound channel is needed.

2.2 THE CHARACTERISTICS OF FLOW IN A COMPOUND CHANNEL.

In order to develop a reliable method for estimating discharge in compound channel, first of all, the characteristics of flow in compound channel must be known. In order to better understand the flow characteristics, experiments to study the flow resistance has been carried out by Myers and Brennan[3] (1990) at the Flood Channel Facility (FCF) in the United Kingdom. The results of this studies have shown that :-

i. The primary stage discharge relationship for compound channel are as shown in Fig.3. The most notable feature of these relationship is the discontinuity at bankfull depth.

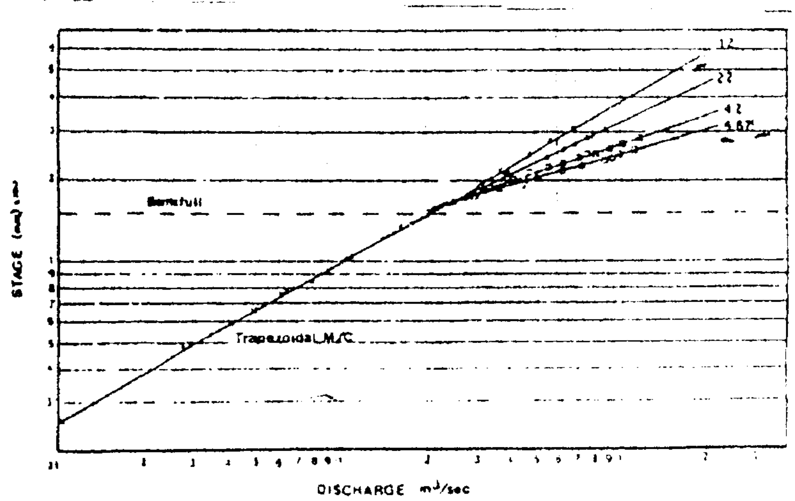


Fig.3. Stage discharge relationship.

ii. There is a rapid increases in flood plain discharge and velocity as depth rises, to a point where main channel and flood plain are roughly equal in carrying capacity (as shown in Fig.4 and Fig.5). This equalization of discharge and velocity results in a consequent decrease in momentum transfer from main channel to flood plain and may lead to a reversal in the direction of momentum transfer at larger depths.

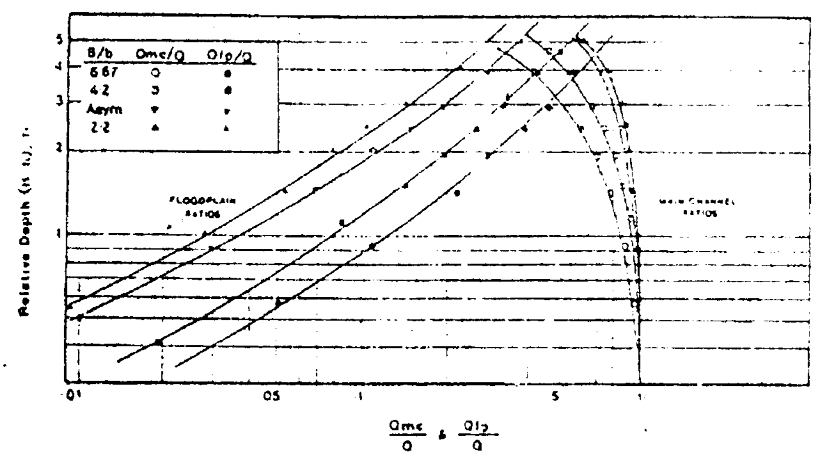


Fig.4. Ratios of main channel and flood plain discharges to full cross-sectional values.

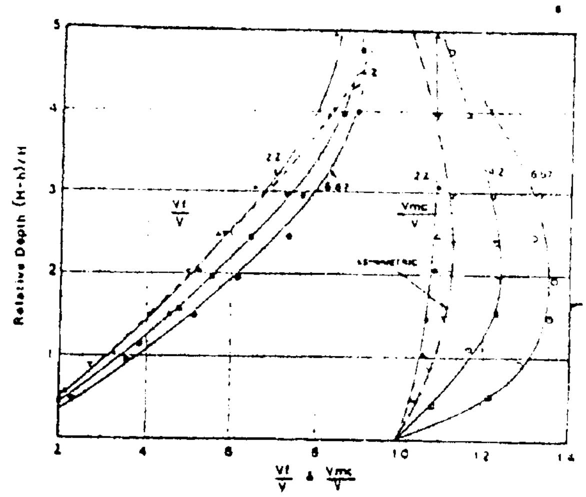


Fig.5. Ratios of main channel and flood plain velocities to full cross-sectional values.

iii. The flow resistance has been presented in terms of Manning's and Darcy-Weisbach resistance coefficients. The compound channel resistance coefficients show a significant reduction in value at depths just above bankfull, but increase to simple channel values with increasing depth (see Fig.6 and Fig.7). The main channel and flood plain resistance coefficients are increased and decreased respectively by the presence of the momentum transfer mechanism.

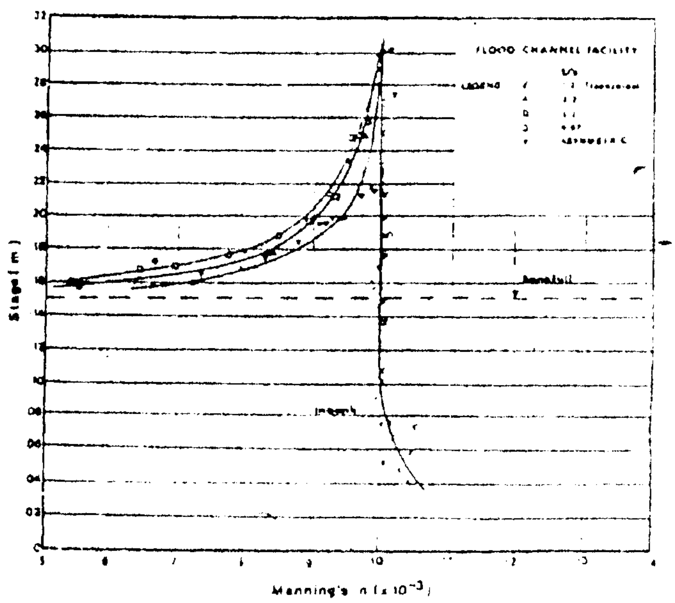


Fig.6. Variation of Manning's resistance coefficients with depth.

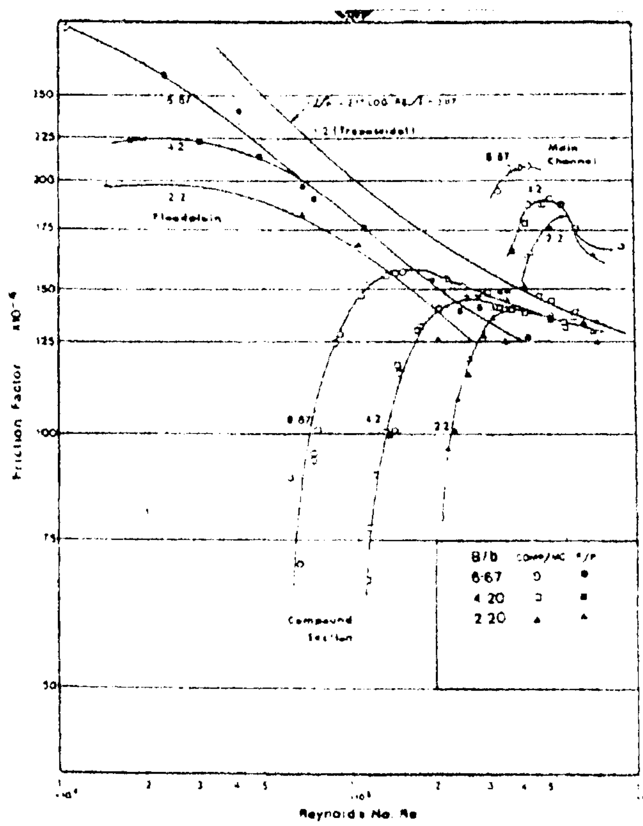


Fig. 7. Variation of the Darcy-Weisbach resistance coefficients with depth and Reynolds number for the compound section, main channel and flood plains.