EFFECT OF TRANSITIONS ON FLOW CHARACTERISTICS IN OPEN CHANNELS

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To
my

Parents,
Wife
and
Daughter

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ABSTRACT

This study aims at investigating the effect of the expanded transitions on flow characteristics.

In the theoretical study, dimensional analysis was employed to relate the different factors affecting the phenomena. Moreover, the momentum principle as well as the continuity equation were used to get an expression for the recovery in water surface elevation in the expanding transition.

Experiments were conducted in a smooth rectangular channel. Models with different diversion angles and expansion ratios were tested using variables flow parameters, i.e. discharge, and tailwater depth.

Using the experimental data, relations were plotted describing the main characteristics of flow. For analysing the experimental data statistical methods were used to deduce empirical formulae for the main characteristics of flow.

LIST OF SYMBOLS

The following symbols have been adopted in this thesis and are defind wherever they first appear :-

A	= Cross-sectional area of channel	L^2
A_1	= Cross-sectional area of channel before transition	L^2
A_2	= Cross-sectional area of channel after transition	L^2
b	= Bed width before transition	L
B	= Bed width after transition	L
B_{act}	=Actual bed width at transition zone for any section	L
b/B	= Expansion ratio	-
C1,D1,E1	= coefficients depending on b/B , θ and F_2	-
E_1'	= Specific energy at section 0.2B cm upstream the transition	L
E_2'	= Specific energy at section 0.2B cm downstream the transition	L
ΔE	= Energy loss through the transition $= E_1' - E_2'$	L
F	= Froude number	-
F_2	= Froude number at the tailwater section	-
Fp	= Hydrostatic pressure force	MLT^{-2}
Fp_{wx}	= The componant of the Hydrostatic pressure force on the side wall in the direction of flow	MLT^{-2}

f1,g1,h1	= Coefficients depending on θ	-
g	= Acceleration due to gravity	LT^{-2}
Δh	= Head recovery = difference in water surface elevation between the minimum depth at the transition zone and the tailwater depth	L
i1,j1,k1	= Coefficients depending on θ	
K	= Coefficient defined elsewhere	-
L	= Model length	L
L'	= Length of the transition measured in the direction of flow	L
l1,m1,n1	= Coefficients depending on θ	-
n	= Coefficient defined elsewhere	-
O1,P1,W1,U1	= Coefficients depending on b/B ,θ	-
Q	= Total discharge	L^3T^{-1}
Rn	= Reynolds' number	-
R	= Correlation coefficient	-
t	= Thickness of model	L
v	= Point velocity in the x-direction	L
V	= Mean velocity	LT^{-1}
V_1	= Mean velocity at the upstream section	LT^{-1}
V_2	= Mean velocity at the downstream section	LT^{-1}
V_3	= Mean velocity at the beginning of the transition	LT^{-1}
V_4	= Mean velocity at the end of the transition	LT^{-1}

X	=	Linear horizontal distance, distance from the beginning of transition measured in the direction of flow	L
Y	=	Depth of water referred to average bottom elevation	L
Y_1	=	Upstream water depth	L
Y_1'	=	Water depth at section 0.2B cm upstream the transition	L
Y_2	=	Tailwater depth	L
Y_3	=	Water depth at the beginning of the transition	L
Y_4	=	Water depth at the end of the transition	L
Ym	=	Minimum water depth at the transition zone	L
Z	=	Linear horizontal distance, measured normal to the direction of flow from the centre line of the channel.	L
α	=	Energy coefficient	-
β	=	Momentum coefficient	-
γ	=	Specific weight of water	$ML^{-2}T^{-2}$
ε	=	Coefficient defined elsewhere	-
θ	=	Angle of diversion of expansion wall with the centre line of the channel	-
μ	=	Dynamic viscosity	$ML^{-1}T^{-1}$
ρ	=	Mass density	ML^{-3}

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INTRODUCTION

At changes in cross sectional area of a channel , the structure that conducts the liquid from the upstream section to the new section is called a transition. Its purpose is to change the shape of flow and surface profile in such a manner that minimum losses result.

Transitions with the shape of cross-sectional dimensions occurring in a relatively short distance will induce rapid change in the characteristics of flow. Such transitions include sudden contractions and expansions vertically, horizontally, or both.

In the previous studies on transitions with divergent walls, an expansion in bed width, most researchers studied the effect of the diversion angle or the expansion ratio on the flow characteristics.

The aim of this study is to find the effect of the diversion angle with the expansion ratio on the flow characteristics and to find the best design of the expanded transition problems.

The dimensional analysis is used to find an expression for the relative head recovery in terms of the other variables.

In this study the theoretical analysis is based on applying continuity and momentum principles between the section just before and after the transition. The energy equation is used to obtain the energy degradation at the centre line through the transition. Moreover, the continuity equation and the velocity distribution are used to obtain the wake width through and at