3D NUMERICAL AND EXPERIMENTAL INVESTIGATION OF SUPERCRITICAL FLOWS AT CHANNEL BENDS

By

Eng. Tarek Abd El-Raheem Mohamed Abuzaid

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of The
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
IRRIGATION AND HYDRAULICS ENGINEERING

FACULTY OF ENEGINEERING, CAIRO UNIVERSITY
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Title of Thesis: **3D Numerical and Experimental Investigation of Supercritical Flows at Channel Bends**

Key Words: open channel bends; superelevation in bends; flow separation in bends

Summary:
The centrifugal force generated by open channel flow around curves will push the water particles away from main stream to radial direction. In order to maintain water particle equilibrium at the bend section, a differential rise in water surface beside the outside wall and a depression along the inside wall is created. This water surface rise causes a pressure force ΔP to balance the flow against the centrifugal force. The rise of water surface above the mean water level is called Superelevation.
Due to steep terrain natures, land acquisition, innovative flood mitigation designs in urban areas, inaccurate cited equations for estimation of superelevation at bends. Accordingly it is essential to investigate 3D flow field around bends, establish design charts for superelevation at supercritical flow (Fr = 1.3 – 2) with sharp bends where r/b<3, to determine the bend outer walls height, and study the extended bend protection against high shear stresses for these sharp bends.
These objectives are achieved through creating a 3D numerical model for rectangular channels with different bends degrees using Ansys Fluent Launcher, and carrying an experimental runs using a rectangular flume on laboratory for measuring the water surface profile for bend with angles of 90^o to calibrate the results of the numerical model as no field data are available.
The results of this study address design charts for calculating the superelevation at sharp open channel bends, address a modified equation for the protection length downstream the bend (Lp) after adding the effect of r/b ratio, confirm the three flow regions around open channel bends after matching them with the predefined regions in the previous studies, and identify the locations of maximum superelevation along the bend radial section.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: **Tarek Abd El-Raheem Mohamed Abuzaid** Date: **17/2/2019**

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ACKNOWLEDGEMENTS

This study was suggested and has been completed under the supervision of Prof. Dr. Ahmad W. Abdeldayem, Professor of hydrology, Irrigation and hydraulics Department, Faculty of Engineering, Cairo University, Dr. Ahmad M. Helmi, Assistant Professor, Irrigation and hydraulics Department, Faculty of Engineering, Cairo University, and Dr. Ahmad H. Shehata, Assistant Professor, Irrigation and hydraulics Department, Faculty of Engineering, Cairo University.

I would like to express my sincerest, deep sense of gratitude and appreciation to my supervisors Prof. Dr. Ahmad W. Abdeldayem, Dr. Ahmad M. Helmi, and Dr. Ahmad H. Shehata for their invaluable guidance, advice and encouragement throughout my whole thesis study. Their wealth of knowledge and enthusiasm to share them with me is most appreciated.

It is also my great pleasure to give a due recognition and sincere thankfulness to my parents, my brothers and my sisters, for their love, understanding, trust and invaluable support throughout my whole life.

Specifically, I want to use this opportunity to express my sincere appreciation to my wife for her love, invaluable support, understand and for her prayers and words of encouragement whenever my enthusiasm waned. Also, I am dedicating this thesis to my darling Childs Malak, Omar, and Mariam.

To My Beloved Egypt
To All Members of My Big Family

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