A THESIS ON

" FLOW OVER A SQUARE SECTION SILL"

BY

KARAM S. KARKI

Department of Applied Mechanics
Indian Institute of Technology
New Delhi

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K.S. Karki
(K. S. KARKI)

CERTIFICATE

This is to certify that the thesis entitled " FLOW OVER A SQUARE SECTION SILL", which is being submitted by Mr. Karam Singh Karki to the Indian Institute of Technology, Delhi, for the award of the degree of DOCTOR OF PHILOSOPHY, is a bonafide piece of research work carried out by him under our guidance and supervision. The quality of his thesis fulfills all requirements of the regulations relating to the said degree.

The results contained in this thesis have not been submitted in part or full to any other University or Institution for the award of any degree or diploma.

RCMalhotra

(R. C. Malhotra)
Professor
Applied Mechanics Department,
Indian Institute of Technolog
New Delhi

(Subhash Chander)
Assistant Professor,
Civil Engineering Department
Indian Institute of Technolog
New Delhi

SYNOPSIS

Flow over sills in an open channel has for long been a subject of study by research hydraulicians. Besides being theoretically interesting such flows are used as a method for the stabilization of the hydraulic jump (which is a basic design element in many hydraulic structures) and are also useful for other practical purposes.

Past investigations in this regard were mostly empirical in nature and were usually based on model studies. Because of its practical importance the forced jump aspect of flow over sills has been examined by many investigators. Various types of jumps with sills of different shape have been studied and the consequent energy loss determined. However, inspite of these numerous studies of the forced jump, it has not been possible to ascertain distinctly either the minimal flow conditions necessary to predict the jump, without consideration of the tailwater or the conditions at which the supercritical stream splashes over the sill thereby endangering the downstream bed. Keeping in view the fact that the prediction of the jump is much more important than a study of the different types of jumps, one phase of the present thesis has as its objective, the determination of the minimal flow conditions necessary for predicting the jump.

Besides these experimental studies some attempts have been made, by various investigators, to mathematically solve the problem of flow over sills assuming such flows to be completely irrotational and inviscid. These studies have been described in Chapter II. Such mathematical analyses have very little practical utility because the assumed flow condition is rarely encountered in nature. The present study has been made with the objective of filling-in the gap in knowledge between the experimental studies on the forced jump and the theoretical studies on the ideal flow over sills.

In order to predict the jump a study has been conducted at the incipient jump flow condition (Chapter V In this case the disruption of the water surface and the dissipation of the energy due to the jump do not exist (because the jump is just on the verge of formation but without its presence). Thus the principles of fluid mechanics can readily be applied at this flow condition. In Chapter V, the non-linear free water surface has also been computed, with the help of a digital computer, by assuming the flow between the separating streamline and the free surface profile extending upto the maximum water rise as inviscid and irrotational.

Another neglected aspect of flow over sills is the study of the drag experienced by the sill under different upstream conditions (except the case of jump). This problem has been investigated experimentally and the results are reported in Chapters VI and VII. Based on experimental data a logarithmic law for the pressure distribution on the upstream face of the sill under the splashing over condition (i.e., when the sill is mostly within the separated flow zone) is proposed.

With the present study of flow over a square section sill with different upstream flow conditions (supercritical flow, incipient jump flow, and subcritical flow) without tailwater conditions it has been possible to represent the flow over a square section sill on an universal plot with sill height to upstream flow depth ratio and the Froude number as the axes. This plot is shown in Fig. (8.1) and has been described in Chapter VIII.

In addition to the experimental and semi-analytical study of the flow over sills, reported in Chapters V-VII, an attempt has been made to calculate the velocity and pressure distributions along a vertical section in a curvilinear flow. These results are given in Appendix A. The effects of the curvature and the inclination of the streamlines has been considered separately with the net effect being the algobric sum of these two effects.

TABLE OF CONTENTS