II-250 Exprimental Study on the Effect of Spot Roughness on Forced Jump

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1.Introduction

Forced hydraulic jump on a rough channel bed was investigated using spot roughness. The main purpose of this study is to shorten the length of jump , and thus , to reduce the size of the stilling basin.

2.Experiments

The experiments were conducted in the hydraulic laboratory, Faculty of Engineering , Ain Shams University , Cairo , Egypt; using a rectangular flume of 0.53 m width under the flow conditions illustrated in table(1). The definitions of symbols are shown in Fig.(1). The bed roughness was formed by brass cubes of 1.60x1.60x1.60cm. The procedure of the work is as follows:

(1)For each experiment,the discharge Q and the gate opening h_o were adjusted, and the tail water depth was controlled until the forced jump was formed within the distance between the gate an the beginning of roughness as shown in Fig.(1).

(2)The average water surface profile and the initial depth h_1 were measured using a point gauge and sixty piezometers connected along the bottom of the flume.The pressure profile and the water surface profile were used to determine the length of jump L_j.The end of jump was taken to be the section at which the water depth became equal to the tail water depth which was considered as the sequent depth h_2.

(3)For various relative length of roughness L_R/h_b , the relation between the relative length of jump L_j/h_1 and F_1 was obtained as shown in Fig.(2).

(4)Using the obtained relations shown in Fig.(2) for F_1= 4,6,8 and 10 Figure (3) can be obtained It is resulted that at a certain value of L_R/h_b the value of L_j/h_1 would be minimum for every F_1 and it is shown in Fig.(3) that this value is almost constant at 28.

3.Discussions and Conclusions

Reffering to Figures (3) and (4) the following discussions and conclusions are obtained:

(1)After Rajaratnam,Mc Corquodale & Khalifa and USBR, the relation between L_j/h_2 and F_1 in case of smooth bed is shown in the upper part of Fig.(4). It is shown that in case of smooth bed the value of L_j/h_2 ranges between 5.5 and 6.5 for F_1 ranges between 4 and 10 . Using the results obtained from Fig.(3) for L_R/h_b= 28 and for F_1= 4,6,8 and 10 a relation between L_j/h_2 and F_1 in case of using spot roughness is obtained and graphed in Fig.(4) and shown by a rigid line. Figure(4) shows that the length of jump is clearly reduced by using spot roughness.

(2)The decreasing of L_R/h_b would improve the efficiency of the stilling basin,namely, decreasing the relative length of jump L_j/h_1. At a certain value of L_R/h_b,the relative length of jump would be minimum (Fig.(2)).

(3)The effective length of roughness L_R/h_b= 28 , regarding to this study , provides a remarkable reduction in L_j/h_2 ranges between about 27.4% for F_1= 10 and about 67.4% for F_1= 4 (Fig.(4)).

(References)

(1)Mc Corquodale,J.A.;and Khalifa; "Internal Flow in Hydraulic Jump" , Journal of Hydraulic Engineering,Vol.109,No.5,May,1983,ASCE,ISSN,Paper No.17941. (2)Mohamed Ali,H.S. et al; "Effect of Length of Roughened Bed on Rectangular Hydraulic Jumps", The Bulletin of The Faculty of Engineering,Ain Shams University, No.16,1985. (3)Rajaratnam,N.;"Hydraulic Jumps", Advances in hydroscience,Ven Te Chow,Vol.4,1967.

TABLE(1)-CONDITIONS

Parameter	Range
L_s and h_b [cm]	10.00 and 1.60
L_R [cm]	28.50 - 200.66
Q [l/s]	23.00 - 47.43
h_o [cm]	2.50 - 4.50
F_1	4.47 - 9.53

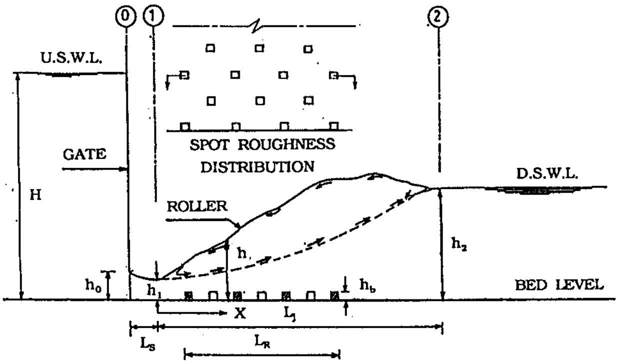


FIG.(1)-DEFINITION SKETCH

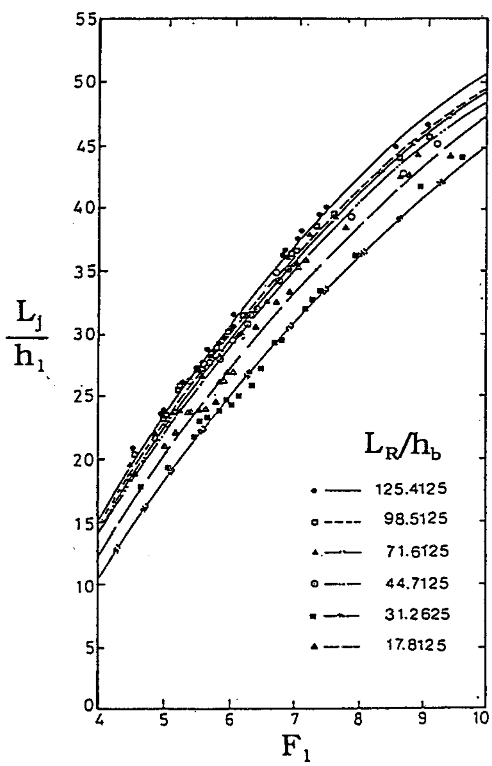


FIG.(2)-THE RELATION BETWEEN F_1&L_j/h_1 FOR DIFFERENT L_R/h_b

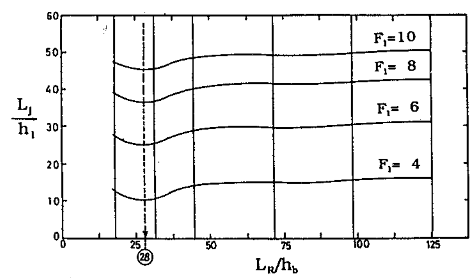
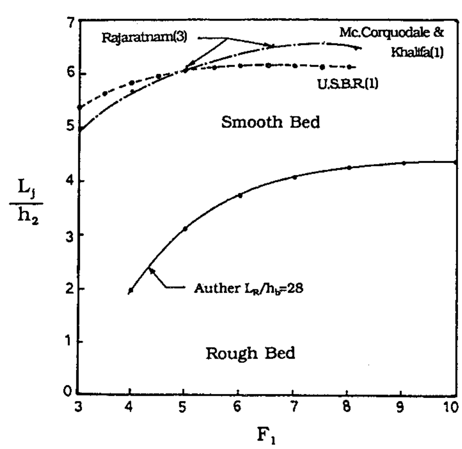


FIG.(3)-THE RELATION BETWEEN L_R/h_b&L_j/h_1 FOR DIFFERENT FROUDE NUMBERS



FIG(4)-COMPARISON BETWEEN RELATIVE LENGTH OF JUMP ON SMOOTH AND ROUGH BEDS FOR VARIOUS F_1