

E.ENG.9

EFFECT OF BED ROUGHNESS ON CHARACTERISTICS OF HYDRAULIC JUMPS

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Hydraulic jump is one of the most common phenomena in open channel flow. The available knowledge on the behaviour of hydraulic jump is only for smooth, horizontal channel beds and literature on, the performance of hydraulic jumps on rough beds is limited. Hence, this study was carried out to develop an accurate relationship to express hydraulic jump characteristics on rough beds that could eventually be used for real life applications.

A series of laboratory experiments were carried out in a rectangular flume which consists of artificially roughened beds obtained by placing rectangular wooden strips at specific intervals while changing the roughness density (d = width of roughness element / spacing) from 8% to 37.5% and the element size from 0.8 cm to 1.5 cm. The hydraulic jumps were formed in the channel for different flow rates ranging from 10 l/s to 25 l/s.

Parameters such as Sequent depth ratio, Froude number, Energy loss, and Jump efficiency were calculated. The experimental results were not in agreement with the existing equations developed for hydraulic jumps on rough beds, as most of these equations were developed using experimental studies with only one type of roughness spacing. Therefore, the new parameter, roughness density (d) was incorporated into the analysis to represent roughness spacing.

An improved non-dimensional correlation was found between hydraulic jump parameters that include the roughness density to represent bed roughness. It was found that maximum effect of roughness elements occurred at a roughness density of 0.23%. The sequent depth ratio was then reduced up to 34%. A new empirical equation was developed to relate the above parameters to sequent depth ratio of hydraulic jumps on rough beds. The effect of roughness element height was also incorporated into the equation using the results of dimensional analysis (Eq.1), where, y_1 , y_2 , t , Fr_1 are initial depth, sequent depth, height of roughness element and Froude number, respectively.

$$\frac{y_2}{y_1} = \frac{0.8568 \left(1 - 0.05 \times \frac{t}{y_1} \right) \times Fr_1 + 0.3378}{1 - |0.23 - d|} \dots \text{Eq. 1}$$

Further research is necessary to extend the applicability of the proposed equation to rough beds that would include non-rectangular roughness elements and natural roughness elements such as granular material.

Funding: Tokyo Cement Group.