Energy dissipation for flow over the gabion weir

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Abstract Gabion weirs are the simplest form of rectangular broad crested porous weirs very low negative impact on the environment. The objective of this paper was to investigate the relative energy dissipation for flow over the rectangular broad crested gabion weir. A series of laboratory experiments were conducted for the rectangular broad crested weir having 0.3 m length, 0.225 m crest height, 0.5 m width, and three types of gabion material with wide range of discharge. It is observed that the ratio of head over the weir to length of gabion weir, ratio of the diameter of gabion material to crest height of gabion weir and ratio of downstream depth to upstream depth are the affecting parameter on the energy dissipation. It was observed that the present study model predicts relative energy dissipation within a maximum of ±10% error for almost all data set.

Keywords: Gabion weir, Relative energy dissipation, Discharge, Gabion material.

Introduction

Gabion weirs are the simplest form of rectangular broad-crested porous weirs that usually span the full width of a river. The flow that passes through the boulders or rocks of gabion weirs allows enhancing the dissolved oxygen due to turbulence, which makes it ecologically and environmentally friendly structure.

The relative energy dissipation between the upstream and the downstream section of the gabion weir can be calculated as

$$\Delta E / E_1 = (E_1 - E_2) / E_1 \quad (1)$$

$$E_1 = y_1 + (v_1^2 / 2g) \quad (2)$$

$$E_2 = y_2 + (v_2^2 / 2g) \quad (3)$$

The functional relationship for the relative energy dissipation on gabion weir may be represent as follows:

$$\Delta E / E_1 = f\left(H / L, d / P, y_2 / y_1\right) \quad (4)$$

A series of laboratory experiments were conducted for the rectangular broad crested gabion weir having 0.3 m length, 0.225 m crest height, 0.5 m width. Three types of gabion materials were used in the present study.

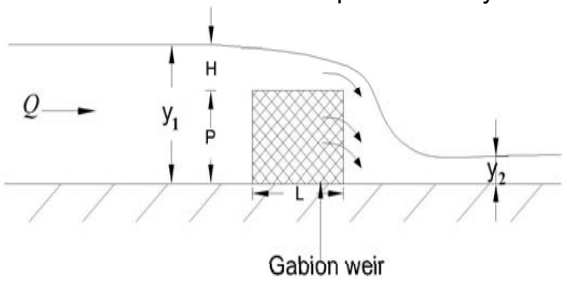

Figure 1. The definition sketch of the model used in the experiment.

Results

An equation for relative energy dissipation is developed herein using the present study experimental data and relating it with parameters given in Equation (5). The regression analysis was carried out for the estimation of relative energy dissipation, using 80% of the data collected in the present study and 20% data used for validation. The following empirical relationship was obtained.

$$\Delta E / E_1 = 0.624 - 1.185(H / L) + 0.662(d / P) + 0.768(y_2 / y_1) \quad (5)$$

The accuracy of the proposed equations (5), the value of R is (0.958) while average percentage error (*APE*), standard deviation (STDV), and scattering index (SI) values are as low as -1.469, 6.82, and 0.105, respectively. Details of performance parameters can be found in Shariq et al. (2018) and Ansari et al. (2019). It was observed that Equation estimates relative energy dissipation within a maximum of ±10% error for almost all data.

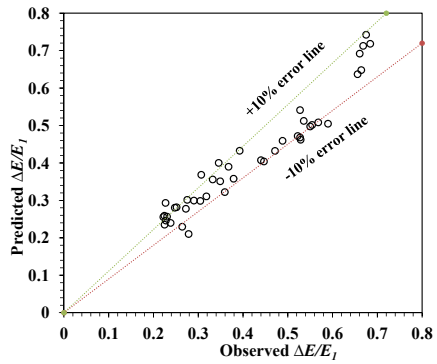

Figure 2 Comparison between observed and computed values of relative energy dissipation

Conclusions

Experimental and analytical studies related to the relative energy dissipation for flow over the gabion weir in an open channel have been reported in this paper. It was found that the *H/L*, *d/P* and y_2/y_1 are the important dimensionless parameter that effect the relative energy dissipation for flow over gabion weir. The proposed relative energy dissipation model was found to estimates results with an error of about ±10%. The qualitative performance of the relative energy dissipation model indicates that it has the low APE (-1.469), STDV (6.82), SI (0.105) and high R (0.958) values.

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