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Experimental Investigation of the Energy Dissipation and the Downstream Relative Depth of Pool in the Sloped Gabion Drop and the Sloped simple Drop

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ABSTRACT: The present study investigates the behavior of hydraulic parameters of simple and sloped gabion drops experimentally. Therefore, 120 different experiments were carried out on both types of drops with three angles and two heights. The results showed that by increasing the relative critical depth in both models, the relative energy dissipation rate reduces but the relative downstream depth increase. Comparing the results for sloped gabion drops with sloped simple drops showed that the use of gabion structures with three angles and two heights increases the efficiency of average energy dissipation by 561% and the average downstream relative depth by 50.1% with regard to the simple drops. This results in a decrease in the erosion of the downstream bed of the structure and the length of the stilling basin. A comparison of the results shows that an increase in the angle decreases the efficiency of average energy dissipation and increases the average downstream relative depth. The results show that the variation in the angle of sloped gabion drops has an insignificant effect in comparison with the simple drops due to the physical properties and the complex hydraulic effects of the flow through the porous structure. Also, some equations were derived to estimate the relative energy dissipation rate and the downstream relative depth rate in the sloped gabion drops by using 80% percent of laboratory data, and the rest 20% of the data were used to test the equations with the goodness of fit criteria.

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1- Introduction

Inclined drops are used to dissipate water flow energy when transferred from a high to a low level [1]. Drops are geometrically divided into three categories: vertical, pipe, and rectangular drops. Little research has been conducted energy dissipation of inclined drops compared to other drops [2, 3].

Gabion can be used in the slope of the inclined drops to dissipate more energy. The materials of Gabion structure are supplied from natural materials available in the region, which in addition to economic benefits and reducing the cost of implementation, have a good adaptation to the environment. Existence of gabions in the flow of water to pass the flow through pebbles or even through porous structures increases energy dissipation [4, 5]. In the present study, the inclined rectangular drop of gabion has been used. And its effect on energy dissipation values and hydraulic parameters compared to a simple incline breaker has been investigated for the first time.

2- Material and methods

The experiments were performed in the hydraulic laboratory of the University of Maragheh, equipped with a laboratory flume with walls and floor of clear Plexiglas and without roughness with an effective length of 5 meters, a width of 0.3 and height of 0.45 meters with a longitudinal slope of zero degrees. To build the drop structure, glass boxes of the same width as the channel were used at two heights of 15 and 20 cm. At three angles of 26.56, 33.7 and 45 degrees, sloping boxes were also used to create an inclined drop.

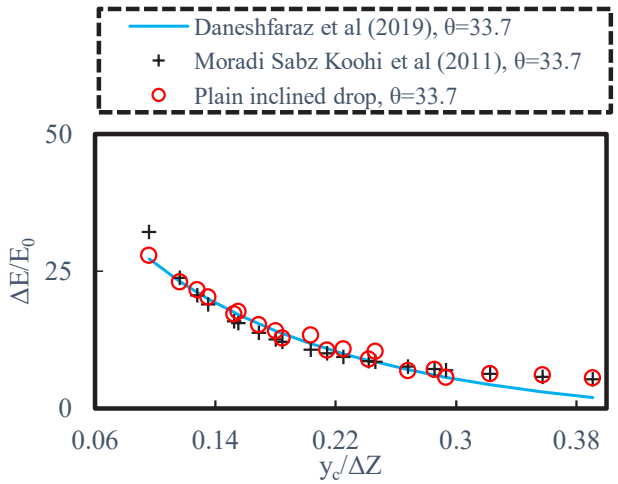

Fig. 1. compares the relative energy dissipation changes of the research studies [1] and [2]

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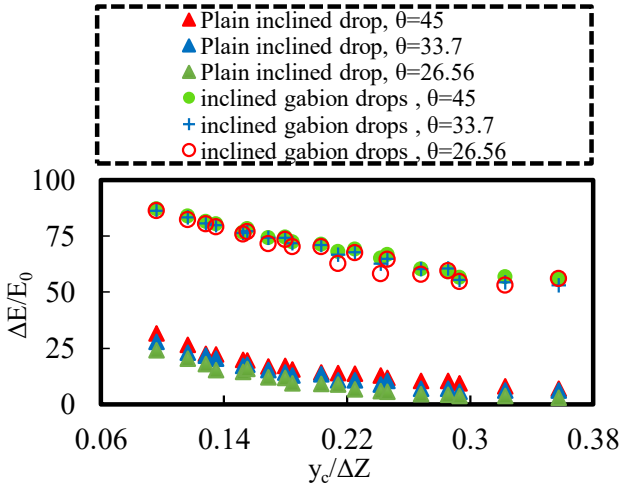

Fig. 2. Changes in relative energy dissipation versus relative critical depths

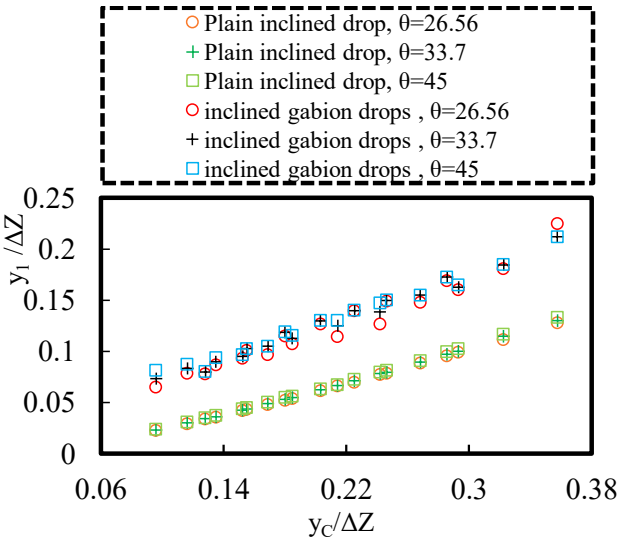

Fig. 3. Changes of downstream relative depth versus relative critical depth

3- Results and discussion

A comparison of the results of the present study with the results of the studies of Daneshfaraz et al. [1] and Moradi Sabz Koohi et al. [2] showed that the total energy dissipation of this research for three different angles with [1] and [2] has a coefficient of determination of 0.984 and 0.941 and a relative error of 7.85 and 18.2 percent

According to Figure 2, for simple inclined and gabion drops at all angles, the total relative energy dissipation values decrease with increasing relative critical depth. For gabion inclined drop, the type of flow also changes as the flow discharge, so that in low discharge, because most of the flow is inflow and the flow penetrates the existing gabion. The entrapment and friction of the aggregates in the porous structure increase the energy dissipation

According to Figure 3 for simple and gabions inclined drops for the three angles studied, the relative depth of the upward trend with increasing relative critical depth. The increase in downstream relative depth of field is significant for the gabion inclined drop for all angles compared to the simple inclined drop.

4- Conclusions

The present study investigated the hydraulic parameters for three angles, two heights and two types of simple and gabion inclined drop. In total, 120 different experiments were performed for both simple and gabion inclined drop of relative energy dissipation and relative downstream depth parameters. The results showed that in both models tested, by increasing the relative critical depth, decreasing height and angle of inclined drop reduced the relative energy dissipation, which among the parameters, the relative critical depth parameter had a greater effect than other parameters. Compared to the simple inclined drop to use gabions on a sloping surface of a structure, the inclined drop of the gabion has an increase in the relative energy dissipation, which is due to the physical properties of the gabion and the presence of inflow and overflow. On the other hand, the gabion structure, bypassing the flow through the structure itself, has caused turbulence in this area by increasing the turbulence and entanglement of the transition flow in this area, compared to the simple inclined drop. This dissipation will reduce the cost of construction and the length of the stilling basin, reduce bed erosion and prevent the formation of holes at the bottom of the structure. By investigating the downstream relative depth, it can be stated that for both inclined drops, the downstream relative has an upward trend with increasing relative critical depth. Also, for the first time, using 80% of laboratory data, relationships were provided to estimate the relative energy dissipation and downstream relative depth in the gabion inclined drop, and with the remaining 20%, the relationship was tested with appropriate evaluation criteria.

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