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The effect of different types of spillways on the rate of energy depreciation and their comparison with each other

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Abstract: The Spillways are hydraulic structures that due to topography of earth are used to transfer water from higher height to lower height, distributing extra energy resulted from water falling, and providing suitable speed in watering channels. The depreciation of energy is of two types: 1.The depreciation of energy due to number and height of steps 2.The depreciation of energy due to hydraulic jumping in the low pool. Type of flow for a given geometry from a spillway can be in the form of nape flow (falling), transferring, and skimming. More studying and recognizing of hydraulic parameters in estimating the depreciation of energy due to number and height of steps and the rate of decreasing of jumping energy, causes decreasing the number of the steep and structural dimensions of spillways and from this point of view causes the studying and designing safe and economic structure. We nvestigated the effects of different type of spillways on the depreciation of energy and hydraulic parameters for three types of spillways. The vertical, oblique, and hierarchical spillways with making physical model in different geometry bands and doing experiments in different flows, the rate of depreciation of energy were determined and compared.Investigating and studying the spillways shows that highest depreciation of energy refers to in vertical spillway.

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Keywords: Hierarchical spillways, depreciation of energy , hydraulic structures, the number and height of steps

1. Introduction

Variety of hydraulic structures depreciate Tvanndhalthay lose energy (Energy dissipator) create.

The following may also be used from the slope breakers:

1 - Stability of stream stability due to the depreciation of additional energy
2 - to limit the erosion of the lining of irrigation canals LinkBacks
3 - Increased aeration of the hydraulic jump flow and create turbulence Byshtrvastfadh entrepreneur Ian Vkarkhanjat industrial wastewater
4 - Use the slope breaker Hadrparkha Vmkanhay leisure recreational purposes with a controlled turbulence
5 - the depth of water rejection and to create favorable conditions underground aquifers feeding.

Waste water from the slope of the energy Asrhrkt breaking in two modes: 1 - depreciation resulting from the number and height of the slope breaker and the second step - the depreciation of the hydraulic jump in the pool downstream relaxation, occurs. Better understanding of the hydraulic parameters of the energy structure and energy levels to drop, reducing the size of the ponds downstream of hydraulic structures Hnzsy it causes.

In this study the effect of different geometric forms Shknha slope on energy for 3 types of vertical structure, (Straight drop), oblique (Inclined drop) and stairs (Stepped drop) has been investigated.

Hydraulic flow and issue record

Figure 1 vertical slope breaker and its various parameters is shown. In this figure, yc, yp, y2, y1, yb, respectively, the critical depth of flow, slope breakers, slope breakers on the edge depth, depth of hydraulic jump, the depth of secondary jump and the depth of the jet stream flow. The φ and ΔZ, ΔH t, ΔH j, ΔH, H0, respectively, the specific energy of the slope breakers, energy structures, energy dissipation jump, the total energy losses, the geometric height and slope angle jet breaking loss to the pond bottom.

White (17) the following equation to estimate the depth of the jump in slope y1 vertical crusher provided that the USBR standard design is used (15):

$y\_1/y\_c = \sqrt{}\, 2 / (1.061 + \sqrt{}\, (1.5 + \Delta z / yc))$

Using the above relation between the energy level of the jump, (H1) is obtainable from the following equation:

$H\_1/y\_c = \sqrt{}\, 2 / (1.061 + \sqrt{}\, (1.5 + \Delta z / yc)) +0.25\ (1.065 + \sqrt{}\, (\Delta z / y\_c +1.5))\ \hat{}\ 2$

However, the total energy of the slope breaker (Ht) in the upstream of the critical regime can be written as follows:

$Ht = \Delta Z +1 / 5yc$

Finally, the relative amount of energy the building of the breakwater slope (ΔH / $H\_t = (H\_t-H\_1) / H\_t$) is calculated.

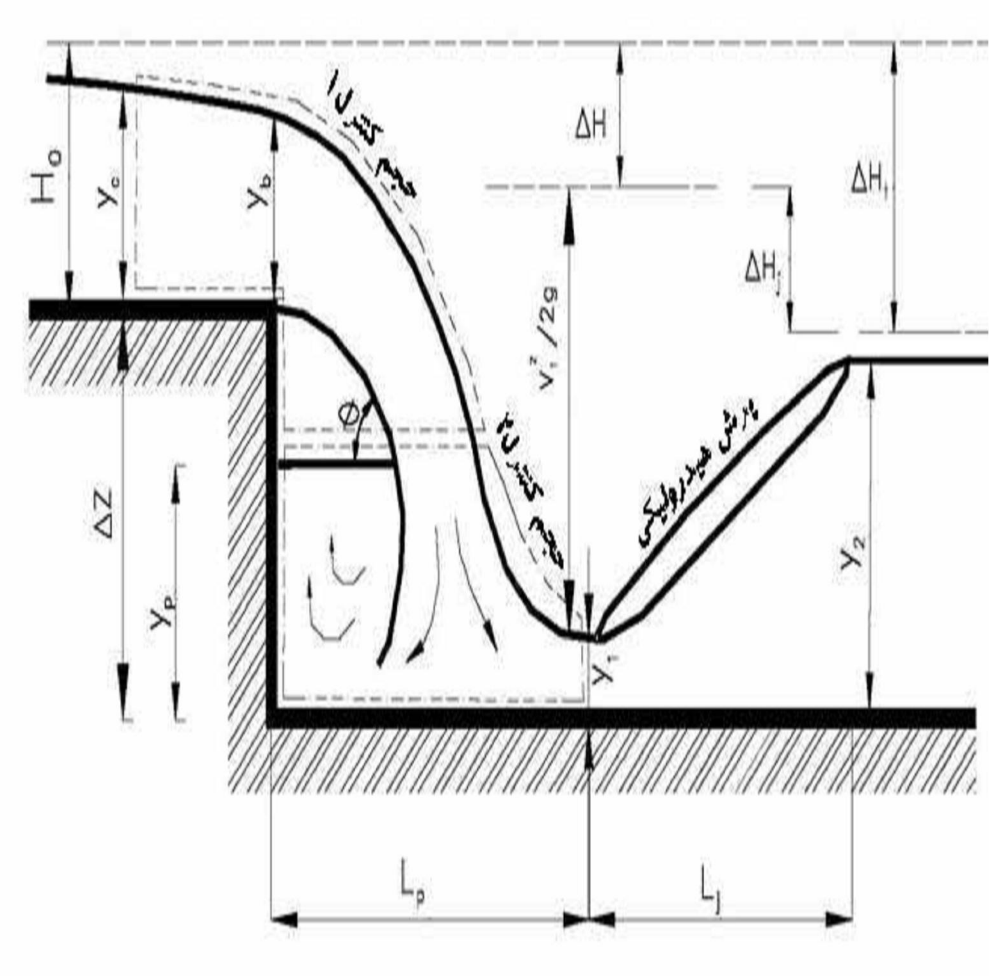


Figure 1. Vertical slope breaker and its parameters

The studies on the vertical slope breakers by Rand (13) was conducted that led to the following relations:

(4) $y\_1/y\_c = 0.54\ (y\_c / \Delta Z)\ \hat{}\ 0.275$

(5) $Y\_2/\Delta Z = 1.66\ \square(y\_c / \Delta Z)\square\ \hat{}\ 0.81$

(6) $Y\_P / \Delta Z = (y\_c / \Delta z)\ \hat{}\ 0.66$

(7) $Lj = 6.9\ (y2-y1)$

(8) $L\_P / \Delta Z = 4.3\ \square(Y\_C / \Delta Z)\square\ \hat{}\ 0.81$

Rajaratnam and grass (12 values for the two control volumes 1 and 2 in Figure 1 were obtained the following relations:

(9) $1/2\ \gamma y\_c\ \hat{}\ 2 + \rho qV = pqvCos\ \square$

(10) $\rho qVCos\ \square\ +1 / 2\ \gamma y\_p\ \hat{}\ 2 = \rho qV\_1 +1 / 2\ \gamma y\_1\ \hat{}\ 2$

In this relationship, and V q discharge per unit width of Mjr velocity at the boundary between 1 and 2 is the volume control. Also associated with the use of energy could be derived the following equation:

(11) $\Delta Z + 1.5 y_c = V^2/2g + y_p$

Using the above relations and the following empirical relationship is given by the unknown parameters y and yP and V1 will be available:

(12) $y_p / \Delta z = 1.107 (y_c / \Delta z)^{0.719}$

Figure 2 is an example of breaking the smooth slope and the hydraulic parameters is given. Various parameters like the shape and slope breakers before θ is the angle from horizontal duct. Compared with those in structures with a smooth Mjr, according to the staircase structure in the energy structures of reduced runoff and amortized in the development and implementation of energy of concrete roller RCC), including the steep ladder structures Shknhay Stairway and weirs especially systolic (Stepped wiers) of special importance in recent years have found. In Figure 3 the slope of the geometric parameters and hydraulic breaker stairs and it is given. The height h of the vertical and 1 horizontal length of each stair and slope height ΔZ is breaking.

Other parameters exactly "the same parameters previously defined two slope breakers.

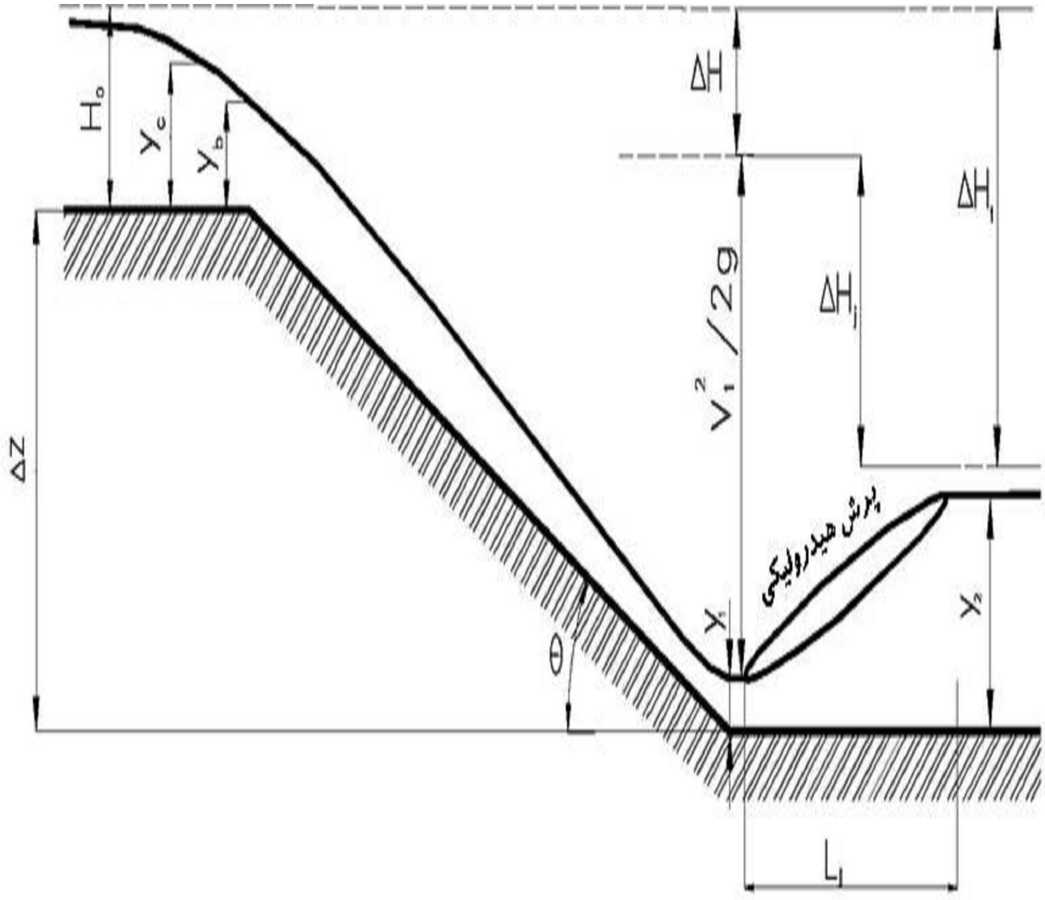


Figure 2. Breaker slope inclination and its parameters

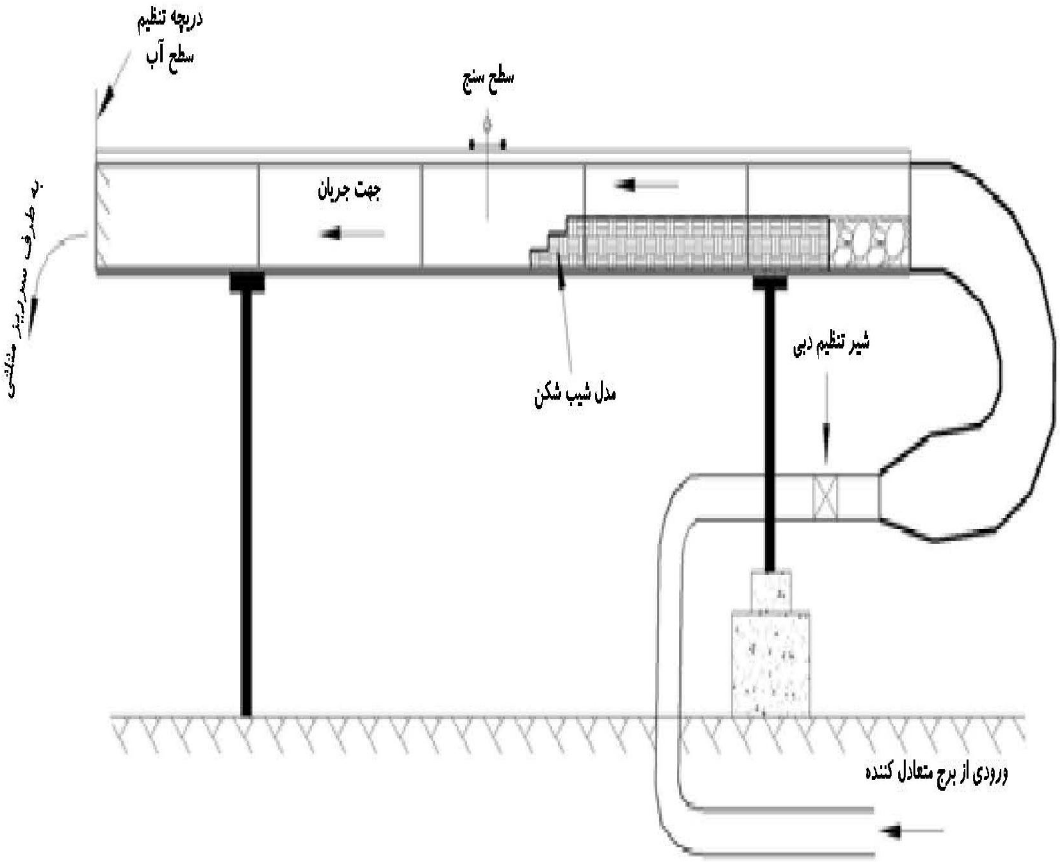


Figure 3. Stairway and its parameters breaking slope

The movement of water on the stairs are two types of flow regimes, including flow regime and flow regime Mjza' procedural characteristics, and a processing intermediate regime before the regime is known (5).
Shedding flow regime

Flight loss in flow regime as a series of acts falling jet Nmayn Mannzshyb breaking behavior is hiding (Fig. 4).

The total loss in the flow regime in the low and high altitude flight is formed (5). Many investigations 5, the current flow regime has been in the past (4, 5)

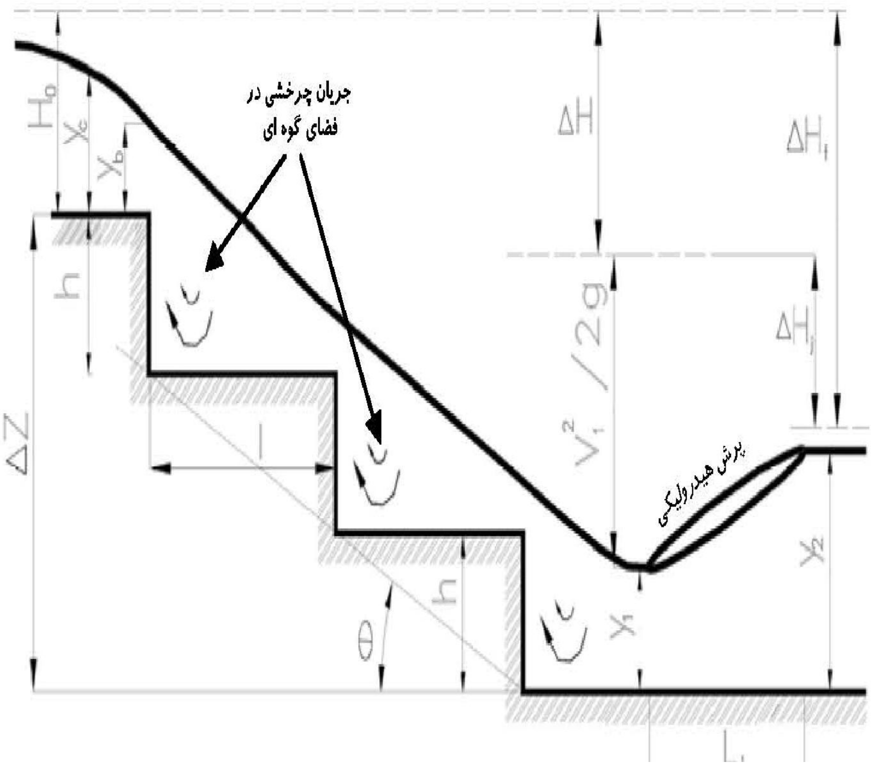


Figure 4. The flow regime of falling on the stairs

Procedural flow

The procedural flow regime, the current flows attached to the stairs. In this regime the stairs to the tip acts as a false floor.

A major part of the energy structure of the procedural regime of the transfer of shear stress on the false floor in the enclosed space of the circulating current wedge between the rotation and maintain appropriate steps are carried out (5). Table 1 Summary of results of a study reported in the literature on the energy ladder weirs for flow regime is procedural. The total energy remaining in the relationship Hres table overflow claw Hmax, the total energy in the upstream flow Hdam weir height and N is the number of stairs. The results of this research is mainly with the formation of uniform flow of water - air duct on the stairs, obtained by increasing the number of stairs depreciation relative energy ΔH / H_t increases.

Materials and Methods

To investigate the effects of altitude steps in the slope breaker and discharge flow Chemists in the energy structure, the determination of parameters, the number of the physical model of slope Shknhay, and the sex Plgsy glass width 24 cm in height and 5/26 5 / 16 centimeters, 2 angle separately (angle θ 5/34 5/27 degrees and the number 3 and 7 stairs built and maintain hydraulic conditions of 75 flow rate of 7/1 to 4/38 liters per second, the rate of energy loss structures were investigated.

Laboratory operations research in the laboratory flume with a length of 12 m and 24 cm longitudinal slope, installation of various models with different parameters Babvr stream flow is measured. For measuring the flow rate through a 53 triangular weir equipped with electrical systems and Vrnyh level gauge with 1/0 mm were used. A view of the experimental devices used in this study are shown in Figure 5.

Summary of general information on tests carried out research on different models is given in Table 2.

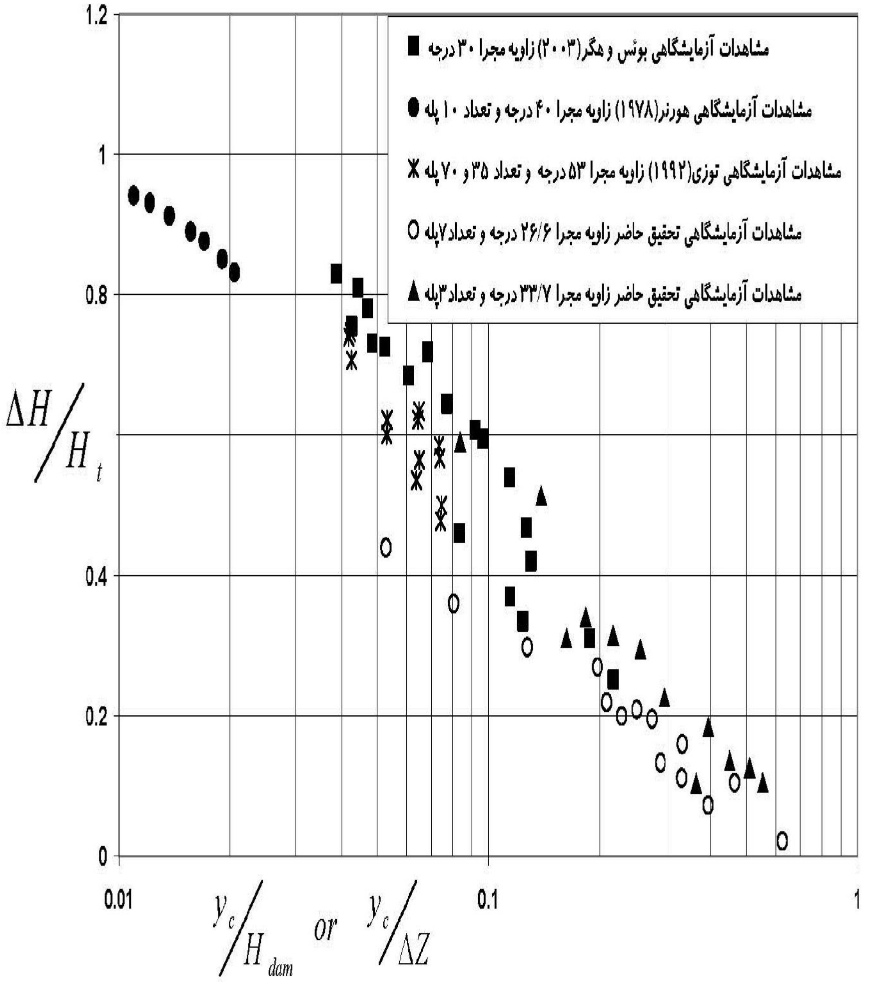


Figure 5. A view of the experimental devices used in the study

Table 2 Summary of experiments in research information

Each model is accurate and current through the critical depth yc Mdlhast and the relationship y_2 = □ ((q ^ 2 / g)) is obtained. Measuring the energy level structure in the downstream and the upstream and downstream energy, energy loss structure is obtained that the combined effect of model geometry and flow conditions that exist. Runoff models to determine the amount of energy in two ways: direct measurement of the depth of the jump, y1 and y2 measure the depth of secondary jump y1 were calculated. Initial results and experiences of previous investigators (10, 14) showed that direct measurement of the depth of the Sr high jump with supercritical flow in this section and more measurement error due to the penetration depth of flow, rate of energy dissipation structuresConjugate relation to the following depths:
(14) y_1 = y_2 / 2 (√ (1 +8 Fr □□ _2 ^ 2-1))
Y1 with the depth and flow rate can be calculated at the average rate of energy flow as runoff Mqt slope breakers (before the jump) to the energy equation H_1 = y_1 + V_1 ^ 2/2g will be calculated and finally the "energy difference total (Ht) and energy levels in runoff, slope breakers, energy level structure due to the geometrical conditions and circumstances will determine the hydraulic
ΔH = Ht - H1
Results and Discussion

The relative amount of energy ΔH / H_t than y_c / ΔZ the slope of the vertical bands in the study and comparison with results

Other research has shown in Figure 6. With the exception of the proposed method of White (17) in almost all cases the relative amount of energy ΔH / H_t study (not rated, air-jet mode) of the experimental data or predicted by other researchers (rated by an air jet mode) is. The issue with respect to the jet aeration effect in reducing the pool of jet angle (φ) was already predictable. If the values of ΔH / H_t non-aeration in the aeration mode in the proposed method Rajaratnam and grass (12) are compared, it is noted that the difference in values y_c / Δz more than 6/0 approximation, and with reduced or zero y_c / Δz to the 07/0 to about 12 percent. It is noteworthy that the slope of the vertical bands with no aeration flow may cause instability due to flow in and out of the air Namandgar especially in applications that are important changes in upstream water level, may be unjustified.

Wide range of parameters before Bynyknndh type regime (flow, procedural or become) the dominant structures staircase in the comments of researchers and (2, 3, 5, 11 and 18) indicate that the desired unit on the flow regime flow, especially if the ranges of conversion regimes to The approximation error of each other was impossible due to the personal judgment can not be ignored.

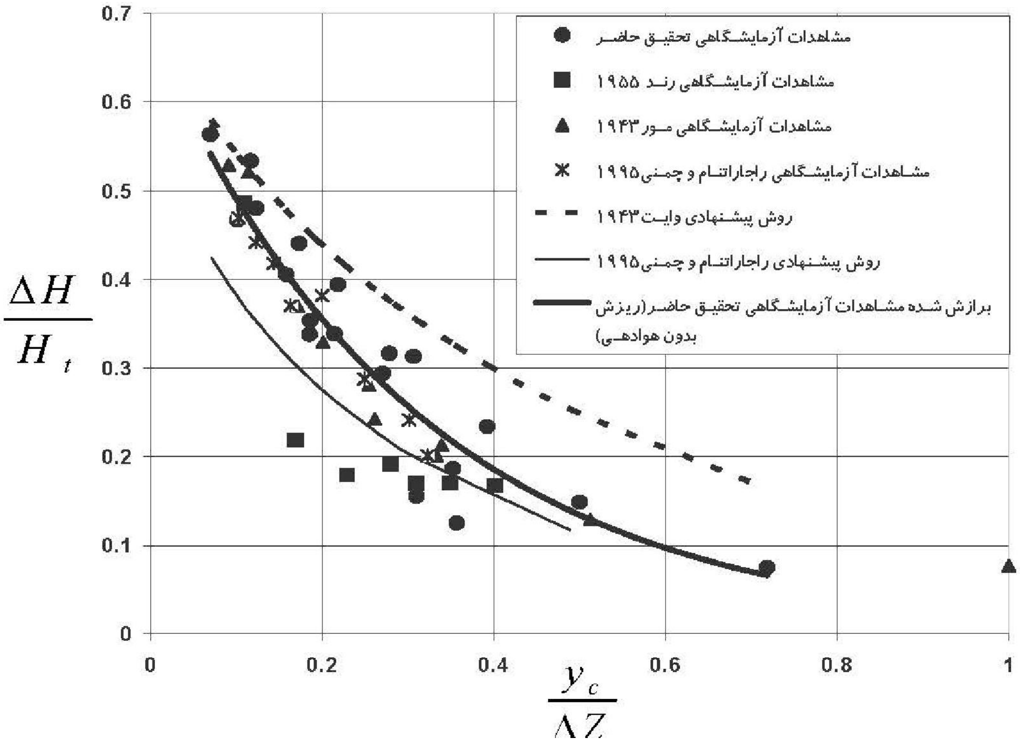


Figure 6. Comparison of changes

In Figure 7 the ratio ΔH / H_t against y_c / Δz for staircase model is shown in this study. Due to the increase y_c / Δz (increased discharge at a fixed height), reduced the relative amount of energy is flowing. The duct angle greater than the number of stairs in the range of variables studied, the relative decline is the result of more energy.

This result is contrary to results based on the research results Chnsn 13 (5) loss for the current regime with a small duct in the angle of the step number is obtained.flow regime of stairs without dealing with the bottom of the stairs seemed to pass over them.

Given the closeness of the average curve for model 3 stepping angle conduit 6/26 degrees and the average curve for the seven-step model with angle duct 7/33 ° C in Figure 7 seems to be about how the combined effect of the number of stairs urethral angle with respect to variables within the scope of this study can be said with confidence.The Word has been compared. According to the results of previous studies (6, 7) in the weir flow regime procedural steps, increasing the number of stairs

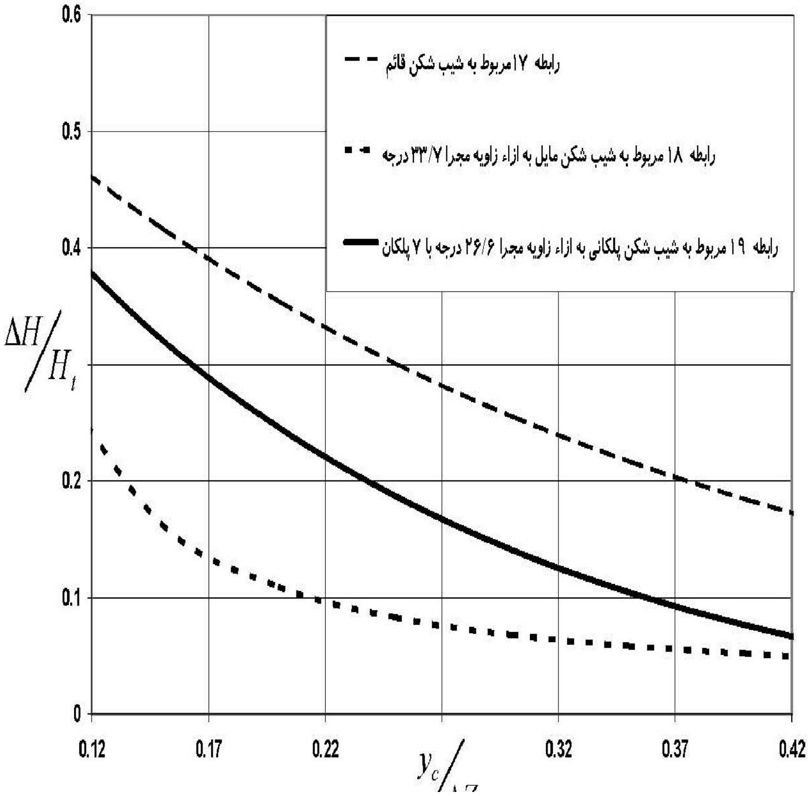


Figure 7. Effects y_c / Δz channel slope and the number of stairs in ΔH / H_t for models stairs slope breakers

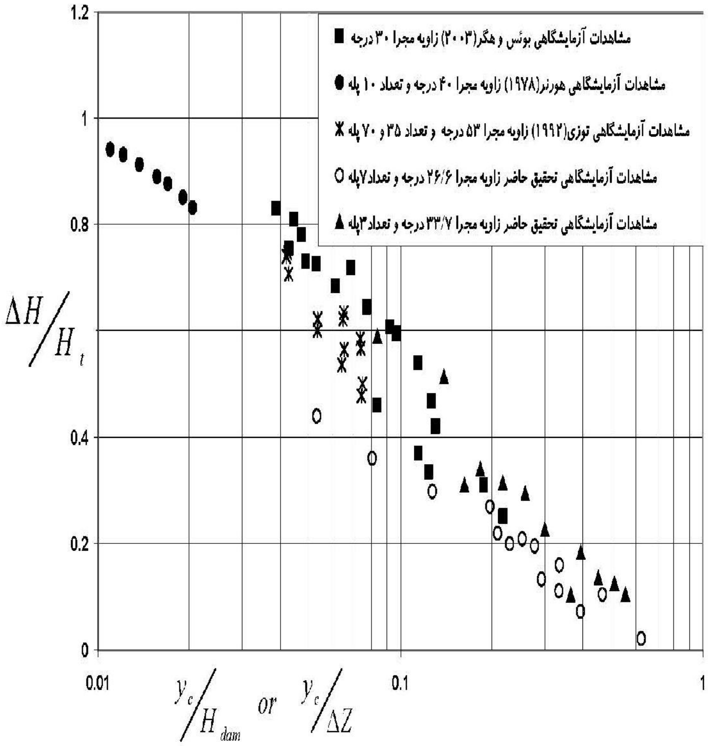


Figure 8. Comparison of ΔH / H_t than y_c / Δz or y_c / H_dam
For some steep stairs Shknha and weirs

However, the bypass angular variables in different studies and flight number, and may be different from each other was the importance of each variable in a particular area may also change.

Another important point with regard to Figure 7 compares the results of similar studies on the slope breaker and weirs inappropriate staircase shows the relative height Δz / y_c low gradient structures in breaking with H_dam / y_c the weir is a staircase. As seen in this figure is that the range of variation y_c / ΔZ the slope breaker and the y_c / H_dam different steps in the weir.

In both structures despite the procedural flow regime, a steady flow of water - air breakers in steep stairs to the lower relative height, not the depreciation rate and the relative energy difference between these two that the formation of a steady flow of water - airseems, a steady flow have been analyzed (2) provided in relation to the energy in the direction of the slope breaker weirs stairs from stair towers must be carefully observed. in Figure 9 amounts y_c / ΔZ in the model The ΔH / H_t slope breakers miles is plotted. As of this form y_c / ΔZ is the result of an increase than a decrease in the relative rate of change of energy structure and the average angle ΔH/H_2 duct 6/26 grade of 20 percent for y_c / ΔZ equal to 07/0 to about 5/1 percent for the y_c / ΔZ equal to 86/0 varies. as per y_c / ΔZ constant with increasing channel slope angle oblique breaking energy relative increases.

Summary results of data analysis to predict the relative energy values for nonlinear regression analysis based on experimental observations of this study are shown in Table 3. Linear analysis of the data in this regard did not show significant results. The dependent variable in Table 4

Results of sensitivity analysis

y_c / ΔZ ratio relationships to independent variables in Table 3, is inserted. For example, the proposed 17 the slope breakers vertical variation of 10 percent increase in the independent variable y_c / ΔZ between 5/3 to 1/2 and an average of 88/7% in ΔH / H_T of decline and the rate y_c / ΔZ small, is too large. This is given in Figure 6, the higher slope of the curve fitted to experimental data in the study with y_c / ΔZ was less evident. Furthermore, the relative changes of slope breakers miles ΔH / H_t slope channel on the relative changes y_c / ΔZ in comparison with the relative change is significantly higher. Breakers in steep stairs, the effect of relative changes in the number of stairs on the relative changes ΔH / H_t in comparison with two other independent variables was less than the average 56/1 percentage decreased effectiveness. Note that the relative effect of independent variables according to relative changes in amplitude ΔH / H_t listed in Table 4 in the low range and in some other interval significantly increased.

Relations obtained for predicted depreciation relative energy slope Shknha added seems that the relations in Table 3 in the range of variables in this study include the y_c / ΔZ tested for different models, angle, channel 6/26 to 7/33 degrees and the number of stairs 3 to 7 are obtained for the range of this interval is not applicable. In Figure 10 the predicted depreciation based on the relative energy of breaking 17 for the vertical slope, about 18 miles with the angle of the slope breaker Channel 7/33 degrees and about 19 stairs with a slope angle of the bypass breaker 6/26 degrees (with 7 steps).

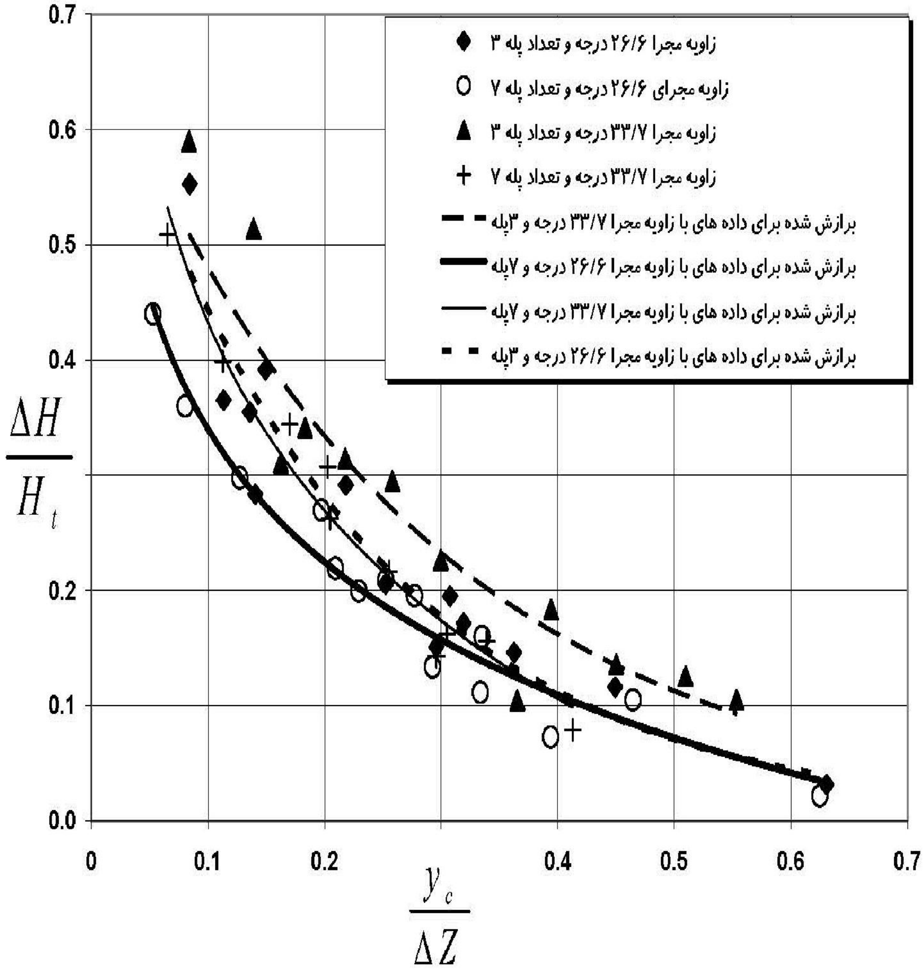
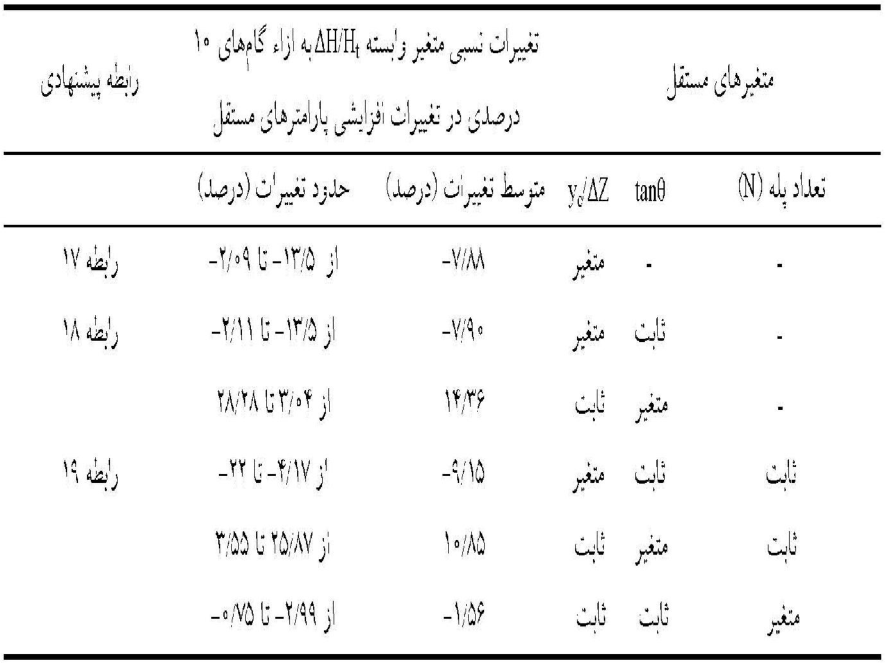


Figure 9. Changes ΔH / H_t than y_c / Δz for slope Shknhay miles

Table 3. Relations obtained predict the slope of the energy relative depreciation Shknha

ضریب تعیین	تعداد داده ها	رابطه تعیین استهلاک نسبی انرژی	شماره رابطه	نوع شیب‌شکن
۰/۸۷	۱۹	$\frac{\Delta H}{H_t} = \text{۰/۶۷}\ e^{\text{-۲/۲۶}\,(y_c/\Delta Z)}$	۱۷	قائم
۰/۸۱	۲۲	$\frac{\Delta H}{H_t} = \text{۰/۰۰۰۲}\ \left(\frac{y_c}{\Delta Z}\right)^{\text{-۱/۷۵}}\ e^{(\text{۴/۷۹}\tan\theta)} + \text{۰/۰۲۸}$	۱۸	مایل
۰/۸۷	۴۹	$\frac{\Delta H}{H_t} = \text{۰/۷۲۳}\ e^{\text{-۴/۸۸}\ y_c/\Delta Z} + \text{۰/۱۸۱۸}\ \ln(\tan\theta) + \text{۰/۲۰۴}\ N^{\text{-۰/۳۶۷}}$	۱۹	پلکانی

Table 4. Sensitivity analysis of the obtained relations for predicting the relative depreciation in the energy slope Shknha



متغیرهای مستقل			تغییرات نسبی متغیر وابسته $\Delta H/H_t$ به ازاء گام‌های ۱۰ درصدی در تغییرات افزایشی پارامترهای مستقل		رابطه پیشنهادی
تعداد پله (N)	tanθ	$y_c/\Delta Z$	متوسط تغییرات (درصد)	حدود تغییرات (درصد)	
-	-	متغیر	۷/۸۸-	از ۱۳/۵- تا ۲/۰۹-	رابطه ۱۷
-	ثابت	متغیر	۷/۹۰-	از ۱۳/۵- تا ۲/۱۱-	رابطه ۱۸
-	متغیر	ثابت	۱۴/۳۶	از ۳/۰۴ تا ۲۸/۲۸	
ثابت	ثابت	متغیر	۹/۱۵-	از ۴/۱۷- تا ۲۲-	رابطه ۱۹
ثابت	متغیر	ثابت	۱۰/۸۵	از ۲۵/۸۷ تا ۳/۵۵	
متغیر	ثابت	ثابت	۱/۵۶-	از ۲/۹۹- تا ۰/۷۵-	

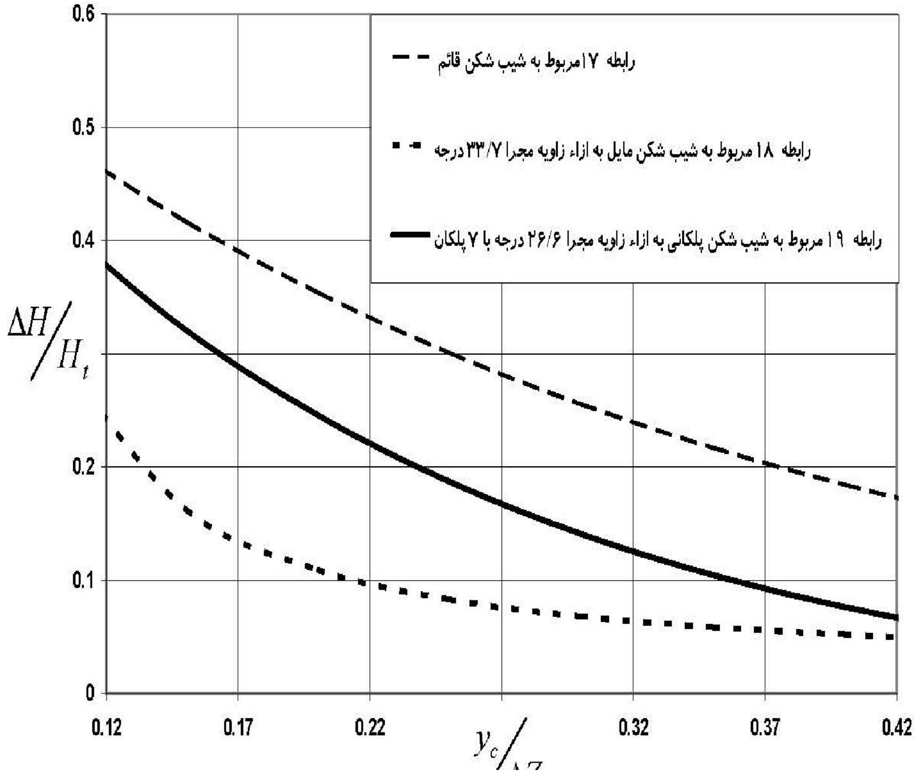


Figure 10. Comparison of relative energy in Table 2 based on the proposed relationships in three different types of slope breakers for a range y_c / Δz are drawn together. As of this form will result in the same conditions of discharge and the height difference (compared y_c / Δz constant), the ΔH / H_t of breaking belong to the vertical and minimum slope ΔH / H_t is oblique to the slope breaker.must be considered.

Conclusion

In this study the parameters affecting the relative energy ΔH / H_t current passing through the three common types of slope breakers (vertical and inclined stairs) and to compare these three types, 14 Breaker physical model of the slope above and made establishment of various hydraulic conditions following results were obtained in 90 different flow rates:

Increased y_c / Δz in all models), increased number of) stairs (stairs in the model) and a decrease in urethral angle (in two steps and miles) in the range of variables reduces the relative energy was present. However, the effect y_c / Δz is more than other parameters. The effect on stair number of changes in the relative energy loss models slope breakers Stairclimbers study compared with previous research results on systolic Sryz·hay Mtf Avty shows.

It seems that the weir height due to higher systolic gradient structure with a structural relief is low, the need for a steady flow of water - there was air in the low elevation of systolic structures, slope breakers, causing the formation The tone is one of the show. Nonlinear regression analysis based on experimental observations of present value relations based on dimensional parameters to estimate the relative energy was proposed.

Comparison of relative energy ΔH / H_t in the range of variables investigated in this study showed that the geometric conditions (ΔZ the slope of Mjr) and hydraulic (yc) the same, the highest energy relative to the vertical gradient of the slope breaker breaker stairs and miles, respectively, are next in rank. Despite the relatively higher energy in comparison with the other two vertical slope breakers, slope breakers to choose the kind of project implementation, hydrodynamic pressure exerted on the bottom section, as well as soil sampling in the vertical position of the slope breaker and its cost should be considered be.

Compared with the relatively high altitude (H_dam / y_c) weir ladder, relative height Δz / y_c breaking down the steep stairs and often "makes a steady flow of water - air duct on the steep stairs, not the breaker. Hence thebe cautious.

Resources

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