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RESEARCH ARTICLE

ASSESSMENT FLOW 3D PROGRAM EFFICIENCY COMPARING WITH LABORATORY MODELS.

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Key words:-
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Abstract

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scour a major risks which Threaten Hydraulic Structures that intersect runoff in rivers or in canals and scour increases in times of flood or when the high slope of the river or irrigation canals, which leads to increased flow velocity will be greater than the force of the bottom cohesion of the river bed components or channel, scour treatment neglecting may be lead of hydraulic structures failuer. There are many ways to reduce scour behind hydraulic structures, which rely on the principle of dissipating energy among these methods and the most important is the weirs, the weir is structure placed on a river width or the channel to change the flow characteristics, weirs are smaller than conventional dams, the most important benefits of weirs is to prevent flooding and measure the amount of discharge and raise the water level in the upstream as well as provide assistance to the river navigable and the study migration of fish. The best simulation software to represent the flow and what happens from scour behind the weirs is Flow 3D program, which represents the flow corresponds to the reality of the true representation and to study the efficiency of the program and its ability in represent of flow and study its properties has been applied to some laboratory models for weir made by the researcher (Abdelnasser, 2015) and which has been used different models of weir, were taken one model for three different discharges to examine the program and measure the flow velocity and its depth, and pressure in the upstream and the downstream in addition to measuring the depth and length of the scour. Results of the Flow 3D program is identical for laboratory results as tables (2, 4). Clear that the Flow 3D software program can be relied upon in modeling of flow and find appropriate designs for weirs to its ability in fact represent a real form where provide time and reduces the cost of the work of laboratory models.

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Introduction:-

Weir is the origin hydraulic structure established across the river or stream for the purpose of raising the water level or water distribution between the irrigation channels as well as can measure water flow. The weirs are used widely to control the depth of water flow in the river or irrigation canal. The most prominent types of dams and the most

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common is the broad crest weir and studies related to this type of weirs focused heavily on scour in the downstream as result of increased flow velocity and turbulent which leading to the occurrence of scour, that threatens the foundations of those structures. (Chanson, 2001). (Ahmed 2015) Use the practical side by applying physical model contain holes in the downstream (double lines water jets) to reduce the scour and also used CFD program to compare the results, has reached a same results which obtained from the laboratory model and the results that have appeared by using CFD techniques. (Helal EY, 2013) study the minimizing scour downstream of hydraulic structure using single line of floor water jets, found through the many experiences decrease scour in downstream between (40% - 85%).(Abdel Halim 2013) study theeffect of semi-circular baffle blocks on local scour hole to reduce scour in the downstream when he put concrete blocks on the form of semi-circle on four lines and able to reduce the depth and length of the scour hole.Either (chen, 2005) study the scour downstream clear-overfall weirs found a relationship between Froude number and water levels above and below the submerged dam also stressed the affecting scour by materials bottom, the depth of the flow and type of submerged dam. (Sobeih, 2012) found the holes in the body of weir will be reduce the scour.also (Al Talib, 2007) used semi crest weir with three different gradations to find a relationship between slope of the weir, radius of crest weir and type of gradient in the weir body, the effect of these gradients on the scour in downstream of the weir. The main objectives of this work are to study the flow characteristics, energy dissipation, and pressure distribution over stepped spillway for mild slope channels. Furthermore, to develop modify empirical relation for percentage of energy dissipation and pressure distribution depended on affecting factors. (Abdelnasser, 2015) used four model of broad crest weir three models with a different obstacle heights and found the best height of the obstacle is (24)cm, which gives less scour downstream weir. The gradation and its shape has large impact on the runoff coefficient and percentage of energy dissipation (E %). Has been verified from efficiencies of CFD techniques (Flow 3D program)with compare its results by laboratory experiments have proved that the Flow 3D program superior (outperform) than another programs in its ability on represent the flowidentical to reality.(Arkan, 2016)

Model setup:-

this study used Flow 3D program in experimental model done by(Abdelnasser, 2015) which held his experience in the Hydraulic laboratory of civil engineering department University of Gaziantep, where used laboratory channel, which has a length of (12)m, width(0.8) m and height(0.9) m with glass sides and base made of steel, while the dimensions of the experiment (2)m length, (0.8)m width, height depends on the height of the weir and the amount of discharge, weir was placed on (3)m distance from the beginning of the channel as shown in Figure (1):

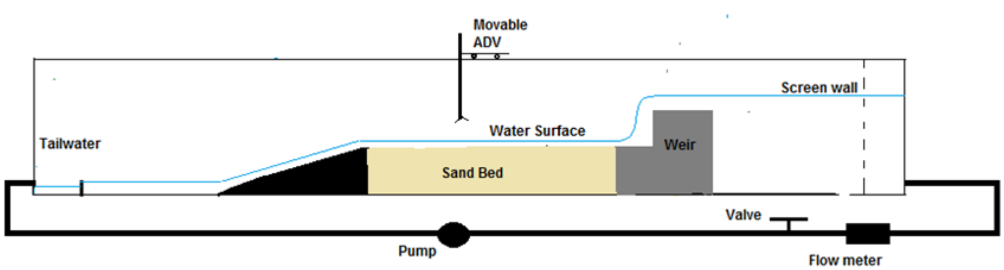


Figure 1:-Schematic layout of the flume (Abdulnaser et al, 2015)

Channel had been filled in sand at a distance (2) m from a weir's body (0.21) m height. Particle size ds=1.8 mm and density the specific gravity of (2.65), sieve analysis of the sand is given in Figure (2).

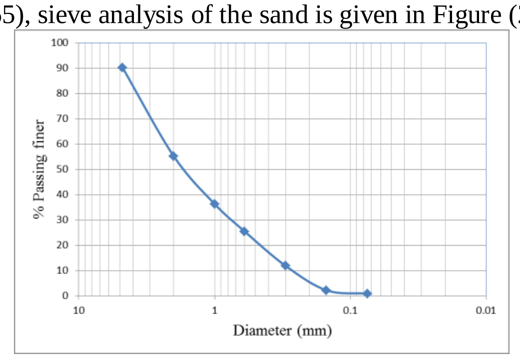


Figure 2:-Grain size distribution of bed (Abdulnaser et al, 2015)

A gnetic flow meter used to measuring the discharge before entering water the channel and laser meter to measure the depth of scour, depth of flow and the depth of bed channel on a vehicle moving manually slide on the edge of the channel, among of four models choose one model (A) for a comparison the efficiency of the program and practical results in the lab, a model is a broad crest weir with one step, weir base dimensions (0.768 x 0.8) m, high of its crest (0.39) m and a width (0.384)m while the weir height at downstream (0.21) m, as in Figure(3) three different value of discharge(Q) used (0.015) m^3/s model A_1, (0.02) m^3/s model A_2, (0.025) m^3/s model A_3, water level above the weir crest (0.055, 0.063, 0.073)m, respectively.

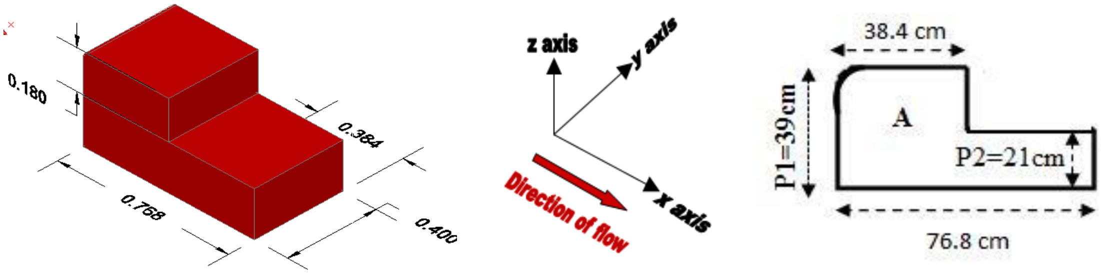


Figure 3:- Views of tested models

Model painted in the Flow 3D program as well as possible painted in any other program, and import the geometry into the Flow 3D program in file (stl.) format, As shown in Figure (4) and, after being examined the model by FAVOR^{TM} which permits true representation of complex geometry in a simple Cartesian mesh, have been identified discharge and direction of flow, the program allows to draw half of the figure width if it is symmetry (0.4)m instead of (0.8)m, then adding water to model and sand layer, made a large number of runs until reach a wonderful and very close results from the experiment.

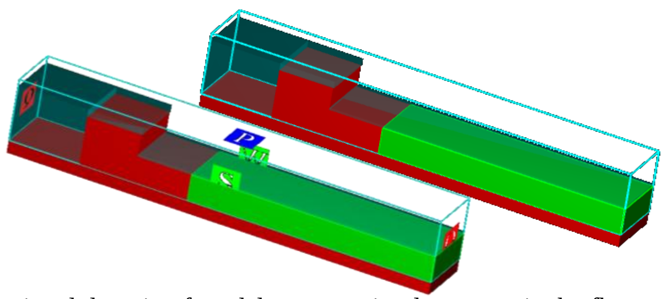
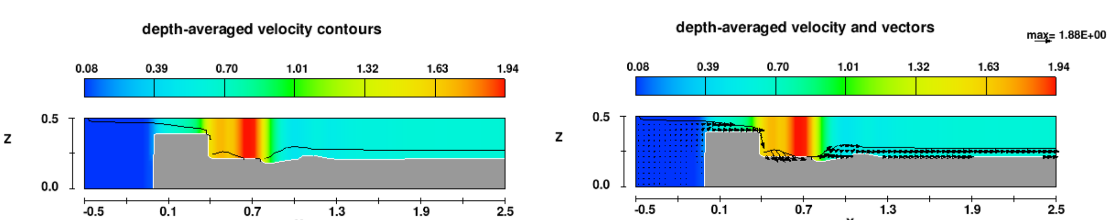


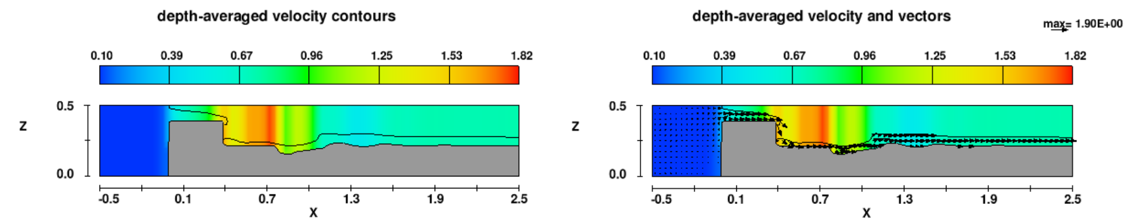
Figure 4:- Computational domain of model setup to simulate scour in the flume, Configurations of boundary conditions.

Results and Discussion:-

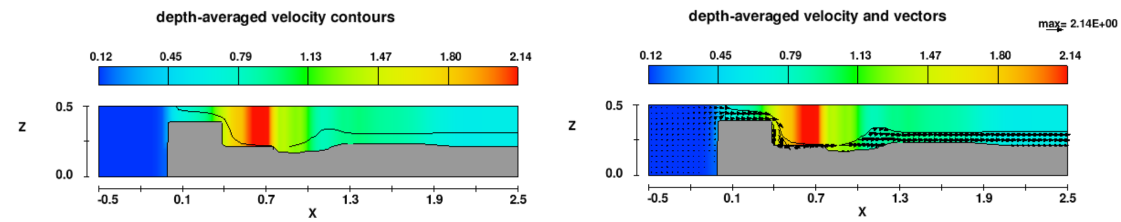
Results showed that the Flow 3D program is real presenter to practical experiment as table (2) comparison with Table(1) a big match between the results of scour volume for discharge (0.015, 0.02, 0.025) is (26851, 40483.45229) very close to the values in Table(1), a match in the depths of the scour in tables(1, 2) as it emerged that the average discharge(0.02) m^3/s gave more depth of scour in laboratory and in the program compared to another discharges, while the longest scour distance from weirs body in third discharge (0.025), totaled (65) cm in the program model also the longest scour in the third discharge (0.025) as tables (1, 2). Figure (5) shows surface runoff profile and depth Average velocitythrough the model which gives values in any place and at any time as faster than experimental model, which needs much effort and time. In Figure (6) can be calculate the pressure value and directions at any point on the channel and distribution pressure contour. Sand packed vol. The deepest point was at the end of weir figure (7), either Contour lines of flow depth in the three models show that more depth of flow was in upstream and less depth was at obstacle figure (8), the highest value of pressure in upstream, movement of the bed material, sand, assembly areas and size as well as the depth of flow, as Tables (3, 4). Flow 3D program had shortened the time, effort,costs andprospects errors in making physical models.



A_1 (minimum discharge= 0.015)

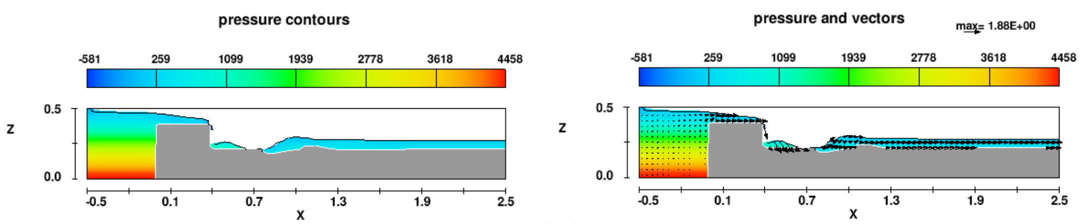


A_2 **(average discharge= 0.02)**

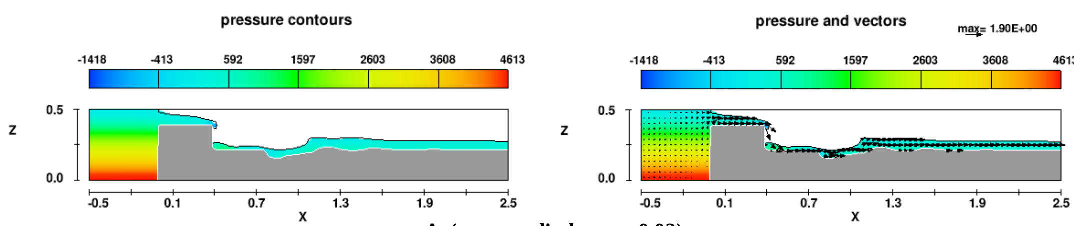


A_3 **(maximum discharge= 0.025)**

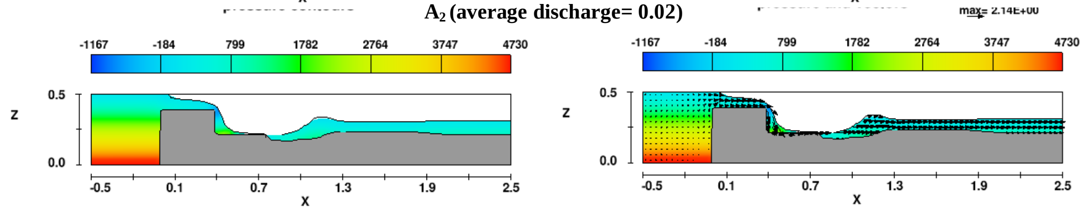
Figure 5:- Comparison of longitudinal water surface profile and depth Average velocity at the central axis on the weirs' crest in various models.



A_1 **(minimum discharge= 0.015)**

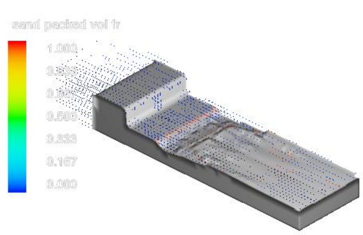


A_2 **(average discharge= 0.02)**

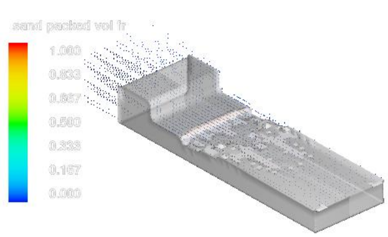


A_3 **(maximum discharge= 0.025)**

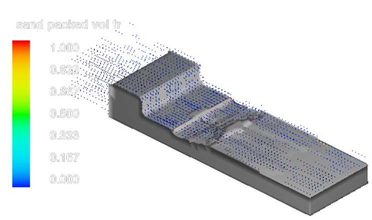
Figure 6:- Flow pressure distribution changes on weirs' crest for different models.



A_1 **(minimum discharge= 0.015)**



A_2 **(average discharge= 0.02)**



A_3 **(maximum discharge= 0.025)**

Figure 7:-. Sand packed vol. fr. for different models

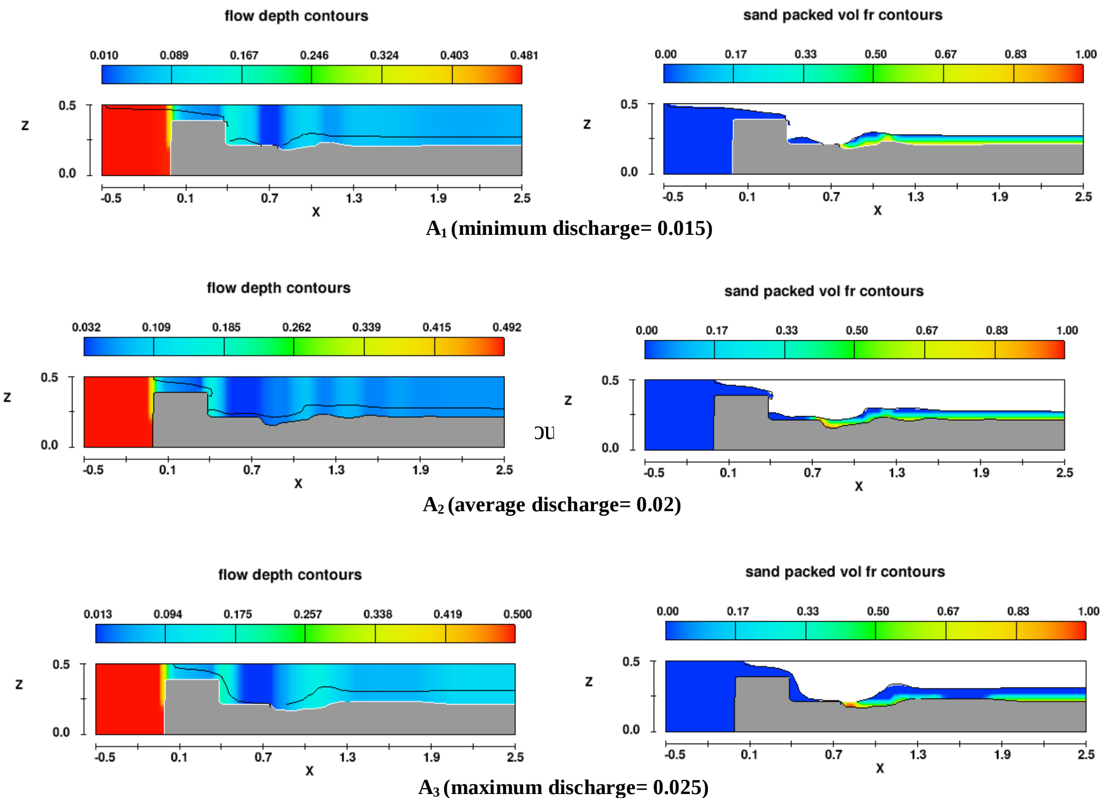


Figure 8:- Flow depth contours and sand packed vol. fr. contours for different models

Table 1:- Local scour dimensions for each model.

Model	Q (l/s)	Volume of scour(cm3)	Maximumdepth of scour(ds)(cm)	Distance of scourfromweir (cm)
A1	15	27993	11	40
A2	20	42537	12.8	52
A3	25	48583	12.4	68

Table 2:- Local scourdimensionsforeachmodel in Flow 3D program.

Model	Q (l/s)	Volume of scour(cm3)	Maximumdepth of scour(ds)(cm)	Distance of scourfromweir (cm)
A1	15	26851	9.93	38.5
A2	20	40483	11.75	49
A3	25	45229	10.98	65

Table 3:- the height of water at upstream, downstream and average velocity for each model

Model	U/S water depth (cm)	D/S water depth (cm)	Velocity (m/s)
A1	5.5	10	1.563
A2	6.3	13	1.667
A3	7.3	14	1.736

Table 4:- the height of water at upstream, downstream and average velocity for each model in Flow 3D program

Model	U/S water depth (cm)	D/S water depth (cm)	Velocity (m/s)
A1	5.5	0.93	1.172
A2	6.3	11.88	1.443
A3	7.3	12.52	1.656

Conclusion and Recommendation:-

- Representation of the model laboratory trickier than the program's model spend time, effort and cost as well as it does not gives the required accuracy.
- •Flow 3D program features easily work and accuracy of information and provides us with a huge number of outputs that have proved through the current study, it is closer to reality.
- Perhaps we are met difficult in drawing complex models in the program but able to draw simple models in addition to the existence of ready models either possible replacement of drawing in specialized programs such as AutoCAD program.

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