

« Research Note »

Numerical Study of Impact of Vertically Constricted Entrance on Hydraulic Characteristics of Vertical Drop**Amir Ghaderi^{1*}, Mehdi Dasineh² and Saeed Abbasi^{3*}**

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* abbasi.saeed@znu.ac.ir**Abstract**

Vertical drops are used in irrigation and drainage networks and surface run-off collection channels. In the present study, the impact of vertically constricted entrance on hydraulic characteristics of drops is numerically study utilizing FLOW-3D®. In the first step, for choosing the best model of turbulence, two types of turbulence models $k-\varepsilon$ and $RNGk-\varepsilon$ were used. In the next step, four constriction layouts of $S/H=0.312, 0.500, 0.875, 2$ (ratio of constriction distances to drop height) were utilized as long as the case without any constriction. The results showed that the $RNGk-\varepsilon$ turbulence model has less relative error percentage and RMSE in comparison with $k-\varepsilon$ model and more efficiency to simulate hydraulic characteristics on drops. Based on the obtained results, it was observed that the vertically constricted entrance would result in decreasing the relative depth of water in the pool, the depth of downstream water and normal residual energy by 42.31%, 47.23%, and 23.59%, respectively. Presence of entrance constriction results in increasing the velocity at drop edge and thus the kinetic energy decreases by flow turbulence increment caused by divided jet falls and production of more air-water mixing region. Some relations are proposed to calculate pond depth ratio, downstream depth ratio and normal residual energy with acceptable correlation coefficients which are in accordance with those of other researchers.

Keywords: Drop, Vertically Constricted Entrance, Residual Energy, Energy Dissipation, FLOW-3D.

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Experimental study on the effect of circular jet on sediment flushing in reservoirs

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Abstract:

An important concerns pertaining in water resource management is the deposition of sediment in dam reservoir. The importance of implementing reservoir sediment management techniques to preserve reservoir storage space is evident. In this research, the effect of submerged single circular jet was experimentally investigated on flushing efficiency. The results showed that the best position of jet respect to the outlet position in a given jet velocity and the outlet discharge ratio between 46 and 83 is twice the outlet diameter. The best position of jet for outlet discharge ratio between 120 and 157 is $2.5D_{\text{outlet}}$.

Keywords: Flushing efficiency, Sediment hydraulic, Submerged jet, Water resource management.

Introducing and Evaluating the Effectiveness of Various Image Processing Algorithms in Determining Hydraulic Roughness Using Gradation Curve in Gravel Bed Rivers

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Abstract

The importance and role of bed roughness in conducting hydraulic flow studies and sediments, especially in river simulation models, are not covered by any of the experts in this area. For this reason, researchers used simple methods such as direct measurement using ruler or calipers or mechanical sieving for many years to determine the size of roughness of bed particles. In recent years, with the advancement of technology and the promotion of digital photography cameras, various algorithms and software for automated analysis of bed surface data are provided using digital images taken from the river bed. But so far, no comparative study has been conducted regarding the comparison of the results of different methods and their validation and only researchers have been evaluating and commenting on the shape of the gradation curve and the particle diameters. In this study, imaging of one kilometer from the bed of the Kordan river in the west of the Alborz province, and then the images obtained in nature, as well as images taken from the particles collected from the bed in the laboratory with three different image processing methods and in two backgrounds with different colors have been analyzed and compared with the results of the sieve analysis method. Based on the results, it can be said that the presentation of an acceptable gradation curve does not mean the accuracy of image methods, and these methods are sometimes found to have a notable error in the counting of particles, which, by shrinking the image field or increasing the number of fine particles in the image or the presence of particles with longitudinal elongation, this error will be tangible and indescribable. Factors such as how adjacent particles are placed, the color and appearance of aggregates, the distribution of light in the image, and the algorithm used to process the image on the grain size curve, are effective. Therefore, using these methods in estimating hydraulic roughness should be done with sufficient accuracy.

Keywords: Bed roughness, Gravel bed, Gradation Curve, Error Analysis, Image Processing Softwares.

Experimental study of the effect of urban wastewater treatment on the process of deposition and consolidation of cohesive sediments in water transfer systems

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Abstract

Consolidation of cohesive sediments has an effective role in the critical stresses of erosion of sediments deposited in reservoirs and water channels. Knowing the behavior of fine-grained sediments can have a significant effect on the operation and maintenance of water structures. Therefore, in this study, the effect of urban wastewater, which is used as a renewable resource in drought conditions, is considered on the deposition and consolidation of cohesive sediments in transmission systems. For this purpose, the stages of consolidation of sediments were performed for four time intervals of 1, 3, 14 and 28 days using deposition columns and for three concentrations of 0, 30 and 60% wastewater and for three initial concentrations of sediments of 200, 300 and 400 g/l. The results showed that the initial concentration increases with the sediment deposition depth (H/H_0) and the initial concentration of sediments up to 300 g / l affects the consolidation process. Thus there is no significant difference between the initial concentrations of 300 to 400 g / l. It was also found that the consolidation stages in pure water and the fluid containing 60% of the wastewater are very close together, but fluid containing 30% of the wastewater shows a different behavior. By analyzing the percentage of exchangeable sodium (ESP) for different percentages of wastewater and at the end of 28 days consolidation, it was found that the change in H/H_0 for different percentages of the wastewater is the same with changes in ESP. The cause of the dispersal phenomenon in a fluid containing 30% of the wastewater can be explained by fluid chemistry and substitution of calcium instead of sodium ion in clay particles.

Keywords: Consolidation, ESP Index, Cohesive sediment, Wastewater.

Investigation of the transient flow turbulence in pipes with leakage

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Abstract

The remote leakage detection methods in pressurized pipes, are based on the analysis of the pressure fluctuations during the transient flow. In this regard, practical applications of transient flow can be improved and simultaneously, the destructive effects of transient flow on the pipeline and its equipment would be decreased by studying and understanding the transient flow. In the present paper, it has been tried to analyze the flow behavior and the turbulence parameters during different cycles by modeling transient flow with a leak in two dimensions. The proposed numerical model is based on the finite difference scheme and a flux-corrected transport method is used to eliminate numerical dispersion. In order to study the behavior of turbulence in the flow and its dissipation, the $k-\omega$ turbulence model is coupled with the 2D transient flow model and also the leak effect is added to the steady and unsteady parts of the model. In the presence of the leak in the transient flow, a considerable change is seen in the velocity profile and the turbulence parameters in the flow back and forward cycles. In the initial cycles of the transient flow, the different parameters in the upstream of the leak, decrease gradually and increase in the downstream of the leak until these two flows reach each other. Later, the turbulence initiates to extend from the near pipe wall into inner layers and the magnitude decreases gradually by passing time.

Keywords: Turbulence, Viscoelasticity, Transient Flow, Leak.

Effect of same phase hydraulic jet on reduction of scour in 180-degree bend

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Abstract

This study is an attempt to investigate the effects of the same-phase hydraulic jet on the scour reduction at a river bend. In this method, a perforated open-ended tube was placed along the bed of abend and water was injected into the bend flow from both ends of this tube. The goal was to form a water screen against secondary flows so as to prevent them from reaching the outer bank of the river. Results showed a change in the maximum point of the scour depth from the outer wall to the middle parts of the cross section in the main experiments. On the other hand, as the tube ports were further spaced, a reduction occurred in the maximum point of the scour depth. Moreover, with the reduction in the tube distance from the outer wall of the bend, the maximum scour depth decreased. Based on the results, the maximum scour depth at the bend sections of 90, 130 and 175 degrees reduced by 60%, 64%, and 87%, respectively.

Keywords: Same phase hydraulic jet, River bends, Scour depth.

Experimental Study of Modification of the Velocity Profiles of Water Turbulent Flow Using Polymeric Solutions

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Abstract

Low concentration of drag reducing agents have found their efficient applications to reduce required energy of the pipeline turbulent flow transportation. These additives can effect on turbulent structures, and can modify velocity profile, and thus they cause to reduction of the skin friction of the flow. In the present study, two commercially available copolymer of polyacrylamide with different molecular weights, were employed to study the possible impact of different concentrations of the polymers on pressure drop reduction of turbulent flow of water in pipeline. The obtained results demonstrated that both the copolymer showed high drag reduction along with low degradation rate for 2hr of the experimentation. Addition of 30ppm of the high molecular weight polymer to turbulent flow showed 54% drag reduction. Following the drag reduction measurement, turbulent velocity profiles for the optimum concentration of the two polymers were obtained by using laser Doppler velocimetry technique. The results showed a tendency to laminarization of the flow supported with low amounts of Reynold stresses and velocity fluctuations in the presence of the polymer. In all the cases, the effects of the higher molecular weight polymer on the velocity profiles of the turbulent flow is more desirable than lower molecular weight one.

Keywords: Pressure drop, Turbulent flow, Polymer, Laser Doppler velocimetry, Velocity profile.

Analytical and Experimental investigation of the Hydraulic Jump Characteristics over Permeable Beds

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Abstract

In this research, the effect of channel bed permeability on the hydraulic jump characteristics is investigated. At first, through analyzing the momentum equation, a new equation for direct calculation of the sequent depth ratio for permeable beds obtained. Then, using a channel 6 meters long and 80 centimeters wide laboratory channel, a series of experiments over permeable porous beds with different gran size distribution and different length and width were conducted. The Froude number ranges from 5.3 to 7.4. It was observed that over the permeable bed, the analytical equation estimates the sequent depths ratio better than the Blunger equation and also the sequent depths changes show more dependency on the Froude number in comparison to the bed permeability. The results also showed that permeability of the bed reduced the sequent depths ratio and the jump length significantly compared to the impermeable smooth bed and also increased the energy loss caused by the jump.

Keywords: Hydraulic jump, Momentum equation, Permeable bed.

Study of double free surface flows under radial gate using coupled element-free Galerkin (EFG) and radial point interpolation (RPIM) methods

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Abstract

The element-free Galerkin (EFG) and the radial point interpolation (RPIM) methods are two meshless methods in the field of the computational mechanics. In the present study, a computational scheme using a variable domain and a fixed domain is presented based on the coupling of EFG and RPIM for analysis of two dimensional double free surface flows under radial gate for the computation of the free surface profiles, velocity and pressure distributions, and the flow rate of a 2D gravity fluid flow through the conduit. The coupling between EFG and RPIM is achieved by using the RPIM shape functions as the weight functions for EFG method. In this approach, contrary to EFG method, the imposition of the essential boundary conditions is straight forward and shape functions fulfill the Kronecker delta property. In this study, the fluid is assumed to be inviscid and incompressible and the obtained results are compared by conducting a hydraulic model test. The results are in agreement in terms of free surface profiles and pressure distributions.

Keywords: Meshless methods, Double free surface, Coupled EFG-RPIM, Radial gate.

Geometry Modification of Stilling Basin USBR VI with Numerical Simulation

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Abstract

Stilling Basin USBR VI is one of the most commonly impact type energy dissipaters. Also this basin is one of the oldest basins that designed for dissipating of outlet flow from the pipes. This basin is a small box-like structure with a hanging wall and an endsill. Hanging wall is to distribute energy of incoming flow to basin width. This basin requires no tailwater for successful performance. Numerical model validation was performed with comparison of recorded pressure on hanging wall and flow depth on endsill in physical model and with comparison of incoming pipe velocity profile with nikuradse physical result in 1932. For basin outlet flow field modification, 4 parameters of mean velocity on endsill, mean velocity in vicinity of endsill, coriolis coefficient and discharge distribution on endsill was selected. These parameters were calculated for more than 100 different models. Finally, with comparison of results of parameters in different models, it is found that gradual variation of width of stilling basin has had the best results after vertical wall for the modification of stilling basin and uniform distributing of flow rate in width direction.

Keywords: Stilling Basin USBR VI, Numerical Model, Flow Field, Beichley Graph, Flow3D.