« Research Note »

Developing Practical Relationships for Circular Sharp Crested Weirs Based on Hydraulic Sensitivity Concept

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Abstract

Weirs are the most common hydraulic structures for discharge measurement. Variety of weir types have been developed and used so far. Sharp crested circular weirs provide specific advantages and could be employed in different circumstances. However, the complex discharge relationship of these weirs limits their applications. In this study the currently available complex relationships of sharp crested circular weirs have been investigated and based on the hydraulic sensitivity concept, simple yet practical and reliable discharge evaluation relationships were proposed accordingly. It was shown that the relative sensitivity of circular weir is restricted to 1.2 to 2 which is lower than that of triangular weir, whereas it might be higher or lower than the sensitivity of rectangular weirs based on the range of non dimensional head value. The validity of the proposed relationships was examined according to the available experimental data which showed that for a very wide range of the employed data the discharge could be evaluated with a marginal error of less than 2.5%.

Key words: Sharp Crested Weirs, Circular Weirs, Sensitivity Analysis, Discharge Measurements.

Scour Formation Due to 3D Circular Wall Jets

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Abstract

In this paper the results of 63 experiments about the inclination wall jets are presented. The angle of the jets changed from 0 to 20 degree and the densimetric Froude number of the jet change between 3.9 to 12.8. the tailwater ratio changed between 1.5 to 19. The scour mechanism due to 3D inclined wall jets is investigated. The effect of the jet angle for different values of the tailwater depth ratio and different values of the densimetric Froude number of the jets are studied. By using the densimetric Froude number of the jets, tailwater depth ratio and jet angle appropriate equations for estimating the scour hole dimensions are presented. The results show that by increasing the tailwater depth ratio decreasing of the dimensions of the jets are increased. There is a critical tailwater depth that beyond which by increasing or decreasing the tailwater depth the scour hole depth increases. The critical tailwater depth is increased by increasing the jet angle. In general the scour hole dimensions decreases by increasing the jet angle. Therefore, the inclined jets can be used as a procedure for decreasing the scour hole dimensions.

Key words: Experimental study, scour, 3D jet, inclined jet, wall jet.

Development of 3D MP-MPS Model for Flow Pattern Prediction Under Intensive Hydraulic Gradient

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Abstract

Analyzing of shape, location and other properties of propagating waves involve complicated boundary conditions, nonlinear equations, variant domain and intensive effect of various flow phases on each others. These properties have made waves modeling one of the most complicated computational problems. In this research a Lagrangian, multiphase, meshless and three dimensional method called MP-MPS (Multi Phase Moving Particle Semi-implicit) have been developed based on the MPS method. The MPS method is applicable in solving turbulent flow equations such as prorogating near shore waves. In the multi phases model of MP-MPS the three dimensional and viscous equations have been extended for three phases of gas, liquid and solid. In this way different phase's counteraction effect have been exerted in the equations by some variables, so the phase changes are modeled synchronically. The dam breaking and wave propagating problems have been applied to show the ability and accuracy of the model. The results have been compared against experimental and analytical models. Comparison of model results against applied methods of primary researches represents the accuracy and applicability of modified methods and algorithms deployed in the developed model.

Key words: Lagrangian Methods, Multiphase Model, MPS Method, Particle Density, Effective Radius, Intensive Hydraulic Gradient

Study of Turbulent Flow Structure and Qualitative Investigation of Sediment Entering Lateral Intake in River Bend Using 3D Numerical Model

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Abstract

In this paper the 3D turbulent flow field through lateral intake in a 180 degree curved channel is numerically simulated using the RSM turbulence model as implemented in the Fluent software and the VOF technique is used to model the free surface at junction region and along the intake system. The used turbulence model and the VOF technique are able to predict the velocity field and furthermore the simulated water surface profiles have good agreement with measurements.

Results of simulations show that in this case, similar to the lateral diversion in the straight channel, a separation zone forms along the intake and moreover due to the presence of the strong lateral flow, a stagnation zone forms along the inner bank of the main channel, downstream of the junction region.

The flow field through the intake is so that the separation zone and the oblique near bed stream lines cause the formation of a wedge like zone at intake entrance. Investigation of previous experimental observations shows that this zone coincides with a triangular shaped sediment point bar in movable bed case.

The depth varying structure of the dividing stream surface is completely different from the lateral diversion in the straight channel and this difference highlights the role of secondary flows in curved channels in controlling the sediment entry to the lateral intakes.

Key words: Lateral Intake, River Bend, Turbulent Flow, Secondary flow, Numerical Simulation, Fluent

Effect of Collar Shape on the Local Scouring Around the Bridge Piers

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Abstract

Scouring around bridge piers causes serious damages to these structures all around the world every year. In order to control this phenomenon, riprap is placed around the piers to increase streambed resistance (direct method). However, in indirect method, some partitions such as collar slot and submerged vanes are used to reduce scouring caused by horseshoe vortex and downstream flow. In this research, effect of two types of square and circular collar on a single cylindrical model has been investigated. The results showed that using the two kinds of collar, especially below bed level decreased the scour depth. Square collar was more effective than circular one in decreasing the scour depth. The square and circular collars showed 70% and 50% decrease in the rate of scour depth, respectively, as compared to pier without any collar.

Key word: Scouring, Collar, Bridge Pier. Clear-water.