« Research Note »

Assessment of Regression Trees and Multivariate Adaptive Regression Splines for Prediction of Scour Depth Below the Ski-Jump Bucket Spillway

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Abstract

Spillways are constructed in dams in order to discharge the excess water in the reservoir. In the ski-jump bucket spillways, water jet impacts diagonally to downstream erodible bed and causes scour hole downstream of the dam. The scour hole development may threaten the stability of the dam. Hence, an accurate and correct estimation of scour depth is one of the most important issues in hydraulic engineering. In recent years, soft computing tools have been widely used to model complex and nonlinear phenomena. Therefore, in this study, using data mining algorithms such as classification and regression trees and multivariate adaptive regression splines have been used for estimation of maximum scour depth at the downstream of the ski-jump bucket spillway. For this purpose, these models were developed using 95 experimental data and dimensionless parameters. The results showed $q/\sqrt{gH^3}$ as the most important parameter in prediction of scour depth. In addition, statistical indicators and scatter diagrams showed that multivariate adaptive regression splines have the highest value of correlation coefficient CC=0.966 and minimum error measures RMSE=0.075 and MAE=0.057 and were more accurate than regression trees in prediction of scour depth below a ski-jump bucket spillway.

Key words: Scour depth, Ski-jump bucket spillway, Regression trees, Multivariate adaptive regression splines.

Numerical Modeling of Flow around Cylindrical Piers Using Single and Dual Time-Stepping and Methods of RANS and LES

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Abstract

In this study, details of a developed numerical model and results of modeling of the flow around cylindrical piers are presented. The governing equations are Navier-Stokes and continuity equations. Discretization of the equations is carried out by finite volume method. Modeling of turbulent flow is done by two different methods namely RANS and LES. The method of solution of equations is the artificial compressibility method with two different single and dual time-stepping methods. Considering the adopted time-stepping method, the implicit or explicit time discretizations are adopted in simulations. Results of the present numerical modeling are compared with experimental data of flow around cylindrical piers. Results of this study show the influence of the method of solution, time-stepping method and turbulence modeling methods on the results of flow around cylindrical piers.

Keywords: Flow, Cylindrical Pier, Navier-Stokes, Single and Dual Time-Stepping, Turbulence.

Application of Near-wall Models Along with LES to Free Surface and Separated Flows

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Abstract

Application of Near-wall models along with large eddy simulation method for free-surface flow over backward-facing step is investigated. Smagorinsky and Dynamic sub-grid scale models are used in LES code. Four different near-wall models have been developed based on advanced Werner-Wengle model. The simulation results are compared with experimental data of Nakagawa and Nezu (1987). The comparison shows a relatively good agreement for time-averaged velocities and also it shows high accuracy in computation of reattachment point. Near-wall models have very close results in whole domain except the reattachment region and this has been shown by comparison of viscose sub-layer thickness that is an important parameter of these models. Although the dynamic sub-grid scale model is more complicated than standard model, both models have shown very close results in present case study.

Key words: Large Eddy Simulation, Near-Wall Model, Sub-Grid Scale Model, Backward-Facing Step.

Investigation of the Effect of Roughness Wave Length on the Hydraulic Jump Characteristics of Roughened bed

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Abstract

In this study, variation of hydraulic jump characteristics including jump length and secondary depth and the variation of the effective length of roughness in relation to the wave length were studied. For this purpose, the characteristics of hydraulic jump under four different wave lengths and four different Froude numbers were experimentally determined. Totally, 84 tests have been carried out in the range of Froude numbers from 5.84 to10.13 in a flume with length of 12 m , width of 40 cm, and height of 40 cm. The results showed that the characteristics of hydraulic jump such as length of jump and secondary depth declines as the length of roughness increases. It was also found that, the effective roughness length on the secondary depth increases as the wave length increases, but the effect of roughness length on the length of jump is reverse. Regarding the derived relationships, the optimum dimensionless wave length was obtained to be 4.5.

Keywords: Hydraulic Jump, Rough Bed, Wave Length of Roughness.

Investigation on the Effects of Slope on the Derivation of Artificial River Network using Different Routing Algorithms

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Abstract

Hydrologic modeling requires artificial derivation of river network. In this research, 5 famous routing algorithms including D8, D∞, RHO8, MFD and DEMON were employed. These algorithms route flow on the basis of slope gradient. Therefore, the effects of slope on their performance were investigated. The case study revealed that for overland slope greater than 5%, the differences between the algorithms are not considerable, while all of which for slope less than 5% have problems because of generating parallel flow. The results show that if one could solve the problem of the RHO8 to return the same pattern of drainage network in every running, it could be recommended unconditionally. Meanwhile, the ability of the D8 and its relative reliability was confirmed, while the D∞ didn't show any superiority over other algorithms.

Key words: D8, D∞, RHO8, MFD and DEMON, Flow tracing algorithms, Slope.

Using In-Line Storage Strategy to Improve the Operation of Automatic Main Irrigation Canals (Case Study: Dez Main Irrigation Canal)

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Abstract

Successful operation of a main irrigation canal system is achieved under the conditions that differences between supply and demands are eliminated. In this research, the effect of In-Line storage strategy on operation and management of an automatic main irrigation canal is assessed as an approachable method for improving the main irrigation canal performance in rehabilitation and modernization projects. A Proportional-Integral (PI) local upstream controller is designed for Dez main irrigation canal to assess the capability of the proposed strategy. The controller was tested for an extreme and sudden increasing–decreasing water off-taking scenario on two different operation conditions. The first one refers to the normal operation and the latter refers to operation of the main canal with in-line storage in the three canal reaches of the case under study. Controller performance was evaluated with ASCE indices includes: MAE; IAE; and StE, for irrigation schedule time period (6 days). Results indicate that using in-line storage strategy leads operational performance improvement. The maximum MAE index improvement happens in the first canal reach with improving values from 2.1 to 0.32. For the IAE and StE indices, maximum improvements are obtained from 1.3 to 0.5; and from 0.71 to 0.14 respectively. The satisfactory results is obtained for the irrigation schedule with drastic changes, so using in-line reservoirs lead to the better results for the normal irrigation schedule.

Keywords: In-Line Storage; Operation of Main Irrigation Canal; Hydrodynamic Model, PI Controller.