Rheological Behavior of Homogeneous Thickened Mine Tailings

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Abstract

The present paper deals with the rheological behavior of homogeneous thickened mine tailings. Knowing the rheological behavior of a fluid is critically important and essential in the study of fluid motion, both in open channel and pressure pipe flow. The calculation of flow characteristics and parameters such as Froude number and Reynolds number are directly or indirectly related to the rheological behavior of the fluid so that the analysis of flow would not be possible without having a proper knowledge of the rheological behavior of the fluid. In order to study the rheological behavior of thickened tailings; different mine tailing slurry samples with different solid contents from three major Iranian copper mines; Sarcheshmeh, Miduk and Sungun and also the tailing samples from Peak gold mine in NSW Australia were selected. The rheological characteristics and the affecting parameters for each sample were carefully tested and determined by means of a Contraves Rheomat 155 rheometer. The solids contents of the slurry mixtures were within the range of 45% to 70% (by weight). The solid particles in the slurries had a D_{50} varying from $11\mu m$ to $47\mu m$. The particle size distribution curve for each sample was obtained using a Laser Sizer. All of the tests were performed in the technical laboratory of Rheology and Materials Processing Centre at RMIT University, Melbourne Australia. Experimental results indicated that high solid content slurry mixtures exhibit non-Newtonian behavior with shear. It reveals that these slurry mixtures should be treated and considered as a single-phase uniform and homogeneous non-Newtonian fluid. Comparison between experimental data and different theoretical models for non-Newtonian fluids motion was done and the best model fit to experimentally obtained data was recognized. Model parameters and rheological properties such as yield stress and viscosity for each slurry sample are obtained and the effect of different parameters on the Rheological properties of slurry has been investigated.

Keywords: Rheology, Mine Tailings, Non-Newtonian Fluid, Plastic Viscosity, Yield Stress.

Study on Structural Characteristics Changes on the Irregular Wave Transmission Thorough Reshaping Breakwaters

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Abstract

In this research the irregular wave transmission from reshaping rubble–mound breakwaters have been investigated. Reshaping breakwaters are recent development in breakwater design, which their initial profiles are changed to a (s) shaped after wave impact. Therefore, the usual relations for transmission coefficients on conventional breakwaters cannot be used for this type of structure.

A comprehensive experimental research was carried out for many sections of reshaping breakwaters with three different slopes in SCWMRI wave flume equipped with a DHI wave generation system.

The hydraulic responses of wave transmissions were investigated by changing the wave parameters such as significant wave height, mean and peak wave period and storm duration on three seaward slopes (respectively 1:1.25, 1:2.0, 1:2.5). JONSWAP wave spectrum was used in all experiments. The armor layer materials were used in three grading class (D_{n85A}/D_{n15A}=1.14, 1.44, 1.82) and a range of structural permeability, P_e $(1 \le D_{n50A}/D_{n50C} \le 20)$. In order to change structural geometry, wave properties and other variables, 100 tests were carried out with 1000 to 6000 waves.

The experimental results showed the relation between transmission coefficients and the new parameter R*. An improved and new relation was achieved using multiple linear regressions.

Keywords: Experimental modeling, Irregular waves, Reshaping breakwaters, Rubble mound, Wave transmission.

Experimental Investigation of 3-D Turbulent Turbidity Currents

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Abstract

In this investigation, the effect of different parameters on the behavior of three-dimensional, turbulent, and steady state turbidity currents has been studied experimentally. One of the important parameters which shows the hydrodynamics of turbidity current is the velocity profiles and in this investigation, it has been measured by ADV (Acoustic Doppler Velocimetery). Kaolin with specific gravity of 2.65 was used as suspended material. The mean particle diameter (D_{50}) is approximately 11 micron. The results show that by increasing the entrance volume flux of turbidity current the height of turbidity current increase. An increase in entrance concentration and slope often would decrease the height of turbidity current. In addition, due to the intense entrainment in the lateral and longitudinal directions, along the interface of fresh water and turbidity current, the height of the current is increased after entering this channel. The velocity profiles show that a high inertia force exists at the entrance region near the source where the maximum and average velocity is high. Towards the end of the tank; it is observed that the location of maximum velocity is shifted upward. After entering the channel, turbidity current moves forward down-slope, spreads laterally and shows behavior of developed flow which entrainment rate remains constant. Experiments also show that this density current preserve its three dimensional structure after reaching the side walls.

Keywords: 3-D flow, Density Currents, Turbidity Currents, Experimental Investigation.

Experimental Study on Some of Design Parameters Affecting the Hydraulic Behavior of Three-Sided U-shaped Spillways

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Abstract

Three-sided spillways are used in dams as well as in irrigation networks, and water and wastewater treatment plants. In this study, the effect of some major parameters on hydraulic behavior of flow in a three-sided U-shaped spillway and its side channel was evaluated using a physical model. The effect of changes in the end-sill height, the distance of the end-sill from the beginning of the side channel, and the side channel slope with different discharges were studied. Flow pattern and pressure fluctuations in the channel were considered as an indication of the flow behavior. Results showed that the end-sill height had the greatest influence on the intensity of pressure fluctuations and flow behavior in the side channel and increase in the end-sill height, decreased pressure fluctuations. Results also indicated that the location of end-sill from the beginning of the side channel, did not have considerable influence on pressure fluctuations. Moreover, increase in side channel slope up to about 3 percent decreased pressure fluctuations. However in slopes beyond 5 percent, pressure fluctuations increased again. Negative bed slopes decreased pressure fluctuations in the side channel considerably. It was also concluded that increase in flow discharge improved the flow condition in the side channel.

Keywords: Spatially Varied Flow, Three-Sided Spillway, Pressure Fluctuations, U-Shape Spillways, Hydraulic Performance.

Development of Mathematical Model for BIVAL Downstream Control System in Irrigation Canals

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Abstract

The control systems and related structures have an important role in water distribution in irrigation networks, and the success of irrigation networks highly depends on their proper functioning. Control structures behave differently under different control systems. Providing higher flexibility in water delivery and reducing water losses by application of downstream control systems is an important factor for performance improvement of irrigation networks. One of the downstream control system which is suitable for sloping canals is constant volume control system named BIVAL system. In this system while the water volume in canal reaches is kept constant, demand variation is satisfied quickly and canal earthwork is reduced. In order to study hydraulic behavior of irrigation canals in coordination with control systems which is unsteady, using hydrodynamic model is inevitable. In this research mathematical model of constant volume downstream control system (BIVAL) is developed and linked with ICSS model. For calibration and evaluation of developed model on local and global scale, E1-R1 branch of Dez canal network in Iran and the standard canal introduced by ASCE are chosen respectively. Each system was calibrated in wide ranges of different flow rate and different values of numerical coefficients and the proper coefficients were derived. Afterward each one of control systems were operated under different operational schedule and performance indices, MAE (Maximum Absolute Error), IAE (Integral of Absolute Error) and SRT (System Response Time) in 5% and 1% levels were computed. Performance indices for a reach with highest variation derived as 2.57, 0.28 and 0 respectively. Depth, flow rate and gate opening fluctuations for local testing, and depth fluctuations for global testing at middle of reaches are calculated and depicted. Performance indices and hydraulic behavior of the system indicates proper functioning of the developed model.

Keywords: Irrigation canal, Mathematical model, Control system, Downstream control, BIVAL, ICSS.