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Experimental study of load characteristics on hyperconcentrated discharge flow

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Abstract: The characteristics of hyperconcentrated flow have been deeply studied by former scholars, and most of them are about gradually varied flow in the riverway, but are barely about the load characteristics of high dam discharge flow on hyperconcentrated river. In this paper, the time-average pressure and fluctuating pressure of orifice energy dissipater were studied. The experiment contained 28 different conditions, with sediment concentration ranging from 0 to 300kg/m^3, and velocity ranging from 1.78m/s to 3.73m/s. The results show that: the time-average pressure and fluctuating pressure of high dam hyperconcentrated discharge flow has the same distributing rule as the pure water, but differs in the value, the value of time-average pressure increases as the sediment concentration increases under the same velocity condition, while the fluctuating pressure is affected by both the sediment concentration and the velocity condition, which declines after the first increase; the probability density of fluctuating pressure follows the normal distribution; the frequency distribution range of fluctuating pressure increases as the velocity increases, and the low frequency component increases as the sediment concentration increases. Based on the results, this paper proposed a load calculation correction method which has an important value of project design on hyperconcentrated rivers.

Key words: hyperconcentrated discharge flow; orifice energy dissipater; time-average pressure; fluctuating pressure; load calculation correction method

The characteristics of the riverbed change and its impacts in the Inner-Mongolia reach of the Yellow River during ice flood season

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Abstract: One of the factors, impacting the ice flood disaster of the Inner-Mongolia reach, is the sand riverbed changes. According to the observed data, this research statistically analyzed the sediment transport characteristics of the Inner-Mongolia reach in the ice flood season, and explained the mechanism of generating the characteristics, and then on these bases the rule of riverbed scour and deposition and the riverbed change were studied. The results show that during the ice flood season the flow in the Inner-Mongolia reach has strong capacity in coarse sediment transportation, because the ice flood with lower temperature has the higher suspension efficiency than that of the summer one and the movement of the shifting ice forms a specific hydraulic regime. The transportation of vast coarse sediment increase the sensitivity of riverbed change to the flood magnitude and the shape of flood hydrograph, and the bed morphology becomes more shallow-wider. After ice flood season, the riverbed of the reach from Sanhuhekou to Toudaoguai has been obviously scoured, raising the riverbed of the reach from Bayangaole to Sanhuhekou due to the flushed fine grain sediment and the silted coarse sediment. Hence, the riverbed change caused by the characteristics of the sediment transport in ice flood season, should be considered fully in the measures for ice prevention and disaster mitigation.

Keywords: ice flood; transport characteristics; riverbed change; Inner Mongolia reach

Research on the training of Lower Yellow River based on three dimensional numerical simulation

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Abstract: This research aims to investigate the impacts of river training in the lower reach of the Yellow River through a three-dimensional model. Four design floods with different return periods were chosen from historical records as incoming hydrographs to simulate flood events in the region of Huayuankou to Aishan. Results under two training measures, i.e., the measures without production levees and the new measure with two defence lines, were compared with each other. We analyzed the results with focus on the character of flood propagation, erosion and deposition, sediment transport, flood diversion and inundation on a typical floodplain. The results clearly revealed the training measure with two defence lines can not only protect the floodplains from being inundated, but also lead to sedimentation reduction in the whole reach compared with the measure without production levees. It indicates that the measure with two defence lines can benefit the prevention and reduction of flood disasters, and improve the sediment transport capacity.

Keywords: Lower Yellow River; training measure; two defence lines; numerical simulation

Parameter estimation for furrow infiltration model with Gene Expression Programming

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Abstract: Accurate estimation of infiltration parameters is critically important for the optimal design of furrow irrigation system. In the present study, a method for estimating the edge effect parameter γ of furrow infiltration model was proposed by using of the gene expression programming (GEP) algorithm. A numerical experiment was conducted to produce the dataset for validating the GEP algorithm. The input factors of GEP algorithm were determined on the basis of the sensitivity analysis of γ, and then the quantitative relationship between γ and the optimal combination of input factors was established. The results show that γ is very sensitive to ponding water depth, initial effective water content and furrow depth. Soil hydraulic properties had a great influence on γ. The optimal combination of the input factors are the ponding water depth, furrow depth, initial effective water content, saturated hydraulic conductivity and inverse of the air-entry value. The estimated γ under the condition of variable ponding depth is approximately the same as those of constant ponding depth condition. For variable water depth, the difference between the cumulative infiltration obtained by using the furrow infiltration model with the GEP estimated γ and the "exact" cumulative infiltration calculated by HYDRUS-2D is less than 5%. The contribution of edge effect to total infiltration increases gradually during the infiltration process. Compared with the fine soil, coarse soil shows a larger edge effect on the total infiltration. The edge effect in clay loam is about 25%, and about 37% in sand under the conditions of this study. It can be concluded that the GEP algorithm is an effective method to estimate the parameter γ for the furrow infiltration model.

Keywords: furrow irrigation; infiltration; parameter estimation; gene expression programming

Contrast experiments on permeability of transparent soil influenced by pore fluids

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Abstract: Transparent soil is widely used for visualization of physical model tests on internal soil deformation engineering problems. Based on the transparent soil materials manufactured by fused quartz and three typical pore fluids (mixed oil, calcium bromide solution, and sucrose solution), a group of constant head permeability tests were carried out. Considering the difference between pore fluid and penetrating liquid, the permeability coefficients influenced by different pore fluids, particle size distribution, and relative density were measured in detail. Water infiltrations through transparent soil manufactured by different pore fluids were also measured. The penetration test on China ISO standard sand was taken for comparative analysis. Then, electro-osmosis visualization model tests were carried out based on transparent soil samples manufactured by different pore fluids. The influence of pore fluid on electro-osmotic process and mechanism is preliminary discussed. It shows that the permeability of transparent soil are not only related to particle size distribution and relative density, but also related to the pore fluids. Permeability coefficient of transparent soil manufactured by mixed oil or calcium bromide solution is the closest to that of natural sand.

Keywords: transparent soil; pore fluid; permeability; electro-osmosis; model test

Study on evaluation of rock mass groutability of dam foundation based on Fuzzy RES-cloud model

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Abstract: The analysis and evaluation of rock mass groutability is the key point and difficult problem in dam foundation grouting engineering. Scientific and reasonable groutability evaluation has important theoretical and engineering significance to ensure grouting effect. There is a lack of analysis on the rock mass groutability of dam foundation under multi-influencing factors, and the uncertainty in the evaluation process cannot be considered at the same time. To solve these problems, this paper proposed a fuzzy comprehensive evaluation method to assess rock mass groutability based on Fuzzy RES (Rock Engineering System) - cloud model. First, based on a comprehensive analysis of the controlling factors, an evaluation index system with twelve factors representing the properties of geological condition, grout properties and grouting technology parameters was established. Then, with the help of RES theory, the degree of importance of evaluation factors were determined scientifically and rationally. In addition, fuzzy theory was introduced to overcome the dependence on subjective factor in RES method, obtaining more objective weights of evaluation factors. The cloud model method, with considering the issue of fuzziness and randomness, can realize the uncertain mapping between groutability levels and evaluation index values. The application of Fuzzy RES-cloud model in a large domestic hydropower project shows that the proposed method is of high accuracy and reliability.

Keywords: dam foundation grouting; rock mass groutability; comprehensive evaluation; fuzzy RES; cloud model

Accounting methodology of the balance sheet for water resources

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Abstract: Balance sheet for water resources (BSW) is a kind of tabulation method in employing the concepts and formation of balance sheet (BS) to reflect the changes of water resources stock and flow when it is regarded as economic assets including water liabilities due to inappropriate uses to environment. In multi-visions of accounting, statistics and hydrology, starting from description of balance sheet (BS) evolution, the author analyses the basic principle of BS in both accounting and statistic methodologies and gives the viewpoints as that BSW should combine and absorbs the advantages of micro process control in accounting and macro decision support in statistics. It should follow the basic principles and rules of BS and meet the characteristics of water resources and the demand of water management as well. The author proposes the accounting methodologies for three classes of BSW with different accounting targets and entities. Those classes are BSW for a single water entity, BSW for national/regional economic entity and BSW for nations/regions. The first two are designed based on accounting principle and for describing the water-related activities and the impact they made. It will help accounting body to obtain water-related decision information and enhance delicacy water management. Third one is designed based on statistic principle and for revealing the relations of obligatory right and debt between virtual environmental entity and economic entity on water resources. It will form fundamental approaches in water resources utilization assessment and in environmental effect evaluation.

Keywords: balance sheet; water resources; accounting; statistics; water accounting

Experimental study of the velocity profile of rill in the loess region

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Abstract: The flow velocity distribution under the condition of steep slope (20°) is studied by using the method of indoor fine simulated rainfall experiment. Through the observation and analysis of the rill morphology evolution and the overland flow velocity during the experiment, the variation rule of the flow velocity during the rill formation and development was studied. The results show that the overland flow velocity between the rills is not affected by the degree of rill development, but there is a relationship between the flow velocity within the rill and the rill development. First, the emergence of the rill will lead to an increase of runoff in the rill, but with the rill development, the confluence area decreases, the rill bed morphological resistance increases, resulting in the gradual decrease of the rill flow velocity. The reciprocal contrast between the rill bed morphological resistance and the flow velocity increment caused by runoff concentration affects the flow velocity in the rill.

Keywords: loess slope; rill erosion; morphology evolution; overland flow velocity

Double frequency radar system for ice thickness and water depth measurement

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Abstract: For overcoming disadvantages of single frequency radar system, this study presents a new double frequency radar system with 100 MHz and 1500 MHz working frequency to measure water depth and ice thickness at the same time. A RTK system is used in this system to collect GPS coordinates of measuring points. To avoid interference, 100 MHz and 1500 MHz radars work alternately and the working cycle is 15 ms. Consider that ice thickness and water depth change gradually, a correlation algorithm is used to track and measure horizon data to improve measuring accuracy. During the winter of 2015–2016, field survey was carried out at Longdao Wharf, Mohe Section of the Heilongjiang River where is the northernmost area in China. 21 water depth and 19 ice thickness measuring points were used to compare radar system with traditional drill–hole method and then ice regime observation was carried out. This study provides a valuable reference for the future ice regime observation.

Keywords: ground penetrating radar; field observation; ice thickness; water depth; ice jam; ice dam

Prediction of breakup ice jam with Artificial Neural Networks

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Abstract: Breakup ice jams occur during periods of thaw in many northern river courses, which is hard to predict because the formation and progression of breakup ice jams result from a complex interaction between hydrologic, hydraulic, and meteorological processes. Ice jam prediction methods based on artificial neural networks (ANNs) are desirable to provide early warning and to allow rapid, effective ice jam mitigation. The soft computing through artificial neural networks and Clustering method is applied to predict breakup ice jam in Mohe reach of the Heilongjiang River (Amur River). The ANNs predict with qualified rates of 85% to the occurrence of breakup ice jams proves to be more accurate than the statistical methods with qualified rates of 62%. The prediction of breakup dates is qualified according to the national standard published as Hydrographic Forecast Standard, with the errors of less than 2 days between the forecasted and measured results and the average 10-day forecast period. The forecast on the breakup ice jam in 2017 was released 24 days ahead on Apr.1, 2017, which provides the accurate results for the breakup data and the occurrence of breakup ice jams.

Keywords: river ice; breakup; ice jam; prediction; neural network; clustering method

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Study on probability density evolution method for time-dependent dynamic reliability of concrete dams subjected to earthquake

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Abstract: With the increasing of service time, the seismic capacity of concrete dams decreases because of the deterioration of material. Therefore, it is necessary to assess the life-cycle seismic safety of dams. Based on the theory of probability density evolution, this paper proposes a probabilistic analysis method of life-cycle seismic performance of concrete dams. The relative displacement angle as the index of performance evaluation is introduced, while the randomness and time variability of material are considered. Firstly, the probability density evolution equation is established for the extreme value of the dynamic nonlinear response of the dam in its service life. Then, the initial condition is obtained by employing the theory of the equivalent extreme value event and the equation is solved by the difference method. Finally, the time-dependent dynamic reliability is acquired in the safety domain. The validity of the method is verified through a numerical example. The results show that the proposed method can obtain probability evolution information of seismic performance and the development of the dynamic reliability of dams in its service life. Compared with the Monte Carlo method, the new method shows higher accuracy and efficiency.

Keywords: concrete dam; deterioration; life-cycle; probability density evolution; equivalent extreme value event; time-dependent dynamic reliability

Estimation of hydraulic and thermal parameters in saturated layered porous media based on heat tracing method

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Abstract: Hydraulic and thermal parameters are the most important factors to simulate water and heat transport processes in porous media quantitatively. In this work, a sand box was packed with layered silicon sands and a laboratory experiment was carried out with steady-state flow based on heat tracing theory. Thermocouple and thermal imager were used to monitor inner and surface temperature of porous media at the same time. Temperature from both method were used to estimate parameters, such as saturated hydraulic conductivities, longitudinal and transverse thermal dispersivities at different locations of the sand box via the inverse model of HYDRUS-2D software. The results indicate that thermal images could shoot the behavior of water flow in different sand layers through the early process of transportation. The migration rate of heat front slow down within fine sand layer, so the heat in fine sand layer could expand to a larger space and temperature become more uniform along the way perpendicular to the flow direction. The results also show that temperatures information from both inner and surface is a feasible way to estimate hydraulic and thermal parameters of layered porous media at saturated condition. The estimated saturated hydraulic conductivity and longitudinal thermal dispersivity enlarged with the increasing of diameter of silicon sand, while the estimated transverse thermal dispersivity possessed the opposite tendency. The ratio of longitudinal to transverse thermal dispersivity ranged from 10 to 120. Besides, the heat loss during heat tracing test and relatively lower estimated value of saturated hydraulic conductivity in the fine sand layer were the major reasons for the underestimating of water flux. With the number of observation node in fine sand layer increasing, the relative error between estimated and measured water flux declined from 37.7% to 20.7%. The result from this experiment provides a method for estimation of hydraulic parameters of heterogeneous porous media using heat tracing.

Keywords: heat tracing; layered porous media; parameter estimation; HYDRUS-2D software

Numerical simulation of melting ice and optimal arrangement of return pipe in nuclear power plant

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Abstract: In the cold area, it is necessary to conduct a research on anti-ice design for nuclear power plant during the winter diversion process. Using cooling water of the power station is an ideal method to raise the water temperature in the diversion channel. In this paper, the phase transition temperature band method is proposed for the turbulence condition. Through the research, it is found that the key to melting ice efficiency is to extend the mixing time. Thus, to improve the ice melting efficiency, optimization has been carried out in two aspects of structure and operation, facilitating the mixing position of hot and cold water to move upstream and extending the mixing time of them. In the present example, the ice-cooling efficiency of the cooling water increases with the increase of the ice concentration. When the ice concentration is 0.84%, the corresponding ice-melting efficiency is 30%.

Keywords: melting ice; return pipe arrangement; structural optimization; diversion channel; nuclear power plant