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EDITORIAL BOARD

Flow control and measurement in centrifugal model tests for earth-rock dam breaching

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Abstract: Aimed at the existing problems in the centrifugal model tests for earth-rock dam breaching, a set of servo water valve flow control device was developed. The control precision of upstream inflow condition was improved significantly after the adoption of the device, therefore, the uncertainty of the results of centrifugal model test for earth-rock dam breaching was effectively reduced. In addition, the similarity criterion of water flow in the centrifugal model tests for earth-rock dam breaching is established. Meanwhile, a measuring method utilizing a thin-walled rectangular water weir which was placed into the end plate of the model box is developed to measure the discharge hydrograph of dam breach in the centrifugal model tests. Furthermore, based on the outflow tests under the high gravity field, the conclusion can be drawn that the flow coefficient of the thin-walled rectangular water weir has no connection with the centrifugal acceleration, so the measurement method can give the accurate breach flow discharge hydrograph for centrifugal model tests.

Keywords: earth-rock dam breach; centrifugal model test; similarity criterion of water flow; flow control and measurement

New discharge algorithms of radial gates based on the flow regime identification

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Abstract: Accurate estimation of flow discharge though radial gates in water diversion projects is an essential precondition for automatic control of gates, simulation of the operation and dispatching system, etc.. The flow discharges predicted by the conventional empirical coefficient model and dimensionless analysis model are of large errors under the submerged flow conditions with low jet Froude number at vena contracta. In this paper, the influence factors of discharge coefficient are analyzed. A new parameter Er is proposed to identify flow regime for submerged flow, which is defined as $Er=e/H+Xr$. When $Er<1$, the submerged flow is of large jet Froude number, and when $Er\geqslant 1$, the submerged flow is of low jet Froude number. Based on the above flow regime identification, the discharge algorithms are established for free flow, partially submerged flow and totally submerged flow, respectively. Then, the model parameters are estimated by the least squares method. The verifying results show that the discharges predicted by new discharge algorithms are of higher precision. The relative errors $|EQ|$ of 80% tests are less than 10%, and EQ is close to the normal distribution. The flow regime identification criterions and the discharge algorithms proposed in this paper can provide new ideas for the accurate prediction of discharge through gates.

Keywords: radial gate; discharge algorithm; submerged flow; flow regime identification; the least square method

Discrete element modeling of hollow cylinder shear behavior of granular material with fixed principal stress direction

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Abstract: This paper studies the macro and micro behavior of granular materials under torsional shear with fixed principal stress direction, using PFC^{3D} discrete modeling on hollow cylinder tests, with emphasis on the effect of major principal stress angle on monotonic shear behavior. Stacked-wall boundaries are used to simulate the flexible membranes in hollow cylinder tests. An update controller method is developed to control the rotation velocity of particles at the top boundary, so that the shear force can be applied more effectively. The results from the simulation show that discrete element method can well simulate the stress path and stress-strain behavior of sand samples under torsional shear. The variation of the major principal stress angle α greatly affects the shear strength of the samples, and the pattern observed in the numerical modeling is similar to that in laboratory tests. The peak friction angle of the soil minimizes at the angle α=60°. The evolution of shear band is related to the variation of void ratio and coordination number in micro scale.

Keywords: discrete element method; hollow cylinder sample; principal stress direction; shear strength; anisotropy

Review on disaster prevention fractal theory of nonlinear dynamic system in rivers (networks) at home and abroad

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Abstract: The development of nonlinear dynamic system in rivers (networks) generally follows the law: "relatively steady—chaos—disorder—fractal self-organization—back to relatively steady", and the evolution process shows a certain degree of chaotic fractal characteristics. From the aspects of long sequence hydrological process fractal, flood stage and fractal, river morphology evolution fractal, flood timing and frequency fractal, state-of-the-art and trend of disaster prevention fractal theory of dynamic system in rivers (networks), multi-scale analysis and fractal in hydrology at home and abroad are analyzed and discussed in the paper. Some aspects which include composite theory of water conservancy intelligence fractal, fractal dimension dynamic mechanism of multi-scale flood disasters in the basin, fractal dimension discrimination standard of river pattern change, compound parameter fractal characteristic and physical mechanism of river evolution and fractal chaos theory of embankment catastrophic system, intelligent fractal and decision support of multi-scale analysis in hydrology are key directions. These directions are about cross-development of fractal chaos science, water science, disaster science and artificial intelligence for great breakthroughs in the future.

Keywords: dynamic system in rivers (networks); fractal and fractal dimension; hydrological series; seasonal flood; channel pattern discrimination; intelligent fractal; catastrophe system; multi-scale fractal in hydrology

LID facility allocation and rainfall-runoff monitoring for the Future Science & Technology Park in Beijing

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Abstract: The complete procedure of LID (Low Impact Development) planning includes: goads determination, facility allocation design, scheme optimization, construction, operation-maintenance, effects monitoring, assessment and improvement. For the large scale LID area, the overall goal can be divided into different sub regions, and facilities should be allocated by considering the type of land block. The Future Science & Technology Park in Beijing was selected for case study, and the decomposition allocation method for LID facilities was introduced. Rainfall-runoff monitoring and effectiveness analysis was carried out in order to establish the mechanism of "construction-monitoring-assessment-improvement". The results show that the reduction rate of runoff coefficient can reach 78% and the utilization ratio of rainwater is greater than 85%.

Keywords: LID; facility allocation; effects monitoring; assessment and improvement

Study on dynamic evaluation of compaction quality of earth rock dam based on Random Forest

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Abstract: Evaluation of compaction quality of dam body is the key to control the safety of earth-rock dam construction, and the dry density is an important index to evaluate the compaction quality. However, the method of obtaining dry density through random pit test is difficult to fully reflect the compaction quality of the work area. Meanwhile, there is a lack of in-depth analysis and quantification of the uncertainty of parameters of material sources in the compacted quality evaluation model. In view of the above shortcomings, based on the real-time compaction monitoring system, a dynamic compaction quality evaluation model considering the random uncertainty in material sources and evaluation process is proposed. Its functions mainly include the following three aspects: (1)the information entropy theory is used to quantify the uncertainty of the parameters of material source; (2)P5 content and humidity are added to the indexes affecting dry density, which reflect the influence of gradation and meteorological factors on the compaction quality. Meanwhile, random forest algorithm is used to dynamically solve the compaction quality evaluation model under the condition of considering the uncertainty of the material parameters; (3)The Kriging method with high interpolation results is used to realize the dynamic evaluation of the whole work area compaction quality, which makes up for the problem that the limited detection points cannot fully reflect the compaction quality of the work area. The model is applied to evaluate the compaction quality of an engineering core wall area, and the feasibility of the model has been verified by the five-fold cross validation and F test and compared with the BP neural network and linear regression method. The analysis results show the consistency, representative and superiority of this evaluation method.

Keywords: the earth-rock dam; compaction quality evaluation; random forest; uncertainty; rolling real-time monitoring system

Bivariate structure load return period and joint flood quantile estimation

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Abstract: Currently, flood hazard event and hydrological failure scenario judged by the widely used bivariate return period may violate the real case. In this study, the exceedance probability of the highest water level in the reservoir was adopted to measure the safety design criteria of flood control. The estimation methods for structural load return period and most likely joint design values of flood peak and volume were presented. The Geheyan reservoir located at Qingjiang basin was selected as a case study to perform the application and comparative study. In this Geheyan reservoir example, it is demonstrated that compared with structural load return period, the design standards of most likely joint design values of OR and AND return period are higher or lower systematically. Meanwhile, design standards were either over-estimated or under-estimated to some extent in most likely joint design values of Kendall and survival Kendall return period. The presented structural load return period considers the interaction between flood characteristic variables, i.e. peak and volume, and operation rules of the reservoir. Consequently, it is in accordance with the essential implication of design flood and can achieve the specified flood control standards, which will provide more scientific and reasonable basis for flood control design and risk assessment of the reservoir.

Keywords: design flood; bivariate return period; joint design value; structural load; Copula function

Transfer coefficients for Kaplan turbine based on neural network

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Abstract: Building the mathematic model of hydro-turbine is basic for the research on its stability and optimal operation. In engineering practices, piecewise-linear models are usually used to analyze the little disturbance of hydro-turbine, which requires the transfer coefficients in different working states. However, conventional methods have the shortcomings of more computing burden, limited number of transfer coefficients and larger errors in lightly loaded conditions. In this paper, a computation method of transfer coefficients for hydro-turbine is proposed based on characteristic curves and the derivation of neural networks. The original data of hydro-turbine model is acquired using model synthesis characteristic curves, runaway curves and boundary conditions, and the neural network is trained and obtained reflecting the characteristics of discharge and torque of hydro-turbine. The derivative of the mathematical expression that contains the neural network is computed to deduce the calculation formula of transfer coefficients, which should be the function of working states. Finally, the transfer coefficients calculated respectively by the proposed method and curve fitting are compared at some working states, and the characteristics of them are analyzed. The results indicate that the proposed method based on the derivative of neural networks has a higher accuracy, reduces the computation and is conducive to an overall recognition on the change of transfer coefficients along with working states.

Keywords: transfer coefficients; Kaplan turbine; neural network; curve fitting

Experimental study on incipient motion of remolded cohesive soils and cohesive/non-cohesive mixtures

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Abstract: The erosion resistance of two kinds of remolded pure cohesive soils as well as cohesive/non-cohesive mixtures with 20%, 40%, 60% non-cohesive fraction respectively was tested in Erosion Function Apparatus. The influences of cohesion, dry density, non-cohesive soil particle size and mass content on the critical shear stress of soils were investigated. The results obtained show that the critical shear stress of pure cohesive soils has a linear relation to cohesion, but for different kinds of cohesive soils the coefficients are much different. Compared to cohesion, the relationship between dry density of 2 pure cohesive soils and critical shear stress can be determined by an exponential function. For mixtures, the critical shear stress is mainly related to cohesion, however, non-cohesive soil particle size and mass content can affect critical shear stress as well. When the particle size of non-cohesive soil is determined, with the increase of non-cohesive soil content, the threshold exhibits an increase at first and then a decrease. Nevertheless, as non-cohesive soil content is constant, with the increase of non-cohesive soil particle size, the threshold increases. A critical shear stress model of remolded soils is proposed, which can provide a proper prediction of critical shear stress of cohesive/non-cohesive mixtures.

Keywords: scour; cohesive soil; remolded soil; mixture; critical shear stress

POA-ETA method for seismic performance evaluation of concrete gravity dam

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Abstract: In this paper, adopting the advantages of endurance time analysis (ETA) and pushover analysis (POA) method, the POA-ETA method is proposed to realize the seismic performance analysis of concrete gravity dam, which can consider the influence of structure's multi-modes and seismic randomness. According to the analysis on basic principle of ETA and POA method respectively, the principles and the key steps of POA-ETA method are established. In POA-ETA method, ETA method is used to generate ETA history, which describes increasing peak ground acceleration and is loaded as excitation, and to get the dynamic response of structures eventually. By analyzing dynamic response, the capacity spectrum, ductility ratio-equivalent period ratio and ductility ratio-equivalent damping ratio curves are acquired to bring in POA method to evaluate seismic performance of structures. The POA-ETA method is used to calculate performance points in 'moderate damage' and 'severe damage' factor, and further, to analyze seismic performance and damage factor of Koyna concrete gravity dam. The results show that the POA-ETA method has high accuracy and the applicability.

Keywords: ETA; POA; multi-modes; seismic randomness; damage factor; performance points

Dynamic characteristics of river evolution under the influence of riparian vegetation cover

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Abstract: Riparian vegetation has an important influence on the flow movement, the stability of main channel and river bend migration, especially in the process of fluvial evolution during flood period. In order to analyze the effect of different density vegetation revetment on river dynamic process, the natural model experiment was used to simulate the river evolution process by changing the planting density and unilateral and bilateral arrangement of riparian vegetation. Given the same discharge, gradient, grain size and other water and sediment boundary conditions, set the control variable for riparian vegetation coverage, respectively, 0%, 20%, 40%, 80%. The results show that: (1) The mainstream stability of unilateral vegetation coverage is worse than that of the bilateral vegetation; (2) the more dense the riparian vegetation is, the stronger the local disturbance of the water flow to the riverbed, the longer the period of river evolution reaches a stable state; (3) the stable curvature of the meandering channel covered by the bilateral vegetation decreases with the increase of vegetation coverage. The larger flow shear force will result in larger river bend migration.

Keywords: natural model experiment; hydrodynamic; river evolution; riparian vegetation; vegetation coverage rate; sediment transport intensity

Permeability and micro-cracks of concrete layer interfaces

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Abstract: The permeability of a concrete is closely related to its internal micro-cracks. This paper presents an experimental study focusing on characterizing micro-cracks within concrete layer interfaces and examining its effect on the permeability of the concrete. Six concrete specimens were prepared with layer interfaces formed by placing the concrete at different time intervals. Permeability tests were performed and micro-cracks of the concrete layer interfaces were characterized through fluorescence microscopic observation. The results show that the specimens will have greater permeability if they have layer interfaces formed by longer time intervals, may indicating higher opening of the layer interfaces. Consequently, higher charge passed, initial current and AC conductivity are also observed with the longer intervals. The fluorescence micro-images reveal that the length of micro-cracks obeys logarithmic normal distribution. A parameter λ, quantifying the orientation of micro-cracks, indicates the micro-crack distribution changes from isotropic to anisotropic with increasing time interval of concrete placement. Meanwhile, the predominant direction of micro-cracks tends to follow the layer interface. The maximum value, λ_{max}, is positively linearly correlated with permeability coefficient, initial current and equivalent conductive width, with correlation coefficients of 0.85, 0.80 and 0.95, respectively. Whereas, λ_{max} is negatively linearly correlated with AC resistance, with a correlation coefficient of 0.76.

Keywords: concrete; layer surface; permeability; micro-cracks; fluorescence microscopy

Indoor experiment and simulation of soil water two-dimensional movement of the paddy fields in the northeast frigid of China

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Abstract: In order to explore the water movement in the layered soil of paddy fields in the northeast frigid of China, indoor infiltration experiments of layered soil and homogeneous soil were conducted respectively by controlling water irrigation table and underground water level, and the soil used in experiments were coming from Qin'an experimental irrigation station in Heilongjiang province. The infiltration devices were improved to collect water by layers in order to recognize water seepage and percolation quantitatively. A two-dimensional model was also developed based on HYDRUS-2D by using inverse solution submodel to inverse the hydraulic parameters through inputting observed values of soil water content. The results indicated that the simulated results agreed well with the observed values. The cumulative infiltration rate, seepage rate and percolation rate of the layered soil columns were all less than the homogeneous ones, at the meantime, the different layers in the layered soil columns also had different rates, and there were no observation of seepage in the middle layer, and the steady seepage rate in the cultivated horizon layer and the illuvial horizon layer were 0.007 and 0.023cm/h respectively. Analysis of water balance in the layered soil column indicted that the vertical percolation accounted for 27.55% of the cumulative infiltration, the rest outflow was contributed by seepage which mainly occur in the soil below 35cm. By analyzing the influential factors to seepage, the increase of irrigation water table promotes the seepage of per unit width in the cultivated horizon layer and the illuvial horizon layer observably, which indicats that controlling irrigation water table is good for decreasing water seepage and improve water use efficiency. And the increase of the plow pan layer depth mainly contributes seepage of per unit width in the illuvial horizon layer. On the contrary, water seepage of per unit width is decreased in the illuvial horizon layer because of the increase of groundwater level. Therefore, the reasonable thickness of the plow pan layer and groundwater level can make for reducing deep percolation loss.

Keywords: paddy fields of black soil; seepage; recharge of groundwater; water balance; water seepage of per unit width; HYDRUS-2D