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EDITORIAL BOARD

Numerical analysis of seismic performance of steel fiber reinforced concrete face rockfill dam

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Abstract: The damage failure of concrete slab is a threat to Concrete Faced Rockfill-Dam(CFRD). Fiber reinforced concrete is one of the engineering measures to reduce the damage of the face slab. In this paper, the steel fiber reinforced concrete (SFRC) is used as a constructional material of face slab to improve the ultimate seismic-resistance capacity of the dam. The constitutive relationship of SFRC is introduced into the plastic damage model. By combining the generalized plasticity model and plastic damage model, an elasto-plastic seismic response analysis was performed for a 200-m-high CFRD. The process and development of dynamic damage in reinforced concrete (RC) face slabs and SFRC face slabs were analyzed. The effects of different steel fiber contents are considered. The results show that the plastic damage model can simulate the stress-strain relationship of SFRC well. Using the equivalent steel content, the tensile damage positions and areas of weakness in RC slab and SFRC slab are all distributed above two-thirds of the dam height. Compared with the RC slabs, the maximum tensile damage of SFRC slab is reduced by 18%, and the area of weakness is reduced by 55%. The maximum tensile damage of the SFRC slab was decreased by 14% and the area of weakness was decreased by 80% as the fiber content increased from 70kg/m^3 to 110kg/m^3.

Key words: steel fiber reinforced concrete; Concrete Faced Rockfill-Dam; plastic-damage model; elastic-plastic analysis

Dynamical characteristics of formation processes for non-homogeneous debris flow

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Abstract: As a kind of typical two-phase flow, non-homogeneous debris flow behaves some basic properties such as grain size distribution with a large scale, more specific gravity, and non-uniformity of both flow resistance and velocity, which results in heavy natural disasters. As for this, 48 runs simulation experiments for non-homogeneous debris flow were carried out at Debris flow Observation and Research Station at Jiangjia Gully in Yunnan Province. It has been shown by experimental results that the ways of particle starting were stated as individual, common and generous particle starting, and types of particle starting includes three types such as common-encountered type, dam-break type and landslide type. Furthermore, the formation processes may be divided into three kinds of the stage, such as solid particle starting stage, refined and accumulated mixture stage and formation stage of two-phase flows. Therefore, the dynamical characteristics responding to three kinds of the stages have been revealed, and the sequencings for water flowing intensity are dam-break type's debris flow, common-encountered type's debris flow and landslide type's debris flow. These results not only enrich the subject of debris flow dynamics, but also benefit the disaster prevention and mitigation of debris flows.

Key words: non-homogeneous debris flow; formation processes; particle starting types; accumulated mixture; dynamical characteristics

Transient pressure pulsations of prototype Francis pump-turbines

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Abstract: The increasing need of electricity market leads to frequent switches of operating conditions for pump-turbines, which forces them to work in off-design conditions with high-amplitude pressure pulsations. Pressure pulsations for Francis pump-turbines are mainly caused by flow-induced instabilities such as rotor stator interaction, rotating stall and vortex rope in the draft tube. However, few researches concentrate on pressure pulsations in transient state compared with steady state. This paper presents a study of pressure pulsations of a prototype pump-turbine including steady state and transient state with pressure data measured in spiral case, draft tube inlet and vaneless space in field test. Pressure pulsations are first obtained with Savitzky-Golay filter and then analyzed by FFT and STFT. The results indicate that when the turbine reaches runaway during load rejection, pressure pulsations in spiral case and vaneless space constitute rotor stator interaction with high frequency and rotating stall with low frequency. The maximum amplitude for rotor stator interaction occurs in turbine brake condition for spiral case and in runaway point for vaneless space. The maximum amplitude for rotating stall occurs in turbine braking condition. Pressure pulsations in draft tube are made up of components with low frequency, which is in connection with vortex rope and unstable flow.

Key words: pump turbine; transient state; pressure pulsations; signal processing

The relationship of particles and pixels of micro-numerical models of cement-based materials

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Abstract: The micro-numerical simulation of hydration process of cement-based materials is one of the most advanced methods of the research on the cement-base materials´ performance. During the calculation process, the relationship of the particles and the including pixels will affect the reasonability and accuracy of the numerical simulation as well as the accuracy of packing particles. The relationship between particles and pixels, established based on the different mathematical regulations, was compared and validated by an available foreign relationship. Besides, the further research conducted to figure out the relationships of particles and pixels with the particle motion. It is found that the "vibration" can be realized and the particles can be compacted when moving the small particles, which is of great significance for optimization of particles' packing. Meanwhile, the numerical simulation error was analyzed to put forward that the appropriate accuracy of cement particles should be selected when using actual application.

Key words: cement-based material; micro; numerical analysis; particles and pixels; packing the particles

Nonstationary frequency analysis of low-flow series considering both baseflow recession process and rainfall

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Abstract: The frequency analysis of low flows plays a key role in water resources management and planning. Due to the influence of climate change and human activities, the frequency spectrum of extreme hydrologic events would have changed over time. In order to implement hydrological frequency analysis under the changing environments, many nonstationary frequency analysis techniques have been developed recently. However, these methods are put forward mainly for analysis of floods rather than low flows. In this paper, a method incorporating the information of base-flow recession and rainfall into the nonstationary frequency analysis of low-flow series is carried out. The analysis presented in this study is based on 50 years of daily rainfall-runoff data from Huaxian gauging station of the Weihe River of northwestern China. The result shows that the method that establishes the link of low flows to base-flow recession process and rainfall is able to describe the frequency evolution of nonstationary low-flow series better than the method of trend analysis, thus providing important guidance to develop better techniques for the low-flow frequency analysis.

Key words: nonstationary frequency analysis; low-flow; recession analysis; Weihe River

Rheological parameters of debris flow slurries with different maximum grain sizes

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Abstract: According to the grain size distribution of viscous debris flows in Jiangjia Gully of Yunnan Province of China, four groups of debris flow slurries with different maximum grain sizes (0.25, 1, 2, 5 and 10mm) were prepared. Each group corresponds to a specific density of debris flow. Rheological tests were performed with ball measuring system, and rheological parameters were then determined using the Herschel-Bulkley model to study how these parameters vary as coarser grains were added to a finer-grained slurry. The results show that all slurry samples behave as shear-thinning fluids, whereas they become less shear-thinning and exhibit higher yield stress when coarser grains were added. For slurries with the same maximum grain size, yield stress increases exponentially with volumetric solid concentration. There is no distinct relationship between the consistency index and the maximum grain size because of the variation in fluidity index. However, the apparent viscosity increases when coarser grains were added, and the increasing amplitude is a little less than that of the yield stress. A good linear relationship exists between the relative viscosity and the relative yield stress of coarser-grained slurries to fine-grained slurries, which can be used to estimate the apparent viscosity of debris flow.

Key words: debris flow; slurry; rheological parameter; Herschel-Bulkley model; Jiangjia Gully; ball measuring system

Simulation of fracture impacts on light non-aqueous phase liquids migration and distribution in the unsaturated zone

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Abstract: Macropore and fracture make rock-soil mass present strong anisotropy. Compared with the homogeneous medium and heterogeneous medium without fracture, Light Non-aqueous Phase Liquids (LNAPL) priority through fracture into the soil, its migration law is more complex, and cause more serious pollution. Therefore, the study on migration and distribution of LNAPL in soil with fracture is very necessary, and the results will provide a theoretical basis for the remediation of zone with fracture. In this paper, the effect of fracture on LNAPL migration and distribution was examined through laboratory investigation and TOUGH2 numerical simulation. The results indicate that the pressure in fracture increased rapidly and formed a radiative zone that the fracture as the core, the pressure decreased slowly; LNAPL infiltrates into fracture first, and formed a fracture-centered zone that the LNAPL saturation decreased slowly. The longer the fracture is, the bigger the contaminated area of LNAPL will be, and the shorter the time that LNAPL would take to reach the aquifer under a same situation. The fractures have an effect of "fast track", which would make the LNAPL infiltrates the soil in a short time, and cause a serious pollution.

Key words: LNAPL; fracture; TOUGH2 numerical simulation; distribution characteristics

Salt-frost heave properties of channel bed soil in the Northern Xinjiang

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Abstract: Water shortage has been the main constraint on agricultural development, and salt-frost heave of conveyance channel bed soil in winter has caused severe leakage in the northwest region of China. A typical frost heaving susceptible channel bed soil was chosen from the Northern Xinjiang and a series of salt-frost heave experiments were conducted to study the heaving property of this soil. The test results show that: (1)the salt-frost heaving rate increases firstly and then decreases as dry density of the soil increases, and it reaches its peak at one particular dry density; (2)with the increase of Na_2SO_4 and water content in the soil, the salt-frost heaving rate increases rapidly, and the relationship of salt-frost heaving rate with these two variations are correlated as quadratic polynomial and linear respectively; (3)compared with the dry density, Na_2SO_4 and water content has more influence on salt-frost heaving rate of this Low-Liquid limit clay. This research provides basic data to solve the freezing injury problem of conveyance channels in North Xinjiang cold and arid area.

Key words: seasonal frozen soil; salt-frost heave; dry density; Na_2SO_4 content; water content

Study on weakening effect of structural plane and stability analysis of Jinping I high arch dam

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Abstract: In order to quantitatively reveal the weakening effect under thousands of tons of water load and long-term effect of complexity seepage field after the project put into operation, as well as to reasonably reconsider the weakening effect in evaluating the dam abutment stability of Jinping I high arch dam, firstly, the weakening effect experimental research was carried out in this paper. In the experiments, the dam abutment rock samples of weak rocks and structural planes of Jinping I high arch dam were collected, and the similar specimens were prepared, then the triaxial compression tests and the water-rock coupling triaxial compression tests were conducted in the MTS815 Rock Mechanics Testing System. Through the tests, the weakening rates of weak rocks and structural planes were obtained, which provide the basis for determining the strength decreased range of weak structural plane in the dam abutment stability research of Jinping Ⅰ arch dam. Secondly, in order to study the dam abutment stability of the high arch dam under reinforced foundation conditions, the three-dimensional geo-mechanical model comprehensive method test has been carried out. In the experiment, the integrated strength decreased range of weak structural plane was determined as 30% according to the weakening test results, and in order to simulate weakening effect of rock mass and structural plane of dam abutment and dam foundation, the temperature analogous materials applicable to all types of weak structural plane strength weakening characteristics have been developed. Through the geo-mechanical model comprehensive method test, the deformation characters, the failure process, pattern and mechanism of dam rocks and structural planes in foundation and abutment are obtained. And the dam abutment stability of comprehensive method test safety coefficient are determined as 5.2~6.0. Evaluation of the stability and security of the arch dam project has been done. The research results provide an important scientific basis for the design, construction and safe operation of the project.

Key words: Jinping Ⅰ high arch dam; weak rock and structural plane of dam foundation; weakening effect; the dam abutment stability; temperature analogous material; the geo-mechanical model comprehensive method test

Experimental research on characteristics of nitrogen output from different layers in red soil slopes

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Abstract: Hilly red soil region of southern China is characterized by thin soil layer susceptible to erosion during the period of concentrated precipitation and frequent rainstorms. Thus, non-point source pollution of nitrogen carried by runoff in development of agriculture and forestry on slope land poses a threat to the water environment. In this paper, vertical layered output characteristics of nitrogen carried by runoff on red-soil slope were analyzed in three treatments, which were Bahia grass planting, hay mulching and bare land respectively, under three natural precipitation events which happened before, after and one year after spreading fertilizer with the use of Drainage Lysimeter. The results showed that output amounts of TN through surface runoff in three treatments decreased gradually from bare land, hay mulching to grass planting, and output amounts of TN through interflow and underground runoff were ranked in descending order, from hay mulching, bare land to grass planting. Under condition of rainstorm, underground runoff was main carrier for layered output of TN in runoff on red soil slope, accounting for 55.28% ~ 95.30%. Nitrogen loss was not only reflected in surface runoff, accounting for 0.12% ~ 42.16%, more of which was also reflected in interflow and underground runoff. Soil and water conservation measures such as vegetation covering and dry litter mulching could help dissolved inorganic nitrogen infiltration.

Key words: red soil; slope land; nitrogen output; surface runoff; interflow; underground runoff

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Construction intelligent control packaged technology and its application for a large hydropower project

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Abstract: The foundation of quality control, the quality of concrete construction and temperature control is an important technique problem of 300m super high arch dam during construction period. The traditional quality management depending on the professionalism and responsibility of employees exhibit difficulty to ensure the fine control requirements of the construction quality. Based on the intelligent control idea of "comprehensive perception, real analysis and real-time control", the intelligent construction key technology of the large volume concrete water cooling, concrete construction process, foundation grouting engineering are captured, which realize the precise automatic online entire-process monitoring, warning and intelligent control of the whole dam construction quality. In addition, in order to solve data collection in the complicated conditions, data mining in huge data, data sharing in the condition of multi participation, data application in the condition of the essence of quality, business collaboration platform (iDam), with dam information model (DIM) as core, are presented, which provides an effective means for the fine management of each specialty and link during the dam construction process, and a supporting platform of the real analysis, prediction of the dam working state and dynamic adjustment and optimization of construction scheme.

Key words: hydropower project; intelligent temperature control; intelligent vibration; intelligent collaborative platform iDam; dam information model (DIM)

Framework and delimitation study of aquatic ecological red-line

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Abstract: Aquatic ecological red-line is an important method in water eco-environment protection, which provides a more feasible management mechanism for protecting water ecological security. By analyzing the relationship between the characteristics of aquatic ecosystems and ecological processes, this article proposes a framework for aquatic ecological red-line which contains magnitude red-line, spatial red-line and water quality red-line, and analyzes the interaction among these three kinds of red-lines and their connotations. Based literature research in methods of environmental flow, inundated area, ecosystem health assessment, etc., considering rules and regulations about environment protection in China, a defining method which combines natural attributes with social attributes is put forward. Three cross-sections (Huaibin, Wangjiaba and Bengbu) in the Huai River basin are chosen as examples to set aquatic ecological red-line. This study fills in gaps in aquatic ecological red-line and has profound meaning to further research.

Key words: aquatic ecological red-line; framework; delimitation; indicators; environmental flow

Effects of temperature control curtain on water releases in deep water reservoirs

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Abstract: Stop log gate intake and multi-level orifice intake are often used to control the temperature of water releases in thermally-stratified reservoirs. However, these measures must be completed before the reservoir running and will cause some power loss. For those reservoirs which have been put into operation without selective withdrawal structures, a temperature control curtain set before intakes has been proposed. A 3-D numerical model is developed to verify its validity and analyze the effect factors. The results show that the temperature control curtain can raise the temperature of water releases by 2~8℃ in spring and summer. The degree of improvement is affected by the type, height of curtain and vertical temperature distribution. Then, a temperature prediction formula of this scheme is put forward based on the above conclusions. The temperature control curtain has good effects and can be widely spread.

Key words: low temperature of water releases; temperature control curtain; selective withdrawal; 3D numerical simulation; formula of water temperature releases

Study on coupling of optimal water transfer and supply process for inter-basin water-transfer multi-reservoir system

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Abstract: For delineating and solving water transfer and supply processes of inter-basin water-transfer multi-reservoir system, the 0-1 programming method is employed in this study to determine the optimal water-supply and water-transfer progress, which need to be considered together in the joint operation process. For reducing decision variables in single optimization and improving the global search ability, the principle of Progressive Optimization Algorithm is adopted to develop the traditional Particle Swarm Optimization algorithm into a Progressive Reservoir Algorithm-Particle Swarm Optimization (PRA-PSO) to solve the optimization model. Finally, an inter-basin water transfer project in North China is taken as the case study to verify the reasonability and efficacy of the model. The optimal operation process not only can provide the data samples for stochastic optimization operation, but also can be used to evaluate the operation result of multi-reservoir system.

Key words: inter-basin water transfer; multi-reservoir; optimal water transfer and supply process; coupling; improved PSO

Statistics of the initial defects within concrete based on CT image

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Abstract: Concrete is a multiphase composite material consisting of aggregates, mortar and initial defects. In order to understand the distribution of the initial defects, X-ray computed tomographic images were utilized to extract and reconstruct the three dimensional configuration of the defects by means of the image processing software. Each individual defect was identified and approximated with a specific ellipsoid using MATLAB codes. Statistics of the parameters of the ellipsoid, such as axis orientation, coordinates of the center, as well as the semimajor axis, can provide distributions of the initial defects within concrete. It was demonstrated that normal distribution, exponential distribution or uniform distribution could be used to describe the distribution of the axis orientation, and uniform distribution might be suitable for the position of the defects, while logarithmic normal distribution or extreme value distribution might be appropriate for the size of the defects. Such quantitative statistics improve our knowledge of initial defects within concrete.

Key words: concrete; initial defect; CT; ellipsoid; probability density