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Influence of Na^+ and K^+ on the early-age shrinkage properties of cement-based materials

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Abstract: The influence of the different metal ions (K^+ and Na^+) and alkali content on autogenous shrinkage and drying shrinkage at early age has been investigated through mercury intrusion porosimetry (MIP), nanoindentation and ^{27}Al magic angle spinning nuclear magnetic resonance (^{27}Al MAS NMR). The results indicate that the autogeneous and drying shrinkage of cement-based materials are increased by K^+ or Na^+, whereas the effect of K^+ is much more obvious. The mechanisms of these phenomena are attributed to three reasons: (1) the capillary pores less than 50nm in cement-based material with high K^+ content are more than those with high content Na^+, leading to a higher driving force when shrinkage occurs; (2) K^+ tends to promote the formation of high density calcium silicate hydrate (HD C-S-H), but the total content of C-S-H in cement-based material with high K^+ content is higher than the one with high Na^+ content, and the large amount of C-S-H is primary cause of high early-age shrinkage; and (3) K^+ is easier to hinder the formation of AFt and accelerate the transformation of AFt to AFm than Na^+ at early age, leading to the weak framework function of AFt. The cement-based material with high K^+ content has more shrinkage values at early-age.

Key words: shrinkage; alkali type; pore structure; calcium silicate hydrate; nanoindentation; nuclear Magnetic Resonance

Study on the pool ice growth-decay and numerical modeling

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Abstract: To study ice growth and decay evolution on still water, a prototype test was conducted at different time and different water depth on Nanhu pool, located at Tuoketuo County in Inner Mongolia, from mid-November 2014 to mid-March 2015, through which the process of ice thickness, water temperature and ice temperature changing with time and air temperature were obtained. According to the analysis of the physical process of water freezing and melting, the author established a water temperature model and the model of ice growth and decay. The results show that air temperature is a major influential factor on ice growth and decay. Water depth has minor impact on ice cover evolution, which only influences ice thickness in later freezing period and ice completely melting period. Water temperature in surface is more influenced than that in deep water by air temperature. The ice temperature is changing with air temperature consistently. On the basis of previous mathematical model, we added boundary conditions and ice-water-air heat exchange formula to simulate water temperature and ice thickness. It is showed that the simulated results agreed to the measured results on the whole, and the errors are within the allowance range. These results deepened the cognition for ice cover mechanism and numerical modeling under hydrostatic condition.

Key words: still water ice; prototype test; water temperature; ice cover evolution; numerical simulation

Optimal design of the gravity micro-irrigation pipe network for irrigation district

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Abstract: Micro-irrigation pipe network system is composed of field pipe network system and main pipe network system, the pressure at the entrance of field pipe network is only related to emitter operating head and the difference of allowable pressure head of field pipe network, so the optimization of the two parts are mutually independent. Currently, optimal design of field pipe network is mainly in the conditions of area is limited and layout has been confirmed. In this paper, optimum design mathematical models of field pipe network with unilateral capillary and paired laterals and main pipe network were established in the condition with unlimited area of pipe network, which can optimize both the layout of pipe network and pipe diameter simultaneously, and obtain the best control area of pipe network. In order to improve the population quality, an infeasible degree of solution is adopted to select the initial population that generated randomly. In the model, the penalty function method is adopted and the genetic algorithm is applied to carry the optimization. The results show that field pipe network with paired laterals is better than that with unilateral capillary in control area and investment of unit area, so field pipe network is recommended as the foundation of main pipe network optimization, the algorithm is of good convergence and high precision. The results of this paper have some practical significance for optimal design of the gravity micro-irrigation pipe network and regional pipe network.

Key words: micro-irrigation field pipe network; optimal layout; optimal design; genetic algorithm

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Research on identification methods and applications for harmony of human-water relationship

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Abstract: The relationship between human and water is very complicated, which involves many elements of water system, and contains numerous relationships and influence factors. It is necessary to quantitatively identify which are key factors affecting human-water relationship, and which is dominated party in the interaction between human and water. This is of great significance for a correct understanding of the relationship between human and water, as well as scientific regulation of human-water harmony. Based on analyzing the interaction mechanism of human-water relationship, the concept of "Harmony Identification" was put forward, which was defined as "the discrimination process of the primary and secondary relations and contribution of different related parties dominating harmonious relationship, and of the primary and secondary relations and impact of different factors affecting harmonious relationship through quantitative analyzing the harmonious relationship between two or more parties". In view of harmony identification problems, harmony identification methods were summarized from both modeling methods and non-modeling methods. The system framework of harmony identification method and application was established, and the application of harmony identification methods to human-water harmony regulation was explored. Finally, an example of application is given to expound the application process of identification methods for harmony of human-water relationship, which provides a new approach for the study of human-water harmony, and the analysis results lay a foundation of harmony regulation of human-water relationship.

Key words: harmony identification; human-water relationship; identification methods; harmony theory; harmony regulation

Stable isotope characteristics in the Poyang Lake region at Jiujiang section of the Yangtze River in different seasons

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Abstract: In order to find out the relationship between the Poyang lake and the Yangtze River and other inflowing rivers, and to objectively discuss the influence of the Three Gorges Reservoir's operation on the lake, samples of river water and lake water in the Poyang Lake region at Jiujiang section of the Yangtze River were taken and analyzed for stable isotopic composition. The isotopic composition of rivers and lakes shows a great temporal and spatial variation, which can be used to reveal the relationship between the lake and rivers. The water-supply dispatch effectively reduces the water loss of the lake in spring. In April, the lake greatly recharges the Yangtze River because of the considerable flow volume of inflowing rivers which have just entered rainy season. During the flood storage dispatching period, the high water level of the Yangtze River restrains the discharge of lake water. The lower water level of the Yangtze River caused by the impoundment dispatch greatly accelerates the water discharge of the Poyang Lake during its dry season. Thus, the water regime of the Poyang Lake basin should be taken into consideration during the dispatches of the Three Gorges Reservoir, alleviating possible floods in wet season and droughts in dry season.

Key words: Poyang Lake; Yangtze River; Three Gorges Reservoir; dispatch; stable isotope

Regularity for sediment floc deposition in the Three Gorges Reservoir

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Abstract: Difference between sediment gradation measured in field and primary particles gradation indicates that there exist sediment flocs in the Three Gorges Reservoir, which may increase sediment deposition rate in the reservoir. In order to determine the influence of flocculation on sediment deposition, sediments from the Three Gorges Reservoir were collected to investigate the sediment settling process by hydrostatic settling experiments, in which the water environment is similar to that in the Three Gorges Reservoir. The results show that when sediment concentration larger than 0.3kg/m^3 some particles flocculates and the extent of flocculation gets larger when sediment concentration increases, and the maximum diameter of the primary particles which may be affected by flocculation is about 0.022mm, that means that 83% of the total sediment may be influenced by flocculation. Within the concentration of the sediment in the Three Gorges Reservoir, the average settling velocity is proportional to the sediment concentration. Flocculation factor and mass settling flux factor is used to reflect influence of flocculation on reservoir sedimentation and it is found that both factors increase with sediment concentration at the beginning of the experiment and when sediment concentration below 1.5kg/m^3 the maximum value of flocculation factor and mass settling flux factor are 5.03 and 1.66 respectively, which indicates that flocculation may have great influence on sediment deposition in the reservoir.

Key words: sediment flocculation; the critical diameter; flocculation factor

Research on the safety of high gravity dams considering hydraulic fracturing

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Abstract: Hydraulic fracturing is a phenomenon in which crack is fractured by a pressurized liquid. It is often a factor influencing the safety of hydraulic structures. This study presents a test method to evaluate the safety of high concrete gravity dams in the presence of hydraulic fracturing. A large concrete specimen with embedded crack was designed according to the stress condition of gravity dam heel, and a series of tests at various concrete ages and under different uniaxial stress conditions were performed. The influence of concrete strength and stress on the test results was discussed. On the basis of the tests, a finite element method was developed to analyze the influence of hydraulic fracturing on high gravity dams. Furthermore, safety of different dams designed by specifications in China, the USA and Switzerland was compared with the finite element method. It revealed that gravity dams higher than 200m designed by current specifications will be in risk considering hydraulic fracturing and dams designed by different specifications have significant differences in anti-hydraulic fracturing. The vertical compressive stress at the dam's upstream surface might be the key for improving the resistance of hydraulic fracturing. However, more studies need to be conducted to quantify this indicator.

Key words: hydraulic fracturing; gravity dam; concrete crack; physical test; design specification

Experimental study on the effect of pipeline turbulence on killing *Limnoperna fortunei* larvae I. Hydraulic characteristics

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Abstract: Golden mussel (*Limnoperna fortunei*), belonging in the family Mytilidae, can lead to biofouling and pipe clogging. The species invades the pipelines during its planktonic larva stage, which is apt to be killed by high frequency turbulence. To obtain efficient methods to prevent golden mussel invasion in the pipelines, 3 types of galvanized plates embedded with circular pores and 3 types of galvanized wire meshes were selected as turbulence-generating materials (TGMs) and installed in an experimental pipe (average flow velocity≈1 m/s) with intervals of 50 cm and 25 cm. The downstream flow field of the TGMs was measured by Acoustic Doppler Velocimeter (ADV). The experimental results indicated that the velocity distribution was disturbed by the TGMs in short longitudinal distance. Velocity disturbance was observed in the downstream transverse sections of the 6 mm and 10 mm pore plates and was weakened with the TGM interval reduced from 50 cm to 25 cm. All the wire meshes exhibited little influence on discharge capacity of the pipe and might accelerate downstream flow velocity within short distance if the wire meshes were densely installed. The downstream turbulence intensity of the pore plates showed a banded distribution pattern while the wire meshes had a less distinct banded pattern. The downstream turbulence intensity of the TGMs turned to decline until the next installation. The energy of high frequency turbulence behind the pore plates were enhanced to a large extent. Meanwhile, the turbulence intensity was improved and the eddy length scale was reduced in a range of 5 cm downstream the materials, which was beneficial in golden mussel larvae killing. The wire meshes presented a much weaker effect on increasing the high frequency turbulence energy and led an energy decrease of low frequency turbulence. The installation of pore plates resulted in larger resistance than wire meshes and dense layout did not lead to higher resistance for each TGM. In summary, 6 and 10 mm pore plates and 3 mm wire mesh revealed higher potential for improving the effect of pipeline turbulence on killing Limnoperna fortunei larvae.

Key words: *Limnoperna fortunei*; pipeline; turbulence-generating material; high frequency turbulence; hydraulic characteristics

A modified UH model for rockfill materials

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Abstract: The original UH model for rock-fill materials via different stress path tests is validated in this paper. The results show that, there is a certain error between the experimental data and model predictions in the constant stress ratio paths, and the characteristic line of the original model can not reflect the practical deformation law of rockfill materials. A new plastic potential surface is used to modify the UH model, which obeys a non-associated flow rule. The modified model has been improved markedly in predicting rockfill materials behaviors under different stress paths. In a similar manner, the UHD model is also modified to predict cyclic loading behaviors of granite rockfill materials. The results of model prediction agree well with the experimental laws.

Key words: rock-fill materials; UH model; stress path; cyclic loading

Analysis of crack propagation of concrete under uniaxial compression based on double scalar variables damage-based cohesive crack model

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Abstract: In order to solve the problem for crack propagation of concrete under uniaxial compression, the viewpoint of damage mechanics is introduced into the description of the cohesive crack model, and a kind of double scalar variables damage-based cohesive crack model is presented in the framework of thermodynamics. Tensile and shear damage evolution curves is fitted according to the experimental data, and Coulomb's law is introduced into the shear damage evolution curve, which makes the proposed cohesive crack model more perfect. It can synthetically describe the stress-relative displacement relationship between the crack surface, not only for the single (Mode Ⅰ and Ⅱ) crack mode, but also the mixed (tension-shear and compression-shear) crack mode. In the numerical method, irregular interface element method is used to divide the triangle mesh randomly and then embed the interface element on the boundary of all triangular elements, so that the crack can propagate in the global of the specimen. Combined with the above two methods, the numerical simulation of the crack propagation of concrete under uniaxial the compression is carried out. Phenomena including multi-cracking, crack coalescence, and lateral expansion deformation during crack propagation of concrete can be described in the numerical simulation.

Key words: concrete; damage; crack propagation; cohesive crack model

Conversion relationship between initial fracture toughness of site-casting and sieved concrete

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Abstract: This paper studies the conversion relationship between the initial fracture toughness of site-casting dam concrete and that of sieved concrete. The concrete mixture produced by the mixing tower system on the construction site of a super-high arch dam is used to cast and mold different sizes specimens, of which the maximum aggregate size of dam concrete specimens is 150 mm and that of sieved concrete specimens is 40 mm. Based on the experimentally acquired initial cracking loads, the initial fracture toughness K_{Ic}^{ini} of the dam concrete and the sieved concrete were obtained using the finite element method. Furthermore, the effect of dam concrete and sieved concrete specimens size on initial fracture toughness was analyzed and discussed. The results show that, regardless of the dam concrete specimen or sieved concrete specimen, when the ratio of the ligament height to the maximum aggregate size is equal to or larger than 6.0, the stable values of initial fracture toughness can be obtained. Based on the test results, the calculating formulas for the initial fracture toughness of large dam concrete specimens are derived from that of small sieved concrete specimens.

Key words: initial fracture toughness; dam concrete; sieved concrete; conversion relationship; site-casting

Establishment and application of cascading failure model based on connection degree of cascade reservoirs system

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Abstract: At present, a lot of rivers have entered the stage of cascade development. In order to assess the safety of the cascade reservoirs system, a cascading failure model is established in this paper based on the analysis of the characteristics of cascade reservoirs system according to the failure effect relationship between upstream and downstream reservoir. The definition and calculation of connection degree is the most important part in the analysis of the cascading failure model. In the process of analysis, the set pair analysis theory and the ideas of the connection degree is introduced, and the contact distance is defined. The index value which reflects the relationships of each reservoir is changing within a certain interval, so the interval Numbers of the mathematical knowledge is introduced, the method that based on TOPSIS is deduced, and finally the connection degree is calculated through the cascading failure model. This paper provides a foundation theory for the overall safety analysis of cascade reservoirs system, and certain theoretical reference for the optimization design of cascade reservoirs system.

Key words: cascade reservoirs; cascading failure; connection degree; set pair analysis

Vertical dynamic load identification of hydraulic turbine based on orthogonal polynomial decomposition

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Abstract: Hydro-turbine vertical dynamic load is very complex. The transmission of dynamic load has uncertainty through the bearing-housing-frame-pier. A dynamic load identification method of hydraulic turbine was proposed based on orthogonal polynomial approximation. The algorithm not only has high speed but also needs less measuring points information. Comparing with the genetic algorithm identification, the orthogonal polynomial algorithm could avoid falling into local convergence and don't need repeat many times positive analysis. The traditional orthogonal polynomial identification obtained the modal displacement through the modal force by Duhamel integral. But the time cumulative error problem of the Duhamel integral decreases the identification accuracy of the dynamic load. The algorithm proposed in this paper constructs the relationship between the modal displacement and modal force according to orthogonal characteristic of the polynomial and derivative relation between the displacement and velocity or acceleration. The proposed method does not need Duhamel integral and increases the identification accuracy. Numerical simulations demonstrate that the identification and assessment of dynamic loads are effective and consistent when the proposed method is used.

Key words: hydro-generator set; vertical dynamic load; orthogonal polynomial; identification

Similarity of horizontal mixing of thermal effluent distorted model

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Abstract: Close relations exist between the mixing coefficient of thermal effluent and the distortion ration. Understanding and clearing the impact of similarity of mixing is important to design the thermal effluent model, to choose the distortion ration and to improve the accuracy of model simulation. Previous computational methods of mixing coefficients and previous studies about the problem of similarity theory study of mixing are summarized, and the common computational model of the horizontal mixing coefficients in the wide-shallow waters is proposed. On the base of these, mathematic model calculation is combined with thermal discharge flume experiment under the condition of controlled temperature and humidity. And contrastive study on transport and mixing of thermal effluent distorted model under similar conditions of surface heat dissipation is carried out. The main characteristic parameters of flow field and temperature field and horizontal mixing coefficients under different scale rates are analyzed. Finally, the logarithmic formula used in the wide-shallow waters between horizontal mixing coefficient and the distortion ration is proposed. Verified by the field measured data, the formula has acceptable feasibility. It can be used for the conversion calculation of horizontal mixing coefficients between the distorted model and the prototype. The research findings lay a good foundation for numerical simulation and the selection of physical model test parameters of thermal effluent or other pollutants in the wide-shallow waters.

Key words: similarity of mixing; horizontal mixing coefficients; distortion ration

Research on river health assessment method based on coordinated development degree

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Abstract: To evaluate the health and coordinated development of river systems, firstly, a complete system for river health assessment which includes water resource, physical structure, water quality, biology characteristics and social service is established; secondly, the concept of coordinated development in the sciences of society and economy is used in this paper, and then construct the coordinated development evaluation model of river system, and put forward the criteria of the coordinated development evaluation model; finally, carried out the empirical research for the health coordination status of Luanhe River. The results show that the coordinated development model can not only reflect the health degree of the river system, but also can measure the harmonious development of the natural and social attributes.

Key words: river health; index system; coordinated development degree; combination weighting method; criteria; Luanhe River