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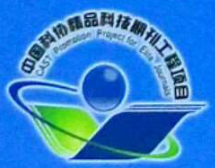

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Research and application of dynamic programming algorithm in reservoir operation based on functional analysis

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Abstract: The functional analysis can be used to model for complex problems due to its high abstraction and generality, then the problems can be solved using simple mathematical method. For the large calculation scale and long calculation time of the traditional dynamic programming algorithm in reservoir optimal operation, an average output model has been built and a new modified dynamic programming algorithm based on functional analysis is introduced in this paper. The new algorithm eliminates a large number of repeated calculation procedures in the traditional DP, and reduces the computational scale, which can improve the efficiency of the algorithm. A hydropower station is taken as the study instance. The paper compares the annual average generating capacity and the cost time using the traditional DP, DPSA and the modified DP. The result shows that on the basis of ensuring the global convergence, the modified DP can reduce the calculation scale and shorten the calculation time compared to the traditional DP.

Key words: mapping; linear operator; functional analysis; dynamic programming; reservoir operation

(责任编辑：王成丽)

Performance and failure criteria for plastic concrete under biaxial compressive stress

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Abstract: Based on biaxial compression test of cubic specimens, the performance and failure criteria for plastic concrete were discussed. The results indicate that the failure mode is similar to that of axial compression when the ratio of both biaxial stresses is little, and the most serious damaged surface is of obviously crevasse crack when the ratio is large. The biaxial compressive strength of plastic concrete is extraordinary enhanced to 1.77 to 4.72 times as much as the axial compressive strength. The biaxial compressive strength of plastic concrete first increases and then decreases with the increasing of stress ratio, and is up to its maximum when the stress ratio reaches about 0.75. The larger the axial compressive strength of plastic concrete, the less increase the biaxial compressive strength. With the stress ratio increases, the slope of octahedral normal stress strain and octahedral shear stress-strain curve has an increasing trend. The biaxial deformation decreases with the increase of compressive strength. There is an obvious linear relationship between octahedral shear stress and normal stress under each stress ratio, but its slope gradually decreases with the increase of stress ratio. Based on the analysis for test results of plastic concrete under biaxial compression test, the strength envelope equation and the failure criteria with double parameters, three parameters and considering the impact of load paths were established for plastic concrete under biaxial stresses.

Key words: plastic concrete; biaxial stress; failure criterion; mathematical model; performance

(责任编辑：李　琳)

Back-analysis of instantaneous and rheological deformation parameters for concrete faced rockfill dams

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Abstract: Settlement of rockfill dams include instantaneous elastic-plastic deformation during construction and time-dependent rheological deformation after water impoundment, but it is difficult to distinguish these two kinds of deformation accurately from actual monitoring deformation. In this paper, a back analysis method was proposed to obtain the instantaneous and rheological deformation parameters successively by the combinatorial intelligent optimization algorithm. Firstly, dam deformation was calculated by the finite element method using some prepared parameter samples. Then a RBF neural network has been trained using these samples to establish a mapping relationship between the parameters and dam deformation. Thirdly, the instantaneous and rheological deformation parameters of the dam have been determined by multiple population genetic optimization algorithm according to the actual dam deformation measurements. The computing time of dam deformation has been saved greatly by RBF neural network instead of finite element method, and the precocious problem can be avoided by the multiple population genetic algorithm. The recalculated settlement values of Shuibuya concrete faced rockfill dam using the inversion parameters are well agreed with the actual measured values.

Key words: rockfill dams; creep; parameter inversion; RBF neural network; multiple population genetic algorithm.

(责任编辑：王冰伟)

Analysis and evaluation of nutrient retention efficiency in an agricultural headwater stream predominated by *Phragmites australis*

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Abstract: From September 2014 to April 2015, seven field tracer experiments, in which a solution of biologically active (NH_4Cl and KH_2PO_4) and conservative (NaCl) tracers was added to the stream at a constant rate, were conducted in a typical agricultural headwater stream of Ershibu River in Hefei District. Based on the data sets of tracer experiments, retention efficiency and characteristics of ammonium and phosphorus were interpreted by using OTIS model code and nutrient spiraling theory. Study results show that the ratio of A_s/A in the steam predominated by *Phragmites australis* surpass other ordinary headwater streams, implying a great effect of the transient storage on nutrients retention. The values of first-order uptake rate coefficients for NH_4^+ and SRP in transient storage zone were all higher by an order of magnitude than that of main channel, and the positive of uptake rate coefficients suggested that the study reach even acted as a nutrient sink. The uptake lengths of S_w-NH_4 was smaller than S_w-SRP, especially in winter and early spring, suggesting that the retention capacity for ammonium was better than that of SRP in the study reach. The total retention efficiency for NH_4^+ and SRP were 14.46% and 10.73%, respectively, and their biological retention efficiency were 9.17% and 3.67%, respectively. Estimates of mass loss indicated that the main channel and transient storage zone accounted for 43.12% and 56.88% of the NH_4^+ uptake, and 50.13% and 49.87% for SRP, respectively.

Key words: agricultural headwater stream; aquatic macrophyte; nutrient retention; nutrient spiraling theory; OTIS model

(责任编辑：韩　昆)

Game theory in water resources allocation for stakeholders

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Abstract: The natural river flows are seriously disturbed because of the quasi public goods attributes and externality of water resources. Based on game theory, non-cooperative model with leader-follower relationship is established to analyze the water resources allocation. Because the individual benefit can not reach Pareto optimal state, cooperative model is provided for more beneficial to all stakeholders. Cooperative game increases the total benefits, but reduces leader's payoff. It is necessary to allocate benefits from cooperation to leader. The feasible solution set of benefits allocation is constructed by introducing indifference curve of the microeconomics and formation condition of coalition. A fair and efficient allocation is determined using the marginal contribution method from the feasible solution set. The results show that the total benefits of cooperative game are more than benefits from non cooperative game and achieve Pareto optimum. The leader benefit from cooperation is more than non cooperation benefit, which is advantageous for the leader to form coalitions.

Key words: game theory; leader-follower relationship; indifference curve; Pareto optimum; allocation of cooperation benefits

（责任编辑：王成丽）

Survey and analysis of the "7·04" river-blocking debris flow of Xiongjia Gully in Shimian county, Sichuan province

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Abstract: Since the "5·12" Wenchuan earthquake, the geological tectonic activities in Sichuan area have happened frequently. After the "4·20" Lushan earthquake, the geological disasters in Yaan district entered a frequent period. On July 4, 2013, a debris flow in Xiongjia gully was broken out at 20:00, and the Zhuma River was blocked, which causes great economic loss and casualties. In order to study the river-blocking characteristics and the prevention measures of debris flow in Xiongjia gully, through field investigation, it is found that the longitudinal slope of terrain in alluvial fan zone increases suddenly, which triggers the mutations of debris flow movement in this area, because of the Shi-Gan highway and especially the river embankment engineering of the Zhuma River. This kind of debris flow is defined as an engineering increasing longitudinal slope type of river-blocking, according to the longitudinal slope variation characteristics of debris flow in the accumulation area. Investigating the changes of the provenance of pre and post the "7·04" debris flow in the study area, it is found that the average conversion rate of sediment source to debris flow is 0.307, and the debris flow provenance located in the downstream is eroded more easily. According to the screening test of deposits of up-water and under-water of debris flow, the flow density increased by 3%, and that the median diameter d_{60} increased by 3.4%. Using the Spss statistical software and theoretical analysis, the relationship has been obtained between debris flow velocity, flow and drainage basin, and its attenuation characteristics, which provide a certain gist for the debris flow type and its prevention and control in the study area.

Key words: longitudinal slope; river-blocking; bulk density; median diameter; attenuation coefficient

(责任编辑：李　琳)

Research on seepage law of splitting sandstone with non-fillers under multiple factors

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Abstract: The crack seepage law of splitting sandstone is complex with numerous influence factors, so its research is of great significance to end infiltration in engineering. Experiment on seepage of splitting sandstone was carried out by using ELE rock seepage instrument. Based on the methods of CAD-ANSYS interface program, ANSYS skin technology and ArcGIS collaborative modeling that calculates the splitting surface area. Studies on seepage flow variation rules caused by splitting surface area, trace length, import and export length, joint roughness and various stress paths were conducted. The results show that variation stress path has a significant effect on the seepage flow. Seepage flows with negative exponential function change when the confining pressure is constant while the seepage pressure increasing; and seepage flows with power function change when the seepage pressure is constant while the confining pressure increasing. Then non-uniform coefficient λ is put forward, which can reflect the seepage flow variation rules with confining pressure when the seepage pressure is a constant. And efficient ended infiltration and effective ended infiltration are put forward, which can describe the seepage flow variation rules with confining pressure when the seepage pressure is constant and can provide references for exerting pressure and ending infiltration. According to the test results, permeability coefficient k is put forward, which means that seepage parameter of porous medium and crack seepage parameter can be converted to each other, and in addition which can provide a reference for seepage of porous medium of splitting sandstone.

Key words: splitting sandstone; seepage area; non-uniform coefficient; coefficient of permeability; crack seepage; average seepage

(责任编辑：李　琳)

Research on the crack propagation processes of concrete based on energy consumption equivalence between stochastic damage and fracture

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Abstract: Based on energy consumption equivalence between damage and fracture, a micro-spring stochastic damage model was established with the assumption that the micro-spring failure strain is lognormal distribution and further the method of constructing the cohesive law of concrete was studied. The specific expressions of the cohesive laws of dam concrete (d_{max} is 80mm) and sieved concrete (d_{max} is 40mm) were obtained respectively by this method. Then the obtained cohesive laws were used to simulate the crack propagation process of three-point bending notched beams of dam concrete and sieved concrete respectively. Then the *P-CMOD* curves obtained from calculation were compared with the available experiment data, indicating a good agreement, which show the rationality and the effectiveness of the model and the calculation method presented in this paper. The characteristic lengths of the dam-concrete and wet-screening concrete were studied using this model and calculation method. The results show that, for the concrete investigated in this paper, the characteristic lengths are advised to be 6 to 10 times than the maximum aggregate size.

Key words: dam concrete; crack; fracture; stochastic damage model; cohesive law

（责任编辑：王冰伟）

Effect of streamflow forecast uncertainty on reservoir operation

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Abstract: It is of importance to analyze the influence of streamflow forecast uncertainty on reservoir operation. This paper proposed a copula-based uncertainty evolution model to characterize the uncertainty evolution process. Based on this model, the forecast uncertainty series was simulated. Then, the effect of streamflow forecast uncertainty on reservoir operation was analyzed using the Monte-Carlo method. Results demonstrate that the proposed CUE model performs very well. When the pre-released operation method used, the flood risk cannot increase.

Key words: streamflow forecast uncertainty evolution; reservoir operation; risk analysis

(责任编辑：韩　昆)

Nonuniform sediment transport with lateral output in river networks

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Abstract: Water quality in river networks can be quickly and effectively improved by water diversion but the problem of sediment deposition could be also caused at the same time. Laden-sediment flow in main rivers would enter into connected tributaries, therefore the calculation of lateral sediment output in river networks should be taken into account. The observations on real-time water level with discharge and daily sediment in the river network of West Hangzhou were carried out for one year. According to the data, an applicable logarithmic formula for nonuniform sediment transport capacity is established. Then, a new method for calculating sediment transport in river networks is first derived under the consideration of time-dependent lateral sediment output with lateral outflow. The 1-D differential equation for sediment transport in river networks and its discrete model are thus improved. The results of simulation agree well with the measurement. Lateral sediment output calculated accounts for about 11% of total deposition. This means that ignorance of lateral sediment output would cause considerable error, as previous model for river networks did.

Key words: nonuniform sediment; transport capacity; lateral output; river network

(责任编辑：李福田)

Safety evaluation of Xiluodu ultra-high arch dam during the initial impoundment period

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Abstract: To study the safety evaluation of Xiluodu ultra-high arch dam during the initial impoundment period, four qualitative criterions was proposed based on prototype monitoring analysis. Comprehensive analysis was integrated to establish the method and quantitative criterions of safety evaluation, including prototype monitoring and numerical simulation. In this study, the proposed method was used to Xiluodu ultra-high arch dam, and revealed the deformation mechanism of dam structure, reservoir foundation deformation effect, valley amplitude deformation and dam-heel compression mechanism. In conclusion, the performance of Xiluodu ultra-high arch dam is safe and under control during the process of water storing.

Key words: ultra-high arch dam; prototype monitoring and feedback; numerical simulation; safety evaluation

(责任编辑：王冰伟)

Integrated evaluation on aquatic ecosystems of main rivers and lakes in China

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Abstract: Integrated evaluation on aquatic ecosystems of rivers and lakes is one of the important contents in water resources protection planning. From the aspects of hydrology and water resources, water environment, habitats morphology of rivers and lakes, and biology and habitat status, etc., an integrated evaluation system on aquatic ecosystems of rivers and lakes has been built with six indicators, including satisfaction level of ecological base flow, water qualification rate of water function areas, eutrophic index of rivers and lakes, longitudinal connectivity, and retention rate of important wetlands and fish habitats. On this basis, aquatic ecological status of 1006 planning reaches of rivers and lakes and reservoirs, including 673 rivers, 97 reservoirs and 100 lakes and wetlands in nationwide, were evaluated and classified. Aquatic ecological problems faced by rivers and lakes in China's major river basins were analyzed. Research results have important guiding significance for the practice of aquatic ecosystem protection and restoration of main rivers and lakes in China.

Key words: water resources protection planning; health of rivers and lakes; integrated evaluation on aquatic ecosystems

(责任编辑：韩　昆)

Preliminary discussion on crack resistance of eccentric compression hydraulic structure based on TRC

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Abstract: To study crack resistance of eccentric compression hydraulic structures with Textile reinforced concrete, the experiment of six eccentric compression columns under different textile ratios and pre-loads was conducted. Based on the experiment result, the analytical theory of eccentric compression crack propagation was proposed, and then the crack propagation law was investigated. The results show that for structures under one-off load, the crack propagation phase is divided into three phases by cracking of matrix and yield of tensile steel. For structures under secondary load, when the post-strain (caused by preload) is smaller than cracking strain of matrix, the crack propagation is divided into four phases by applying TRC layer, cracking of matrix and yield of tensile steel; when the post-strain is greater than cracking strain of matrix, the crack propagation is divided into three phases by applying TRC layer and yield of tensile steel. In the transfer point of different phases, there is sudden increase for crack propagation rate (the ratio between eccentric compression load and crack extend depth). However, the crack propagation rate decreases gradually at the same stage. The propagation of eccentric tension cracks can be controlled effectively by using TRC, the higher the textile ratio, the more even the distribution of cracks, the smaller the cracks gap and growth rate. The influence of preload on controlling crack propagation at depth is obvious while it is slight at width, overall, the larger the preload, the worse the controlling effect.

Key words: textile-reinforced concrete; eccentric compression; cracks; extend rule

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Water and salt movement under partial irrigation in Hetao Irrigation District, Inner Mongolia

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Abstract: Field experiments were conducted in Hetao Irrigation District, Inner Mongolia, to study water and salt movement under partial irrigation. Compared with uniform irrigation, groundwater of irrigated area dropped significantly faster when partial irrigation was applied, resulting in higher salt leaching efficiency. In contrast, un-irrigated area acted as temporary discharge and buffer zone between irrigated area and drainage ditches, therefore its groundwater and salinity increased significantly during irrigation period, and salt storage in soil profiles also increased consequently. Analysis further indicates that influences of partial irrigation on water and salt movement of un-irrigated area are determined by the area ratio of irrigated land to some extent.

Key words: Hetao irrigation district; fall irrigation; water; salt

(责任编辑：韩　昆)

Research of classification for wet/normal/dry year based on the operation characteristics of hydropower station

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Abstract: The traditional runoff classification method of wet/normal/dry year is not combined with the actual operation process of hydropower stations, which makes it has some limitations in guiding the actual operation of hydropower stations. By taking the Jingsha River cascade hydropower stations as an instance, this paper proposed a new classification method of wet/normal/dry year after the system characteristics analysis of hydropower stations. Its classification results are consistent with the actual operation results, and the consistent rate is as high as 94%, which indicates that the proposed method is reasonable and reliable. Traditional hydrological classification is of static partitioning based on single factor input, while the operation characteristics based classification is the dynamic partitioning based on multi-factor output. The method proposed in this paper can adapt to the complicated actual operation situation, and guide the choice of operation mode more effective for hydropower stations, which has an important practical value.

Key words: hydropower station; operation; runoff; classification; middle Jingsha River

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