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《水利学报》第九届编辑委员会组成名单

EDITORIAL BOARD

Characteristics for circulating currents and water-flow shear stress under the condition of bank slope collapse

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Abstract: Riverbank collapse is a major form of bank slope instability because of hydrodynamic forces, which is the interaction result of the river water flow and bank slope. Eight series of experiments were carried out in a bend flume to simulate the process of bank collapse and river topography in small scale. Cohesive bank material from Dengkou site of the Ning-Meng river reach of the upper Yellow River was used to make the bank slope model. The experiments pay attention to the features of changes in three aspects of water-sediment-riverbed, such as water level, near-bank flow velocity distribution, particle size and riverbed erosion and sedimentation, and the distribution characteristics of water shear force distribution during the collapse of sticky bank slope are revealed and analyzed. The bed shear stress was calculated and found that the shear stress of the head and tail of the collapse body increased suddenly, which formed a larger shear force zone. The tail shear stress is greater than the head shear stress, and the tail is formed eddy current and the flow velocity is chaotic, which increases the local sediment transport capacity of the river bed to speed up the decomposition of the collapse of the body. The paper analyzes the hydrodynamic change characteristics of the bank slope collapse, which provides not only the basis for cohesive bank sediment transport model, but also the reference for the planning and design of river bank construction.

Keywords: bank collapse; cohesive bank material; flume experiment; circulating currents; water-flow Shear stress

The sediment producing mechanism of the No.5 sub-region of the Loess Hilly Region in the Loess Plateau

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Abstract: The No.5 Sub-region of the Loess Hilly Region located mainly in the Northwest Loess Plateau is one of the major sediment source areas in the Yellow River Basin. Based on the results of field surveys and the observed data of underlying surface and rainfall and hydrology, this paper analyzed its sediment source, sediment yielding characteristics and influence factors, and the sediment yielding mechanism were revealed. The results proved that No.5 Sub-region of the Loess Hilly Region is a combination of Loess Hilly Region type and Loess Plateau-gully Region type, and it is characterized with a stretch of loess basin surrounded by groups of loess hills, and possesses loose soil, sparse vegetation, and light rainfall amount and intensity. The sediment sources of this region are not only from the surrounding hilly area, but also from the riverside-bank or the gully-bank of the middle plateau area by a significant amount. The erosion intensity of riverside-bank and gully-bank is most severe in the Loess Plateau, the sediment amount produced from river-or-gully bank in some area even comprises two-thirds of the total sediment yield in the basin, and the intensity would increase with the increase of water joining from mini-ditch to stem-ditch and to river. Floods produced by surrounding hills are main driving force of the bank collapse and slide, and the key influence factors affecting the flood production are vegetation coverage degree and terrace area. The flood yielding ability of the No.5 Sub-region is rather low, but the sediment concentration is high and difficult to reduce notably.

Keywords: No.5 Sub-region of the Loess Hilly Region; climate; underlying surface; sediment source; sediment producing; mechanism

Analysis of pressure damping in air–water transient flow in viscoelastic pipes

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Abstract: Leakage or blockage detection by transient-based techniques is the hot spot and frontier of pipe fault identification in recent research. However, the existence of air makes these techniques difficult for applications in viscoelastic pipes, it is necessary to study the pressure damping and distortion of air–water transient flow in viscoelastic pipes. Firstly, an one-dimensional transient model modified by air content (α) is validated by experimental data. Furthermore, the influence of pipe-wall friction and viscoelasticity on pressure damping is studied through energy and Fourier analysis based on the validated model. Finally, a suggestion on parameter calibration is proposed according to practical application. It is concluded: when $\alpha<2.37\%$, the pressure dissipation rate due to pipe-wall friction increases with the increase of α and size-thickness ratio, while the pressure dissipation rate due to pipe-wall viscoelasticity shows an inverse trend, however, both of them decrease as the pipe length increases; when calibrating the transient flow model, it is suggested that the viscoelastic parameters do not need to be corrected when $1\% \leqslant \alpha \leqslant 2.37\%$.

Keywords: air–water transient flow; pressure damping; pipe-wall friction; viscoelastic effect; parameter calibration

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Primary investigation of isogeometric analysis for hydraulic structures numerical simulation

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Abstract: Numerical simulation of hydraulic structures is an important step in their design and evaluation processes. However, the traditional modeling and meshing patterns of complex structures are complicated and time-consuming. The big gap between the design and the analysis model directly affects the accuracy and efficiency of the solution obtained by finite element analysis(FEA). As a new numerical method, isogeometric analysis(IGA)could integrate pre-processing and analysis processes and has advantages in modeling and analysis. Based on IGA, a new method for numerical simulation of hydraulic structure was developed. A RCC gravity dam model was chosen and the corresponding multi-patch model was built. The simulation results of IGA and FEA were made a contrast from the point of view of accuracy and efficiency. The results show that IGA method could contribute to simple modeling processes, more accurate solutions, faster convergence speed and higher simulation efficiency. It would provide a new and valid method for numerical simulation analysis of complex hydraulic structures.

Keywords: isogeometric analysis; NURBS basis function; isoparametric element; finite element analysis; RCC gravity dam; simulation accuracy; numerical simulation

Hydro-mechanical coupling analysis of pervious lining in high pressure hydraulic tunnel

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Abstract: For the engineering practices of the high pressure tunnel during the operation process, the reinforcement stresses are generally much less than expected, indicating that the economical purpose is not achieved. The concrete plastic-damage model is used to simulate the lining concrete and the water load is treated as a body force applied to the interior of lining, thus a hydro-mechanical coupling algorithm is proposed. Based on the large-scale finite element software ABAQUS, the secondary development is carried out. The user subroutine in ABAQUS, USDFLD, is adopted to adjust the hydraulic conductivity with the material damage synchronously, and the utility routine GETVRM activated by the Fortran language is utilized to acquire the material damage. And the lining cracking process during the first water-filling period of the hydraulic tunnel is simulated. Moreover, the evolution characteristics of lining damage, pore pressure and reinforcement stress are studied. Additionally, the influence of the conditional cooperation between lining and surrounding rock on the coupling results is discussed. It can be found that the lining cracking characteristic matches well with that in field tests. The evolution characteristic of reinforcement stress shows significant differences when the conditional cooperation considered, indicating that the detachment of lining from surrounding rock is the reason why the reinforcement stress values are generally much smaller than expected. The results obtained by the coupling algorithm proposed in this paper consistent with the general engineering phenomena. It means that this algorithm can be applied to other engineering practices and provide some reference for the lining design problem.

Keywords: pervious lining; damage and crack; coupling; reinforcement stress; conditional cooperation

Analysis of regional irrigation water demand based on high-dimensional Gaussian Copula function

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Abstract: In order to investigate irrigation water demand in Guangdong province, South China, as a study case, an eight-dimensional joint distribution of sub-regional precipitations was built. For given frequencies of precipitation of the entire province, the calculation procedures of irrigation water demand of the entire province and its sub-regions were proposed. Frequency combinations of sub-regional precipitation and water demands using three methods, i.e. the equalized frequency, the typical year and the most-likely weight function, were compared. The results demonstrate that the Gaussian copula function efficiently fits the joint distribution of precipitation of eight sub-regions, in which the generalized extreme value distribution and generalized normal distribution are the optimal univariate distribution for individual sub-regions. The differences of water demands of the entire province among the three methods are quite small, but those of individual sub-regions are comparatively large, in particular using the typical year method. The design frequencies of precipitation of individual sub-regions using the most-likely weight function mostly occur near the lines of the equalized frequencies, but those of the Ⅷ sub-region in the extreme dry and extreme wet conditions remarkably are far from the lines in association with a large uncertainty due to a wider confidence interval. The most-likely weight function method on the basis of the high-dimensional Gaussian copula can simulate individual univariate distributions of sub-regional precipitations and capture their dependences, and also present a confidence interval of sub-regional water demands, which is recommended to acquire irrigation water demand for a large-scale region.

Keywords: irrigation water demand; frequency of precipitation; high-dimensional joint distribution; Gaussian Copula function; typical year; most-likely weight function

Multivariate hydrologic uncertainty processor based on Copula function

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Abstract: The traditional hydrologic uncertainty processor (HUP) belongs to the univariate structure type, which only independently provides a marginal Bayesian posterior probability density function of observed discharge for each lead time and does not consider and characterize the inherent dependence among these variables. In this paper, the analytical expression of Bayesian posterior transition density was derived by using Copula function, and therefore the Copula-based BTF (CBTF) method and Copula-based multivariate HUP (CMHUP) was proposed. Subsequently, the Copula-based BEF (CBEF) was developed. Application results of Three Gorges Reservoir (TGR) indicate that the proposed methods are practical and effective, of which the CBTF method and CMHUP not only can quantitatively evaluate the uncertainty of transition forecast for inflows of the TGR, but also reveal the evolution characteristic with time of uncertainty in hydrological forecasting. Moreover, the uncertain information about the maximum inflow forecast within specified lead time is provided by the CBEF method. The proposed methods relax the linear-normal assumption and capture the nonlinear and non-Gaussian characteristics of discharge process adequately, which lead to more extensive application scope and support the flood control and disaster mitigation, and reservoir operation better.

Keywords: hydrological forecasting; Bayesian theory; hydrologic uncertainty processor; probabilistic transition forecast; probabilistic extremum forecast; Copula function

Study on several key problems about anti-cracking design of induced joints in RCC archdams

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Abstract: After decades of practice, it has been proved that setting joints in the dam is an effective measure to prevent cracks in a dam. As for RCC arch dams, transverse joints and induced joints are usually discussed together, and they have played a synergistic effect of preventing cracks because of their different structural features. However, in practical engineering, cracks haven't appeared in a lot of RCC arch dams or some cracks appeared in the positions where joints are not set, which means that the induced joints haven't met the expectations to induce cracks, instead, they bring some additional effects. In many reasons, improperly arrangement of induced joints affected the most. Since the Thermal Stress of RCC arch dam is complicated, changeable and dynamical, the anti-crack design must truly reflect the whole process of dam behavior from construction to operation. Practical application shows that the research of anti-cracking design based on the overall process simulation technology of the whole dam is an effective method, in which the induced joints and transverse joints of the RCC arch dam are simulated with open-closed iterative function, and the Equivalent Strength Theory is adopted for the failure criterion. Study on joints design and structural types of interface according to the simulation results can make the cracks appear as expected, releasing the tension stress caused by the temperature drop, which makes the construction quality of concrete of dam be ensured.

Keywords: RCC arch dams; anti-cracking design; induced joints; equivalent strength

Experiments on characteristics of open-channel flow through submerged rigid vegetation with ball-like canopy

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Abstract: The tree-like canopy model, formed by crown and trunk, are conducted in laboratory flow experiments. MicroADV are used to study the flow characteristics influenced by vegetation with ball-like canopy in open channel. Flow condition varied in four cases, with different flow rate and water depth. Focusing on the mean velocity and turbulence structure, the vertical profiles of longitudinal velocity, vertical velocity and turbulence intensity were analyzed. The results show that the normalized longitudinal velocity increases as the water depth decreases. The longitudinal velocity is almost constant in the stem layer. It decreases firstly then increases with increment of depth in the canopy layer. Strong fluctuation of turbulence intensity is found in the canopy layer. The longitudinal velocity in no-canopy layer follows logarithmic law. The quadrant analysis recovers the canopy layer is the sweep-dominated area and no-canopy layer is the ejection-dominated area.

Keywords: rigid vegetation with ball-like canopy; MicroADV; mean velocity profile; turbulence structure; quadrant analysis

Dynamic visual simulation of diversion tunnel construction based on CATIA

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Abstract: Present studies usually use animation to realize dynamic visual simulation of tunnel construction, which makes 3D models difficult to modify, makes visual simulation process complex to realize and lacks of interaction. Therefore, this paper proposes a dynamic visual simulation method of diversion tunnel construction based on CATIA. Firstly, a 4D simulation model of diversion tunnel was built using parametric design. This 4D model can not only be modified easily and realize construction dynamic visual interactive simulation, but also can modify the visual simulation results easily. Secondly, the construction information could be inquired with secondary development. Finally, this method was applied to an engineering project. It shows that the efficiency of dynamic visual simulation of diversion tunnel construction is improved and helps project managers to make decision when scheme changes.

Keywords: diversion tunnel; CATIA; parametric design; dynamic construction simulation; 4D model

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Experimental research on guide hydro-dynamic torque of a pump turbine in turbine mode

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Abstract: To obtain the hydro-dynamic torque magnitude and its variation law of the pump turbine under the turbine mode, the electromotive stress analysis method and the specially processed shaft of guide vane were applied in a pump turbine model of the domestic pump storage plant. The hydro-dynamic torque of each guide vane was investigated under the situation of synchronous guide vane and misaligned configuration respectively. The main conclusions are as follows: once the synchronized guide vane is employed, with the opening increasing, the hydro-dynamic torque factors magnitude of the guide vane has the consistency among all tested vanes, and the direction of the torque shift gradually from the turn-off direction to the turn-on direction. When the $10^{\#}$ guide vane is set as the misaligned guide vane, and the difference between misaligned guide vane opening and the synchronous one is less than 16.4%, the hydro-dynamic torque factors of the tested guide vanes tend to be distributed regularly. However, when the opening difference is bigger than 16.4%, the hydro-dynamic torque increases sharply with the use of the misaligned guide vane, and the hydro-dynamic torque factors of the different guide vanes change significant.

Keywords: pump turbine; guide vane; hydro-dynamic torque; opening

Impacts of land use change on runoff in Panjiakou Reservoir watershed

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Abstract: Taking the Panjiakou Reservoir watershed as study area, this paper analyzed the spatiotemporal variation of four land use data in 1970、1980、1995 and 2010, and evaluated the impacts of land use change on runoff and spatial distribution of hydrological components combined with the SWAT (Soil and Water Assessment Tool) model. The results show that the spatiotemporal variation of land use types is different which major included water reduction, the increase of forest and urban area expansion. Due to the transition from agricultural land and pasture to forest, the mean annual runoff decreased by 6.36% in Luanhe, Yixunhe, Wuliehe and Laoniuhe sub-watersheds under 2010 land use scenarios. Land use change had little impact on runoff. Constructions of check dams and the increase in social water use were main factors which lead to annual runoff decrease.

Keywords: land use change; SWAT model; runoff; hydrologic response units; Panjiakou Reservoir

Application of kinematic diffusion model to frequency analysis on precipitation samples with zero values

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Abstract: This study developed a frequency analysis method for precipitation samples with zero values using Kinematic Diffusion model. Taking the precipitation series of 6 stations in Shaanxi Province as an example, based on the Strupczewski derivation of the moment method and the maximum likelihood method, the parameter estimation formulas of KD model based on probability weight moment method are deduced by mathematical transformation principle and numerical calculation principle. The fitting effect of KD model, frequency proportional method and type Ⅱ multiplication distribution model is evaluated by using of the AIC criterion and OLS criterion and residual sum of squares criterion. The results show that the KD model can be applied to calculate the frequency of precipitation samples with zeros, and the fitting effect of the model is better than the frequency proportional method and the type Ⅱ multiplication method. Compared the three parameter estimation methods of KD model, the best fitness is the probability weight moment method to estimate the KD model parameters. The method of this paper provides a new calculation method for frequency analysis of precipitation samples with zero values.

Keywords: precipitation sample with zero values; frequency analysis; KD model; probability weighted moment method; frequency proportional method; type Ⅱ multiplication method