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Sediment reduction of warping dams and its timeliness in the Loess Plateau

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Abstract: The sediment reducing effect of warping dams need to be discussed thoroughly due to the sharp decline of the sediment runoff of the Yellow River in recent years. Based on the observed data, this paper analyzed the relationship between the intercepted sediment quantity of warping dams and the corresponding sediment incoming reduction of the Yellow River, the timeliness of sediment intercept ability, and the erosion reduction function of the warping land. The study results reveal that the intercepted sediment quantity of warping dams is normally larger than or equal to the corresponding sediment incoming reduction of the Yellow River. The higher the basin's vegetation-terrace coverage degree and the coarser the Soil particle size is, the smaller will be the proportion of sediment incoming reduction to the intercepted sediment quantity. The timeliness of the dams' sediment trapping function is very prominent, once the sediment storage usage limit is reached, a warping dam would lost its sediment trapping capacity. After that, the dam will continuously reduce and control the soil erosion by its warping land. The influence area of warping land in the term of erosion reduction even reaches 4 times of warping land area, if the vegetation-terrace coverage of the basin is rather poor. But with increased vegetation-terrace coverage rate, the erosion reducing quantity of warping lands will be gradually weakened.

Keywords: Loess Plateau; warping dams; intercepted sediment quantity; timeliness; warping land; sediment reduction

Study on the influence of Poyang Lake Hydraulic Project on hydrodynamics and water-quality in wet and dry year

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Abstract: The original relationship between the Yangtze River and the Poyang Lake will be hindered after the construction of Poyang Lake Hydraulic Project, which may have a great effect on water flow situation in the lake. A 2D well-balanced shallow water model for unstructured grids is established on the base of the Godunov-type finite volume method. According to the water level scheduling scheme by Poyang Lake Water Conservancy Project Construction Office, the variation of hydrodynamics and water quality in wet and dry year is researched. The results indicate that the annual average water level in Xingzi station increases by 1.49m in wet year and 1.88m in dry year after the construction. The water-level variation, velocity variation and the duration of the impact in dry year are all greater than those in wet year. The surface area will increase by 15.3% and the water quantity increase by 29.2% in the dry season of wet year, while that will be 22.8% and 54.1% in the dry year, respectively. The tracer model is applied in studying material transmission of the lake. The residence time increases by 1~2d in wet year and 2~9d in dry year. The tracer travel time increases by 1~9d in wet year and 1~20d in dry year. The material transport process in the lake is significantly slowed down after the construction. A simulation research of hydrodynamics and water quality in wet and dry year is applied in this paper, which lays the foundation of further study on migration and transformation of the contaminant and establishment of ecological model of lake-wetland.

Keywords: Poyang Lake; hydraulic project; hydrology and hydrodynamic; residence time; tracer travel time

Derivation and application of analytic method for reservoir mid-long term optimal operation

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Abstract: Reservoir mid-long term optimal operation is a significant way to utilize the water resource effectively. Due to the discrete mathematical description of the reservoir characteristic curve, the model and the solution for mid-long term operation is mainly based on mathematical method, which is of low efficiency. Aimed at this issue, the paper proposes an analytic method. First, establish an analytic model based on the functionalization of reservoir characteristic curve, then put forward APOA algorithm. The case study testifies that the proposed way can guarantee the precision and its computation time is only as long as 1/20 of the traditional method. So this method is stable and efficient and makes some researches by analytic thoughts in reservoir mid-long term operation.

Keywords: mid-long term operation; characteristic curve; analytic method; APOA; computation efficiency

Quick evaluation of the pipeline equivalent sand-grain roughness based on the surface roughness parameters

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Abstract: The accurate friction factor of pipeline is an important prerequisite during the hydraulic design process of water conveyance project. The equivalent sand-grain roughness is a key parameter to calculate the pipeline friction factor. However, it takes lots of manpower, material, financial resources and time to measure the equivalent sand-grain roughness by the traditional hydraulic test method. In this study, the hydraulic performances of 3 kinds of ductile iron pipes with different coatings were tested, and the equivalent sand-grain roughness values were obtained based on the measure uncertainty analysis, respectively. Then, the inner wall surface roughness parameters of 3 kinds of pipes were detected by the E-35B portable surface roughness tester profilometer. By the comparison of the surface roughness parameters and the equivalent sand-grain roughness k, and the reanalysis of others researcher's data, a quick evaluation method of pipe equivalent sand-grain roughness based on the surface roughness parameters was given: when the arithmetical mean deviation of roughness profile $Ra \leqslant 10\mu m$ or the maximum height of roughness profile $Rz \leqslant 50\mu m$, the sampling length of roughness profile lr set to 2.5mm, then $Rz \approx k$. So, the equivalent sand-grain roughness k in the Colebrook-White formula was replaced with Rz, and the friction factor can be calculated. The research results can also be used to control and improve the coating quality of pipeline.

Keywords: pipeline; friction factor; measurement uncertainty; surface roughness parameter; equivalent sand-grain roughness

Optimization of the shape of lateral intake/outlet using multi-island genetic algorithm

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Abstract: The traditional method for optimizing hydraulic structures shape is generally carried out by model test or numerical simulation to study the hydraulic characteristics, and then adjust the shape of the inlet/outlet for the unfavorable hydraulic characteristics until obtaining satisfactory shape. The shape optimization of lateral inlet/outlet under two-direction flow conditions can be regarded as multi-objective optimization problem. The multi-objective optimization is transformed into a single objective optimization problem by using weighted method, and the multi-island genetic algorithm (MIGA) is used to search the global optimal solution. The weighted head loss coefficient is defined as the objective function, and velocity uneven distribution coefficient and discharge uneven distribution coefficient of the four orifices are taken as constraints. Parametric modeling method and the approximation of response surface model based on CFD calculation, which speed up the modeling and numerical simulation in the scheme selection, improve the optimization efficiency. Compared with the original shape, total head loss coefficient is reduced by 3.35%, velocity uneven distribution coefficient is reduced by 14.50% and discharge uneven distribution coefficient is reduced by 20%. The optimization methods provide a convenient way to optimize the shape of hydraulic structures.

Keywords: lateral intake/outlet; two-flow directions; shape optimization; parametric modeling; multi-island genetic algorithm

The prototype test study of prestressed concrete cylinder pipe structure deformation law Ⅱ. The external pressure

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Abstract: PCCP is a composite structure composed of concrete core, steel cylinder, prestressed wire and mortar coating, it is not only withstanding the internal water pressure, but also bearing the external load including the tube body weight, soil and water weight, live load and load from pile soil temporarily, the deformation law of PCCP under external load and the deformation law of PCCP under the internal load is completely different. The test used BOTDA and FBG optical fiber sensor technology for the first time both at home and aboard, and the optical fiber implanted steel cylinder surface in the PCCP manufacturing process. A three-edge bearing test was carried out on 2.6 m diameter embedded PCCP (ECP), continuously tested the strain response of PCCP each layer structure in the process of loading. Through in-depth analysis of test data, it is found that in the loading process of the three-edge test, the deformation of PCCP each layer structure is proportional to the external load, the concrete core outside of cylinder are in harmony with the wire in deformation, the deformation between the concrete core inside of the cylinder and the cylinder are coordinated fundamentally. The outer concrete core at the pipe waist and the wire are in tension, the inner concrete core at the pipe waist and the wire are in compression, concrete core at invert and crown is opposite, but the law of deformation coordination is consistent. The prototype test of external load not only obtained the loading response law of the PCCP layers structure, but also provided valuable experimental data for deeply basic theoretical research and engineering application of PCCP structure.

Keywords: prestressed concrete cylinder pipe; three-edge bearing test method; BOTDA; FBG; bearing capacity

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Spatial-temporal distribution characteristic and course of sedimentation in the Ningxia-Inner Mongolia reaches of the Yellow River

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Abstract: With water-sediment and section-observation data, the sediment erosion and deposition of Ningxia-Inner Mongolia reaches of the Yellow River since 1960 were calculated by the sediment balance method and the section method. The results from two methods were close and complementary. The erosion and deposition varies in different periods that the sedimentation in the Ningxia-Inner Mongolia reaches has been aggravating since 1987, which mainly concentrated in the flood season and the sediment volume of particle size less than 0.1mm, while particle size more than 0.1mm has decreased. That sedimentation mainly occurred at Sanhuhekou-Toudaoguai reach and Bayangaole-Sanhuhekou reach that river channel sedimentation predominated and cross sectionh has atrophied since 1987. According to the source of water and sediment, the mainstream water and sediment conditions change, especially that from the combination of Longyangxia and Liujiaxia reservoirs, including the decrease of water amount and the flow process during the flood season, is the main cause of the increased deposition in Ningxia-Inner Mongolia reaches of the Yellow River.

Keywords: Ningxia-Inner Mongolia reaches; sedimentation; spatial-temporal distribution; course of sedimentation; Upstream of Yellow River

Research and application of early warning model of vibration deterioration for hydroelectric-generator unit

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Abstract: In recent years, vibration stability problem of hydroelectric-generator unit has becoming increasingly prominent. Traditional method for early warning of vibration is realized by comparing the monitoring value with the limit value of vibration. Problems such as limited application range of operating conditions and single vibration limit exist in traditional method. To solve such problems, the normal operation vibration data of the unit was firstly collected, and the operation condition was refined into several typical conditions according to the active power and water head, by which, the vibration health range of each typical condition was calculated. Finally, the early warning model of vibration deterioration was established. The applying results show that the proposed model can realize the early warning of vibration in different operation conditions for hydroelectric-generator unit by digitization and 3D visualization. Also, it makes use of the historical vibration data for self-learning, which can update the vibration limit for each typical condition and improve the accuracy of early warning. Therefore, the proposed model of vibration is obviously superior to the traditional warning method.

Keywords: hydroelectric-generator unit; early warning model; vibration deterioration; self-learning

Study on the anti-dip layered rock slope toppling failure based on centrifuge model test

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Abstract: In view of the insufficient recognition of the toppling failure mechanism of anti-dip layered rock slope, multiple of centrifugal model tests were carried out under different combinations of slope angles and anti-dip angles, in which flat glass was used as similar materials. Based on the image processing, the deformation and toppling failure mechanism of anti-dip layered rock slope under centrifuge loading condition were investigated, and the topping failure mode of anti-dip layered rock slope and the method of determining the location of failure surface were proposed. The results show that the deformation of the slope mainly occurs above the failure surface, the rocks located in the toe of slope prevent toppling failure. The displacement changed against time at the top of the slope is divided into two stages: the steady growth of the displacement and the accelerated growth of the displacement. The slope toppling failure process can be divided into four stages: (a)the toe rock of slope fracture; (b)the generated of slope top tension cracks; (c) rock fracture and progressive extension and (d)rock toppling failure instantly. Slope angle and rock anti-dip angle have a significant influence on the critical slope height and the position of failure surface when the slope is topping failure. The above research results can provide some references for the development of toppling failure theory, the evaluation of engineering geological disasters, and the prevention and mitigation of geo-disaster.

Keywords: layered rock slope; toppling failure modes; deformation and failure mechanism; centrifuge model test

Study on the influence factors of landslide surge wave on the impact pressure on dam's surface

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Abstract: Slopesaround the reservoir area may be damaged by strong earthquake or rainstorm and slide into the reservoir which can induce huge surge hitting on dams. In this paper, the surge generation and propagation process and the distribution pattern of impacts on dam's surface induced by landslide surge were studied using the smoothed particle hydrodynamics(SPH) method. The influences of particle space, initial falling velocity, water depth and slider width etc. on the surge wave height and impact pressure on dam surface were analyzed. The results show that the maximum wave height decreaseswith the increase of the width of the landslide mass, whereas the following wave amplitudes increase and intensity of impact pressure on dam surface increase; the amplitude of surge wave increases with the increase of initial falling velocity of landslide mass, whereas when it increases to exceed a certain extent, the intensity of impact pressure does not change obviously; the amplitude of the first surge wave height decreases with the increase of water depth of the reservoir, where the maximum impact pressure and its relative position to water surface are basically unchanged

Keywords: SPH method; landslide surge; dam; impact pressure

Risk-based nonstationary design flood and uncertainty analysis

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Abstract: Design flood and its uncertainty analysis under nonstationary conditions is critical consideration in the planning and design of hydraulic structures and making flood control decisions. The time-varying moment method is widely applied, but a measure of design flood varying from one year to the next derived from the time-varying moment method is hard to be applied to practical application. The basic information needed for engineering design should consist of the design life period and the hydrological risk of a flood event occurring during the design life period. This paper is aimed to improve the characterization of nonstationary design flood and its uncertainty under the concept of hydrological risk by employing meteorological covariates in the nonstationary frequency analysis. The advantage of the method is that the downscaled meteorological variables from the General Circulation Model (GCM) can be used to calculate the nonstationary statistical parameters and exceedance probabilities for the design life period and thus the corresponding design flood quantile. The method of using time as the only covariate was also employed for comparison. Both methods were applied to the annual maximum daily streamflow series of the Wei River, China. It is demonstrated that the nonstationary design flood results of both covariate situations were significantly different from the stationary case. The nonstationary design flood result using temperature and precipitation as covariates was found more reasonable and advisable than that of the case using time as covariate. It is concluded that the nonstationary design result of this study can be valuable reference for the planning and design of hydraulic structures and making flood control decisions.

Keywords: nonstationarity; design flood; time-varying moment method; hydrological risk; uncertainty

Separation of snowfall from precipitation and its evolution trend and reasons analysis in upper reaches of Nujiang River Basin

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Abstract: Precipitation phase has a direct influence on the surface energy balance and hydrological processes. It is important and necessary to separate the snowfall from precipitation and quantify the impact of climate change on the snowfall for the improvement of snowmelt runoff simulation and the management of the water resources in the alpine area. Based on the relation between snowfall proportion and daily temperature of six meteorological stations before 1979 in upper reaches of Nujiang River Basin, a separation scheme with exponential function structure was applied to estimate the snowfall, which was validated by the precipitation phase data before 1979. Furthermore, the snowfall was estimated and analyzed by the separation scheme from 1980 to 2016, and the impact of temperature and precipitation change on snowfall evolution was explored. The results show that: (1) the separation scheme performs well in snowfall estimation with Pearson correlation coefficient above 0.86 and relative BIAS under 5% in the six stations. (2) Temperatures after 1979 show a significant increasing trend in the six stations, while the annual precipitation and snowfall demonstrate insignificant increasing and decreasing trends overall the basin, respectively. (3) Increase of temperature promotes the decrease of snowfall, and the influence intensity of temperature on the snowfall gradually increases from the southeast to the northwest of basin. Moreover, the precipitation probability increases in the low temperature condition under the climate change, which significantly promotes the snowfall increase in upper reaches of Nujiang River Basin. However, the significant increase of temperature has a dominant effect on the snowfall change after 1979, and the overall snowfall shows a decreasing trend in upper reaches of Nujiang River Basin.

Keywords: precipitation phase; snowfall separation; evolution trend; attribution analysis; upper reaches of Nujiang River Basin

Construction and application of precipitation ensemble forecast model for Qingshitan Reservoir

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Abstract: The numerical ensemble forecast of precipitation can reduce the uncertainty caused by single value forecasting, and it is a hot topic both at home and abroad. But most of the researches at present treat the forecast skills of set members equally, and obtain the final forecast conclusion with the average value of the collective arithmetic extensively, so this kind of method can hardly effectively show the differences among the forecast skills of different parameterization schemes. Aimed at this problem, the Qingshitan Reservoir located at the rainstorm center of Guangxi Zhuang Autonomous Region was selected in this paper as the research area and a comprehensive quantitative evaluation model based on the ETS grading was built, through sensitivity analysis on the WRF model and the 21 groups of parameterization schemes and the quantitative analysis for the number of samples and ensemble forecast skills, the establishment of ensemble forecast scheme of rainfall in Qingshitan Reservoir was realized based on the ETS evaluation results. Through verification, compared with the collective arithmetic average forecast, the ensemble forecast scheme constructed in this paper has higher skills and a more stable performance.

Keywords: Qingshitan reservoir; ensemble forecast; WRF model; parameterization scheme disturbance