

# 城市道桥与防洪

主管：中华人民共和国住房和城乡建设部

主办：上海市政工程设计研究总院(集团)有限公司

2023



第1期 总第285期 月刊  
2023年1月

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### ● 本期看点

- 上海新城交通规划建设思考
- 城市路网中车辆碳排放量的影响因素研究
- 预制装配式波形钢腹板组合小箱梁的研究及应用
- 高密度建成区径流污染源精确计量与系统阻控关键技术及应用

中华人民共和国住房和城乡建设部优秀期刊



万方数据

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中华人民共和国住房和城乡建设部优秀期刊

# 城市道桥与防洪 (月刊)

CHENGSHI DAOQIAO YU FANGHONG

2023年 第1期(总第285期)

2023年 1月15日出版

1984年创刊

主管单位: 中华人民共和国住房和城乡建设部

主办单位: 上海市政工程设计研究总院(集团)有限公司

出版单位: 《城市道桥与防洪》编辑部

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国内发行: 《城市道桥与防洪》编辑部

国外发行: 中国国际图书贸易总公司 代号: BM 1859

排版印刷: 上海商务联西印刷有限公司

地址: 上海市春和路1350号7号楼

中国标准连续出版物号: ISSN 1009-7716  
CN 31-1602/U

广告发布登记号: 3101020130030

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期刊基本参数: CN 31-1602/U \* 1984 \* m \* A4 \* 272 \* zh \* P \* ¥25.00 \* 5000 \* 65 \* 2023-01

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**封面工程**

本期封面工程为金庄公路(金海公路—现状金钱公路)新建工程,由上海奉贤建设发展集团市政公路工程有限公司承建。

金庄公路(金海公路—现状金钱公路)新建工程位于上海市奉贤区北部,西起金海公路,东至现状金钱公路,长度约 2 072 m,其中跨金汇港设大桥一座。大桥全长为 589 m,主桥为空间网状索面独塔斜拉桥,墩、塔、梁固结体系,跨径组成为 70 m+120 m。边跨 70 m 主梁为预应力混凝土现浇箱梁,主跨 120 m 主梁为钢箱梁。大桥主塔采用竖转工艺,其转体重量和高度均为上海桥梁工程之最;斜拉索采用同步张拉工艺,属全国首例。

以金庄公路金汇港大桥施工工艺为背景,两项技术成果——“一种斜拉索整体张拉施工系统”和“一种尺寸可调的吊索夹持工具”获得国家实用新型专利。工程荣获 2019—2020 年度上海市建设工程金属结构(市优质工程)金钢奖。

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# Urban Roads, Bridges & Flood Control

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Number 1, 2023 (Total Number 285)

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Thoughts on Traffic Planning and Construction of Shanghai New Town ..... GU Min, YANG Yijiao, WANG Shilin ( 1 )

**Abstract:** The development and construction of new town are the important strategic means to optimize the layout of urban spatial structure in Shanghai. During the 14 th Five-Year Plan period, Shanghai accelerates the formation of a new spatial pattern of "center radiation, two-wing flying together, new city driving force and north-south transition". Five new towns of Jiading, Qingpu, Songjiang, Fengxian and Nanhui are cultivated into the independent and comprehensive node town. On the basis of reviewing the development of Shanghai New Town, a new round of new town traffic development requirements is summarized. It is proposed that it is necessary to handle the five pairs of key relations between main and auxiliary, fast and slow, external and internal, old and new, customer and goods in a new round of new town traffic development so as to form the relative countermeasure to support the high-quality development of new town transportation, which provides the suggestion and technical support for the planning and construction of new town transportation.

**Keywords:** Shanghai New Town; comprehensive transportation; new town planning

Study on Development Strategy of New Town Traffic System under Background of Shanghai Metropolitan Areas ..... WANG Baohui, LI Qinghua ( 6 )

**Abstract:** On the basis of further understanding *Guidelines for Planning and Construction of New Towns in Shanghai*, the spatial structure characteristics of the areas in Shanghai and the future traffic demand features of new towns are analyzed and judged. The traffic development vision and traffic development strategy of the comprehensive transportation system for the new towns in Shanghai are put forward at the national and international levels, the city cluster and metropolis area levels, and the internal levels of new towns.

**Keywords:** Shanghai Metropolitan Areas; Shanghai New Town; traffic system; development vision; development strategy

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Research of Influencing Factors on Vehicle Carbon Emissions in Urban Road Network ..... ZHANG Junhua ( 10 )

**Abstract:** In the urban road network, some factors may influence the average kilometric vehicle carbon emission (AKVC), especially in the road network of large cities. These factors may be more diverse. Factors in this study include the number of intersections per kilometer on the number of registered vehicles, the number of intersections per kilometer between the road section and the total area, and the total area between the road section and the number of vehicles. The study shows that the number of intersections per kilometer is the only important factor affecting AKVC of the regional road network, and all other factors have no significant impact

on AKVC. The study also shows that the number of intersections per kilometer is the most influencing factor to reduce the vehicle carbon emissions in road networks, which means that the number of intersections in urban road networks should be controlled or reduced.

**Keywords:** urban road network; vehicle carbon emission; intersection; fuel consumption

Study on Carbon Emission Model and Characteristics of Asphalt Pavement Construction Period Based on LCA .....

..... ZHANG Xingyu, ZHU Xiaodong, ZUO Guiqiang, NIU Kai ( 13 )

**Abstract:** A mass of greenhouse gases produced from the construction of asphalt pavement is the focus of energy conservation and emission reduction in the field of transportation. By analyzing the sources of carbon emission during the construction of asphalt pavement, combined with the carbon emission factors provided by IPCC and CLCD databases and the other information, the carbon emission measurement model of asphalt pavement construction period is constructed by LCA method. Based on the typical pavement structure schemes, the carbon emission and characteristic laws of raw material production, off-site mixing, transportation and on-site construction stages are obtained. The results show that during the construction of asphalt surface layer, the carbon emission in the raw material production stage is the highest, accounting for 47.52% of the total emission, and the mixing stage of mixture is the second highest, accounting for 44.71% of the total emission. The energy conservation and emission reduction measures should be mainly to adopt the clean fuel and to improve the production efficiency of construction machinery. In the production stage of the same raw material for laying the water-stabilized base/subbase, the proportion of carbon emission is the highest, accounting for 90% of the total emission. The energy conservation and emission reduction measures are mainly to use the low-carbon cement.

**Keywords:** LCA; asphalt pavement; carbon emission; measurement model; energy conservation and emission reduction

Research on Road Traffic Operation Strategy Based on Reducing Carbon Emission .....

..... GAO Jianing, ZHAO Jiafa, MENG Weiei, GUO Liping ( 18 )

**Abstract:** Under the background of the current "double carbon" policy in China, taking Tianjin as an example, the current indicators of traffic travel in six districts of Tianjin are sorted out, and the influencing factors on the pollutant emission of road traffic are put forward. From the perspective of technical means and management policies, aiming at the different influencing factors, the relevant policies and technical means to control the total number of motor vehicles, to optimize the traffic structure, to improve the traffic operation efficiency and to strengthen the vehicle emission supervision are formulated in order to alleviate the current emission pressure of CO, NO<sub>x</sub>, HC, PM and other motor vehicle pollutants in Tianjin so as to achieve the energy conservation and emission reduction goal in the field of transportation at the whole city level.

**Keywords:** road traffic; energy conservation and emissions reduction; traffic carbon emission; MOVES model

Analysis on Low-carbon Design of Wastewater Treatment Plants under "Double-carbon" Background .....

..... LI Qinggui ( 22 )

**Abstract:** Town wastewater treatment plant (WWTP) is the main bearer of pollution discharge and reduction and is also the major carbon emitters. Therefore, the low-carbon design of town WWTP is particularly important under the "double-carbon" background. The process optimization and clean production are the primary control factors for low carbon. By selecting the advanced treatment processes and equipment, the energy consumption can be controlled from the source, the resource recovery and comprehensive utilization are strengthened, and the carbon emission is reduced to achieve the goal of sustainable development. From the "double-carbon" perspective, the low-carbon design for WWTP is comprehensively analyzed in terms of clean energy utilization, process design, equipment selection, and intelligent control. At the same time, the direction

of the future process of WWTP is selected and proposed.

**Keywords:** carbon peak; carbon neutral; clean energy; process design; equipment selection; intelligent control

## ROADS & COMMUNICATION

Management Policy Research of Urban Road Construction in East of Wenzhou ..... CHEN Hao, QU Heou ( 26 )

**Abstract:** At the beginning of this year, Wenzhou Bay New Area was officially approved to be the 7th provincial new area by the provincial government after Hangzhou Qiantang New Area, Ningbo Qianwan New Area, Shaoxing Binhai New Area, Huzhou South Taihu New Area, Jinhua Jinyi New Area and Taizhou Bay New area. By building a national demonstration zone for high-quality development of private economy as the goal, Wenzhou Bay New Area is an important strategic starting point to build and advance the port industrial belt of Ningbo, Zhoushan, Wenzhou and Taishou, and to promote the optimization of the regional coordinated development pattern of the whole province. The construction of Wenzhou Bay New Area can further strengthen the industrial collaboration of Wenzhou with Shanghai, Hangzhou, Ningbo and the cities, become the important supporting point of the provincial high-quality development, form an important pole of growth leading the high-quality development of industry in Wenzhou, become an important platform for the urban transformation and industrial upgrading of Wenzhou in order to effectively upgrade the energy level of metropolitan area and the primacy of the central urban area of Wenzhou, to build the bridgehead of Yangtze River Delta linking southern Zhejiang and northern Fujian and better to play Wenzhou in the service of the major strategic role of China. At present, the construction of the roads in the eastern Wenzhou seriously lags behind the progress of economic and social development in the area, which leads to not form the road network system and seriously restricts the development of Wenzhou Bay New Area.

**Keywords:** Wenzhou Bay; eastern Wenzhou; road system

Study on Overall Design Scheme of North Huanshan Road (Ecological Park Section) in Wenzhou .....

..... DONG Pingyang, LI Wanbai, ZHENG Chunuo ( 29 )

**Abstract:** Taking the urban trunk road of North Huanshan Road (ecological park section) in Wenzhou as an example, the functional orientation and main technical standards of the project are introduced, and the lane sizes are reasonably determined through the traffic forecast. Combined with the actual construction conditions, the selection of the trunk road forms, and the overall layout of important interchange nodes and ramps in the built-up areas are expounded in detail. The peripheral influencing factors to be considered in the overall design of urban trunk roads in the built-up areas and the solving methods are systematically introduced.

**Keywords:** urban trunk road; overall design; design of interchange node; ramp design

Design of Municipal Roads under Planning Concept of "Narrow Road and Dense Network" .....

..... SHI Xiao, FU Yuelong ( 33 )

**Abstract:** Taking the road network project in the starting area of Jiangdong New Area in Haikou as an example, the design of municipal roads under the "narrow road and dense network" is further discussed from the aspects of traffic organization, cross-section design, municipal pipeline layout, etc., and the contradictions which still need to be further studied and solved are put forward in order to promote the feasibility of "narrow road and dense network" implementation in China.

**Keywords:** narrow road and dense network; traffic organization; cross-section design; pipeline layout

Traffic Protection and Guidance Strategy of Historic Urban Areas in Changzhou ..... XU Qin ( 38 )

**Abstract:** The problems existing in the road traffic of the historic city of Changzhou are further analyzed.

The coordination relationship between the protection and the traffic improvement of the ancient city is discussed. And the traffic protection and guiding strategy of the historic urban areas in Changzhou are put forward. At the same time, the reasonable suggestions on the traffic development of the historical urban areas are proposed from six aspects of traffic load reduction, traffic zoning, road network, public traffic priority, advocating slow traffic and parking regulation. It is pointed out that the urban transportation should be transformed into the green traffic which is mainly based on the public traffic and slow traffic.

**Keywords:** historical urban area; traffic load reduction; public traffic priority; parking regulation

Discussion on Shortest Distance between Expressway Tunnel Exit and Interchange .....

..... PENG Guangyin ( 41 )

**Abstract:** Aiming at the traffic safety problem of tunnel exit and interconnecting section, from the perspective of driver's visual characteristics, the setting parameters and calculation method of the minimum spacing between the exit and interconnecting section when the traffic signs are located inside and outside the tunnel are explicated by analyzing the process of driver's obtaining the sign information and carrying out operation at the tunnel exit and interconnecting section. Through field test, the change rule of driver's pupil diameter and the fluctuation range of pupil diameter change ratio at the exit of tunnel are studied, and the mean of the open adaptation time of drivers at the exit of tunnel is 1.782 s. It is suggested that when the traffic signs are located inside and outside the tunnel, the minimum spacing between the exit and interworking sections of the tunnel is 400 m and 500 m respectively.

**Keywords:** tunnel exit; interconnecting, shortest spacing, change ratio of pupil diameter

Research on Optimization of Traffic Organization in Entrance Lane at Intersection at Grade of Urban Road .....

XU Zhihong, GE Ruoyu ( 45 )

**Abstract:** The intersection at grade is the bottleneck point of the road network. The congestion and accidents often occur at the intersection. Therefore, it is necessary to systematically study the bottleneck point. In the context of urban renewal, taking the intersection of Heshan Road and Huafeng Road in Suzhou National New and Hi-Tech Industrial Development Zone as an example, the traffic operation of the straight lane when the road is widened to the right side is studied. It is found that the distribution of traffic in the lateral lane is uneven, which has a greater impact on traffic efficiency. Based on the research object of safety and efficiency, the service quality of nodes is improved through the optimization measures of traffic organization of the existing facilities.

**Keywords:** intersection at grade; widening on the right side; traffic distribution; service quality

Overall Design of Shijiazhuang Ring II Expressway Upgrading and Reconstruction Project .....

..... XU Lixing ( 48 )

**Abstract:** Shijiazhuang Ring II Road is an important urban ring expressway in Shijiazhuang. The ground expressway was built in 2010. To further promote the outward development of the city and realize the interconnection of intersected roads inside and outside Ring II, Ring II Expressway is further to upgrade and reconstruct. The upgrading and reconstruction scheme of Ring II Road is analyzed from many aspects of project background, engineering situation, overall scheme, node scheme and so on. The main reconstruction form of Ring II Road, the current interchange and ramp connection scheme, the old bridge jacking scheme, the entrance and exit arrangement schemes, and the other contents are introduced in detail in order to provide the reference for the upgrading and reconstruction of the similar ground expressway projects.

**Keywords:** Ring II Road; overall scheme; node scheme; bridge jacking, entrance and exit

Thinking and Exploration of Public Parking Planning in New Urban Area for Nanhui New Town .....

..... YAO Zinan ( 52 )



**Abstract:** The main causes of parking problem in urban new area are specially analyzed. Aiming at itself characteristics of new town and the different land use classes, the refined prediction method is proposed to calculate the parking insufficiency. The specific principles and optimization ideas for the location selection and scale calculation of public parking lots are further put forward under the premise of service object and on the purpose of promoting implementation. Finally, taking Shanghai Nanhui New Town as an example, the optimized improvement suggestions for the public parking planning of the new town are put forward.

**Keywords:** public parking; urban new area; scale prediction

Research on New Detection Method of Road Flatness Based on On-board Laser-point Cloud .....

..... HUANG Qingcai ( 57 )

**Abstract:** Pavement flatness is one of the main technical indexes for evaluating the pavement quality of road. The traditional detection method of flatness has the low detection efficiency and high labor intensity, which is difficult to meet the needs of quick routing inspection and highway maintenance. The mobile measurement system can quickly and dynamically obtain the high-precision road point cloud data and reproduce the detailed features of road in detail. Therefore, by analyzing the accuracy characteristics of the on-board point cloud and the calculation method of international flatness IRI, a method of applying the on-board laser-point cloud to detect the pavement flatness is put forward. Firstly, the on-board point cloud data is preprocessed and the pavement points are extracted along the direction of the wheel track belt. Then, the pavement elevation value is obtained by using the method of equal spacing neighborhood mean sampling points. Finally, IRI is calculated by using the pavement elevation value and compared with the calibration results calculated by high-precision leveling data. The experimental results show that the on-board mobile measurement system can be used for the rapid detection of pavement flatness, which provides the technical support for 3D quick routing inspection and highway maintenance.

**Keywords:** on-board mobile measurement system; pavement flatness; laser-point cloud data

Discussion on Parameter Selection in Rock Slope Calculation .....

RUAN Tiefeng ( 61 )

**Abstract:** Slope design is inevitable in the process of road design, in which the excavation slope is key and difficult points in the slope design. The designers often directly adopt the parameters from the geological survey without analysis. In fact, the rock stratum is not homogeneous but continuously changing from top to bottom. It is obviously not precise to directly use the parameters from the geological survey in the design, which will certainly lead to the deviations between the calculation result and the physical truth. Taking a general natural mountain as a study object, from the analysis on the rock stratum property, the calculation and analysis are carried out through the refining hierarchy and the practical engineering cases, and the relevant calculation suggestions are put forward.

**Keywords:** excavation slope; rock stratum; geological parameters

## BRIDGES & STRUCTURES

Study and Application of Prefabricated Assembled Corrugated Steel Web Composite Small-box Beam .....

..... MA Biao, XU Hang, SU Jian, HUANG Hong ( 64 )

**Abstract:** The corrugated steel web composite small-box beam bridge is a new steel-concrete composite structure by using the corrugated steel plate to replace the concrete web or stiffened plain plate. For the elevated bridges, the design scheme of prefabricated assembled corrugated steel web composite small-box beam is put forward, and its economy and technology are analyzed. Combined with Shanghai Riverside Channel West Extension (Fuchang Road – North Jiangyang Road) Reconstruction Project, the practical application is carried out. The study and application show that this kind of structure has the advantages of

high prestressing efficiency, definite structural stress, fast construction speed, low comprehensive cost and attractive appearance, which is worthy of further promotion and application in the elevated bridges.

**Keywords:** corrugated steel web; small-box beam; prefabricated assembled; elevated bridge

Analysis on Mechanical Characteristics of Arch-pylon Cable-stayed Bridge with Different Arch Axis Shapes

..... MA Wengang, CHEN Li, ZHU Yuqin, HU Shixiang ( 67 )

**Abstract:** The arch-pylon cable-stayed bridge combines the features of both arch bridge and cable-stayed bridge. The beautiful shape splendidly meets the aesthetic requirement of bridge design, which often makes it become the landmark building of a city. Taking the development process of arch-pylon cable-stayed bridge as the basis, the design and construction of this kind of bridge at home and abroad are summarized. On this basis, the influences of the different arch axis shapes on the deck layout and the arch-pylon force of arch-pylon cable-stayed bridge are analyzed so as to obtain the advantages, disadvantages and mechanical characteristics of various arch axis shapes. This conclusion can provide some reference for the design and late maintenance of the arch-pylon cable-stayed bridges.

**Keywords:** arch-pylon cable-stayed bridge; arch axis shape; mechanical characteristics; landscape effect

Anti-seismic Design of Bridge in Ultra-high Intensity Zone of Kangding Transit Section in Yaye Expressway

..... ZHAO Zhi, WEN Lina ( 73 )

**Abstract:** In order to study the seismic design characteristics of small and medium-sized bridges in the ultra-high intensity zone and taking the design of the bridges in the interconnected and the main lines of Kangding Transit Section in Kangxin Expressway as the engineering background, the multiple seismic design schemes are put forward for the irregular bridges. The nonlinear time history analysis method is used to compare the conventional concrete structure with the steel structure, and the lower cylinder pier with the hollow pier, and the influencing effect of seismic isolation design with ductility design on the seismic resistance. The results show that the steel structural bridge to be used can effectively reduce the seismic effect. More excellent seismic performance can be obtained by optimizing the dead loads of sub-pier column, tie beam, bent cap and other details. When the pier height is high, the seismic isolation design schemes may not be the most reasonable, so it is necessary to compare the seismic isolation design with the ductility design during design.

**Keywords:** ultra-high intensity zone; irregular; steel-concrete composite structure; detailed structure; seismic isolation and ductility design

Analysis on Influence of Viscous Damper Parameter on Seismic Response of Continuous Beam Bridge .....

..... LIU Chaofu, LIU Weijuan, ZHOU Huihui ( 79 )

**Abstract:** To improve the reliability and safety of the continuous beam bridge under the earthquake action, it is to give full play to the seismic isolation technology in seismic application of bridge. Taking a continuous beam bridge of an expressway in Yunnan as the background, the finite element model of the bridge with the viscous dampers or without viscous dampers is established by the finite element software Midas Civil. The nonlinear dynamic time history analysis method is used to calculate and analyze the beam end displacement, the shear at pier bottom and the bending moment at pier bottom. The influence of viscous damper parameters on the continuous beam bridge under the seismic response is studied. At the same time, the damping coefficients are optimized to achieve the best damping coefficient of viscous damper. The calculation results show that the bending moment and shear at the pier bottom show the change of regularity when the damping coefficient is constant. The best damping coefficient  $C=4\ 000$  and the damping index = 0.4 viscous damper are selected.

**Keywords:** seismic response; viscous damper; continuous beam bridge; nonlinear dynamic time history analysis.

Design of Spatial Multi-limb Skew Steel Arch Bridge .....

..... LI Jiading, LI Shengyu, ZHANG Haiping, YU Zhiguang ( 83 )

**Abstract:** In order to satisfy the needs of the people for a higher quality of life, as one of the most important public buildings in a city, the urban bridge is required to show the better architecture beauty and technical beauty, thereby the higher requirements are also put forward for the design of bridge structures. In order to better express the architectural structure form and adapt the road plane alignment and oblique bridge location with the river, the structure of West Binhe Road Bridge in Beichuan River Area of Xining in Qinghai presents the remarkable characteristics of "space, multi-limb and oblique", which belongs to a complex landscape steel arch bridge. Therefore, its design method is obviously different from the design of the conventional arch bridge. Combined with the BIM forward design of the whole process of the bridge, the key design contents of structural system, spatial arch axis, polygon variable cross-section multi-limb arch rib, suspender and link rod and, oblique steel box beam are discussed in order to provide the reference for the design of the similar urban landscape bridges.

**Keywords:** steel arch bridge; thrusting arch; oblique bridge; multi-limb arch rib; BIM forward design

Research on Design of Anti-thrust Foundation of Deck Box Arch Bridge in Karst Area .....

..... WANG Liang, YU Zhangliang ( 88 )

**Abstract:** There are many mountains in the south of China and the geological conditions are generally good. The scheme of deck box arch bridge is selected mostly for the river-crossing bridges. However, for some areas, the geological conditions are limestone, and the karst development exists in the strata, which will bring certain difficulties to the design of arch bridge. The horizontal thrust of the deck box arch bridge is larger. The gravity-type expansion foundations are generally used directly to act on the bedrock. If the bedrock is karst, there is certain risk to the stability of the foundation. How to select the suitable foundation type of arch bridge to ensure the structure safety is the critical problem for the designers to study. Taking the design of a deck box arch bridge in a karst area as an example, the feasibility of the arch foot foundation scheme is analyzed, and a new type of composite thrust structure of arch bridge is put forward, which provides a certain reference value for the similar projects in the future.

**Keywords:** karst; box arch; anti-thrust

Analysis on Design Essentials of Multi-beam I-steel-concrete Composite Beam .....

..... LI Zelin ( 91 )

**Abstract:** Taking a 40 m-span multi-beam I-steel-concrete composite beam as an example, a three-dimensional numerical analysis model is established by the general finite element software ANSYS. The effects of the cluster distribution and uniform distribution of welding studs, the slippage effect of composite beam, the layout of inter-span beam and the other conditions on the transverse distribution factors of structure, the effect of shear lag, the lateral bending of bridge deck and the stability of bridge completion process are analyzed. The conclusion and suggestions are put forward in order to provide the reference for the design of the similar structures.

**Keywords:** steel-concrete composite beams; I-steel; transverse distribution coefficient; shear lag; transverse bending of deck; buckling stability

Study and Analysis on Deformation of Multiple Operating High-speed Railway Bridges during Underneath Passing of Pile-plate Structure .....

..... LAN Hongxiang ( 97 )

**Abstract:** In order to study the influence of the underneath passing of pile-plate structure in the new municipal roads on the deformation of high-speed railway bridge, taking a new municipal road project passing underneath the existing high-speed railway bridge as an engineering case, and in order to ensure the safety of the railway operation, the finite element software of pile-soil interaction Midas GTS NX is

used to simulate and analyze the additional deformation of the existing high-speed railway bridge caused by the implementation and operation of the project. The results show that the underneath passing scheme of the pile-plate structure adopted in this new municipal road project has a little influence on the high-speed railway bridge. And the theoretical results are generally consistent with the deformation trend of high-speed railway bridge by on-site automatic monitoring. The results are in good agreement, and are all within the standard deformation control range.

**Keywords:** municipal road; automatic monitoring; pile-plate structure; passing underneath high-speed railway; finite element analysis

Investigation and Analysis on Splicing Technology of Expressway Bridges in Fujian Province .....

..... CHEN Linghui, YANG Xinyan, HUANG Wenjin, SU Hua, KE Liwei, HE Jiaquan, PAN Guoxiong ( 100 )

**Abstract:** Many bridges in Fujian Province are facing the splicing reconstruction. In order to reduce the structural diseases and maintenance pressure after splicing, it is necessary to investigate and study the technical status of the existing spliced bridges, and analyze the rationality of splicing design scheme. The analysis results show that the same section types are all used for the old and new girders in the splicing of expressway bridges in Fujian Province, and plate girder is the majority, T girder is the second and box girder beam is very few. The splicing of plate girder mainly adopts the form of connecting the top and not connecting the bottom, and the disease amount is less than those of other forms. The splicing of T girder all adopts the form of connecting the top and not connecting the bottom, and its disease amount is the most, but it can still meet the normal use requirements of bridge. The splicing of box girder mainly adopts the form of all not connecting the top and the bottom, and the flange gnawing and leakage phenomenon frequently happen. Therefore, from the perspective of disease prevention and control, the splicing form of connecting the top and not connecting the bottom is suitable to use for the splicing of the bridges with the same section of the main girders.

**Keywords:** bridge engineering; splicing construction; statistical analysis; section type; structure disease

Design Practice of Conventional Beam Bridge Landscape Enhancement under Background of Urban Renewal in Zhenjiang .....

ZHANG Yao, GAO Yi, XU Yeming, SHI Kairan ( 105 )

**Abstract:** Urban renewal is an important measure to reshape the urban space, stimulate the urban vitality and perfect the urban functions, and is also one of the important tasks of urban construction in China in the future. With the rapid development of city economy in China, the demands of the masses on the city environment are increasing day by day, and the image quality of a batch of old urban bridges can no longer satisfy the aesthetic needs of the people. Taking Lanyun Bridge of Jinshan Scenic Spot in Zhenjiang as an example, by studying the regional cultural characteristics of Zhenjiang and the site attributes around the bridge, the scheme of architectural modeling of Lanyun Bridge is created from three aspects of design intention, design element extraction and design deduction. The practice has proved that the landscape enhancement of Lanyun Bridge plays a positive role in guiding the regional cultural connotation of Zhenjiang and promoting the socio-economic value around the scenic spot, which provides the creative ideas for the enhancement and reconstruction of the conventional small-span and medium-span beam bridges beam bridges.

**Keywords:** urban renewal; regional culture; scheme creation; architectural modeling; landscape enhancement

Design and Structural Calculation of Noise Barrier .....

HE Chao, ZENG Tao ( 109 )

**Abstract:** With the continuous development of social economy and urbanization, more and more noise barriers have been adopted. In the design process, the designers often pay more attention to the main structure of bridge, but not the auxiliary structures of bridge. Relying on a viaduct noise barrier project in

Guiyang, the design parameters of the noise barrier are briefly described, and the main stressed structures are checked according to the current relevant specifications to ensure that the structural strength and stiffness all meet the requirements, which provides a reliable basis for the safe implementation of the project.

**Keywords:** noise; design of noise barrier; structural calculation

## FLOOD CONTROL & DRAINAGE

Key Technologies and Applications of Accurate Measurement and Systematic Control of Runoff Pollution Source in Highdensity Builtup Areas ..... LYU Yongpeng, WANG Jinbing, JIANG Zhuwu, XIE Sheng, WANG Pan, CAO Wenzhang, CHEN Jian, GAO Shang, ZHANG Tianbin ( 113 )

**Abstract:** The rainwater runoff pollution is a critical cause affecting the quality improvement of urban water environment in China. In order to solve this problem, the research has been conducted in the analytical measurement of runoff pollution sources, the accurate inspection and in-situ remediation of drainage pipelines, the systematic control technology of pollution, and the other fields to form a series of technologies and equipment, which breaks through the technical barrier to improve the quality and efficiency of drainage systems in the high-density built-up areas. The research achievements have been applied in Fuzhou, Xiamen, Shanghai and other cities, and the good environmental and social benefits are achieved, which provide the important technical support for the improvement of urban water environment in China.

**Keywords:** runoff pollution; high-density built-up area; drainage system; improvement of quality and efficiency

Brief Discussion on Construction of Town Rainwater System ..... CHEN Donghua ( 118 )

**Abstract:** *Standard for Design of Outdoor Drainage* (GB 50014—2021) was approved and issued by the Ministry of Housing and Urban-Rural Development in China on April 9, 2021 and was executed on October 1, 2021. Chapter 3 Drainage Engineering is added to the standard, which systematically stipulates the composition and mutual relation of the outdoor drainage engineering, and firstly mentions the construction of outdoor drainage design system at the norm level. From the experience in the municipal design and the new standards, the construction, design essentials and system extension of town rainwater system are briefly sorted out and summarized.

**Keywords:** system construction; design essentials; drainage safety

Research on Comprehensive Regulation Project of River Channel Entering Lake in Dongshan Town, Wuzhong District, Suzhou City ..... HU Xinghua, CAO Qiannan, SU Xiang, ZHENG Ying, NI Sijiang ( 122 )

**Abstract:** As an important part of the ecological conservation area of Wuzhong District, Suzhou City, the inland rivers in the villages and towns mostly link up with Taihu Lake, and the water quality of inland rivers has a certain impact on the water quality of Taihu Lake. Due to the mixed connection and misconnection of rainwater and sewage pipes in the surrounding plots, and the pollution of the surrounding agricultural non-point source, the phenomenon of non-rainwater outflow from the river estuary is serious, which leads to the serious pollution to the surrounding water environment. Therefore, based on the planning objectives proposed in the *Planning of Suzhou Ecological Conservation Experimental Development Zone* and the *Notice of the Provincial Government on Issuing the Work Plan for Water Pollution Prevention and Control in Jiangsu Province*, combined with the monitoring results of river water quality, aiming at the poor water quality and broken head of the rivers, various regulation measures of source control, sewage interception, ecological dredging and ecological restoration are taken to ensure the water quality of the river to be stable and meet the standards. In the later stage, combined

with various methods of farmland non-point source pollution control and non-rainfall outflow traceability investigation, the goal of Class III water quality in the eastern area of Taihu Lake is finally achieved.

**Keywords:** river channel entering lake; source control and pollution interception; ecological dredging; ecological restoration

Analysis on Upgrading Countermeasures for Flood Control Capacity of Urban Rivers .....

..... LI Ke, JIANG Xin, WAN Wei ( 126 )

**Abstract:** Under the influence of climate change and human activities, the situation of repeated flood disasters is becoming more and more intense. The flood control and security capacity of urban rivers restricts the high-quality development of urban economy and society. It is necessary to improve the weak links of water conservancy infrastructures and build a solid defense line to protect the safety of people's lives and property. In order to study the countermeasures of urban rivers in the process of upgrading the flood control capacity, taking an urban river as an example, the measures are considered for increasing the volume of regulation and storage area, reconstructing and heightening the river dike and increasing the discharge capacity of pumping station. Combined with the needs of urban development, the advantages, disadvantages and feasibility of different measures are analyzed, and the design scheme of urban river governance is put forward comprehensively. The effect, impact, investment, difficulty, management and other factors in the implementation of each scheme are compared, and the control countermeasures are selected comprehensively.

**Keywords:** urban river; flood control; upgrading countermeasure

Study on Water Allocation Scheme of Chuhe River Basin in Jiangsu Province .....

..... DENG Renchao, YANG Shutan, WANG Xianhui, GUO Lijuan, HOU Pan ( 130 )

**Abstract:** Taking the Chuhe River Basin in Jiangsu Province as the research object, according to the allocation scheme of water resources and the decomposition results of total water use control indicators, it is to take into account the relationship between the surface and underground conversion, main stream and tributary, the water use in river and out of river, and water use and consumption. The water allocation scheme of cities from Chuhe River Basin in Jiangsu Province is reasonably determined. The important control sections and control indicators are put forward. The rational allocation of water resources is promoted. A good ecological environment is maintained and the water resources are saved and protected.

**Keywords:** Chuhe River Basin; water allocation; allocation scheme of water resources; total water consumption control

Study on Joint Construction of Sponge City Construction and black-odor Water Treatment .....

..... SHI Huiting ( 134 )

**Abstract:** The treatment of black-odor water bodies is an important task of water environment treatment in China at the present stage. The treatment of black-odor water bodies and the construction of sponge cities partially coincide with each other in terms of construction objectives, locations and scope, and there is a need for joint construction in terms of measures, means and ways of construction. The joint construction of black-odor water treatment and sponge city construction are studied from three aspects of the source control, sewage interception and rainwater source reduction, the flowing water circulation and rainwater purification utilization, and the ecological restoration and rainwater regulation storage so as to reduce the engineering investment and improve the effect of comprehensive treatment of water environment, which maximize the project benefits and provide reference for the professionals

**Keywords:** sponge city; black-odor water body; source control and sewage interception; rainwater regulation and storage

Design of Decentralized Sewage Treatment Station in Southwest Rural Areas .....

..... YUE Chongfeng, LI Chihao, XU Jiangcheng ( 137 )

**Abstract:** Aiming at the problems of high influent concentration and significant water fluctuation in the process of sewage treatment construction in the rural villages and towns in southwest China, an improved AAO+MBBR integrated treatment device is designed. The device has the characteristics of strong resistance to influent impact load, small land occupation, low technologic operation cost and the others, which is suitable for the scattered living in the southwest hilly areas. The monitoring results of continuous operation show that the removal rates of COD<sub>cr</sub>, BOD<sub>5</sub>, TP, NH<sub>3</sub>-H and SS are 88%, 96%, 83%, 83.3% and 77.8% respectively. The water quality indexes of the effluent meet Class A standard in *Standard for Pollutant Discharge from Town Wastewater Treatment Plant* (GB 18918—2002).

**Keywords:** decentralized sewage; integration; sewage treatment; AAO; MBBR

Comprehensive Evaluation and Practical Application of Trial Operation Conditions of Wastewater Treatment Plant Construction Project .....

..... WU Manlin, JIA Yusong ( 141 )

**Abstract:** The detailed technical rules mainly suitable for the comprehensive evaluation of the trial operation conditions of the newly built, reconstructed and relevant wastewater treatment plants (WWTP) are put forward. The detailed rules stipulate that the trial operation conditions of WWTP construction project should meet the basic requirements in these aspects of procedure compliance, engineering quality, equipment facilities, design accessibility, safety production and operation management. On this basis, the practical application of the detail rules is analyzed.

**Keywords:** WWTP construction project; trial operation; comprehensive evaluation, application

## MANAGEMENT & CONSTRUCTION

Construction Research of Digital Management System for Highways in Tianjin .....

..... LIU Ruijing, XU Guoshan, AN Rui ( 145 )

**Abstract:** The base number of ordinary national and provincial trunk highway facilities in Tianjin is obtained according to the hazard-affected body investigation work of the first national comprehensive risk survey of natural disasters. Combined with the digital informatization demands of risk emergency management and daily maintenance of highways, the digital management system is constructed. Based on the results of the census data, the dynamic infrastructure database is constructed to realize the visual expression and dynamic management of the existing ordinary national and provincial trunk highway facilities.

**Keywords:** national and provincial highways; management system; comprehensive risk survey of national disasters

Discussion on Design and Construction of Prestressed Concrete Box Girder by Form Traveler Pouring .....

..... ZHANG Hejin ( 148 )

**Abstract:** In the structural design of 80–150 m span bridge in China, there are rich bridge types, such as continuous beam, arch bridge, low-pylon cable-stayed bridge and the others. When the design schemes are selected for the bridges, this kind of span is mainly combined with the position environment, engineering cost, construction conditions and landscape coordination. The continuous box beam scheme of form traveler pouring is still the scheme firstly recommended for many projects now because of its advantages of well-known technology, good integrity, large stiffness, simple shape and low cost. This scheme is well known, but there is still something worth discussing in the design details and construction

process control. Combined with the design case of Lanjiang Bridge in Yuliang Highway North Extension Project, the design and construction essentials of such bridges are discussed, which can be referred for the design and construction of similar bridges.

**Keywords:** form traveler pouring; continuous box beam; design; construction; discussion

Design and Construction of Continuous Steel Box Girder Spanning Railway Throat Area .....

..... ZHU Yongbing ( 151 )

**Abstract:** Bayannur Road Expressway in Hohhot spans the throat area of Hohhot West Railway Station and needs to span 16 tracks. In order to select a reasonable bridge type scheme and minimize the impact on the operating railway and ground roads, the schemes of incremental launching continuous steel box girder and swivel cable-stayed bridge are compared and selected respectively. And the structural design and incremental launching steps of continuous steel box girder are introduced. A finite element model is established to analyze the structural stress of the bridge in the operation and construction stages. The research results show that the incremental launching continuous steel box girder scheme is economical and reasonable, and the structural stress meets the requirements of the code, which provides a reference for the design and construction of the similar bridges.

**Keywords:** throat area of railway station; continuous steel box girder; incremental launching construction; structural design; stress analysis

Briefly Discussion on Construction Technology of Municipal Road and Bridge under Complicated Pipeline Conditions .....

..... XUE Chuang ( 155 )

**Abstract:** The reconstruction and extension projects of urban municipal road often involve many underground pipelines. Dou to the different ownership units of large pipelines and generally longer laying time, it is hard to determine the positions and directions of pipelines. The pipeline drawings provided by the owners and ownership units can be only used as the reference for the construction of projects, which will cause the great influence on the substructure construction of road and bridge. Through a practical engineering case, several methods of precisely positioning and protecting the municipal road pipelines are introduced successfully to solve the problems that the distance from the pipeline to bridge pile foundation is close and the laying depth of pipeline below road is shallow, which can provide the reference for the construction of the similar projects.

**Keywords:** complicated pipeline; precise survey of pipeline; pipeline protection

Simulated Study on Rhombus Form Traveler of Cantilever Construction Based on Midas Civil .....

..... LUO Xiaowei, NING Liyan, ZHANG Qiao, HAN Fude, HUANG Gang ( 159 )

**Abstract:** Based on the analysis of a bridge engineering example, the simulation of the form traveler used in the pouring process of the project is carried out with the help of Midas Civil to determine the internal force level and deformation of the form traveler during the pouring operation, and also to check the stability of the form traveler structure. The results show that the cantilever pouring beam of form traveler can play a role of saving the materials. The section height of the box girder of the bridge is large, the concrete load of the web is large, the elastic deformation of the bottom carling is close to the allowable value, and the layered pouring to the roof of symmetrical construction is adopted, which can control the layer thickness. During the construction of the form traveler, it is necessary to adjust the anchoring force and sling device in the anchor bolt repeatedly. When the construction of form traveler is affected by the lateral force of wind load, the load of insulation material should be considered, which provides the guidance and reference for the cantilever form traveler construction of bridge.

**Keywords:** rhombus form traveler; Midas Civil; simulated analysis



Research on Suspender Replacement Technology of Bowstring Arch Bridge Protected by Outer Steel Pipe .....

..... ZHU Jun, CAO Wenbin, ZHU Liming, YI Chenyang ( 162 )

**Abstract:** Based on the suspender replacement project of a bowstring arch bridge, several suspender replacement construction methods are compared and analyzed. By fully considering the safety, the economy and the particularity of the suspender with the outer steel pipe in this project, the appropriate suspender replacement method is selected. In order to ensure the reasonable structural deformation and stress in the whole process of suspender replacement construction, a full bridge finite element model is established to calculate the suspender replacement construction process, and determine the reasonable process of cutting and welding the outer steel pipe so as to formulate the detailed replacement construction steps. During the on-site construction, the internal force of suspender, internal force of steel pipe, stress and deformation of arch rib and tie beam are monitored. The monitoring results show that the direct replacement method is suitable for this project, which can provide reference for the similar projects.

**Keywords:** bowstring arch bridge; suspender replacement; outer steel pipe; construction monitoring; direct replacement method

Floating Tank Transporting Construction Technology of Ultra-wide Steel Beam for Cable-stayed Bridge

..... ZHANG Huan ( 166 )

**Abstract:** Taking Fuyu Bridge in Fuyang City as the background project, the combined method of the theoretical analysis and numerical calculation is used to study the construction technology of ultra-wide steel beam transported by the floating boat. The results show that the multiple floating tanks connected by the anchor bolts and section steel can form a floating boat for transporting the ultra-wide steel beams. By injecting water into the floating tank or draining water, its draft depth can be flexibly adjusted. The top elevation of the floating tank is controlled able to conveniently transform the steel beam support from the platform up to the floating boat without the large-sized hoisting equipment. Therefore, this technology has the good economic benefit, which provides the basis and reference for the cantilever assembly construction of ultra-wide steel beam cable-stayed bridges limited by the transportation.

**Keywords:** cable-stayed bridge; wide steel beam; floating boat transportation; cantilever assembly

Research on Temporary Support Scheme of Large Full-hole Precast Box Girder in Transporting and Erecting Conditions .....

..... XU Yangmin ( 169 )

**Abstract:** For the large-scale bridges or extra-long continuous elevated bridges in the sea area or intertidal zone, the full-hole precast concrete box girder is a very competitive bridge structure type because of its good manufacture quality and durability when the temporary facilities such as large prefabricating sites are available. Combined with a coastal expressway project in Ningbo, Zhejiang, the finite element software ANSYS is used to analyze the transportation and erection of girders, and study the force characteristics of various temporary support schemes, which can provide the beneficial reference for the full-hole precast bridge structure projects of large sea-crossing bridges.

**Keywords:** continuous elevated bridges; full-hole precast; concrete box girder; temporary support

Research on Key Technologies of Completion and Commissioning of Underwater Tunnel Structural Health Monitoring System .....

..... QIU Anqun, CHEN Xikun, WANG Anfei, CHEN Fei, HUANG Jie ( 172 )

**Abstract:** Taking the completion and commissioning of a typical underwater tunnel structural health monitoring system as an example, the debugging process of 47 sensors with the abnormal data is expounded. The principle of system debugging is defined. The methods of monitoring center debugging, acquisition station debugging, line debugging and sensor debugging are put forward. The revelations of debugging results and construction stage are analyzed in order to provide the reference

for debugging the similar engineering systems.

**Keywords:** underwater tunnel; health monitoring; structural safety; completion commissioning; data exception

#### Research and Application of Combined Treatment Measures for Confined Water in Deep Foundation Pit

..... DAI Xingyun, YING Weichao, SUN Haiming ( 178 )

**Abstract:** With the development of society, the excavation of foundation pit is deeper and deeper. How to deal with the confined water in foundation pit more economically, safely and effectively is becoming more and more important. Combined with the deep foundation pit project of a subway in Hangzhou, four common treatment measures of confined water are analyzed. The combined treatment method of confined water in deep foundation pit is proposed. The length of waterproof curtain is simulated and analyzed by the numerical analysis software. The most economical and reasonable enclosure depth is 63 m. The rationality of the numerical model is further verified by the field pumping test. The test results also verify the feasibility of the combined treatment method of confined water in deep foundation pit, which provides a useful reference for the treatment of confined aquifer in other deep foundation pits in Hangzhou and other areas.

**Keywords:** deep foundation pit; confined water; combined; treatment measures

#### Research on Cracking Mechanism of Pipeline Arch Bridge Lug Plate under Low Temperature Welding Conditions

..... CHEN Jinyi, LIAO Weihua, FAN Zuoyin ( 183 )

**Abstract:** A theoretical study is carried out on the cracks in the circumferential welding seam of the lug side plate of a through-type steel structure tied-bar pipeline arch bridge. Based on the detailed investigation of the cracks on the side plates of the lifting lugs on site, a spatial finite element analysis is carried out on the lug joints. The analysis results show that the main cause of the lifting lug cracks is the on-site welding of the lug joints in a low temperature environment. The strong restraint relationship between the lug side plate and the cover plate hinders the cold shrinkage effect of the welding seam. The welding residual stress of the steel structure is superimposed with the other effects to cause a relatively large stress in the lug cover plate. If the advantageous measures of plant processing the joints with the complex construction, and adopting the reverse deformation method and heat dissipation method are taken, the welding cracks of pipeline bridge can be effectively avoided at the low temperature.

**Keywords:** bridge engineering; steel structure; residual stress; cracking; finite element

## STUDY ON SCIENCE & TECHNOLOGY

#### Analysis on Sources and Control standards of Secondary Pollutants from Mixed Incineration Gas of Sludge Power Plant

..... GU Minyan, DUAN Nina, ZHU Jun ( 186 )

**Abstract:** Aiming at the secondary pollutants from the mixed incineration of sludge power plant, the types and sources of particular pollutants in the mixed incineration system of sludge power plant are summarized. The formation process and mechanism of dioxins and heavy metals are specially expounded. By summarizing the emission standards of flue gas related to incineration at home and abroad, the differences of pollutant control types and limits at home and abroad are compared and analyzed. The existing flue gas treatment systems and functions of coal-fired power plants are sorted out, and the control methods and mechanisms of dioxins and heavy metals are specially set forth.

**Keywords:** sludge; mixed incineration of power plant; incineration; flue gas; secondary pollutants

Engineering Characteristics and Environmental Risks of Solidification and Modification of Landfill Sludge as Backfill ..... WANG Lei, TAN Xuejun, ZHENG Xiaoguang ( 192 )

**Abstract:** An urban wastewater treatment plant (WWTP) in Shanghai began to landfill the dewatered sludge in 2004, and the landfill site was closed in 2010. Recently, the land of the landfill site is to be requisitioned, and the sludge needs to be excavated for secondary treatment. Aiming at the study on the solidification and modification of landfill sludge, the technical feasibility and environmental risks of the modified product as backfill are analyzed. The following conclusions are obtained that the 7-day unconfined compressive strength of landfill sludge is only 0.1 MPa, which does not meet the requirements of mechanical operation and cannot be compacted. After adding 5% curing agent, the strength of sludge is increased to 0.9 MPa, which can meet the requirements of mechanical operation and different grades of road subgrade, and is more smooth and dense after rolling compaction. The proportion of curing agent is further increased to 7.5%, the strength is increased to 1.9 MPa, and the flatness is better after rolling compaction. The content of heavy metals in sludge is lower than the screening value of construction land and the standard value of mud for landscaping. The corrosion grades of sulfate ion, bicarbonate ion, chloride ion and magnesium ion are all small, and the environmental risk as the backfill is small. After more than 10 years of degradation in the process of sludge landfill, the content of organic matter decreases from 50%~55% to 32.90%, which is still higher than the requirements of building foundation cushion material for organic matter so that it is not suitable to be directly used in the backfill area with compaction requirements.

**Keywords:** wastewater treatment plant (WWTP); sludge; landfill; solidification, backfill

Study on Structural Health Monitoring of Urban Underground Road Tunnel ..... DING Hongzhi, ZOU Honghao, ZHAO Guang, LI Ao, DONG Fei ( 197 )

**Abstract:** The number of urban traffic tunnels is increasing with the economic development. As an effective measure to grasp the safety state of tunnel structure, the structural health monitoring of tunnel has also been developed to a certain extent. Due to the small investment scale and tunnel length of underground road tunnel, the structural health system is rarely used in underground road tunnel. Relying on the underground road tunnel of Yuanteng Road, the semi intelligent structural health monitoring method is used to monitor the structural health status of the tunnel on the premise of reducing the cost of structural health system. At the same time, the monitoring results of joint gauge, static level and shape sensor are compared to verify the feasibility of shape sensor in joint opening and uneven settlement on both sides of joint. For the short tunnels such as urban underground roads, it is of importance to properly reduce the intelligent degree of structural health monitoring system, improve the utilization rate of structural health monitoring system in short tunnels, improve the quality of management and maintenance and ensure the structural safety of underground road tunnel.

**Keywords:** underground road tunnel; structural health monitoring; shape sensor; deformation monitoring

Research on Stiffness Coordination and Distribution of Key Structures of Seamless Bridges ..... ZHANG Jicun ( 202 )

**Abstract:** With the development of science and technology, the technical level of the transportation industry is also steadily improving. In view of the problem of bump at bridge head, the research on bridges without expansion joints has gradually been used in the practical application of bridges. The seamless bridge, also known as the bridge without expansion joints, is divided into material without expansion joints and structure without expansion joints. The earth pressure behind of bridge without expansion joints will be directly transmitted to the superstructures such as beams and slabs. The stiffness of each component of the bridge is different, and the effect of the earth pressure behind of the abutment on the bridge without

expansion joints is also different. Based on the research content and the basic theory of structural stiffness, a single-span integral seamless bridge is built, which only includes three parts of beam slab, abutment and abutment pile foundation. The stiffness of three parts will be changed if independently. The influence of its stiffness change on the structure stress is obtained. And the quaternary function is obtained by fitting the drawn influence curve, and the method of solving the coordinated distribution coefficient of stiffness is concluded.

**Keywords:** seamless bridge; structural stiffness; coordinated distribution coefficient

Research on Automatic Design of Longitudinal Section for Reconstructed Road Based on Particle Swarm Algorithm ..... DONG Huazhen, NIE Cen ( 205 )

**Abstract:** In order to change the situations of the manual time-consuming, large randomness, strong subjectivity and uneven design schemes for the slope design by the longitudinal section software of the existing reconstruction road, the automatic design of longitudinal section for the reconstructed roads based on particle swarm algorithm is firstly put forward to improve the design efficiency and reduce the engineering investment. Under the premise of satisfying the relevant codes and the pavement reconstruction scheme, taking the minimize value of the total fill and excavation height of the reconstructed longitudinal section as the objective function, the longitudinal slope length, longitudinal grade and vertical curve radius as the constraint conditions, and the mileage and elevation of grade change point as the variables, the principle of particle swarm algorithm is used to build the automatic design model of longitudinal section for the reconstructed roads based on the particle swarm algorithm. The research results show that the design model achieves the purpose that the longitudinal section of the reconstructed road automatically adapts to the current road elevation and the pavement reconstruction project is minimal. When the number of iterations of particle swarm algorithm reaches more than 400 times, the particle fitness function tends to converge. When the number of iterations is set to 500 times, the satisfactory results can be obtained. The example shows that compared with the traditional manual design, the efficiency of the automatic design algorithm is higher, the automatic design process only takes 2~3 seconds. the effect of fitting the original ground line is better, the investment of pavement paving amount can be saved nearly half, and the optimization design effect is remarkable. The automatic design of longitudinal section for reconstructed road based on particle swarm algorithm provides the theoretical basis and technical support for the design and consultation of road reconstruction.

**Keywords:** road engineering; automatic design of longitudinal section; particle swarm algorithm; reconstructed road

Study on Distribution Rule of Reflection Overpressure of Segmental Assembled Piers under Impact Effect of Explosion ..... XU Kai, SHI Jingxia ( 211 )

**Abstract:** The analysis on the reflection overpressure of bridge pier under the impact effect of explosion is the basis for studying its dynamic response. ANSYS/LS-DYNA is used to establish the three-dimensional solid separation model of the segmental assembled piers under the impact of explosion, and the reliability of the modeling method is verified by the existing tests. Taking the structural form of the pier, the number of segments, the explosion proportional distance and the height of the explosion center as the design variables, the influence on the distribution rule of the shock wave reflection overpressure of segmental assembled piers is analyzed. The study results show that the reflection overpressure of pier increases with the decrease of proportional distance when the number of pier segments and the height of explosion center are fixed. There will be considerable reflection overpressure at the joint position when the explosion height is close to the joints of the piers. The change rule of reflection overpressure of the segmental assembled piers is obviously different from the integral pier. By fitting, the simplified calculation formula of the peak value of reflection overpressure distributed along the height of pier at different proportional

distances of integral and segmental piers is obtained, which can provide the reference for studying the dynamic response of the piers during explosion and the anti-explosion design of the pier.

**Keywords:** segmental assembled pier; explosion; reflection overpressure; distribution rule; simplified calculation

Analysis on Active Earth Pressure of Inclined Retaining Wall under Seepage ..... LI Haipeng ( 216 )

**Abstract:** The Coulomb theory (including the supplementary formula of Coulomb theory) does not consider the seepage effect, and the seepage force is originally a kind of volumetric force. The static model is supplemented to consider the influence of seepage force. For gravity, load, sliding surface resistance (cohesion, friction), retaining wall reaction and seepage force, the different arrangement and combination of these forces will produce the different static models. In the multiple static combined screening, a most concise static equilibrium model easy for analysis is given. The use of the static equilibrium model can analyze the variation law of seepage force. By selecting two engineering examples, the results show that when the slope of the wall top is small (such as  $2^\circ$ ), the effect of seepage on the retaining wall is not obvious. With the increase of the slope of the wall top (such as  $10^\circ$ ), the effect of seepage on the acting force of the retaining wall increases significantly.

**Keywords:** active earth pressure; seepage; cohesion; Coulomb earth pressure; retaining wall

Molecular Dynamics Simulation of Regeneration Mechanism of Aged Asphalt .....

..... ZUO Guiqiang, ZHU Xiaodong, LIU Jinzhou, HE Jia ( 219 )

**Abstract:** The regenerant is usually used to guarantee overall performance of the regenerated asphalt pavement (RAP) during the using process. However, there are a few atomic-scale interpretations on the regeneration mechanism of regenerant in RAP. Mainly focusing on the atomic modeling of regeneration behavior of aged asphalt, three types of asphalt models (virgin, aged, and regenerated asphalts) are built respectively for the comparative analyses of thermodynamics, glass transition behavior, free volume, self-diffusion, and atomic structures. The results show that the free volume of the aged asphalt increases by 4.43% and the temperature of glassy state transition decreases by  $11.82^\circ\text{C}$  after 10% regenerant is mixed. The regenerant can improve its cracking resistance through adding the cohesion of RAP binder. The oxidized and aged asphalt will form a dense and parallelly stacked structure of asphaltene. The introduction of regenerant plays the disaggregation to reverse the negative effects of aging and restore the microstructure and free volume of binder so as to recover its partial properties.

**Keywords:** molecular dynamics; RAP; regeneration mechanism; thermodynamic properties; atomic structure

Effect of AH-1 Warm Mixing Agent on Pavement Performance of SBS Modified Asphalt .....

..... ZHAO Linfei ( 224 )

**Abstract:** In order to study and compare the effect of self-developed AH-1 warm mixing agent on the pavement performance of SBS modified asphalt, and to compare the pavement performance differences between AH-1 and Sasobit with the different dosage, the penetration, ductility and softening point of asphalt are tested by the conventional asphalt performance test. The optimal forming temperature is determined through the asphalt rotary viscosity test and variable temperature compaction Marshall Test. Based on the specification, the Marshall specimen is made for the SMA-13 mixture according to the optimal mixing and forming temperature to detect various indexes. The results show that the addition of AH-1 and Sasobit can increase the softening point and reduce the ductility and penetration of SBS modified asphalt. The mixing temperature of 4% AH-1 is  $250^\circ\text{C}$  lower than that of ordinary hot mix asphalt mixture, and the cooling effect is better than that of Sasobit. AH-1 increases the high temperature performance of asphalt mixture and reduces the low temperature and water stability of mixture, but still

meets the standard requirements.

**Keywords:** warm mixing agent; cooling effect; viscous-temperature curve; voidage; optimal compaction temperature

Study on Transmission Performance of Filled Joints with Stress Waves .....

..... LIU Yaqiang, JIA Shuailong, LI Shanwei ( 229 )

**Abstract:** In order to study the effect of filled joints on the transmission performances of stress waves at different frequencies, the joint models with the different thicknesses and strengths are designed according to the characteristics of the filled joint. And the phenomenon of stress wave with different frequency normally incident on rock joint is simulated to study the law of reflection and transmission of stress wave under the different strength and width filling joints. The results show that for the filled joints with different strengths and thicknesses, its transmission coefficient decreases gradually with the increase of the frequency of the stress wave, and the filled joints serve to the "filtering" effect. With the increase of frequency, the attenuation rate of transmission coefficient is first fast and then slow, and gradually comes to stability. And the lower the strength of filled joint and the larger the width, the phenomenon is more obvious.

**Keywords:** stress wave; filled joint; transmission performance; UDEC

Study on Large-scale Application of Ultra-high Performance Concrete in Ningbo Airport Road South Extension Project .....

JIN Zengxuan ( 234 )

**Abstract:** In Ningbo Airport Road South Extension Project, the ultra-high performance concrete is used as the wet joint of small box beam, the steel bar is not welded, and the amount of concrete to be poured on site is greatly reduced, which effectively accelerates the construction speed, ensures the joint construction of rail transit Ningfeng Line on schedule opening time, and reduces the construction influence on the environment and traffic. The experimental study on the wet joint of bridge deck is carried out, which shows that the cracking resistance and bearing capacity of V-shaped interface are superior to the groove interface and plane interface, and the wet and chipped interface can obviously improve the interface bonding performance of ultra-high performance concrete and precast concrete. The study on a mass of its application in Ningbo Airport Road South Extension Project can form the packaged technical requirement system of design, construction, detection, acceptance and inspection of the ultra-high performance concrete precast assembled bridges.

**Keywords:** ultra-high performance concrete; wet joint; small box beam; precast assembly; interface processing

## APPLICATION OF ACHIEVEMENTS

Application of Ultra-thin Cover of RenewCoat in Pre-maintenance of Municipal Roads .....

..... LU Guangyan ( 239 )

**Abstract:** In order to study the application effect of high-viscosity modified asphalt SMA-10 mixture in road ultra-thin cover maintenance technology, through the laboratory tests and combined with the practical projects, the proportion design, performance inspection, field construction and others of the asphalt mixture are studied. The results show that the high-viscosity modified asphalt used for SMA-10 asphalt mixture has the excellent road usability, and the engineering effects are significant, which can provide the reference for the maintenance material of ultra-thin cover of the roads.

**Keywords:** high-viscosity modified asphalt; ultra-thin cover; asphalt mixture; engineering applications

Application of Pipe-curtain Tunneling Method in Water Diversion Project Crossing under Expressway .....

..... WANG Hongyu ( 242 )

**Abstract:** With the construction of a large number of underground projects, the crossing under the existing operating expressways occurs from time to time. It is particularly important to ensure the normal operation and safety of the existing expressways. Taking a water diversion project crossing under an expressway by the pipe-curtain tunneling method as the background, the design and construction schemes of pipe-curtain tunnel project are expounded, and the MIDAS/GTS NX numerical software is used to analyze the subgrade settlement of the expressway section after the pipe-curtain tunneling method is used. The analysis shows that the pipe-curtain tunneling method can effectively control the subgrade settlement during excavation and ensure the operation safety of expressway, which provides the beneficial reference for the similar projects.

**Keywords:** pipe-curtain method; tunnel engineering; crossing under expressway

Application of PHC Pipe Pile in Metro Depot .....

..... WU Heng, LYU Wenfu, QI Xiaoliang, WANG Yihua, YI Yunpeng ( 246 )

**Abstract:** Due to the large amount of earthwork filling in the later stage, the subway depot often has problems such as large post construction settlement. Taking the foundation reinforcement of a metro depot in Hangzhou as an example, through the field high strain detection test, the application effect of PHC pipe pile in the metro depot is discussed, the integrity of pile body is analyzed, and the bearing capacity of PHC pipe pile is verified. The results show that the vertical compressive ultimate bearing capacity of PHC pipe piles is greater than 1 000 kN, which meets the structural and design requirements. The structural integrity coefficient of PHC pipe pile  $\beta$  is all 1, indicating that the PHC pipe piles tested are class I piles. PHC pipe piles have exerted the side resistance and end resistance. The ratio of end resistance to total resistance is 37% ~ 44%, and the ratio of side friction to total resistance is 56% ~ 63%. PHC pipe pile has the good application effect in foundation reinforcement of metro depot.

**Keywords:** PHC pipe pile; metro depot; field test; high strain detection; foundation reinforcement

## THE RELATIVE SPECIALITIES

Analysis on Settlement Law of Existing Railway Subgrade under Tunneling Construction .....

..... YU Dunmeng ( 250 )

**Abstract:** In order to study the impact of tunneling construction on the settlement and deformation of the existing railway subgrade, the finite element method is used to simulate and analyze the longitudinal and lateral settlement laws of the subgrade in different periods of tunneling, the horizontal deviation settlement simulation on both sides of the subgrade, and the influence of the different tunnel depth and different rock soil strength parameters on the settlement of railway subgrade. The results show that the difference curve of the settlement of the roadbed by the tunnel excavation presents an obvious normal distribution law. When the tunnel face is far from the stratum ahead where the vault will be excavated, the settlement is slower and the settlement value is also smaller. When the tunnel face reaches the vault position, the settlement will increase rapidly at a larger rate, and the vault settlement is more obvious. The larger the tunneling depth is, the smaller the maximum subgrade settlement is. The main rock soil strength parameter leading to the settlement and deformation of the subgrade is the internal friction angle.

**Keywords:** tunneling construction; subgrade settlement; finite element analysis

Analysis on Impact of TBM Tunneling-through Construction on Adjacent Buildings .....

..... ZHAO Mingchun, ZHANG Yongjuan; LI Shuguang; KONG Desen; LI Suozai ( 256 )

**Abstract:** Taking TBM tunnelling through the buildings in Qingdao Metro Line 2 as the background, the deformation rules of buildings and ground surface under the influence of TBM tunnel construction are further studied by numerical simulation. The results show that during TBM tunnelling through two adjacent brick-concrete structural buildings, the maximum settlement of the surface and the building does not appear at the centre line of the two tunnels. The maximum surface settlement will shift toward the location of the larger buildings. The maximum settlement of the building appears at the adjacent positions of the two buildings. For the buildings with the irregular concave and convex, the maximum settlement value will shift to the superposition direction of the convex part and the adjacent buildings. When TBM tunnelling through the frame structural building, there will be the peak settlement at the independent foundation in the ground surface. The closer to the tunnel is, the larger the peak is. The strip foundation used for the brick-concrete structure does not have this effect on the surface settlement. There will be the uplift phenomenon far from one side of tunnel, more than a certain distance from the tunnel. The building uplift will tend to a fixed value.

**Keywords:** tunnel engineering; numerical simulation; tunnelling through buildings; surface settlement; building settlement

Design of Large-span and Small Clear Distance Tunnel Group of Mine Tunneling Method in Qinzhou, Guangxi  
..... XIAO Min ( 260 )

**Abstract:** There are four tunnels in the Beibu Gulf Project of Qinzhou, Guangxi Province, which are B1, B2, B3 and B4 tunnels. B2 and B3 tunnels are the double-way eight-lane tunnels, and B1 and B4 are the pedestrian and non-motored vehicle lane tunnels. The mutual clear distance is only 4.5~5 m. In order to ensure the integral safety of tunnel during the construction, the interlaid rock reinforcement is adopted, the construction procedures are strictly controlled, the advance support and initial support are strengthened, and the secondary lining construction time is adjusted according to the monitoring and measuring results, which finally ensure the smooth construction of the tunnel in the project.

**Keywords:** tunnel group of mine tunneling method; large span; small clear distance

Calculation of Bearing Capacity and Settlement Observation of Hill-pile Engineering Foundation in Sandy Soil Area  
..... LIN Min ( 264 )

**Abstract:** The artificial hill-pile project has the characteristics of large volume of earthwork, wide load distribution and long consolidation time. At the same time, due to the high requirements for the hill-pile engineering foundation, it is easy to cause the major engineering accidents such as the insufficient bearing capacity of foundation or insufficient shear strength of soil. Combined with the artificial hill-pile project in Zilang Park in the Central Innovation Zone of Nantong, through the analysis of geological conditions, the calculation of foundation bearing capacity and the observation of periphery surface settlement, the feasibility of using the natural foundation treatment scheme for the hill-pile project is studied. The analysis on the long-term observation data shows that the periphery surface settlement is all in the range of allowed settlement. Therefore, the natural foundation can be used to build the mountain more than 20 meters for the hill-pile project in the sandy soil area, which provides some suggestions for the foundation treatment of the similar hill-pile projects in the sandy soil area.

**Keywords:** sandy soil; hill-pile project; bearing capacity of foundation; settlement observation

Study on Technology of Gas-shielded Unclean Root Penetration Welding for Medium Plate  
..... LIU Xiaolong, HU Yuanfeng, WEI Huijun ( 268 )

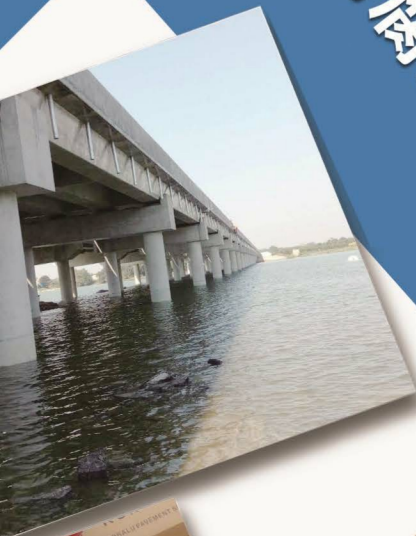
**Abstract:** In the conventional fabrication and welding of steel bridge structure, in order to meet the requirements of design and specification, the penetration of weld seam is ensured and the welding quality





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ISSN 1009-7716  
CN 37-1002/U

国内发行：《城市道桥与防洪》编辑部  
国外发行：中国国际图书贸易总公司（代号：BM 1859）

定价：25.00元



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