

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：上海市市政工程设计研究总院(集团)有限公司

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图为天津市市政工程设计研究总院有限公司设计的潍坊白浪河大桥工程



因为我们专心，所以我们专业！

——《城市道桥与防洪》

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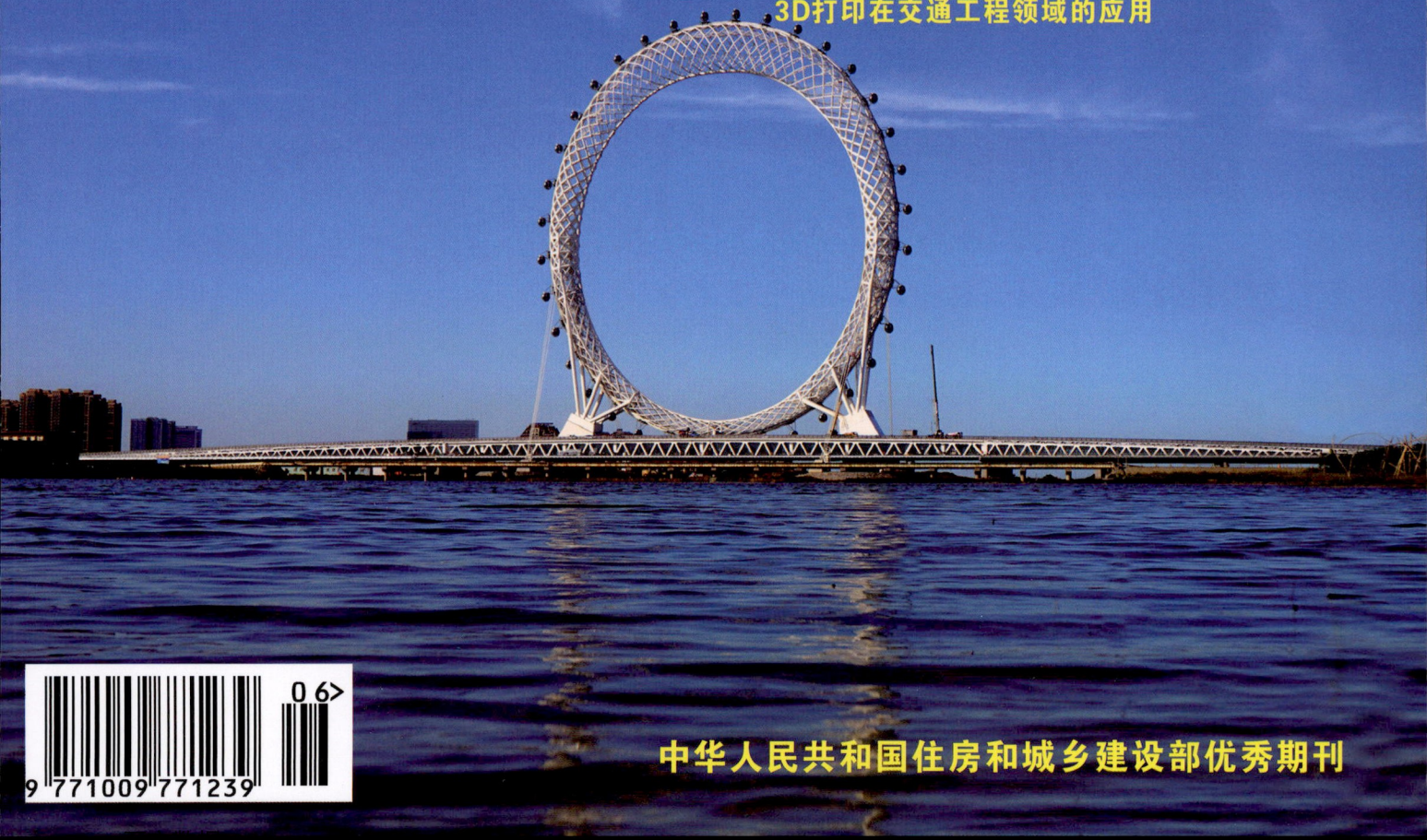
● 本期看点

城市主干路快速化改造的策略及案例分析

大跨度拱桥变截面吊杆索力的分析与识别

“一网统管”背景下上海市排水信息化建设实践探索与研究

3D打印在交通工程领域的应用



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封面工程

本期封面工程为潍坊滨海经济技术开发区白浪河大桥工程。工程位于山东省潍坊市滨海新区,建设单位为潍坊滨海经济技术开发区交通运输局,由天津市政工程设计研究总院有限公司设计,中国建筑第六工程局有限公司施工。

该工程为世界首例“超高无轴摩天轮—桥综合体”,项目涵盖交通、市政、建筑、机械、自动控制、游艺等多个领域。大桥长 540 m,主桥为双层桁架桥,长 190 m。摩天轮采用编织网格结构、无轴式轮桥合一形式,在世界摩天轮建造历史上属首次。摩天轮直径为 125 m,高度为 145 m,从主桥中央穿过,形成超高轮—桥合一体系。

该工程从前期建设到竣工运营,采用了超大直径无轴式摩天轮“轮—桥合建”设计、建造,临海高空精准安装,以及综合体运维与应急救援体系等关键技术,被央视网、新华网、凤凰网和齐鲁网等媒体报道,被誉为“渤海之眼”“中国新地标”,并打破吉尼斯世界纪录,成为“世界最高的无轴摩天轮”。以此为基础,潍坊市滨海新区承办了“国际风筝节”“中国龙舟公开赛”等多个文旅项目,增强了城市内生动力,打造了中国制造文旅品牌。

工程从 2013 年 8 月开始前期设计,2014 年 1 月完成施工图设计,2014 年 4 月开工,2016 年 2 月主体竣工,2017 年底正式运营。

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Overall Scheme Design of Changfu Expressway in Nanning HUANG Haitao (1)

Abstract: Changfu Road is an important north-south expressway in the east of Outer East Ring of Nanning. Based on the planned road network, its functional orientation is analyzed. On the basis of traffic volume prediction, the construction scale is proposed. Combined with the construction conditions, its cross-sectional layout, the main interchange nodes and the relationship with the railway along the line are studied in detail, and the overall construction scheme of Changfu Road is reasonably determined.

Keywords: urban expressway; overall design; hub-type interchange; interchange scheme

Analysis and Study on Overall Scheme of Xinshiba Avenue Expressway WANG Zhengnian, XI Hongqing (6)

Abstract: The construction of expressways can greatly improve the traffic travel conditions of city, and the preliminary research work on the overall design scheme is very important, which has a huge impact on the traffic operation and the development of regional society and economy of city after completion. The overall scheme of the first elevated expressway in Xinyang City is studied in detail. Aiming at the special geomorphological conditions and environmental constraints of the project, the analysis and study are carried out from the functional orientation, design principles, construction scale and standards, construction forms, traffic conversion and ramp layout, general layout scheme, node scheme and other aspects. The project after operated greatly improves the traffic travel conditions of the old and new urban areas in Xinyang City. The social response effect is good, and the comprehensive benefits are very remarkable.

Keywords: expressway; overall scheme; traffic conversion

Strategy and Case Analysis of Express Reconstruction of Urban Trunk Road GAO Wangsheng (9)

Abstract: The express reconstruction of urban trunk road is not only to reconstruct it into expressway and carries out the express reconstruction for the node to increase the travel speed, but also one of the important reconstruction strategies. The applicable conditions and advantages and disadvantages of the two are different. Taking the Dongguan Guantai Road (Hongfu Road - Dongguan Avenue) Express Reconstruction Project as an example, the detailed strategy and overall layout scheme of the node express reconstruction in the whole line are analyzed and introduced. The solution is proposed for some problems caused after the express reconstruction of the nodes. The conclusion is that relatively speaking in the central urban area, the adaptability of node express reconstruction strategy is stronger, more economic and more actionable.

Keywords: trunk road; express reconstruction; node reconstruction; travel speed

Overall Design Scheme of Hefei Changtong Ring II · North Ring Expressway Reconstruction Project

..... ZHANG Wei (12)

Abstract: The overall design scheme of Hefei Changtong Ring II · North Ring Expressway Reconstruction Project is analyzed and studied. The construction conditions of the project are analyzed, its planning is interpreted, and the functional orientation, the study essentials and the difficulties are obtained. The road cross section and construction scale of the project are determined through the traffic flow prediction. The overall layout scheme focusing on how to effectively shield the cross-city traffic on the ring expressway is studied. The layout of interchange nodes and ramps is comprehensively considered. Finally, the key and difficult points in the design of the ring expressway are summarized, and the treatment measures for the complex switching system of the main and auxiliary roads in the road section are proposed.

Keywords: overall design; expressway; overall design; interchange node; switching of main auxiliary roads

Overall Scheme Design of Express Reconstruction of G107 in Dongxihu District of Wuhan City

..... QU Xingwei, XIONG Zhuang, CAI Han (16)

Abstract: Aiming at the problems of low construction standards, low traffic efficiency and frequent traffic accidents of the current G107, the overall scheme of the express reconstruction of G107 in Dongxihu District of Wuhan studied. Based on the functional orientation, service objects and technical standards of the road, combined with the analysis on the planning conditions, construction conditions and traffic volume prediction, the overall scheme of the expressway is studied and determined. The key node schemes for the interchange and the intersection of "one ditch and two roads" are specially expounded.

Keywords: expressway reconstruction; overall scheme; one ditch and two roads

ROADS & COMMUNICATION

Comparison and Study on Bridge and Tunnel Schemes for Cross-river Channels under Complex Urban Conditions in Ningbo

..... LONG Teng (20)

Abstract: With the acceleration of urbanization, there are a growing number of urban cross-river channels to be planned. In the urban built-up areas, the construction conditions of the cross-river channels have become more complex. Generally, the relationship among the cross-river channel, the traffic network, land development, subway construction, river navigation and other significant constraints should be treated with caution. There are the advantages and disadvantages of cross-river channels on the types of bridge and tunnel. Taking the channel crossing Fenghua River in Siming Road of Ningbo as an example, the overall layouts of the bridge and tunnel cross-river schemes are studied separately. And the relationship between the bridge-tunnel scheme and the subway is analyzed. After the comparison and analysis on the advantages and disadvantages of the bridge and tunnel schemes, the conclusion is that the bridge mode crossing river is the best scheme, which provides the reference for the similar cross-river channel projects.

Keywords: cross-river channel; bridge and tunnel schemes; subway; sinking pipe

Research on Traffic Improvement for an Area of Hefei High-tech Industrial Development Zone

..... REN Weiqiang (23)

Abstract: Based on the research on the improvement of traffic congestion in a certain area of Hefei High-tech Industrial Development Zone, through the analysis on the causes of traffic congestion in the current roads, a series of proposal is put forward, such as tapping the potential of the existing road network, strengthening the management of road parking, optimizing the traffic organization structure and carrying out the local

reconstruction of the current road in order to strive for maximizing the release of road traffic capacity under the less engineering investment. The proposal put forward has certain reference significance for the research and reconstruction of urban road traffic improvement.

Keywords: urban road; traffic congestion; traffic capacity; parking place

Study on Setup of Slow Traffic System for Yellow River Fenghuang Bridge in Jinan ZHU Xiaoyu (26)

Abstract: With the development of economy and society and the progress of engineering technology, the development and the connection of urban areas along the banks of rivers become the subject of urban development and transportation system. However, the development of motorization has aggravated the problems of traffic congestion and environmental pollution. As the representative of green slow traffic, the non-motor vehicles are getting more and more attention. The slow traffic channel crossing river is not only a display window of city style, but also the direct embodiment of urban life quality. In order to solve the problem of slow traffic crossing the river, taking the setup of slow traffic system for Yellow River Fenghuang Bridge in Jinan as an example, the application of different slow traffic organization patterns across the river are discussed under the different conditions so as to provide reference for the slow traffic organization of urban channels crossing river.

Keywords: slow traffic; river-crossing bridge; pedestrian; non-motor vehicle

Study on Adjustment of Speed Restriction for Urban Roads in Zhoushan ZHANG Fanglun, WANG Feng (30)

Abstract: According to the relevant research and reports in recent years, the urban traffic problems caused by the unreasonable speed restriction are common in China, especially in some high-grade roads. Some sections with the good traffic conditions often lead to the waste of road resources due to low speed restriction. At present, in some large and medium-sized cities of China, such as Chengdu and Xiamen, the relevant research and practice on the adjustment of speed restriction are carried out, and good efficiencies are achieved. But in the most cities, the problem of unreasonable speed restriction is still common. How to formulate the speed restriction scientifically and reasonably is still an important subject of the urban traffic operation and management. In order to reasonably formulate the speed limit value of urban road and improve the road efficiency and traffic safety, relying on Zhoushan City Binhai Avenue Project, after the investigation and survey of each road section operation speed, and based on the theoretical calculation method of highway speed limit design, the optimization adjustment scheme of the speed limit value is determined, and the existing problems of taking the design speed as the speed limit value and the theoretical basis of taking the 85% percentile speed as the speed limit value of urban road are verified.

Keywords: speed restriction; design speed; urban road; 85% percentile speed

Research on Design Scheme of Extra High Voltage Line Nodes Involved in Expressway LIU Huan (33)

Abstract: The construction of expressway outside the city is growing vigorously, in which the interaction of the important municipal pipelines, such as expressway, extra high voltage line, oil conveying pipe and gas pipe in the urban area is increasing. Taking the Riverside Channel Pudong Section Construction Project as an example and focusing on the node of Zhouhai Substation, the scheme design of expressway under the condition of extra-high voltage lines is studied. Based on the complex construction conditions of extra-high voltage lines, three design schemes of tunnel, ground and "low overhead" are proposed, and are systematically compared and selected. Combined with the pipeline characteristics at the nodes of Zhouhai Substation and the design requirements of the riverside channel

project, the ground scheme is comprehensively recommended as the implementation scheme. The research results provide a useful reference for similar projects.

Keywords: extra-high voltage line; expressway; scheme optimization; Pudong section of riverside channel

Research on Alignment Indicators and Optimization Measures of Urban Road Based on Sight Distance OUYANG Zhao (37)

Abstract: Restricted by the construction conditions, the small horizontal and vertical alignment indicators are often used for the urban roads. The curved sections of underground road and elevated road are affected by the mid-partition wall, side wall, structural roof or anti-collision wall, anti-dazzle facilities, sound barrier and other structures, which are easy to cause the poor sight distance and bring the potential safety hazard. On the basis of summarizing and analyzing the calculation method of the sight distance for driving and the required value of specification, the corresponding values of the horizontal curve and vertical curve radiuses of urban roads under the different design speeds and sight distance requirements are calculated and achieved by the numerical analysis. And the optimization design measures for the poor sight distance are put forward in order to provide the reference for the similar projects in the future.

Keywords: stopping sight distance; sight distance calculation; alignment indicators; optimization measures for sight distance

Design of Sand Conveying Ditch and Analysis of Air Flow Field for Expressway in Desert Hinterland JIA Xiaolong, LUO Yanchi, DING Xinjian, YU Guogeng, SUN Yuexuan (41)

Abstract: In order to avoid the problem of sand damage on desert highways, relying on the Uma Desert Expressway Sand Prevention and Control Project, around the sand conveying concept of "sand conveying section", based on the principle of wind and sand movement and the principle of computational fluid dynamics (CFD) digital simulation, the influence of the location and size of sand conveying structure on the characteristics of subgrade airflow field and sand accumulation is analyzed. The research results show that when the sand conveying structure is 5 m away from the subgrade, the overall subgrade is least affected by wind erosion, and the amount of sand at the toe of the slope and the pavement is minimum. When the sand conveying structure is 3m away from the subgrade, the leeward side of subgrade has the least sand accumulation. When the width of the sand conveying structure is 9 m, the wind erosion of the subgrade toe and the slope surface is the smallest. When the width of the sand conveying structure is 6 m, the wind erosion of the roadway is the least. At the same time, when the sand conveying structure is grade 3 and the width is 9 m, the sand conveying pressure in the sand conveying ditch and the accumulation of sand particles at the wind dike can be effectively alleviated, but the width of the sand conveying structure has little effect on the sand accumulation of the subgrade. In general, based on the different terrains and different needs, the parameters of sand conveying structures can be set according to local conditions for sand prevention and control in practical projects.

Keywords: sand prevention and control; sand conveying; structure; design

Application of "Soft Foundation Strong Surface" Resonant Macadam Pavement Structure in Municipal Heavy Load Roads in Port Area ZHANG Xinyu (45)

Abstract: Based on the practical application of the "soft foundation strong surface" resonant macadam pavement structure in a municipal heavy load road of port area, the difficulties and solutions of this new pavement structure in its application and the engineering design of municipal heavy load road of port area

are analyzed. The applicability of this new pavement structure in the municipal heavy load roads in port area, and the design method and control essentials better combined with the existing normative system are summarized. The relevant design application and promotion of this pavement structure have some referring values.

Keywords: soft foundation strong surface; resonant macadam; municipal heavy load road of port area; reflection crack; intensity factor

Analysis on "Cement to Asphalt" Design of Road Based on Practical Examples LI Lingcong (50)

Abstract: In recent years, the cement concrete pavement has not been recommended for the new road pavements because of its high driving noise, poor driving comfort, difficult maintenance and other shortcomings. The built concrete pavements are also being reconstructed to the asphalt pavements step by step. Taking the overhaul project of West Changjiang Road in Baoshan District of Shanghai as an example, a variety of "cement to asphalt" design schemes are compared through the aspects of the effect after the completion of project, the difficulties of construction method, the length of construction period and the impact on environment. Aiming at the practical situation of this project, the most feasible recommended scheme is proposed to provide a reference for the "cement to asphalt" design of roads in the future.

Keywords: urban road; concrete pavement; cement to asphalt design

Analysis on Stability of a Slope under Complex Construction Conditions DONG Rongqiang (53)

Abstract: Taking a pipeline relocation project as an example, the Midas/GTS software is applied to simulate and analyze the stress-strain law of the slope soil body and the stability situation of the slope in the construction process of water supply pipeline, and the reasonable scheme of erecting the water supply pipeline is determined. The results show that the safety factor of slope decreases with the increase of the pier spacing of water supply pipeline. The distributional difference of soil stress and strain is larger if the pier spacing is different. But the influence of pier spacing on the stress of retaining wall is less. When considering the rainwater seepage action, the safety factor of the slope is greatly reduced, which provides the useful reference for the other similar slope projects.

Keywords: slope stability; numerical analysis; rainwater seepage

Cause Analysis and Control Measures of Highway Landslide Affected by Structure HUANG Xing (57)

Abstract: The landslide phenomenon of slope at the syncline core of Fujunchang by fast channel in Tianfu New Area of Meishan is analyzed. It is believed that the cause of landslide is the development of mudstone in the slope stratum, and the rock mass is broken with poor integrity because of syncline effect of Fujunchang. The excavation of the slope is too steep and is affected by the rainfall in the construction. In order to determine the treatment scheme, the sliding surface parameters are achieved according to the geotechnical test result and inversion result. The stability analysis and thrust calculation of the landslide are carried out. Finally, it is determined to use the treatment scheme properly for lifting the longitudinal slope and then clearing the earthwork.

Keywords: landslide; cause analysis; structure; control measures; clearing earthwork

Research on Mix Design Method of Recycled SBS Modified Asphalt Mixture

..... HAN Zheng, QI Wenyang, WANG Lijun (61)

Abstract: With the maintenance of SBS modified asphalt pavement, a large amount of recycled SBS

modified asphalt mixture will be produced. Compared with the recycled ordinary asphalt mixture, the recycled SBS modified asphalt mixture has the higher utilization value. On the basis of the current standard design method, the method of mix design of recycled SBS modified asphalt mixture is formed. The design contents mainly include the distinguishing of the aging degree of aged SBS modified asphalt in RAP materials, the regeneration design of aged SBS modified asphalt, the determination of RAP content and the determination of new asphalt content.

Keywords: road engineering; SBS modified asphalt; recycling; mix design

Brief Discussion on Calculation of Uneven Settlement of Inclined Retaining Wall GAO Liu (64)

Abstract: As a retaining structure, the retaining wall is widely used in highways. ABAQUS finite element software is often used in scientific research and hydraulic engineering to simplify the working conditions. The stress nephogram is used to analyze the impact of changes in the relevant parameters of retaining wall and soil on the working conditions. Generally, the working conditions are simplified in highway engineering. The Lizheng Geotechnical Software is used for checking calculation. The stability of the inclined retaining wall is analyzed by the manual calculation, Lizheng Geotechnical Software and GE05 software. The relevant suggestions for calculating the eccentricity of the inclined retaining wall are given.

Keywords: inclined retaining wall; GE05; Lizheng Geotechnical Software; eccentricity

BRIDGES & STRUCTURES

Analysis and Identification on Cable Forces of in Variable Cross-section Suspenders of Long-span Arch Bridge

..... PENG Wei, MIN Jinfeng, YANG Yunbiao, DONG Shuming, SONG Gangwu (66)

Abstract: The variable cross-section suspenders are adopted for the three-span (30m+120m+30m) continuous steel truss arch bridge in Tingfeng Highway crossing the channel of Pingshen Line in Shanghai. Its accurate identification of cable forces in the construction process has certain technical difficulties, which needs the effective theoretical analysis and practical engineering experience to solve. By using the calculation formulae of cable force for constant-section suspenders and combined with the parameter analysis results of variable cross-section suspenders by SAP2000 finite element model, the benchmark equivalent length of different specifications of suspenders is derived. According to the benchmark equivalent length and measured frequency of suspenders, the cable forces are calculated by the cable force calculation formula with one end fixed and one end hinged, and compared with the design cable forces at the corresponding stage, which can be concluded that the cable forces in suspenders of main bridge basically meet the design requirements.

Keywords: long-span arch bridge; variable cross-section suspender; calculation formula for cable force; SAP2000 finite element modelling; benchmark equivalent length of suspender

Design and Analysis of Skew Multi-Span Continuous Beam Arch Composite Bridge

..... HUANG Yi, XU Debiao, ZHAO Weihe (70)

Abstract: The design status of beam arch composite bridge is summarized. Taking a 48 m + 5 × 72 m + 48 m skew continual beam arch composite bridge as an example, the basic situation and overall design idea of the project are briefly introduced. The structure of this bridge is calculated and analyzed. The design difficulties, the innovation points and the relevant countermeasures of the bridge are expounded including the determination of landscape scheme for beam arch composite bridge, the treatment of ultra-wide deck

of urban steel bridge and the treatment of skew steel beam segments in order to provide the reference for the design of the similar beam arch composite bridges.

Keywords: continuous beam arch composite bridge; design idea; landscape scheme; design of steel bridge

Overall Design of Arch-pylon Cable-stayed Bridge in Yaodu Avenue WANG Guannan, DONG Peng (74)

Abstract: Arch-pylon cable-stayed bridge is a new type of special-shaped bridge structure. Its modeling is innovative, unique and varied with a landmark scenery effect. The main bridge in Yaodu Avenue of Bozhou is a 190 m+150 m single-pylon cable-stayed bridge. The conception of the arched pylon is derived from the Chinese peony with the characteristics of Bozhou. The design concept and overall design idea of the main bridge in Yaodu Avenue are analyzed. The modeling of the main pylon, the influence of the beam layout and the structural setting of the pylon-beam consolidation section are introduced in detail. The relative design ideas and experience can be referred by the relevant designers.

Keywords: arched pylon; pylon-beam consolidation; single-pylon cable-stayed bridge

Design and Analysis of Foziling Road Bridge across Phoenix River in Lu'an City CHENG Hongbin (78)

Abstract: Taking the design of Foziling Road Bridge across Phoenix River in Lu'an City as the background, the technical standards, the comparison of bridge types, the overall layout, the design and construction methods of main structure are introduced. The static analysis and dynamic analysis of the bridge structure are carried out. The analysis results show that the design of bridge structure is reasonable, and the checking calculation results meet the code requirements, which can be referred for the design and calculation of similar bridges.

Keywords: low-pylon cable-stayed bridge; bridge design; structure calculation; landscape

Research on Bridge Scheme of Crossing Beijing-Hangzhou Canal in Central Urban Area of Yangzhou ZHENG Qiang (82)

Abstract: With the continuous expansion of the built-up area scope in the central urban area, the construction of bridges across the waterway will inevitably appear in the central urban area. The landscape characteristics, cultural features and surrounding environment of the city will also greatly affect the selection of the waterway bridge scheme. Through the example of the bridge project crossing Beijing-Hangzhou Grand Canal in Wanfu Road of Yangzhou, the construction scheme of crossing-channel bridge in the central urban area is studied to provide the ideas for the implementation of related projects under similar conditions.

Keywords: waterway bridge; bridge type scheme; steel truss arch bridge

Design of 120 m-span Ground Anchored Pedestrian Suspension Bridge in a Park GAO Xiaoxing (86)

Abstract: The pedestrian landscape bridge of Yongxin Wetland Park is a double-pylon spatial double-plane ground anchored suspension bridge with a main span of 120 m, which connects Yangshan Park and the wetland park. Its clear width of bridge deck is 3.35 m and a 20 m-long glass bridge deck is set in the middle of the bridge deck. Through a brief introduction of the main design standards, structural design, calculation and analysis of the bridge, the design ideas and methods of long-span pedestrian suspension bridge are expounded, which is helpful to provide the experience and reference for the design of similar pedestrian suspension bridges.

Keywords: pedestrian suspension bridge; long span; glass deck; design

Design of Prestressed RC-UHPC Simple-supported Composite Box Girder

..... XIAO Gang, YANG Yang, XIA Zhanghua, JI Bangchong, LIN Shangshun, LIN Yulian (89)

Abstract: In order to improve the stress performance of concrete box girder, a new structure of prestressed RC-UHPC simple-supported composite box girder is proposed. Taking a cast-in-situ prestressed single-box double-cell simple-supported box girder bridge in a practical project as the engineering background, the design and study are carried out. The prestressed RC-UHPC composite box girder is used to replace the original design of cast-in-situ box girder. The calculation method of this structure is discussed through the combined method of the theoretical analysis and MIDAS CIVIL, and the box girder is designed and calculated. The results show that the flexural capacity and the maximum deformation of the new designed structure conform to the requirements of the current design code. Through the comparison of the cost, construction convenience and durability of the original designed box girder and the new box girder, it is found that the cost of the proposed new box girder is closer to that of the original designed box girder. But the amount of concrete and prestressing tendons is reduced by 49.6% and 21.1% compared with that of the original cast-in-situ bridge. The prefabrication hoisting scheme can also be used, the construction is convenient, and the UHPC crack resistance and durability of the web are also obviously improved, which has a broad application prospect.

Keywords: composite box bridge; prefabricated assembly; RC-UHPC; durability; cost

Seismic Response Analysis of Curved Bridge Considering Seismic Isolation Design

..... ZHANG Xiaojun (94)

Abstract: In order to fully understand the seismic response characteristics and seismic performance of high-pier curved bridge in mountainous area, taking the No. 1 Bridge of Daqing Expressway as the engineering background, the calculation model is established by using MIDAS CIVIL software, and the time history analysis is carried out. The effects of seismic incidence angle and friction pendulum support on the displacement of pier top and internal force of pier bottom are studied. The results show that the longitudinal displacement at the top of the pier and the internal force at the bottom of the pier increase first and then decrease with the change of the incident angle of ground motion, and the maximum longitudinal displacement does not appear at the top of the highest pier. The variation of the curved surface radius and the friction coefficient of the friction pendulum bearing have a weak influence on the maximum longitudinal displacement of the pier top. When the radius of the curved surface is fixed and the friction coefficient is 0.01, the longitudinal displacement of the pier top and the internal force of the pier bottom are the maximum.

Keywords: high pier; curved bridge; time history analysis; incident angle, curved surface radius

Study on Reasonable Restraint System of Single-pylon Asymmetric Self-anchored Suspension Bridge

..... GU Dong (99)

Abstract: The closed force transferring route of self-anchored suspension bridge is formed through the anchoring connection of the main cable and stiffening girder. The horizontal component force of the main cable is gradually transferred to the stiffening girder of the main span. The vertical component force is balanced mainly by the side span weight. The main girder is a statically indeterminate system under the static force condition, and under the dynamic condition, is usually the full-floating or semi-floating system in order

to reach the purpose of seismic mitigation and absorption. This will result in a change in restraint system. This problem is particularly prominent in the single-pylon asymmetric self-anchored suspension bridge. Based on the four-span single-pylon asymmetric self-anchored suspension bridge across Fenhe River in Tongda Street of Taiyuan City, a finite element model of the whole bridge is established to analyze the influence of the different restraint systems on the stress of the whole bridge under the static and dynamic conditions, which provides the basis for the design of the similar structures in the future.

Keywords: self-anchored suspension bridge; single-pylon asymmetric; restraint system; finite element method; statically indeterminate

Calculation and Analysis on Prestressed Bent Cap of Double-column Vase-shaped Pier ZHANG Anyu, ZHOU Yuli, GUO Yawen (103)

Abstract: In order to reduce the influence on the road traffic under bridge possibly and meet the demand of urban landscape, the prestressed bent cap of double-column vase-shaped pier is frequently use as a preferred scheme of urban viaduct. The conventional force analysis of skeletal structures cannot accurately simulate the stress characteristics of prestressed bent cap at the pier top. Based on an urban viaduct project, the universal finite element software is used to carry out the solid element modeling for the pier column and bent cap. The calculated results of the stress, crack resistance and other indexes all verify that the design scheme is rational and reliable.

Keywords: urban viaduct; double-column vase-shaped pier; prestressed bent cap; stress analysis

Horizontal Static Load Test and Numerical Simulation Analysis of Large-diameter Single Pile under Geological Conditions of Beaded Karst Cave in Sandy Gravel Strata WU Ziru (106)

Abstract: At present, the research on the horizontal bearing capacity and deformation mechanism of bridge pile foundation under the geological conditions of sandy gravel and beaded karst cave is not sufficient. In order to reasonably determine the horizontal bearing capacity of pile foundation of unhinged arch bridge under this geological condition, the on-site horizontal static load test is carried out, and the reasonable value of horizontal bearing capacity of pile foundation under this kind of geological condition is analyzed in order to provide the reference for similar projects. And the GTS finite element software is used to carry out the numerical simulation. The Mohr Coulomb model is modified through the modeling to simulate the sandy gravel strata. The Goodman contact element is set up between the pile and the soil, and the pile tip element is set up at the pile tip. At the same time, it is assumed that the beaded karst cave is distributed in ellipsoidal state. In order to prevent the calculation from the non-convergent situation, the interior of the cavity is specially treated. The unified theory is used to simulate the steel casing and the concrete in it. On this basis, the $H-Y$ curve and $H-\Delta Y_0 / \Delta H$ curve of the pile top under loading are analyzed, and the numerical results are compared with the measured results. The results show that the results of finite element numerical simulation are in good agreement with the field test results under the rational use of constitutive model and geotechnical parameters. The finite element software can be used as a powerful technical means to determine the horizontal bearing capacity of pile foundation under this special geological condition, which provides a new idea for determining the horizontal bearing capacity of a single pile.

Keywords: constitutive model; Goodman contact element; pile tip element; horizontal static load test of pile foundation; load-displacement curve

Design of PLC Pile Cofferdam in Deep Water Foundation CHAI Shizong, LAN Haitao (110)

Abstract: Cofferdam is widely used as a common temporary enclosure structure in the construction of modern bridge foundation pit. It is necessary to design and study cofferdam to ensure the safety. The PLC pile cofferdam is used as the water retaining structure of the pier foundation, which not only enhances the water sealing effect of the locked steel pipe pile, but also saves the steel and reduces the construction cost. Taking the PLC pile cofferdam used in the construction of the main pier of a landscape bridge in Hainan as an example, the PLC pile cofferdam in the deep foundation pit is analyzed. Combined with the finite element method and theoretical formula, the design scheme is analyzed to ensure the safety and stability of the deep foundation pit structure in the construction.

Keywords: PLC pile; cofferdam; deep foundation pit; finite element analysis; bridge

Analysis on Comfort Level of Single-span Long-span Cast-in-situ Rigid-frame Pedestrian Bridge

..... BU Jiangfeng (115)

Abstract: The rigid-frame bridge is a mature and widely used bridge type in bridge design. But generally, the long-span rigid-frame bridge is mainly vehicular bridge, and the comfort level under the pedestrian conditions is rarely checked. At present, the steel structure or composite structure bridges are mostly used for the long-span pedestrian bridges in urban construction. But in some special cases, the cast-in-situ structure has its irreplaceable advantages. Taking a single-span 50 m rigid-frame bridge as an example, the checking calculation method of the comfort level for single-span long-span cast-in-situ rigid-frame pedestrian bridge is introduced, which provides the experience and reference for similar projects.

Keywords: rigid-frame bridge; long span; comfort level; pedestrian bridge

Analysis on Failure Mechanism of Hinge Joints in Fabricated Hollow Slab Bridges

..... RAO Ke, JIANG Fuxiang, QIN Yiming (118)

Abstract: Fabricated hollow slab bridges are widely used. The damage of hinge joints is a common disease of fabricated hollow slab bridges, and there is controversy over the failure mechanism of hinge joints. Most scholars believe that the design of hinge joints is defective and the hinge joints are damaged by the crosswise tensile stress. For the investigation of the old bridges, it is found that the proportion of hinge joint failure is very high, but there is no problem of hinge joints in the investigation of new bridges. If the hinge joints are damaged, not only the problems of hinge joint exist in the old bridges, but also the failure mechanism of hinge joints has the other important causes. The detailed finite element model is established by using ABAQUS fully to consider the contact between the hinge joint and the hollow slab, and the connecting steel bar between the hinge joint and the hollow slab. It is concluded that the structural stress of the hinge joint is reasonable, in which the position of the connecting steel bar is very important. If the connecting steel bar is rusted, the stress of the hinge joint will be defective. Therefore, it is concluded that the disease of the hinge joint is caused by the corrosion of the connecting steel bar.

Keywords: bridge engineering; hinge joint disease; hollow slab; single-slab stress; stress

Material Selection and Design of Steel Deck Pavement System

..... XIE Shengjia, TANG Dongye, CHENG Zhiqiang (121)

Abstract: Combined with the mix design and performance test of pavement materials, the high temperature stability, fatigue cracking performance and the bonding layer application of the typical pavement materials are studied and analyzed. The result shows that the epoxy asphalt mixture EA has the better anti-rut features. Its 60°C final rut depth is about 30% of asphalt mastic macadam mixture. The 70°C final rut depth is only about

25% of SMA. For SMA, a critical strain level should be considered during the design of pavement. Its practical strain level is properly controlled lower than this critical value during the structural design. The optimum bonding material dosage makes the bonding strength among layers maximum. The optimum dosages of the pull-out test and the oblique shear test are same, and two testing results are same.

Keywords: steel deck; deck pavement; material selection; design

FLOOD CONTROL & DRAINAGE

Exploration and Research on Drainage Information Construction of Shanghai in Context of One Network Management WU Siqun (125)

Abstract: For continuously improving the scientific, refined and intelligent level of urban operation and management, the construction of "one network management" platform for the urban operation system in Shanghai has been carried out since 2019. The construction background and current achievements of the "One Network Management" information platform and the related application scenarios in the water affairs and drainage industry in Shanghai are analyzed. Combined with the new requirements of drainage administration, and the new technologies and new trend of information development, and focusing on the data sharing, departmental collaboration and intelligence construction, the construction ideas of the platform in the iterative optimization process in future are studied, which provides the exploratory suggestions for the subsequent platform construction and application.

Keywords: drainage information; intelligent drainage; one network management

Design Scheme and Key Points of Drainage and Flood Control in Mountainous Cities ZHANG Jun (128)

Abstract: Taking the new incubator and the surrounding road project in Chongqing Collaborative Innovation Zone as an example, aiming at the natural terrain of mountain cities, the collection and discharge of rainwater and sewage on the roads and surrounding area after the completion of the plot are solved. At the same time, the design is carried out by considering the combination of flood discharge channels and municipal rainwater in mountain areas. The protection scheme of drainage pipeline in mountain area and the design points of pipeline crossing the gully and river in mountain area are discussed.

Keywords: mountainous city; drainage and flood discharge; pipeline protection; river-crossing pipeline

Analysis on Application of Plastic Steel Sheet Pile in River Regulation Engineering ZHANG Jiade (131)

Abstract: Based on the application cases of plastic steel sheet pile in the river regulation engineering of Shanghai in recent years, the plastic steel sheet pile is compared with the other common revetments from the aspects of production, construction, draining slope protection, late maintenance and engineering cost. The result shows that the high-strength plastic steel sheet pile has the stronger tensile and bending strengths, and has the stronger shock resistance, flexibility and compressive strength. The material quality is sable, strong and durable without the corrosion, ant colony and crack. The material composition is stable, and is not affected by the climate and water quality. At the same time, the product has no toxic and harmful substances, and will never pollute the water and environment. The green environmental protection can be recycled, which can meet the national green building engineering needs. The optimization suggestion is proposed according to the characteristics of plastic steel sheet pile, which is helpful for the

plastic steel sheet pile to be better applied in the future engineering.

Keywords: plastic steel sheet pile; river regulation engineering; application

Analysis on Structural Section Design of Beixi Diversion Trunk Canal in Xiamen WANG Lulu(135)

Abstract: Beixi Diversion Trunk Channel is the main water supply canal of Xiamen. Considering the need of land planning and the necessity of water supply upgrading, the Maluanwan Section of the trunk canal is upgraded and reconstructed. The water supply scale of the trunk canal is 16 m³/s, and the section form is a double-hole reinforced concrete box culvert. The trunk canal is divided into four sections according to the strong adaptability of section design to the foundation, the easy connection with the old and original box culverts and the other principles. Its finite element calculation and analysis are carried out. The relevant internal force and anti-floating effect of box culvert are calculated.

Keywords: diversion trunk canal; section design; reinforced concrete box culvert

Application Exploration and Engineering Practice of River Bypass Treatment Technology

..... JI Chi (140)

Abstract: River bypass treatment technology has been widely used in the water environment governance of China. The selection of the appropriate river bypass treatment process is the first step, which directly affects the pollutant removal, floor area, engineering cost, operation and maintenance cost, ecological landscape, etc. The main river bypass treatment technology is summarized, compared and analyzed. Combined with the engineering practice of a river bypass constructed wetland treatment in East China, the process design characteristics, operation effects and advantages of bypass constructed wetland are summarized and analyzed. The relative engineering design experience is summarized in order to provide the reference for the implementation of related projects.

Keywords: river; bypass processing technology; constructed wetland; engineering practice

Research on Water Saving of Large Sludge Dewatering, Drying and Incineration Engineering

..... ZHOU Bin, WANG Yunyun, LIN Lifeng, ZHANG Dongling (144)

Abstract: Taking a large sludge dewatering, drying and incineration project in Shanghai as an example, the water resource consumption in the operation of sludge dewatering, drying and incineration system is studied. Through the analysis of the water quantity and quality of each water point, the water source substitution, recycling, sequential use and other measures are studied to reduce the usage amount of tap water and improve the utilization rate of water resources.

Keywords: sludge treatment; water saving; water substitution; recycling; sequential use

Application of "Ultrafiltration + Reverse Osmosis" Process in Reclaimed Water Treatment of WWTP

..... WU Jin (147)

Abstract: In recent years, the sewage recycling has attracted more and more attention in the industry. At this stage, there is no consideration to use the sewage recycling in the design of wastewater treatment plant (WWTP) in China. Taking a WWTP of Shanghai as an example, the "ultrafiltration + reverse osmosis" process is innovatively adopted in the design of reclaimed water of the municipal WWTP. After reaching the industrial water purification standard, the reclaimed water can achieve the self-sufficiency in water use within WWTP in order to provide the reference for the design of reclaimed water in the similar WWTPs. The design scale of reclaimed water in the project is 5 000 m³/d.

The ultrafiltration membrane is the hollow fiber membrane with a pore size of 0.02 μm . The designed membrane flux is not larger than 55 L/ ($\text{m}^2\cdot\text{h}$). The designed recovery rate is not less than 90%. The spiral-wound membrane component is used for the reverse osmosis membrane. The design system recovery rate is not less than 70%. The first part of the investment for the project is RMB 20.911 7 million yuan. The unit operating cost is 1.33 yuan/ m^3 .

Keywords: reclaimed water; technological process; ultrafiltration; reverse osmosis

Technological Design of Typical Intensive Wastewater Treatment Plant in Nanjing SONG Luning (151)

Abstract: The design scale of Nanjing Dachang Wastewater Treatment Plant (Phase I) is 90 000 m^3/d . The effluent quality shall meet the Grade A of *Discharge Standard of Pollutants from Municipal Wastewater Treatment Plant* (GB 18918—2002). The difficulties in the engineering design of Dachang Wastewater Treatment Plant are introduced and analyzed to determine the process scheme selection and design parameters for the Phase I engineering treatment. The treatment process of modified AAO + magnetic coagulating sedimentation + denitrification deep bed filter + sludge advanced concentration and dehydration is determined. The problem of land shortage is solved through the process selection and cluster layout. The advanced equipment technology is used to ensure the feasibility of reaching the standard of quasi-IV effluent. The certain reference significance is for the design of similar projects.

Keywords: wastewater treatment plant (WWTP); Grade A standard; modified AAO process; denitrification deep bed filter; intensive design

Study on Application of MBBR Technology in WWTP Quasi-class IV Water Upgrading and Reconstruction GAI Xin (156)

Abstract: The current scale of a wastewater treatment plant (WWTP) in Wuhu City is $10 \times 10^4 \text{ m}^3/\text{d}$. Its effluent is in compliance with the first level A discharge standard of China. WWTP is upgraded and reconstructed. Its effluent quality meets the surface quasi-class IV water standard. By comparing and studying the schemes, the aerobic zone of the biological reaction tank is re-divided. The part of the tank is divided into the adjustable area of anaerobic / aerobic zone, and the part of the tank is used for adding the aerobic suspended filler in order to enhance the nitrification and denitrification process, which ensures the effluent quality up to standard stably, and can provide a reference for the upgrading and reconstruction of WWTP surface quasi-class IV water.

Keywords: moving bed biofilm reactor (MBBR); nitrification and denitrification; nitrogen and phosphorus removal; upgrading and reconstruction

MANAGEMENT & CONSTRUCTION

Research on Synchronous Jacking Technology of Continuous Box Girder Bridge XU Ziyu (159)

Abstract: In order to study the synchronous jacking technology of continuous box girder bridges, taking an overpass in Huaibei as the object of study, and through the monitoring of the whole jacking process and the finite element analysis, the displacement and stress variation of continuous beam bridge during jacking and the influence of jacking displacement deviation on the internal force of the structure are analyzed. The results show that the structure will produce the large lateral and longitudinal deflections in the process of replacing the supports. Therefore, the close attention should

be paid to the displacement of each lifting fulcrum, and also the displacement limiting measures should be taken. The stress direction of beam bottom is basically consistent with the difference of vertical displacement of bridge. The jacking construction is safe and reliable. The additional stress of section is more sensitive on the displacement deviation of the middle piers.

Keywords: continuous box girder; synchronous jacking finite element; displacement deviation

Water Traffic Organization for Multiple Bridge Construction in Inland Waterway LIU Aimin (164)

Abstract: Combined with the example of the water traffic organization for the construction of 20 bridges spanning the waterway in Dalu Line Channel Regulation Phase II Project, the specific traffic organization measures taken for this project are expounded in detail, including the introduction of a third party warning unit, the setup of temporary berthing space, the establishment of water traffic safety management system, the deployment of the overall scheme for water traffic, the setup of water navigation safety signs, and the preparation of safety emergency plan. These measures have played an important role in the smooth progress of the Dalu Line Project, and can provide the reference and experience for the water traffic organization of multi-bridge construction in the inland waterway in the future, which have the extensive promotion value.

Keywords: inland waterway; bridge construction; water traffic organization

Research on Key Construction Technology and Control Essentials of Long-span Steel-concrete Composite Beam JIANG Kai, CHEN Zepeng, SUN Zongshen (167)

Abstract: For the long-span steel-concrete composite beam, its stress structure is complex, its construction procedures are more and its technology is complex, but the construction examples are few. The key construction technologies such as the segmental installation, jacking and multiple superposition of steel-concrete composite beams in the construction process of long-span steel-concrete composite beams of the ring expressway bridge in Hangzhou are analyzed in detail. The key construction control points such as the fine processing, accurate installation and positioning, synchronous jacking, settlement, displacement and deformation control of steel beams are summarized and put forward. The actual measurement shows that the steel-concrete composite beam controlled according to the relevant technology is completed with high accuracy, and the relevant indicators meet the requirements of the design documents and specifications.

Keywords: steel-concrete composite beam; long-span; jacking; superposition; construction technique; control essentials

Analysis on Construction Scheme of Diversion Tunnel Passing through Railway Station and Yard ZHANG Zhengliang (172)

Abstract: In order to clarify the best pre-reinforcement scheme when the tunnel passes through the railway station and yard, and based on the numerical simulation, the effects of two advanced pre-reinforcement measures of the advanced small pipe and the advanced long pipe shed are analyzed. The results show that with the increase of support stiffness, the ground surface settlement and vault settlement decrease continuously. The support stiffness of the pipe shed is relatively large, and the beam-arch effect can be formed after grouting, which can effectively improve the stress state of the surrounding rock and control the deformation of the surrounding rock. This scheme can be recommended for the advanced support when the tunnel passes through the railway line.

Keywords: numerical simulation; pre-reinforcement; ground surface settlement; beam-arch effect

Study on Subgrade Treatment of Adjacent Subway Road Based on Scheme Comparison SHI Jing (176)

Abstract: With the day-by-day improvement of infrastructure construction, more critical roads are being built in the central urban area, but will face the complex environment of old road reconstruction and adjacent subways, facing complex environments such as the demolition of old buildings and the adjacent subway, which puts forward the higher and more precise requirements and challenges for subgrade treatment. Taking the treatment of the subgrade in an old urban area with the subway line as an example, based on the concept of cost-effective and project characteristics, and combined with the comprehensive analysis of project needs, safety requirements and cost, a recommended scheme is achieved, which can provide some reference for similar projects.

Keywords: scheme comparison; adjacent metro; subgrade treatment

Brief Analysis on Design Management of Interval Node in Opening Excavation of Up-crossing Metro
..... LIU Xiaoxi (180)

Abstract: In recent years, with the rapid development of engineering construction in China, the problems encountered in the urban construction become more and more complicated. Based on an example, the design of Suzhou Xinggang Street Tunnel up-crossing the interval node of Metro Line 1 is introduced. How to manage the design process of similar engineering nodes in the mode of design planning, design input, design control and design output is explained. By clarifying the design process of key engineering nodes, the node design work can be carried out more precisely, comprehensively and effectively in order to improve the design quality of the node.

Keywords: opening excavation; up-crossing metro; design management

Study on V-shaped Pier Construction of Jingzhou City Chengbei Expressway Project
..... WANG Hongqiang (184)

Abstract: The V-shaped continuous rigid-frame bridge with the large rigidity and reasonable stress can effectively reduce the building height of the main girder, and increase the spanning capacity of the main girder to some extent. Taking the V-shaped pier continuous rigid-frame bridge crossing Jingxiang River in Chengbei Expressway of Jingzhou City as the study object, the reasonable sequence of bracket erection, segmenting and pouring in the construction of V-shaped piers are analyzed. The bridge construction is successfully completed by the scheme optimization, process monitoring and other means to enhance the construction quality and construction efficiency. This method has some referring values in the construction of V-shaped pier rigid-frame bridges.

Keywords: V-shaped pier; support; pouring

Key Techniques for Foundation Construction of Beijiang Bridge in Guangfozhao Expressway
..... SHANG Qingguo, HE Minghui (188)

Abstract: The 33# pier of Beijiang Bridge is adopted of bored pile and separated base slab. The base slab is located in the range of weathered mudstone, the water level at the pier is deep and the water velocity is fast. The foundation construction technology is difficult. After research, the construction method of "drilling platform + steel sheet pile cofferdam" is determined. The key technologies of rotary drilling rig pilot hole and underwater high-pressure grouting are adopted for the construction of steel sheet pile

cofferdam, and the construction method of pre-excitation and cofferdam dry excavation is adopted for the excavation of bedrock within the range of base slab, which solves the construction problem of low-pile base slab without coating and rock-socketed.

Keywords: Beijiang Bridge; drilling platform; cofferdam; milling groove; high-pressure grouting; dry excavation; construction technology

Influence of Non-resonance Steel Pipe Pile Construction on Environment around Piles

..... HOU Xiaohua (191)

Abstract: Compared with the traditional pile-sinking technology, the high frequency non-resonance construction method has the advantages of high construction efficiency, less noise pollution, less mud pollution, less influence on the surrounding environment and wide range of geological application. But there is less study of construction influence on the adjacent subway. Relying on Middle Yanggao Road Reconstruction Project, the in-situ monitoring test is carried out near the pile position close to the subway. The influence of high frequency non-resonance pile-sinking construction on the environment around the piles is analyzed to ensure the safety of subway operation.

Keywords: non-resonance; steel pipe pile; influence on soil around pile; displacement; vibration

Application of Open Caisson Construction Technology under Sand and Pebble Geological Conditions

..... ZUO Junjie (195)

Abstract: Open caisson is a common construction method for some pump well structures with the large buried depth because of its strong integrity, good structural stability and wide range of applicable soil. Taking the construction of open caisson in the influent pumping house project of a wastewater treatment plant (WWTP) in Suining City as an example, the whole construction process of this project is expounded in detail under the geological conditions of sand and pebbles, through the analysis of geological and hydrological characteristics. The construction scheme of combining that the open caisson is sunk by drainage and without drainage is selected to smoothly completed, which can be referred for the similar projects.

Keywords: manufacture of open caisson; sinking by drainage; sinking without drainage; underwater bottom sealing

Application of Dry Construction Technology of Mud-filled Tube Bag in Seawall Dike Construction

..... YING Wenbin (199)

Abstract: Due to the characteristics of using local materials, low cost and fast construction speed, the mud-filled tube bag dike construction technology has been widely used in the construction of seawall dike projects in Shanghai and the other coastal areas. At present, the construction technology of mud-filled tube bag is mainly the traditional filling construction, and the dry construction method is rarely used. The dry construction technology has the advantages of no need to set up the mud silo, less land occupation, less influence and so on, and has the broad application prospects. Taking the seawall up-to-standard project at the south side of the sluice of Sanjia Port in Pudong of Shanghai as an example, the different construction technologies and technical requirements of mud-filled tube bags are introduced, and the technical essentials of dry construction technology are specially introduced, which provide a reference for the design and construction of similar projects.

Keywords: mud-filled tube bag; dike construction; dry construction; technical essentials

Technology and Control of Water Sealing and Reinforcement of Ultra-deep Underground Diaphragm Wall Joints in Complex Strata WEI Xiangting (205)

Abstract: Aiming at the problem of joint leakage of underground diaphragm wall in complex strata of confined water, the piles of RJP, MJS and N-Jet methods are used to seal and reinforce the joints of underground diaphragm wall in order to control the leakage of foundation pit. Based on a rail transit project in Shanghai, through 75 m ultra-deep pile tests of RJP, MJS and N-Jet methods, the water-sealing reinforcement technology of ultra-deep underground diaphragm wall joints and the pile-forming effect are analyzed, and the corresponding control measures are proposed. The field pile test results show that the quality of the pilot hole directly affects the pile forming effect. The quality of the pilot hole can be improved by the measures such as steel sleeve hole protection and survey deviation correction. When the pile-forming depth is less than 45 m and the soil layer is mainly composed of cohesive soil. The pile-forming effect will be good. The strength and impermeability of the coring specimen meet the requirements. The pile-forming coring effects of RJP, MJS and N-Jet methods cannot meet the requirements when the pile-forming depth is greater than 45 m and the main stratum is composed of ⑦₂ dense silt. When the piles of RJP, MJS and N-Jet methods are used to strengthen the water-sealing effect at the joint position of ultra-deep underground diaphragm wall, the attention should be paid to the property of the soil layer with the depth variation. The construction control parameters should be adjusted timely.

Keywords: ultra-deep underground diaphragm wall; joint reinforcement; confined water; ultra-high pressure jet grouting pile; coring test

Key Construction Technology of Underground Diaphragm Wall of Steel Cage Attached Membrane JIANG Wenjie (209)

Abstract: In order to avoid the late plugging of underground diaphragm wall and save cost, the underground diaphragm wall technology of steel cage attached membrane is proposed. Based on the enclosure structure project of Hangzhou Government Reserves, the experimental research on the performance of impermeable membrane material and the technology of steel cage attached membrane is carried out. The excavation results show that there is no leakage at the wall surface and joints on the excavated side of the diaphragm wall in the test area. The results of the study show that the underground diaphragm wall technology of steel cage attached membrane is feasible and meets the requirements of seepage interception and joint water stop of underground diaphragm wall, which is an effective choice for the seepage-proofing construction of enclosure structure.

Keywords: steel cage attached membrane; experimental research; seepage interception of wall surface; joint water stop

STUDY ON SCIENCE & TECHNOLOGY

Study on Stress Characteristics and Deformation Mechanism of Sand-mudstone Interbedding Gently Dipping Tangential Slope HE Maowei, LI Song (213)

Abstract: In order to better analyze the deformation mechanism of the gently dipping tangential slope with interbedding sand and mudstone, taking a red bed slope in the southwest as an example, a three-dimensional tangential geological model of soft and hard interbedding is established by the

numerical simulation software. The stress field and displacement field after excavation and support of the slope are discussed. The results show that after excavation of the tangential slope of the sand–mudstone interbedding, the stress in the XX direction and the stress in the YY direction of the slope appear a zigzag shape along the tangent. And the stress distribution is greatly affected by the difference between the rock stratum tangent and interbedding lithology, and the stress in the ZZ direction is almost unaffected. The tangential rock stratum is affected by the lateral restraint to cause the slope deformation to appear hierarchical, and the X direction is more significant, the Y direction is second and the Z direction is the weakest. The overall deformation trend of the slope is similar to that of a homogeneous rock slope, showing a circular arc sliding trend. The slope is supported by frame anchor bolts, which only plays the role of structural slope protection. The deformation and stress state of the slope have no substantial effect. The research results have certain engineering reference significance for the deformation prediction and support protection of sand–mudstone gently dipping tangential slopes.

Keywords: sand–mudstone; soft and hard interbedding; tangential slope; deformation mechanism; numerical simulation

Analysis of Modeling Process for Numerical Simulation of Earth Slope on Soft Soil Foundation LIANG Dong (217)

Abstract: Midas GTS NX software widely used in the geotechnical design is applied. On the basis of Moore–cullen constitutive model, through the analysis on value source of each parameter and the establishment of the typical model to demonstrate the modeling process, the rationalization proposal is put forward for the numerical simulation of the similar projects.

Keywords: weak soil foundation; earth slope; finite element calculation

Comprehensive Assessment of Long–span Cable–stayed Bridge Based on Uncertainty Inference FU Yonggao (222)

Abstract: With the rapid improvement of the bridge construction level in China, the technical condition assessment of long–span bridges is getting more and more attention, but also there are still more problems and deficiencies. Taking a cable–stayed bridge as the research background, the multi–level fuzzy synthesis method in uncertainty inference and D–S evidence theory are used to carry out the condition assessment on the steel box beam cable–stayed bridge, and the results are compared with those of the direct weighted average method. The study shows that the uncertainty inference method can be better applied to the technical condition assessment of long–span cable–stayed bridges. The D–S evidence theory method can reflect the difference among sub–indexes, which is conducive to making more reasonable maintenance decisions.

Keywords: cable–stayed bridge; condition assessment; fuzzy synthetic assessment; D–S evidence theory; uncertainty inference

Study on Load Test of Corrugated Steel Web Composite Box Girder Bridge LI Xiaogang (226)

Abstract: In order to test the construction quality and actual bearing capacity of a new corrugated steel web – steel baseboard – concrete top composite box girder bridge, the static and dynamic characteristics of the bridge under the equivalent vehicle load are analyzed. The finite element simulation model of the bridge is established by using the structural finite element analysis software MIDAS CIVIL. Through the field static load test and dynamic load test, the static and dynamic data of the bridge structure under the

equivalent vehicle load are measured and compared with the theoretical calculation values so as to verify the rationality and accuracy of the simplified model. And the construction quality and the actual bearing capacity of the bridge are evaluated.

Keywords: bridge engineering; corrugated steel web; static load test; composite box girder; dynamic load test; bearing capacity

Analysis on Gripping Force of Single-cone-hole Wedge-type Prestressed Anchorage for Bridges
..... DONG Hao, WU Jianfang, GU Jungang, ZHANG Shoulong, LIN Qidong (230)

Abstract: The reverse-pull method is currently the most widely used method for detecting the effective prestress under the anchor. The inflection point of the test curve is used to determine the effective prestress under the anchor. In recent years, many scholars have found that there is a sudden load drop at the inflection point of the test curve. Therefore, the causes of the sudden change segment in the test curve of the reverse-pull method are discussed. The viewpoint is proposed that the reverse pull load needs to overcome the anchorage grip force during the clamping piece pulling-out process, which leads to the generation of the sudden change segment. The gripping force of anchorage is mainly composed of the friction resistance of the anchor ring and the clamping piece and the mechanical bite force of the anchor ring and the clamping piece. At the same time, in order to obtain the influencing factors of the gripping force, a finite element model is established to analyze the gripping force of the single-cone-hole wedge-type anchorage. The method for extracting the gripping force of the finite element model is designed and expounded. Through the finite element model, three factors of control tension force, friction coefficient and tapered-hole amount are obtain to affect the gripping force of anchorage are obtained. And the correlation curve of the control tension force and friction coefficient with the gripping force is fitted. It is concluded that the control tension force and friction coefficient are positively correlated with the gripping force.

Keywords: reverse-pull method detection; effective prestress under anchor; wedge-type anchorage; gripping force; finite element analysis

Experimental Study of Sliding Cable Saddle
..... MO Fan, HUANG Zineng, WANG Yao, PENG Chunyang, OU Zhilian, QIN Sihui (234)

Abstract: In the reconstruction project of cable-stayed system, Dongming Yellow River Bridge is a new type of bridge between the low-pylon cable-stayed bridge and the suspension bridge. In the new type of steel wire cable-stayed system, the sliding cable saddle is set up on the bridge pylon. The adaptive sliding of cable saddle can make the cable force at both sides of the bridge pylon balanced. The sliding cable saddle is the key technology of the new steel wire cable-stayed system. It is necessary to conduct the model test research on the sliding cable saddle. Relying on Dongming Yellow River Bridge, the model design and the implementation method of the performance test of sliding cable saddle are introduced. The cyclic endurance test of cable saddle is completed by intelligent tensioning system. The test results show that the cable saddle has the adaptive sliding function and the good sliding performance and durability, which can meet the demand of the new steel wire cable-stayed system.

Keywords: sliding cable saddle; test model; sliding critical resistance; cyclic endurance test; intelligent tensioning system

Development of Asphalt Warm Mixing Agent Based on Tall Oil Fatty Acid WU Jian (237)

Abstract: At present, the use of surfactant asphalt mixing agent is the mainstream at home and abroad. Its structure is mainly fatty acid amide. The raw materials are mainly the animal and vegetable oils, which causes the high synthesis cost of the product. At the same time, the high freezing point of the product makes it inconvenient to use in the low temperature environment. The main raw material of SWMA bitumen warm mixing agent developed now is the tall oil fatty acid recycled from the papermaking waste liquor, which not only makes full use of waste resources, but also reduces the product cost. At the same time, the low freezing point of tall oil fatty acid makes the product keep the low viscosity at the low temperature, which is convenient for its use in the low temperature environment. The synthesis process of the product is novel and the structural composition is unique. The successful development of this asphalt warm mixing agent is beneficial to reduce the use cost of using the asphalt warm mixing agent and promote the large-scale application of asphalt warm mixing technology in China.

Keywords: asphalt warm mixing agent; tall oil fatty acid; amido-amine compounds; intermediate oleic acid modified hyperbranched polyamide

Comparative Study on Heterogeneous Catalytic Ozone Oxidation for Pilot Treatment of Refractory Industrial Wastewater GU Yang, XU Wenzheng, ZHA Wengui, CHEN Wangyuan (242)

Abstract: Based on the demand for advanced treatment of refractory wastewater in an industrial park in Nantong City, a pilot plant for heterogeneous catalytic ozone oxidation with a treatment scale of 20 m³/d is built by using FeOOH as the main iron-based catalyst. The operation parameters of this system are optimized. The removal efficiency of organic matter and the investment and operation cost of the pilot plant in the long-term operation process are investigated, which is compared with the pilot plant of homogeneous catalytic ozone oxidation and the pilot plant of three-phase catalytic oxidation. The results show that the COD removal rate of the heterogeneous catalytic ozone oxidation system is 57.6 ± 7.3% when the ozone concentration is 200 mg/L, the ozone gas dosage is 2 L/min and the catalytic reaction time is 30 min, which is better than that of the homogeneous catalytic ozone oxidation system and the three-phase catalytic oxidation system. And its occupied area is small. The investment and operation cost of removing COD per unit is RMB 16.7 yuan / kgCOD, which is only about 70% of the homogeneous catalytic ozone oxidation system and three-phase catalytic oxidation system. The comprehensive treatment efficiency is higher with the potential for treating the refractory industrial wastewater.

Keywords: refractory organics; ozone catalytic; advanced treatment; advanced oxidation process

Research on Application of Predicting Wastewater BOD Based on IPSO-LSSVM YU Yang, WANG Ping (247)

Abstract: The rapid and accurate measurement of biochemical oxygen demand (BOD) is very important for the regulation of wastewater treatment process. Aiming at the problems of lower timeliness of BOD concentration measurement in the wastewater treatment process, the least squares support vector machine (LSSVM) is selected as the BOD prediction model and the particle swarm optimization (PSO) algorithm is selected to optimize the regression performance parameters. At the same time, the adaptive inertia weight calculation method is used to improve the PSO algorithm. After establishing the IPSO-LSSVM prediction model, the model is used to simulate and study the data of a wastewater treatment plant (WWTP). Finally, three types of errors are selected to calculate and analyze the prediction accuracy. The prediction results show that the model has the good prediction accuracy.

Keywords: wastewater treatment; BOD Prediction; IPSO; LSSVM

APPLICATION OF ACHIEVEMENTS

Application of 3D Printing in Traffic Engineering

..... CUI Di, LAI Yuhao, LIAO Shiliang, MA Caixia(250)

Abstract: In recent years, due to the rapid development of 3D printing technology, its application has been expanding, which provides a valuable opportunity for the transformation and upgrading of many industries. At present, 3D printing technology is widely used in the aerospace, materials, medical treatment, automobile, construction and other industries, and has received the good feedback. So the researchers are looking at whether 3D printing can be combined with traffic engineering. The types and advantages of 3D printing technology are briefly summarized. The application of 3D printing technology in the bridge engineering, road engineering and rail transit (mainly railway) is overviewed. The application of 3D printing technology in these three aspects is mostly in the stage of exploration. The application prospect of 3D printing technology in the traffic engineering is expected.

Keywords: 3D printing; bridge engineering; road engineering; rail transit

Application of Engineering Application of Improved Geocell

..... LIU Huaixing, YANG Hui, ZHENG Zhaoyi (256)

Abstract: Geocell is a material with three-dimensional spatial structure, is the road material with the characteristics of wear resistance, convenient transportation, strong expansibility, strong self-propulsion and large filler selectivity, and can be used for the rush repairs of road and the paving of easy roads. Geocell acts on the top of the pavement structure when used as the reinforcement material to pave pavement. The format node is easy to break under pressure. In order to solve the problems existing in geocell, the geocell nodes are improved and reinforced, and the trial section is paved to verify its in-situ applicability. The improved geocell to pave road has the excellent pavement performance. In the rush repair of roads, when a temporary road passes the geocell filling, the construction machinery can run directly on it. The protective layer laid on the top of about 5 cm can achieve a high enough road quality, which can effectively solve or even eliminate the defects, and improve the traffic safety and comfort. Geocell is more feasible in road paving under the emergency rescue and disaster relief. Therefore, the improved geocell has the better social and economic benefits.

Keywords: geocell; paving of easy road; performance evaluation; elastic modulus

Frequency Identification Technology of Stay Cable in Road and Bridge Detection

..... ZHAO Lin, JIA Pengfei, WU Huayong, MA Minglei, YANG Wei (261)

Abstract: The specific application of stay cable frequency identification technology in road and bridge detection is expounded, and then the principle of vibration frequency method and the corresponding calculation formula are put forward. Through the test case, it is pointed out that the IBIS-FS system is used to carry out the multi-order frequency identification, and further to analyze the important factors affecting the force measurement of the stay cable, mainly including the boundary conditions of stay cable, setting of the bending strength, the accuracy of the spectrum analysis results, the shock absorber device, and the sags of stay cable. In the future, with the development of science and technology, the application of stay cable frequency identification technology can accurately identify the vibration frequency of the bridge

and road.

Keywords: road and bridge; detection; stay cable; frequency identification; IBIS-FS

Detection Method Application and Cause Analysis of Typical Road Collapse WANG Rui (267)

Abstract: With the rapid expansion of urbanization in China, the road collapse accidents are frequent and recurring, which seriously threaten the social security and cause the adverse social impacts. Under the background of building a resilient city, the prevention of road collapse accidents has become an important task in the urban construction management. Therefore, it is to determine the method effectively to detect the road collapses. It is important and practical significance to analyze the causes of typical road collapses. The applicability of the detection method is determined by comparing the geophysical prospecting data before and after causing the cavity in a typical area. Through the pipeline endoscopic detection and road settlement monitoring, the development process of the collapse is analyzed, and the relevant suggestions are put forward to provide a basic basis for the prevention and control of road collapse.

Keywords: road collapse; ground penetrating radar; seismic image; hidden disease; collapse cause

Application of BIM Technology in Design Stage of Mesh Suspender Arch Bridge LI Huixin (271)

Abstract: In the design stage of long-radius horizontal-curve mesh suspender arch bridge, BIM technology is used to establish the full-stage model for 3D display, which is used to assist in determining the positioning of suspender, the spacing of suspender and the other important data. The collision inspection is carried out for the multi-specialty models to realize the project visualization, the project quality improvement and the digitization delivery. The effect and value of BIM technology in the design stage of bridge can provide the reference for the deep integration of BIM and design of the similar bridges.

Keywords: mesh suspender arch bridge; BIM application; auxiliary design; deep integration

Research on Application of Self-balancing Method in Detection of Large-diameter Cast-in-situ Bored Piles

..... ZHENG Man (275)

Abstract: Coming into the new century, the economy of the southeast coastal areas in China is developing rapidly. The regional characteristics are the soft soil geology with many rivers. The bridge construction is unavoidable, and the bridge safety cannot be separated from the support of cast-in-situ bored piles. Taking the bearing capacity detection of cast-in-situ bored pile of a bridge in soft soil area as an example, the detection schemes of self-balanced method are compared on the basis of meeting the project requirements, and provide the support for the project construction, which can provide some valuable reference for the design of bearing capacity detection scheme of large-diameter and large-tonnage cast-in-situ bored piles of similar projects.

Keywords: cast-in-situ bored pile; self-balance method; bearing capacity detection

THE RELATIVE SPECIALITIES

Structure Design and Analysis of Large-span Irregular Sections for Urban Underground Complex

..... ZHU Xinlong (279)

Abstract: The structure design conception and calculation analysis of irregular sections in an urban underground complex project under construction are introduced. This project is a huge urban

underground complex. Its total construction area is about 1.8 million square meters, which is a shallow buried box-type reinforced concrete structural system. The critical design of this project is to treat the large-span irregular section for the combination and separation locations of road flow. Therewith, the calculation and analysis of the multi-ribbed box section structure are proposed to prove the rationality, reliability and safety of using this design method, which can be referred for the design of the similar projects.

Keywords: urban underground spatial complex; structural design; oversized span; irregular section

Study on Method of Analyzing Karst Development by Combining Borehole and Tube Wave Detection

..... ZHAO Xuguang, WANG Bo (284)

Abstract: Karst is widely developed in China, and its development is irregular and characteristics are extremely complex. In the construction process of various projects, it is difficult to identify the development of karst through the traditional drilling methods, and the scope of karst development cannot be accurately determined. The borehole data and results of tube wave detection are synthesized through an engineering example, and the karst development range analyzed by the borehole data is analyzed and compared with that obtained by combining the borehole data and the tube wave detection. The results show that there are great differences in the range of karst development determined by the two methods. The analysis and research can provide a new idea for judging the karst development, and also provide more accurate engineering geological basis for the relevant design and construction of such areas.

Keywords: geological borehole; tube wave detection; karst development range

Research on Applicability of SMW Construction Pile in Ultra-deep Foundation Pits

..... LI Xueyang (287)

Abstract: The SMW construction pile is generally used as the supporting structure for the foundation pit with a depth of less than 11 m. It has the characteristics of short construction period, no pollution, low noise and recyclable. In order to study the applicability of this construction method in ultra-deep foundation pits, taking a foundation pit project (foundation pit depth of 15 m) in Suzhou as an example, the lateral deformation of SMW construction pile, steel strength bearing capacity, surface settlement and other laws are calculated under the construction conditions of excavating the ultra-deep foundation pit, and the on-site construction verification is carried out. The result shows that the SMW construction method can be used for the enclosure structure of the foundation pit with a depth of about 15 m, and has the obvious advantages in the construction period, environmental protection and economy, which provides the reference for the other similar projects.

Keywords: SMW construction pile; sectional steel cement soil mixing pile; support of foundation pit; deep foundation pit engineering; deformation of foundation pit

Design of Automatic Elevator for Vertically Transporting Segments

..... WU Zhongming, CAI Jiayuan, SHEN Haifeng, ZHANG Haidong, NI Jia (292)

Abstract: In shield tunneling construction, the vertical transportation of segments from the ground to the underground is generally carried by crane, which has problems such as the low transportation efficiency and large safety risks. Based on the working principle of vertical elevator, a kind of elevator used for vertical transportation of segments is introduced, which has a high degree of automation. The safety, synchronization, reliability and adaptability design of the elevator system are expounded in detail. The automatic elevator can greatly improve the vertical transportation efficiency of segments and reduce the

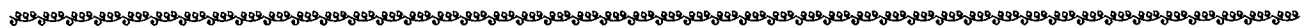
potential safety hazards, and has a broad application prospect in shield tunneling construction.

Keywords: segment; vertical transportation; automatic control; elevator

Deep Analysis on Cost Control of Urban Multi-pole Integration Engineering JIA Ting (295)

Abstract: The economic construction of modern cities is advancing rapidly, and some relevant facilities are also urgently to advance with the times, which can adapt the needs of the continuous development of city. The implementation of new urban multi-pole integration engineering is originated. The necessity of urgent integration of current urban road poles is introduced. Some problems of the proposed projects met in the cost control are put forward from the perspective of investment. The methods of how to reasonably optimize the pole member, foundation, machine box and cable laying are separately analyzed from the entity composition of the project and the full-process cost control of engineering implementation in order to realize the engineering advance on the basis of effectively utilizing the funds and then improve the scientific and technological indicators, aesthetics and comfort level of contemporary city.

Keywords: urban multi-pole integration; cost control; investment



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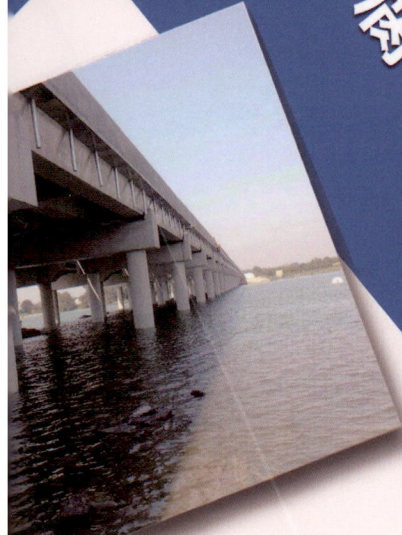
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