

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



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图为上海奉贤建设发展(集团)有限公司施工建设的上海市奉贤区再生能源综合利用中心

因为我们专心,所以我们专业!

——《城市道桥与防洪》

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- 盐坝高速市政化小梅沙立交方案优化——小梅沙片区城市更新交通组织研究
- 巢湖大桥组合梁斜拉桥的设计构思与关键技术
- 自重湿陷性黄土地区海绵城市建设特点
- 现代有轨电车规划实施效益评估指标体系构建



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封面工程

本期封面工程为上海市奉贤区再生能源综合利用中心建设工程,由上海奉贤建设发展(集团)有限公司施工建设。

上海市奉贤区再生能源综合利用中心建设工程坐落于柘林镇楚华地块,项目总建筑面积为 33 032 m²。建设内容主要包括:综合主厂房以及水泵房、冷却塔、消防水池、天然气调压站、附属水处理设施、生产管理和生活服务用房等配套设施;购置垃圾处理、烟气净化处理、余热利用、残渣处理等设备。生活垃圾日处理能力为 1 000 t,全年达 36.5 万 t。厂内配套配置额定容量为 1×30 MW 的汽轮发电机组。

上海市奉贤区再生能源综合利用中心建成后,一、二期两座垃圾焚烧厂可以满足整个奉贤区生活垃圾无害化处理的需求。同时,一、二期两座垃圾焚烧厂在生产运营过程中能够相互统筹兼顾、互为备用,抗风险能力显著增强。此项目的建成标志着上海市奉贤区生活垃圾末端分类处置能力进一步转型升级。

上海市奉贤区再生能源综合利用中心建设工程于 2020 年 2 月开工,计划竣工日期为 2022 年 1 月。

Urban Roads, Bridges & Flood Control

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Abstract: Analysis is conducted on the functional orientation, construction condition, construction form, construction scale and general layout of Xihong Bridge and its connection engineering. The general layout of the bridge and the interchange scheme of Tongtu Road are especially demonstrated. The layout of the main and auxiliary separation of Xihong Bridge is proposed. The full interchange is set up for the upper bridge and the main road of Tongtu Road. The light control is set up for the grade crossing of the lower bridge and the ground auxiliary road of Tongtu Road. The system of sidewalk and bicycle lane is set up to meet the riding demand. The scientific connection of interchange form and bridge span, and the reasonable control of interchange environmental landscape influence and pier flood discharge influence are realized.

Keywords: Xihong Bridge, connection engineering, expressway, interchange, general design

Study on Overall Scheme of Shuyang Ring Expressway (Huaihe Avenue – Songjiang Road)

..... QIAN Hao, LIU Xue, GUAN Jinbo (5)

Abstract: In order upgrade the traffic structure in Shuyang, the overall scheme of Shuyang Ring Expressway (Huaihe Avenue – Songjiang Road) is studied. The planning and construction conditions of the project area are introduced. The demand of Shuyang County as a small and medium-sized city for the function of expressway is analyzed. The traffic analysis and scheme selection are carried out from the overall scheme and important node scheme of the project.

Keywords: expressway, overall layout scheme, node design scheme, Shuyang

Design of Overall Scheme for Tongcheng Expressway in Hangzhou GUO Chuan (10)

Abstract: Tongcheng Expressway is one of the important projects in the unblocked expressway network construction planning of Hangzhou for the Asian Games. Its construction will perfect the regional expressway network and completely improve the development level of city in order to provide a strong guarantee for the successful hosting of the 2022 Asian Games. Based on background and functional orientation of the project, the overall scheme layout of Tongcheng Expressway is systematically discussed, and the up and down ramps and the important interchange nodes along the line are specially introduced.

Keywords: urban expressway, overall scheme, up and down ramps, interchange node

Study on Overall Scheme of Ningbo South Huancheng Road West Extension Project WANG Qian (13)

Abstract: Taking Ningbo South Huancheng Road West Extension Project as an example, by considering the function demand, construction conditions, short-term and long-term combination, environmental impact and other comprehensive factors, a scientific, reasonable and feasible overall design scheme of expressway is put forward, which can be used as a reference for the design of the similar engineering projects.

Keywords: urban expressway, overall design, interchange scheme, on-ramp and off-ramp

Study on a New Interchange Form of Intersecting River-crossing Bridge and Riverside Road

ZHOU Huabao (16)

Abstract: Generally, when rivers pass through cities, the riverside roads are basically laid on both sides of the rivers. With the expansion of cities, in order to support the expansion of urban space and the development of economy, the corresponding traffic goes first. In order to link the urban areas on both sides of the river, it is necessary to build bridges or tunnels across the river. The riverside road is usually close to the flood control wall. A new interchange form of intersecting the river-crossing bridge and riverside road under many restricted conditions is put forward. Therefore, the background technology, problems to be solved for riverside interchange, application conditions, functional orientation, technical standards and detailed scheme of the project are specially expounded.

Keywords: river-crossing bridge, riverside road, separation of embankment, technical standard, new interchange form

Practice of Small Block Regulation Traffic Planning in Mountain City

WANG Youwei, LIN Tao, ZHANG Xiaoxiao (20)

Abstract: To meet the development demand of "small block, high density and compact type" in the new urban areas, taking Chongqing Yuelai Eco-city Traffic Planning as an example, emphasizing the planning design concept of "people-oriented, coordinated promotion and implementation, and aiming at the characteristics of mountain city, the planning target, planning strategy and system planning are proposed. And the footpath system, public transportation system, parking system and refined traffic engineering design are specially introduced.

Keywords: small block, mountain city, traffic planning

Practice and Thinking of Ningbo Street Design

ZHANG Di, FANG Lin, YU Xingyi, XIE Haoqi (23)

Abstract: Ningbo is the second batch of national "city double restoration" pilot city. In order to promote the urban renewal and upgrading, taking the compilation of *Guidelines for the Design of Ningbo Streets* as an opportunity, the evolution and current situation of streets in Ningbo are analyzed, and the countermeasures to improve the street design with the goal of "orderly, vitality, greenness and high quality" are put forward. On the basis of classifying the streets in Ningbo, the design essentials of motor vehicle lane, slow traffic area and intersection across street are further discussed.

Keywords: street design, slow traffic, city double restoration, intact street

Practice of Street Integration Design

LI Yanchu (28)

Abstract: Combined with the new development concept of "innovation, coordination, green, opening and

sharing" and the new requirements of speeding up the construction of park city, the exploration and practice of integrated design for street planning and construction has been carried out in Chengdu, and some achievements have been acquired. Guided by the *Guideline of Integrated Design of Park City Streets in Chengdu* (trial version), the integrated design concept is practiced in the design of supporting road project of Chengdu Sport University from the aspects of road cross section layout, intersection design, facility intensification, which can be referred for the similar projects.

Keywords: street, integrated design, humanization, Chengdu

Introduction on Design of Slow Traffic for Baiyu Road Bridge of Suzhou River XU Mei (31)

Abstract: Slow traffic is of positive significance to improve the urban traffic condition and to enhance the urban humanistic care. Taking Baiyu Road Bridge of Suzhou River as an example, the study background, general situation, study necessity, overall scheme, constraint condition and implementation difficulty of the project are introduced in order to provide the ideas for the slow traffic along Suzhou River.

Keywords: Suzhou River, slow traffic, design scheme

Study on Traffic Organization of Station Area in Front of High-speed Railway Station YI Junwei (35)

Abstract: As the main transfer space between high-speed railway system and urban transportation system, whether the traffic organization of the station area in front of high-speed station is reasonable has an important influence on the operating efficiency of high-speed railway station. However, the multi-mode and multi-level traffic structure in front of the station also puts forward higher requirements for the traffic organization mode. Through the classification of traffic organization mode in front of high-speed railway station, the main principles of traffic organization in front of the station are analyzed. Taking the traffic organization of the station area in front of South Quanzhou Railway Station as a study case, the overall layout and traffic organization of its station area are analyzed and introduced.

Keywords: high-speed railway station, area in front of high-speed railway station, traffic organization mode, South Quanzhou Railway Station

Optimization of Xiaomeisha Interchange Municipal Scheme of Yanba Expressway – Study on Urban Renewal Traffic Organization of Xiaomeisha Area WAN Zhong (40)

Abstract: Based on the traffic characteristics of Shenzhen coastal area in peak tourist season, the "overflow traffic" concept and solving ideas are innovated and proposed. Combined with the urban renewal reconstruction of Xiaomeisha Area and the municipal reconstruction of Yanba Expressway, by analyzing and studying the contradiction between the visiting tourists and the parking supply in peak tourist season, it is fully to play the functions of traffic distribution center and to optimize the planning scheme of Yanbo Expressway Xiaomeisha Interchange Municipal Reconstruction Project in order to make the area unable to accommodate the traffic quickly overflow and to avoid the congestion in the main line of expressway.

Keywords: tourist area, design of traffic organization, traffic distribution center, interchange node of expressway, overflow traffic, slow traffic system

Design of Taiyuan Xindian Street Construction Project Involving Railway SUN Xiankai (44)

Abstract: With the rapid development of urbanization, the intersection of municipal roads and railways is increasing. Due to the different intersection of railway and municipal road, taking Taiyuan Xindian Street

Construction Project as an example, the general situation of the project is briefly described. By expounding the design schemes of road underpass node of railway, interchange overpass node of railway and grade crossing node of railway in this project, the design essentials for attention in the new construction of road involving railway under the different modes are introduced in order to provide the reference and experience for the design of the similar municipal road projects involving railway in the future.

Keywords: municipal road engineering, involving railway, underpass railway, interchange overpass railway, grade crossing railway

Research on Node Planning Scheme of Taicang Expressway Network SHAO Lvmin (48)

Abstract: The selection principle, the functions and the main types of urban interchange are set forth. Taking the expressway network node planning of Taicang in Jiangsu as an engineering example, its intersection situation and traffic forecast are analyzed. According to the control factors around the nodes, the design scheme of the interchange is clarified.

Keywords: expressway network, interchange node, Taicang

Research on Key Technology of Land-side Road Traffic Reconstruction of Airport

..... WANG Wanpeng (51)

Abstract: The traffic of land-side roads in some domestic airports cannot meet the traffic demand of target year. In order to realize the high effective operation of road system, the present road traffic is reorganized. On the basis of retaining the existing facilities to the maximum extent, the interweaving and conflict points are decreased as far as possible. According to the road traffic reconstruction of Xian Xianyang International Airport, the reconstruction principles of road system to meet the passenger throughput of the target year are proposed. The principles of "combination with planning", "separation of arrival and departure", "reasonable functional division" and "simplified decision point" can provide the references for the similar reconstruction projects.

Keywords: traffic engineering, airport, land-side road, reconstruction principle

Value Analysis on Maximum Longitudinal Grade of Urban Expressway Tunnel XIE Zhonglei (54)

Abstract: Expressway is the artery of urban traffic. The construction form of tunnel is adopted for more and more urban expressways because of the minimum effect of tunnel expressway on the urban environment. There are some disputes about the value of the maximum longitudinal grade of tunnel expressway in the current road design codes. The influential factors on the value of the maximum longitudinal grade of tunnel expressway should be considered. Chengyang Road Tunnel in Jiangyin is analyzed. The traffic flow, vehicle type proportion, comprehensive cost and traffic safety of tunnel should be scientifically and systematically analyzed and then determined, which can be referred for the engineering practices.

Keywords: design of urban expressway, maximum longitudinal grade, tunnel, influential factor

Study on Design of Subgrade around Shallow-buried Underground Structures of Municipal Roads in Hangzhou Asian Games Village SONG Xin (57)

Abstract: The cracks, differential settlement, dislocation and other diseases are easily caused in the subgrade and pavement around the shallow-buried underground structures, such as the gateway of urban

utility tunnel. Based on the municipal infrastructure project of Hangzhou Asian Games Village, the design of subgrade around the underground structures with shallow soil, especially the gateway of utility tunnel is studied. By analyzing the disease mechanism under the different construction conditions, combined with the engineering construction experience, the design scheme of subgrade around shallow-buried underground structure for disease prevention is proposed.

Keywords: subgrade design, shallow-buried underground structure, gateway of utility tunnel, disease, Asian Games Village

Study on Soft Foundation Treatment Scheme of Haixiu Expressway (Phase II) in Haikou

..... WANG Liang (60)

Abstract: In this paper, Haixiu Expressway (Phase II) in Haikou is taken as an example to study the soft foundation treatment scheme of urban road in the coastal area. By systematically sorting out the soft foundation treatment problems of Haixiu Expressway (Phase II), and combined with the current situation of domestic soft foundation treatment technology and local existing construction experience, the economical and reasonable soft foundation treatment measures are proposed, which have certain significance for the soft foundation treatment of urban roads in the similar coastal areas.

Keywords: coastal soft foundation, settlement after construction, cement-mixed pile, dynamic compaction, liquefaction

Design and Application of Loading Counterforce Frame for Fabricated Retaining Wall Full-scale Test

..... LIN Jingci (64)

Abstract: Aiming at the fabricated cantilever retaining wall full-scale test, a counterforce frame suitable the construction site and taking into account the tests of two types of connecting retaining walls is designed and manufactured. Through the stress analysis of cantilever retaining wall and the ultimate bearing capacity calculation of retaining wall structure, the loading type, height and design load of counterforce frame are determined. The design scheme of counterforce frame is given. Midas NFX is used to check the finite element analysis under the adverse condition. Finally, the reliability of counterforce frame design is verified by the test, which can be referred for the test of the similar projects in the future.

Keywords: retaining wall, counterforce frame, test, loading device

An Anchor Plate Retaining Wall Applied for High Fill Subgrade

LIU Yuxin (67)

Abstract: Combined with the actual engineering design, the application conditions, advantages, disadvantages and economy of each conventional retaining wall are comprehensively compared. On the basis of traditional anchor plate retaining wall, an anchor plate retaining wall applied for high fill subgrade is proposed. This retaining wall is mainly composed of rib column, pull rod, breast board and other components. The horizontal pull rod between the rib columns at the both sides of subgrade is used to balance the horizontal soil pressure of the fill, which can effectively reduce the base stress of retaining wall. At the same time, the pull rod is made of unbounded epoxy coated pre-stressed steel strand. This kind of pull rod has the good durability and can guarantee the safety of structure. This anchor plate retaining wall has the advantages of small-sized structure, low cast, high safety, good durability and high construction efficiency. Its application range is wide. The reference can be provided for the similar projects.

Keywords: anchor plate retaining wall, high fill subgrade, pre-stressed pull rod, breast board

Brief Analysis on Setup of Traffic Monitoring Facilities for Road Network in Front of High-speed Railway Station WANG Shiwei (70)

Abstract: The traffic flow composition of road network in front of high-speed railway station is more complex. The intelligent transportation monitoring system becomes an important means of traffic management and traffic law enforcement. Taking Gaunyin Station of high-speed railway as an example, the structure, traffic flow direction, traffic flow feature and traffic management demand of the station road network are analyzed. Combined with the construction situation and grade crossing type of the road network in the initial stage, the design thought of traffic monitoring facilities for station road network is summarized, and the selection of the main front end facilities and the layout of point location are put forward.

Keywords: Guanyin Station of high-speed railway, station road network, traffic monitoring, front end facilities

BRIDGES & STRUCTURES

Causes and Lessons of Bridge Collapse Accidents in Past Three Years at Home and Abroad

..... WANG Feng, WU Huayong, ZHAO Rongxin (73)

Abstract: In recent years, the accidents of bridge collapse happen occasionally. The accidents of bridge collapse cause the economic losses and human casualties, and often have a huge social impact. The time, sites, casualties and causes of bridge collapse accidents in 2017~2019 at home and abroad are statistically analyzed. The results show that the bridge accidents in the construction period in China are more than the accidents in the operation period. The bridge accidents of construction period are mainly caused by the instability in the construction process. The main causes of bridge accidents in operation period are the improper operation maintenance and overload. The accidents of new foreign bridge are less than the bridge accidents in operation period. The most of bridge accidents in operation period are related to the improper maintenance.

Keywords: bridge, collapse accident, collapse cause, lesson

Design Concept and Key Technology of Composite Beam Cable-stayed Bridge of Chaohu Bridge

..... LI Wenbo (77)

Abstract: Chaohu Bridge is a super large bridge crossing the outlet of Chaohu Lake in Outer Ring Road of Chaohu City. The road is classified as an urban trunk road. The whole bridge is arranged as a double-pylon double-plane composite beam cooperative system cable-stayed bridge with a main span of 460 m. The total length of the bridge is 1 122 m. The bridge pylon is arranged in the shape of "herringbone". The main beam in the cable area is of double I-shaped section with a bridge width of 34.5 m. The non-cable area is a double small side-box section with a bridge width of 32.5 m. The bridge is located in the approach channel area of three-line lock. The channel conditions are complex. The overall design concept, structural design and main technical characteristics of the bridge are introduced.

Keywords: cable-stayed bridge, composite beam, "herringbone" bridge pylon, double I-shaped composite beam, welding

Reconstruction Design and Construction of Lotus Bridge in Zhuhai Hengqin Port WANG Meng (81)

Abstract: The development project of Hengqin Port and Comprehensive Transportation Hub is the dedication project for the 20 th anniversary of Macao's Return, and is significant and far-reaching. The reconstruction of Lotus Bridge is the key to realize the customs clearance at the new port. To make sure that the port does not interrupt traffic during the reconstruction, the demolition and new construction projects need to be implemented in stages. Considering the complex construction conditions of the project, the overall layout, structural form and landscape modeling of the bridge have been carefully designed. In order to ensure the operation and structural safety of the temporarily retained bridge, the incremental launching construction of the world's small-radius curved bridge is implemented. The permanent use of the old bridge pier is designed for reinforcement. The strict monitoring scheme is adopted during the reconstruction period. The successful reconstruction of Lotus Bridge lays a solid foundation for the smooth customs clearance of the port, and also provides a reference for the design and construction of similar projects.

Keywords: Hengqin Port, reconstruction scheme, overall layout, incremental launching construction, reinforcement design

Design of Spatial Curved Steel Pylon Semi-floating System Steel Girder Cable-stayed Bridge

..... ZHENG Zhao (85)

Abstract: The Xiping Avenue Bridge in Xining is a (135 m+57 m+33 m=225 m) spatial curved steel pylon semi-floating system steel girder cable-stayed bridge. The pylon girder separation is adopted for this bridge. The vertical supports, and the longitudinal and lateral blocks are installed between the girder and the pier to strengthen the anti-seismic performance of the bridge. The main girder is a 3.5 m high flat steel box girder structure. The main span is a double-side box structure. In order to meet the anchorage demand, the single-box four-cell structure is adopted for the side span. And UHPC paving system is adopted for the bridge deck. The bridge pylon is a spatial curved steel structural pylon welded of three box sections. The pylon column below the deck is 10.613 2 m high. In order to ensure the stability of the bridge pylon and transfer the horizontal component, the connecting rods are arranged between the middle pylon and the side pylon as well as the side pylons. Three base slabs of side and middle pylons are connected with the straining beam (straining beam is prestressed) with $\phi 2.0$ -m cast-in-situ piles below. The auxiliary piers are the columned piers and the base slab is a rectangular section with $\phi 1.5$ -m cast-in-situ piles below. The abutment is a thin-wall abutment with $\phi 1.5$ -m cast-in-situ piles below. The stayed cables consists of the $\phi 7$ mm galvanized zinc-aluminium high-strength parallel steel tendons. MIDAS Civil and ANSYS finite element programs are used to carry out the static calculation. The result shows that the static performance of the bridge meets the code requirements.

Keywords: cable-stayed bridge, steel pylon, steel box girder, stayed cable, pier, abutment, foundation, structural design, finite element method

Study on Design of Long-span continuous Steel Box Girder Bridge ZONG Zhirong (91)

Abstract: The superstructure of the bridge spanning Beijing-Hangzhou Canal in an urban expressway is a (85 + 100 + 70 + 65)-m unequal-span variable-height steel structural continuous girder. The single-box double-cell layout is adopted. Its substructure is a plate-type main pier and a counterfort abutment. While ensuring the using function and saving resources of the bridge, the harmony of the bridge landscape is also

considered. For the asymmetric construction method of the whole bridge, the effective widths of the sections at each construction stage and the bridge completion stage are calculated respectively. The achieved section strength meets the requirements of the code. Finally, the camber setting of this unequal-span structure is introduced in order to provide reference for the design of similar bridges.

Keywords: utilization of existing bridges, steel box girder, effective width, camber

Design of a New Plate-column Bridge SUN Liming (95)

Abstract: A widened bridge built along river is introduced. Under the condition of ensuring the same height of road and bridge, in order to reduce the influence of beam on flood discharging of river and to solve the problems of supports inundated in water, a new plate-column solid joint system bridge is designed. Its structure is simple, its beam height is low, its area of water resistance is small and its landscape effect is good. The structure construction is introduced. The stress characteristics are analyzed. The construction schemes are compared and selected. The reference can be provided for the projects under the similar design conditions.

Keywords: bridge design, plate-column bridge, calculation and analysis

Research on Design of 60m+4 × 100m+60m Continuous Rigid Frame for Newly Built Lianzhen Railway DAI Hanchao (99)

Abstract: The main span of the approach bridge at the north bank of Wufengshan Changjiang River Bridge in Lianzhen Railway uses 60 m+4 × 100 m+60 m continuous rigid frame. The main beam is a C55 concrete single-box single-cell variable-height box beam. The double-limb thin-wall pier is consolidated with the main beam. The foundation of the main pier uses 16 2.0-m cast-in-place piles. The software BSAS PRO 2017 is used to compare and select the beam height, spacing of double-limb thin-wall pier and wall thickness for the design of bridge structure. When establishing the full bridge calculation model, the equal-generation model of pile group foundation is used to calculate the influence of 25-m scouring depth on bridge structure.

Keywords: continuous rigid frame, double-limb thin-wall pier, beam height, equal-generation model of pile group foundation

Design of Substructure of Double-pylon Self-anchored Suspension Bridge with 370-m Main Span TANG Shuxi (102)

Abstract: This bridge is a double-pylon self-anchored suspension bridge. The span layout of the main bridge is 150 m+370 m+150 m=670 m. On the basis of the relative technical standards and engineering conditions, the design, calculation and analysis of pier, base slab and pile foundation are introduced. And the essentials adopted in the foundation construction scheme of the main bridge are analyzed. The stress, the entirety and the navigation requirements are comprehensively considered. After analysis and calculation, a safe and applicable design form with reasonable structure is finally formed in order to provide the reference for the similar projects.

Keywords: suspension bridge, substructure, design, construction

Design of Long-cantilever Prefabricated Bent Cap ZHOU Yiyan (105)

Abstract: Taking the long-cantilever prestressed concrete bent cap used in Shanghai Pudong New

District Longdong Avenue Reconstruction Project as an analysis object, the design idea and calculation method of long-cantilever prefabricated prestressed concrete bent cap, and several problems needing attention in the design of the prestressed bent cap are briefly introduced, which can be referred for the design of the similar projects.

Keywords: long-cantilever, prefabrication, design of bent cap

Analysis on Ground Motion Parameters and Soil Seismic Response of Qinglan Bridge DU Qiu (109)

Abstract: Taking Qinglan Bridge in Wenchang City of Hainan Province as an example, the seismic safety of engineering site of long-span cable-stayed bridge is evaluated and studied. The process of determining the ground motion parameters of long-span cable-stayed bridge engineering site is given. The site characteristics are analyzed. The interaction of structure, foundation and soil mass is discussed. The process of analyzing the site soil seismic response is given. The reference can be provided for the designers of the relative engineering projects.

Keywords: long-span, bridge, site, ground motion parameter, seismic response of soil layer, analysis

Research on Mechanical Performance of Anchor-tensile Plate Composite Structure of Cable-stayed Bridge ...

..... WANG Wei (112)

Abstract: The cable-girder anchorage structure of cable-stayed bridge as an important part connecting the main beam and the cable bears a heavy load for a long time. There are the problems of complex load-transferring mechanism and local stress concentration in the cable-girder anchoring area. Based on a 54 m+38 m single-pylon single-plane cable-stayed bridge spanning Leishui River in Luojiang County of Sichuan Province, Ansys finite element software is used to establish a finite element model of the anchor-tensile plate composite structure, and the force analysis of the cable-girder anchorage zone is performed. On this basis, the parameter analysis of the structure is carried out, the design scheme is optimized and a more reasonable structure form is obtained.

Keywords: cable-stayed bridge, cable-girder anchorage zone, finite element, parametric analysis

Calculation and Analysis on Lateral Stability of Single-column Pier Continuous Box Girder Bridge in Shanghai CUI Xin, WANG Zhenhang (118)

Abstract: Taking a 4-link single-column pier continuous box girder bridge of the interchange ramp in an expressway of Shanghai as a research object, according to the related stipulations of 2017 *Guidelines for Checking the Lateral Stability of Beam Bridges in Shanghai* and 2018 *Specifications for Design of Highway Reinforced Concrete and Prestressed Concrete Bridges and Culverts*, its numerical simulation is carried out by Midas Civil to analyze its lateral anti-overturning stability. The similarities and differences between two methods are compared. The relationship between the lateral anti-overturning stability and the curvature radius of the single-column continuous box-girder bridge is studied. And the calculation method of lateral overturning resistance of the single-column pier continuous box girder bridge is discussed. Its aim is to provide a certain reference for the anti-overturning checking calculation of the similar bridges in Shanghai.

Keywords: single-column pier, continuous box girder, lateral stability, anti-overturning stability

Study on Stress of Arch and Girder Joints of Long Cantilever Through Continuous Girder Arch Composite
..... Bridge LIAO Weihua (121)

Abstract: The long cantilever through continuous girder arch composite bridge is a bridge with characteristic structural form. Through the rational and clever combination of girder and arch, the advantages of the combined system are fully played so that the stress of the whole structure is more reasonable. The arch and girder joints are the design key of continuous girder arch composite bridge. The arch ribs of the whole zone are intersected with the main girder. The joint of arch and girder is the intersection of arch thrust, girder internal force and support reaction. The local stress distribution of the arch and girder joints is complex, and is a key stress position of arch bridge structure. In order to study the stress distribution of arch and beam joints, prevent the stress concentration and improve the stress of arch foot, the stress of arch and girder joints is studied by numerical simulation.

Keywords: girder arch composite bridge, arch and girder node, finite element, local analysis

Analysis on Mechanical Performance of Corrugated Steel Web – Steel Pipe Composite Box Girder
..... DAI Liang, CHEN Yiyang, HE Xiaohui (125)

Abstract: Combined with the advantages of traditional corrugated steel web composite box girder and steel truss, the concrete bottom plate of the traditional corrugated steel web composite box girder is improved into a steel pipe truss structure. A new structural form of corrugated steel web – steel pipe composite box girder is proposed. This structure gives full play to the advantage of materials and has the advantages of light dead weight, good seismic performance, excellent structural crack resistance and overall performance. At the same time, the construction is convenient and the construction process is flexible. It is more suitable for use in urban mid- and small-span beam bridges. The composite structure is applied to a practical project, and its flexural performance and structural modal are analyzed by finite element software. The influence of the steel pipe filled with concrete on the mechanical performance of the structure is compared and studied. The result shows that the steel pipe filled with concrete can effectively increase the overall stiffness of the structure and improve the structural stress. The analysis results applied to the engineering design and construction have achieved the good economic and social benefits of the project, which can be referred for the similar projects.

Keywords: composite structure, corrugated steel web, steel pipe, steel pipe filled with concrete, analysis of mechanical performance

Analysis of Influence Factors on Bending Bearing Capacity and Ductility of Reinforced UHPC Plate
..... WU Yu (128)

Abstract: In accordance with the design method of the bearing capacity of reinforced UHPC plate stipulated in Swiss SLA2052 specification, the bearing capacity of the reinforced UHPC plate under the limit state of bending bearing capacity and the calculation method of deformation capacity are discussed. Based on a 12-cm thick reinforced UHPC plate, the main influence factors on the bearing capacity and ductility of the reinforced UHPC plate under the limit state are analyzed. The influences of various variation factors on the limit states of reinforced UHPC plate are studied separately. The bearing capacity under limit state is compared with the design values specified by the specification. The conclusion shows that the limit state bearing capacity of UHPC plate with too low reinforcement ratio will be lower than the design value recommended in Swiss SLA2052 and the structure is unsafe by considering the influence of

UHPC being pulled out of work.

Keywords: reinforced UHPC plate, limit bearing capacity, ductility

Overview on Design of Horizontal Swivel Bridge Spanning Anju Railway in Changzhi – Xiangyuan Connecting Line WANG Xuesong, LI Xuefeng (132)

Abstract: The horizontal swivel bridge can effectively decrease the influence of the construction of long-span continuous girder spanning the existing railway on the operation safety of railway. Taking a horizontal swivel bridge spanning Anju Railway in Changzhi – Xiangyuan Connecting Line as an example, the relative contents and matters need attention for the design of swivel bridges are introduced. The contents have the reference and guiding significance for the design of the similar projects.

Keywords: connecting line, horizontal swivel bridge, design

Flood Disasters and Preventative Measures for Bridges in Mountainous Areas of Sichuan LU Xiaofeng, MOU Tingming, LIU Zhenyu (135)

Abstract: The mountainous areas of Sichuan are located in the special geographic position. The bridge construction faces the great challenge. It is significant to carry out the relative study of the flood control for bridges. The direct and indirect disasters caused by the flood in the bridge construction in Sichuan are summarized. The main measures of flood control for the bridges built in Sichuan are summarized, which have the reference for the construction of bridges in mountainous areas.

Keywords: flood, direct water damaged, indirect water damaged, scour, abrasion

Treatment of Cracks at Overwelding Hole of Diaphragm Plate of Closed Stiffening Rib Steel Box Girder LIU Long (138)

Abstract: With the popularization and application of orthotropic steel bridge deck slab girder structure, the disease case related to this structure form appears constantly. There are often pavement damage, plate crack and component breakage. Combined with the crack treatment of diaphragm plate of a river-crossing bridge, the rationality of fatigue of orthotropic steel bridge deck slab under the condition of vehicle overloading is analyzed. The fatigue details of overwelding hole of closed stiffening rib has a large influence on the fatigue property of diaphragm plate, i.e. the overwelding hole form of stiffening rib and the detail quality often used now in bridge. The thickness and continuity of diaphragm plate have an influence on the fatigue property of diaphragm plate. It is found that the surfacing seal of overwelding hole at the top edge of closed stiffening rib is beneficial to the fatigue property of components. The arc gap form and size dimension of the closed stiffening rib will affect the fatigue property of components.

Keywords: closed stiffening rib, arc gap, fatigue, crack treatment

Application of Earthquake Resistant Construction Measures in Bridge Engineering of Spanning Fault Zone XU Di, YU Deen (142)

Abstract: The countermeasures are often taken for avoiding the fault zone in the bridge construction. However, it is sometimes inevitable to build a bridge spanning the fault zone in the seismically active areas. At this time, it is necessary to carry out the special study on the earthquake resistant design, in which the earthquake resistant construction measures are very important. Combined with a practical project, the earthquake resistant construction of bridge spanning the fault zone is discussed. The proposed

earthquake resistant construction measures can be referred for the implementation of the similar projects in China.

Keywords: spanning fault zone, bridge engineering, earthquake resistant measures

Study on Monitoring Measures for Detection Result Effectiveness of Bridge LI Mingjie (145)

Abstract: The effective detection quality control measures are the guarantee for the detection result effectiveness. The continuous improvement of detection result effectiveness and the guarantee of product quality can further improve the ability level of detection unit, serve the market better and win the market. Aiming at the present situation of bridge detection methods, how to guarantee the detection result effectiveness and how to implement the effective monitoring measures are analyzed. Based on the characteristics of bridge detection parameters and combined with the requirements of quality management, two aspects of personnel and equipment are specially analyzed, and the modernized scientific and technological means are fully utilized to make the monitoring measures more diverse. Certain reference basis is provided for the implementation of bridge detection in order to improve the bridge detection level.

Keywords: monitoring measures, bridge detection, detection result effectiveness

Checking Calculation of Safety of Construction Trestle for Leqingwan No.2 Bridge in Wenzhou

..... TAN Donglian, TAN Zhi, GUO zhigang (148)

Abstract: Taking a construction trestle of Yueqingwan No.2 Bridge as an example, in order to make the strengths, rigidities and stabilities of superstructure components, bearing beam and steel pipe pile of trestle meet the construction safety requirements, the safeties of deck slab, small longitudinal beam, transverse distribution beam, Bailey beam, bearing beam and steel pipe pile are checked and calculated in detail. Some suggestions on the materials and construction are put forward.

Keywords: construction trestle, safety, checking calculation

FLOOD CONTROL & DRAINAGE

Discussion on Application of Mathematical Model in Drainage Field SHANGGUAN Haidong (151)

Abstract: In view of so many application problems of mathematical model in the field of drainage presently, the application methods of integrated drainage model is summarized through the project practice of model software by taking Infoworks ICM software as an example. The rainfall event selection, runoff generation model and model parameter determination method are introduced. The application process and key indicators of the mathematical model in the simulation of drainage pipe network, 2D waterlogging and river pollution are provided for reference in the application of mathematical model in drainage field.

Keywords: urban rainfall flood model, drainage pipe network, waterlogging, river regulation

Application of a Combined Deodorization Device in Sewage Pumping Station

..... QIN Jie, CHEN Hanlong, LIU Qikai, MI Sihui, TANG Wen (156)

Abstract: With the strengthening of environmental protection and the improvement of people demand of the environment, the control of odor pollution has become an extremely concerned problem in the field of

environment. Taking a sewage pumping station in Shanghai as a pilot, four different kinds of compound biological deodorization processes of biological – activated carbon process, biological – ozone treatment process, biological – plant fluid process and biological – ion exchange fiber process are used to treat the odor gas of this sewage pumping station. The effects of the treatment system under the different working conditions on the removal of odorous pollutants are studied, and the treatment system is optimized.

Keywords: odor, biological treatment, ozone, activated carbon adsorption

Construction Characteristics of Sponge City in Dead Load Collapsible Loess Area NIU Ying (160)

Abstract: Qingyang City is located in the northwestern region with little rainfall and uneven spatial distribution, lack of water resources, serious soil erosion caused by collapsible loess geology, and high ecological sensitivity. According to the natural characteristics of climate characteristics and soil geology, the construction of Qingyang sponge city should be based on the local conditions. Its technical route of "maintaining storage, net utilization, moderate penetration and orderly discharge" is determined. The construction of sponge city is combined with the comprehensive reclamation of river basin. The city–water–sand relationship is handled well. A life community of "mountain, water, forest, field, lake and grass" is built in collapsible loess area in northwest China.

Keywords: collapsible loess geology, soil erosion, moderate penetration, based on local conditions.

Study on Design of Flood Control Slope and Box Culvert for High Fill Barrier Lake SHEN Yuansong (165)

Abstract: Aiming at two engineering technological difficulties of box culvert drainage and flood control slope for the barrier lake formed by the field engineering, a method of combining the theory with the practice is used. On the one hand, the hydrologic data model is used to draw the catchment zone of box culvert required for the project in order to obtain the corresponding design flood peak flow of outlet section and then to obtain the corresponding design section of the required box culvert. On the other hand, the mortar rubble slope and retaining dam slope are demonstrated. The result shows that the mortar rubble flood control slope can be adopted to further reduce the engineering cost in the case of mitigation of slope ratio.

Keywords: high fill barrier lake, flood control slope, drainage box culvert

Application of Drainage Tunnel in Urban Flood Control Project HUANG Jixin (168)

Abstract: According to the special high–altitude peaks and plateau climate characteristics of Conglinggou in Tianzhu County of Gansu Province, especially in summer and early autumn, it is easy to cause large flash flood disasters. It will cost a lot to build a new flood drainage facility along the original flood drainage location. From this, the scheme of discharging the flood from Conglinggou to the north near Heitugou is proposed. According to the actual situation of the site, three schemes are proposed for the flood drainage routes of Conglingguo. A long tunnel flood drainage route is determined by the technological and economic comparison.

Keywords: urban flood control, route comparison, drainage tunnel, section determination, lining structure

Analysis on Influence of Metro Line 14 River–crossing Project on Flood Control Wall of Huangpu River DING Xingxing (171)

Abstract: When Metro Line 14 of Shanghai crosses the flood control wall of Huangpu River in

construction, it is inevitably to cause the stress release and heavy consolidation of stratum soil. The project inevitably affects the safety of the flood control wall of Huangpu River. The construction scheme of Metro Line 14 crossing the tunnel of Huangpu River, and the situations of the flood control wall within the range of crossing river are introduced. The finite element software is used to analyze and demonstrate the influence of tunnel construction on the safety of flood control wall of Huangpu River. Finally, the suggestions and measures are proposed for the different influence situations of the flood control walls respectively in Pudong section and Puxi Section, which can be referred for the similar engineering projects.

Keywords: rail traffic, river-crossing project, flood control wall

Key Technology for Design of Foundation Pit in Full Underground Wastewater Treatment Plant Adjacent to Metro
..... GAO Wu, LIU Yi (175)

Abstract: Taking a deep and large foundation pit in a full underground wastewater treatment plant (WWTP) of Suzhou as an example, the key technology for the design of deep and large foundation pit adjacent to the shield area of metro is introduced. The design method of "zoning construction" in deep and large foundation pit project is introduced in detail including the selection of building envelope scheme, the design scheme of foundation pit enclosure, the special protection measures of metro and the construction condition of implementation. At the same time for the current situation of this deep foundation pit facing the pile loading on one side and adjacent to river on other side, the influence of unbalance loading on the deep foundation pit is analyzed, which can be referred for the design of deep and large foundation pits similarly adjacent to the shield area of metro or the unbalance loading on both sides in the future.

Keywords: adjacent to metro, full underground wastewater treatment plant, foundation pit, unbalance loading, key technology

Design and Analysis on Foundation Pit of Ultra-large Storage Tank HE Guitang (179)

Abstract: With the acceleration of urbanization and the continuous increase of runoff volume of town rainwater and sewage, the land area and depth of storage tank playing a peak clipping role of the runoff of rainwater and sewage are also relatively increase. Taking the foundation pit of a large storage tank as an example, the design difficulties for this kind of foundation pit are discussed. The enclosing selection, support arrangement and water-stop measures are optimized to guarantee the construction safety, to shorten the period, decrease the influence on environment and save the cost, which can be referred for the similar projects in the future.

Keywords: storage tank, soft soil region, deep foundation pit

MANAGEMENT & CONSTRUCTION

Installation Technology of Landscape Arch Bridge under Complex Conditions of Crossing River and Subway
..... YU Zhenhua (183)

Abstract: Taking the Shenzhen Qianhai Cooperation Zone Tinghai-Shuangjie River Bridge Project as an example, the structure of the landscape bridge is complex, and the construction conditions are complex for crossing the river, the subway and the long-term planning intercity lines. The construction scheme of the

main girder is put forward, which is composed of ground in-situ assembly, girder erection on the bridge, floating box girder, bridge crane hoisting, incremental launching and slip. The construction scheme of segmental assembly on the girder is proposed for the main arch. These schemes can meet the requirements of subway protection and no supports in the river, and can be referred for the construction of bridges under the similar complex conditions.

Keywords: steel-arch composite bridge, main steel girder, steel arch, construction technology

PLC Multipoint Automatic Jacking Construction Technology of Small Bridge Plate

..... WANG Wendong (186)

Abstract: JK32+240 small bridge (superstructure 2×6 m) in C5 Contract Section of the newly built Guangchang - Jian Expressway in Jiangxi Province is located in Zhixia Town of Qingyuan District in Jian City. Due to the increase of traffic flow, the existing roads are required to upgrade and reconstruct. The heightening of pavement at the bottom of bridge by 0.7 m has caused the decrease of small bridge clearance from 4.5 m to 3.8 m. Through the study of the building unit, design unit, supervision unit and construction unit, it is considered that the prefabricated beam plates of the substructure and superstructure of the original bridge can be completely reserved and utilized, which can not only shorten the construction period, be but also environmental friendly and economic. The construction technology of using PLC multipoint automatic jacking hydraulic system to lift the small bridge plates is briefly introduced.

Keywords: PLC multipoint automatic jacking hydraulic system, jack, small bridge plate

Construction Calculation and Analysis of Steel Hoop Bracket for Bent Cap Based on Finite Element Software

..... LIU Pan (189)

Abstract: Based on a large reinforced concrete bridge project, with the help of finite element software, the safety of steel hoop construction is simulated and analyzed. In the calculation and analysis, the finite element software Midas is used to analyze the stress and deformation of each main component in the process of steel hoop construction, and to verify the safety of the steel hoop method in the bent cap construction of large bridge.

Keywords: steel hoop, bridge bent cap, finite element, stress calculation

Jacking-into-sea Technology of Large-diameter Steel Jacking Pipe under Complicated Geological Condition

..... HE Haiqun, WANG Wenjin (192)

Abstract: Combined with the owned power plant 2×350 MW unit project of Baosteel Guangdong Zhangjiang Iron and Steel Base Project, the crossing in the complicated geological condition, especially in the marine continental interactive sedimentary layer of Zhanjiang formation of lower Pleistocene in Quaternary System is introduced. Two-stage mesh format flushing method is used for the pipe-jacking construction. The improvement in the design of inner and outer double steel plate of mesh format tool head, the optimal configuration of front-end grid and the design of double-layer flushing gate is analyzed. A series of construction technologies and measures of sea ballast and internal and external layered cutting of tool heads under the water are put forward. The improved tool head is light weight, easy to operate, safe and economic.

Keywords: complicated geological conditions, large-diameter steel jacking pipe, mesh format flushing method

- Application and Discussion of Trenchless Restoration Technology in Town Drainage Pipe ZHANG Rui (196)
- Abstract:** The trenchless technology is gradually applied in the restoration of town drainage pipe. The in-site solidifying method in the overall restoration, the stainless steel double-tensioner ring method in the local restoration and the local in-site solidifying method are the most commonly used restoration methods now. The above methods are compared and analyzed in depth and in all directions. The relative experience can be referred for the related specialized persons.
- Keywords:** trenchless restoration, in-site solidifying method, stainless steel double-tensioner ring method, local in-site solidifying method
- Construction Scheme of 0# and 1# Blocks for Lianjiang River Bridge LAI Jiahao (199)
- Abstract:** The general situation of Lianjiang River Bridge Project is introduced. The steel tube brackets are required to erect for the construction of 0# and 1# blocks of 3# pier, 4# pier and 5# pier of the main pier. 0# and 1# blocks are constructed on the brackets. The construction technology of 0# and 1# blocks are further discussed. The experience can be provided for the relative constructions.
- Keywords:** bridge, rigid frame, 0# block, 1# block, construction technology
- Compaction Characteristics and Proposed Compaction Method of Construction Machinery DING Lei (202)
- Abstract:** In order to study the compaction characteristics and the proposed compaction method of construction machinery, an airport expansion project Phase III of China is experimentally analyzed and studied. The treatment and analysis are carried out for the settlement monitoring under the different sections. 2 # and 3 # underpass test stations of this airport are selected to carry out the testing and research work of static and dynamic stresses of the airport pavement and structure. The characteristics of static and dynamic earth pressures in the side walls and subgrades of the underpass under the action of the fill and pavement dead load, and the vibration compaction of the vibratory roller are studied to obtain the scientific measured data. The field test data are analyzed and processed. The depth and range of vibration impact of the vibratory roller are summarized. The empirical research on the interaction is carried out according to the theoretical research results of the earth pressure around the underpass.
- Keywords:** coarse-grained soil, settlement detection, compaction of high filling earthwork
- Study on Application of Informatization Technology in Construction Management of Airport Project ZHOU Shifeng (205)
- Abstract:** The field construction is a key link in the engineering project, and is also the important content in the management work of enterprise. Compared with the traditional construction management mode, the application of informatization technology in the construction management has the advantages of ensuring the construction period, strictly controlling the investment cost and guaranteeing the construction quality. The application of informatization technology in construction management is studied. Its application status and significance of construction management informatization are summarized. Its application in airport construction management based on BIM integrated management platform is briefly introduced.
- Keywords:** informatization, construction management, integrated management platform

Revelation and Suggestion on Contract Money Determined by Financial Evaluation after Winning Bid of EPC Project WANG Changyong (208)

Abstract: At present, there is more and more contract money determined by financial evaluation after winning the bid of EPC project. The mode of design, construction and financial evaluation at the same time not only shortens the construction period of project, but also makes for the owner to control the cost and quality. But there is a certain risk for the construction units. Aiming at the mode of contract money determined by financial evaluation after winning the bid of EPC project, the advantages and disadvantages of each participant in the project are expounded, analyzed and discussed.

Keywords: PEC project, mode of contract money, financial evaluation

Comparison and Analysis of Urbanization Highway Engineering in Different Quota Modes ZHANG Hongmei (211)

Abstract: The urbanization highway projects can adopt the pricing and construction management modes of municipal engineering or highway engineering. But the cost management document, bidding document and bill of quantities directly related to the engineering cost are different from the forms to contents. Due to the difference of the pricing quota and pricing procedure of municipal engineering or highway engineering, even if adopting the same labor, material and mechanical unit price, the result of its engineering cost will be also different. By comparison and analysis of the partial subprojects adopting the municipal and highway pricing quotas in urbanization highway project, the pricing difference between two quotas is analyzed in order to provide some ideas for mutual complementation and reference to build an unified pricing mode or two pricing modes.

Keywords: urbanization highway engineering, municipal quota, highway quota, unit price

Intensifying Strategy of Bridge Engineering Management ZHU Wenzhong (213)

Abstract: In the bridge engineering construction, the level of engineering management has a huge decision impact on the final quality and benefits of a project. In the current bridge engineering construction, especially in the engineering management in China, the general and prominent problems are more concentrated and obvious. The development and leap of bridge engineering construction are seriously hindered by these problems in China, and are disjointed with the overall level of economic development in China, which are urgently required to improve and solve. According to the study subject of bridge engineering management and taking the bridges under construction in Fengxian District of Shanghai as the examples, the main contents of bridge engineering management are briefly introduced. Several constraints on the current bridge engineering management of China are analyzed, and at the same time, the thought and suggestions are put forward to intensify the bridge engineering management. The aim is to provide the beneficial reference and help for the promotion of bridge engineering management.

Keywords: urban construction, bridge engineering, management member, level, thought and suggestion

STUDY ON SCIENCE & TECHNOLOGY

Study on Influence of Longitudinal Connecting System of Bowstring Arch Bridge on Out-of-plane Stability of Arch Rib JIN Chengdi, FAN Lingyu, LINGHU Yunyun (215)

Abstract: Based on the study of arch rib stability of bowstring arch bridge in the research literature, the influence of connecting system on the arch rib stability is studied. The frame type of longitudinal connecting system is commonly used as a study object. According to the calculation of composite columns concerned in the elastic system stability theory, the approximate formula of stiffness combination effect coefficient of frame composite columns is proposed. The current connecting system is checked and calculated. An example of the out-of-plane stability of arch rib is given. The optimization suggestion for setting the lateral straining beam is proposed. Meanwhile, the out-of-plane stability of arch rib of basket-shaped bowstring arch bridge is analyzed by the examples.

Keywords: frame-type connecting system, composite column, stiffness combination coefficient, basket-shaped bowstring arch bridge, out-of-plane stability

Research on Bending Rigidity Efficiency of Fabricated Concrete Tubular Culverts

..... ZHANG Xuefeng, ZHU Rong, LI Piwei, ZHANG Wei, SHI Xuefei (222)

Abstract: Fabricated concrete culverts have a certain degree of weakened structural rigidity due to the presence of connecting joints. When designing and calculating, the influence of joints on the overall structure stress and deformation must be considered. The pipe segments cannot be simply regarded as homogeneous structures. Based on the fabricated tubular culverts in Zhejiang Province, the finite element method is used to establish the analysis models of the tubular culverts with and without joints. The modified routine theory in shield tunnel is introduced into the fabricated tubular channel structure. The reasonable values of bending rigidity efficiency η and the stress calculation correction coefficient ξ of the fabricated tubular channel are analyzed and proposed to simplify the calculation.

Keywords: fabricated concrete culvert, rigidity efficiency, finite element analysis

Evaluation on Properties of Bonding Materials between Thin Overlays

..... XIAO Jun, LI Xu, GUO Yinan (226)

Abstract: With the development of road transportation industry, it is a trend to maintain some roads with weakened surface function. Thin overlay is a reasonable and effective maintenance scheme. In order to improve the bonding performance between the thin overlays and further improve the maintenance life of thin overlays, four different interlayer bonding materials of SBS modified asphalt, ESSO70# matrix asphalt, rubberized asphalt and TB modified asphalt are studied and tested. The test method is a self-developed simple method for detecting the bond strength of materials, that is, a lever drawing method. The drawing force and bonding strength of four different bonding materials with the different spraying amounts are used to evaluate the bonding performances as interlayer materials. The test results show that the four materials can all meet the more stringently required value of bond strength not less than 0.48 MPa, in which SBS modified asphalt is the best bonding material. The best recommended spraying amount is 0.6 kg/m².

Keywords: thin overlay, interlayer bonding, asphalt material, drawing strength

Study on Influence of SBS Content on Water Stability of Asphalt Mixture

..... WANG Texiang (229)

Abstract: In the early stage, the drainage pavement was mainly damaged by water. Once damage occurs, a great impact on the normal performance of the pavement is large. In order to improve the water stability of drainage asphalt mixture, the influence of SBS content on the water stability of asphalt mixture is studied.

Five kinds of modified asphalt with SBS contents of 3%, 4.5%, 6%, 7.5% and 9.0% are selected. The water stability of asphalt mixture are evaluated by the immersion scattering test, freeze-thaw split test, immersion Marshall Test and submerged Hamburg wheel tracking test. The influences of the different SBS contents on the water stability of the mixture are compared and analyzed. The test results show that the modified asphalt with high content of SBS can effectively improve the water stability of drainage asphalt mixture. By comprehensive considering, the recommended SBS content is 6.0%.

Keywords: drainage pavement, asphalt mixture, SBS content, water stability

Experimental Study on Physical Parameters and High/Low-temperature Performances of Emulsified Asphalt Cold-recycling Mixture ZANG Xiaoshuang, WU Shengkun, ZHU Wenbing, ZHOU Jun (232)

Abstract: The asphalt pavement cold-recycling technology is to use the waste asphalt mixture as the raw material and add the emulsified asphalt, cement and admixture to mix the new mixture for paving the pavement, which can save the materials, reduce the cost, save the energy and protect the environment. By using the different emulgator types of emulsified asphalt as the binder material, the physical parameters, high and low temperature performances of cold-recycling asphalt mixture are tested and studied under the conditions of different emulsified asphalt amounts and cement contents to analyze the influences of emulgator type, emulsified asphalt amount and cement contents on the high and low temperature performances of mixture. Through the experimental study, the best emulsified asphalt amount and cement content to meet the requirements of mixture performance specifications is obtained. The study result can provide the theoretical basis for the engineering application of cold-recycling asphalt mixture.

Keywords: emulsified asphalt, cold-recycling asphalt mixture, high-temperature performance, low-temperature performance

Analysis on Influence of Different Pile Foundation Design Assumptions on Calculation of Water Supply and Drainage Structures CONG Haiyang (236)

Abstract: In the water supply and drainage engineering, the pile foundation bearing is used in the most projects. The common pile types are the cast-in-place pile and precast pile. In the structural design, designers often make a simplified analysis of the partial structures. The most unfavorable frame of the structures is selected for calculation, and the reinforcement is based on the calculation results. It is necessary to set a support at the action point of pile foundation in the simplified analysis of structure. But the support type has a certain influence on the calculation result. Taking a project as an example, the influences of the different support types on the calculation results are compared. The partial factors influencing the support type are analyzed.

Keywords: water supply and drainage engineering, pile foundation, elastic support, equivalent stiffness

Study on Frost Heaving Mechanism and Anti-freezing Measures of Tunnels in High Altitude Area of Wushao Mountain WANG Zengyun (240)

Abstract: The frost heaving characteristics of surrounding rock and concrete, and the damage of underground water to the tunnels in the cold regions are studied. The mechanism of frost damage in tunnel is revealed. Based on Wushao Mountain Tunnel from Yongdeng to Gulang in G30 Lianyungang - Korgas Expressway, the measures to prevent the frost damage in tunnel are proposed. The new technology of tunnel heating is introduced.

Keywords: Wushao Mountain, high and cold tunnel, frost heave, insulation and anti-freezing measures

Exploration on Systematic Design of Traffic Relief during Construction Period of Urban Rail Transit

MO Yang (244)

Abstract: The influence on the operation of urban traffic during the construction of urban rail traffic is mainly manifested in the temporary relief road and surrounding road network. At present, the focus of traffic relief design is on the rail transit stations. There is no unified consideration of the situation along the line and road network. From the system point of view, the traffic relief can not only solve the problem of smooth traffic of the occupied road, but also evaluate the influence of relief scheme on the road network. Therefore, by analyzing the characters of traffic composition, traffic volume carried by temporary relief road, traffic allocation of local road network and influence range of road network, the viewpoint and method of traffic relief systematic design are proposed.

Keywords: traffic relief, systematic design, non-transfer traffic, shunt traffic, road resistance

Experimental Study on Anti-dumping Reinforcement of Single-column Bearing Beam Bridge

ZHANG Xinguo (247)

Abstract: Combined with the potential safety hazard treatment projects of urban elevated single-column pier curved beam in Shanghai, the applicability of reinforcement scheme is studied by full scale test. The stress mode and load-transferring mechanism after reinforcement are explored and studied in order to provide the powerful support for accurate optimization and implementation of reinforcement scheme. The test shows that the maximum bearing capacity of the steel bent cap added in this test is 280 t, which meets the design (160 t) requirement. When the load is less than 150 t, no bond failure occurs between the ultrahigh performance concrete (UHPC) and the component. When the design load is 0.93 times, the studs begin to participate in the stress. An optimization direction is provided through this test for the reinforcement scheme, which can be referred for the implementation of the similar projects.

Keywords: single-column pier, anti-dumping, steel bent cap, ultrahigh performance concrete (UHPC)

Stress Calculation, Analysis and Comparison of Post-tensioned Prestressed Concrete Small Box Girder

DING Feng, LUO Zongbao (252)

Abstract: According to *Code for Design of Highway Reinforced Concrete and Prestressed Concrete Bridges and Culverts* (JTG 3362—2018), the midspan hemline normal stress of 40m-span post-tensioned prestressed concrete small box girder is calculated by hand and professional software respectively, and the difference between the two calculation results is compared. The causes of the difference are found out through analysis, and the solutions are put forward, which have certain reference value for engineering design.

Keywords: bridge engineering, small box girder, post tensioning method, stress

Comfort and Dynamic Design Method of Long-span Pedestrian Overpass

LI Dongming (256)

Abstract: *Technical Specifications of Urban Pedestrian Overpass and Underpass* (CJJ 69-95) of China requires the first-order natural frequency of pedestrian overpass greater than 3 Hz. But the large-span pedestrian bridge cannot meet the requirements of this code. Therefore, it is necessary to analyze and control its comfort. After the research and analysis of the corresponding foreign codes, the German codes

are selected as the comfort evaluation criteria of the long-span pedestrian overpass, and the comfort and dynamic design methods are summarized. Through the engineering practice, it is found that the use effect of overpass is good, and the design method is practical and effective.

Keywords: pedestrian overpass, dynamic design, comfort

Study on Rutting Resistance Evaluation and Structural Optimization of Asphalt Pavement GAO Zun (260)

Abstract: In order to study the influence of pavement structure on the rutting performance, the pavement structure is reinforced through the test method. The upper and middle layers of pavement structure are reinforced respectively. The heavy load rutting test and shear stress test are carried out for the tested pavement. The result shows that the vehicles traveling at low speeds have deeper ruts on pavement. And with the load increase of vehicles, the rut depth also increases. By reinforcing the upper and middle layers of pavement, the rutting resistance of pavement can be improved. The improvement of the upper and middle layers of pavement is similar. Finally, the best scheme composed of three materials of rutting resistance asphalt mixture, dense gradation SBS modified asphalt mixture and dense gradation common asphalt mixture is obtained. The improvement of shear resistance of pavement is not obvious if the pavement is reinforced.

Keywords: rutting resistance, pavement structure, shear strength, heavy load test

Study on Durability of Drainage Pavement of Airport Service Lane LI Xu (263)

Abstract: Several kinds of asphalt mixtures are selected to evaluate the anti-loose abilities and water stabilities of the different modified asphalt mixtures through Kentucky scatter test, and the economic analysis of the different modified asphalt mixtures are carried out. The results show that 6% and 5% SBS modified asphalt mixtures, and 4% SBS + 1% PE composite modified asphalt mixture have better anti-loose abilities and water stabilities. The increase of SBS content can significantly improve the anti-loose ability and water stability of modified asphalt mixture. Comprehensively considering the cost and road performance, it is recommended to select the modified asphalt mixture with high content of SBS in the project. The results of standard Kentucky scatter test and immersion scatter test show that the anti-stripping and anti-water loss performances of modified asphalt mixture are highly consistent. The both can mirror each other.

Keywords: airport, service lane, drainage pavement, scatter loss, economy

Evaluation and Study on Regeneration Effect of Thermal Regenerant with High Aromatics Content in Asphalt Pavement LIU Yan, YAN Dongbo (267)

Abstract: A thermal regenerant prepared with high aromatics content is introduced. The regeneration effect of thermal regenerant on the old asphalt in recycled asphalt pavement material is studied by the new and old aggregate distinguishing mixing methods. The test results show that the regeneration effect of the high aromatic content regenerant is remarkable, and the performance of the old asphalt can be better restored when 15% of old asphalt is added to the recycled asphalt pavement material. After adding the regenerant to distinguish and mix, more recycled asphalt is obtained from the surface transfer of new aggregates. The recycled asphalt is evenly distributed on the surface of the new and old aggregates. The surface asphalt of the new and old aggregates after distinguished is analyzed by four-component method

for the first time. The result shows that the four-component compositions on the surfaces of the new and old aggregates are similar. It shows that the thermal regenerant fully plays the role of regeneration and redistribution of old asphalt in the mixing process.

Keywords: high aromatics content, thermal regenerant, regeneration effect

Analysis on Geogrid Tension and Earth Pressure of Reinforced Soil Retaining Wall Based on Unified Strength Theory JI Weijie, YANG Bo (270)

Abstract: The unified strength theory and the equivalent additional confining pressure theory are applied to consider the effect of intermediate principal stress and studies the change rules of geogrid tension and soil lateral pressure of reinforced soil retaining wall. In the analysis of interaction between reinforcement and soil, the relative slip between the geogrid deformation and reinforced soil is considered. And the equivalent additional confining pressure is replaced by friction resistance of the reinforcement and soil interface in order to provide a new method of calculating the equivalent additional confining pressure. Further based on the unified strength theory, the distribution of tension of geogrid along the horizontal direction of geogrid and the distribution of soil lateral pressure of reinforced soil retaining wall are deducted. The results show that the tension of geogrid reaches a maximum in the middle of geogrid, and presents a compound exponential distribution. With the increase of the intermediate principal stress coefficient b at the same place of geogrid, the tension decreases gradually. When $b = 0.5$, the calculation value is in good agreement with the measured value. The soil lateral pressure increases from small to large along the depth of retaining wall under the different strength theories. At the same depth, the soil lateral pressure decreases with the increase of intermediate principal stress coefficient b . Again, when $b = 0.5$, the calculation value of soil lateral pressure is consistent with the measured value of soil lateral pressure.

Keywords: reinforced soil retaining wall, unified strength theory, interaction between reinforcement and soil, equivalent additional confining pressure, geogrid tension, soil lateral pressure

Soil Pressure Calculation Method and Parameter Valuing Analysis of Double-row Larson Piles in Soft Soil Foundation Pit Engineering QU Di (274)

Abstract: Aiming at the characteristics of short construction period, large depth and strict deformation control of small pump sluice foundation pits in urban built-up areas, the double-row Larsen pile retaining structure has been applied to some extent because of its simple procedures, large retaining height, good deformation control and other characteristics. According to an actual engineering case, the Lizheng deep foundation pit software double-row pile support module is used to conduct the safety analysis of foundation pit. The soil layer parameters of different miscellaneous fillings are selected to predict the maximum displacement value of pile top and the surface settlement. The predicted values and monitored values are compared and analyzed to verify the rationality of the calculation method and calculation parameters of double-row Larson support in the soft soil area of Shanghai. When the thickness of miscellaneous backfill is thick and the cohesive soil is the main, the soil-water integration and its corresponding soil layer parameters are used for simulation. The maximum displacement of the pile top and the surface settlement are more in line with the monitoring results.

Keywords: soft soil area, foundation pit, double-row Larson steel sheet pile, earth pressure calculation, selection of soil layer parameters

Deformation Impact Analysis of Cofferdam Supporting of Foundation Pit Close to Water

Hu Qi, XU Yan (278)

Abstract: The supporting structure of foundation pit in the foundation pit engineering close to water is subjected to the different water and soil pressures. When the foundation pit is under the asymmetrical load, the whole structure will deform and tilt to the side with less water and soil pressure. Therefore, the relevant formula in the code cannot be completely used for calculation. Based on the characteristics of the unbalanced water and soil pressures at both sides of foundation pit close to the water, the design of this kind of foundation pit is assumed and discussed. From the formula in the code, the iteration recursive method is adopted to establish a set of system to calculate the deformation of supporting structure in the foundation pit engineering close to water. Its calculation and analysis are carried out by the engineering examples.

Keywords: foundation pit close to water, internal support stiffness, iteration recursion, deformation impact analysis

Numerical Study on Connecting Mode between Lane Slabs of Double-layer Internal Prefabricated Structural Tunnel

WANG Wendong (281)

Abstract: Based on the internal prefabricated structural system of "slab-beam-column" double-layer tunnel, the connecting mode between lane slabs is studied including four modes of straight joint, hinge joint, rigid joint and equal rigidity joint. The results show that the longitudinal moment transmitted by the straight joint is limited, and the hinge joint is equivalent to the rigid joint. The longitudinal shearing force of straight joint is basically not transferred, and the longitudinal bending moment of hinge joint and rigid joint is relatively continuous, almost 100% transfer. The transfer of rigid joint width to bending moment decreases with the increase of the width, but has little effect. From the perspective of construction convenience, a larger joint width can be selected. The transfer of rigid joint thickness to bending moment decreases with the increase of thickness. But when the thickness of rigid joint is equal to the thickness of lane slab (equal rigidity connection), the stress is the most continuous. The near equal rigidity connection recommended in this paper has large joint stiffness and reasonable stress.

Keywords: shield tunnel, double-layer prefabricated structure, joint form, numerical simulation

Distribution Law of Soil Pressure in Underpass of High Fill Airport

GU Leihua (285)

Abstract: For the study of the characteristics of soil pressure within the underpass wall and roadbed under the dead load of filling and pavement, and the load of construction vehicles, the side wall soil pressure of the underpass of a high fill airport in Guizhou of China is tested. After comparison, the pressure values measured on the earth pressure cell and the values calculated on the filling thickness are processed and analyzed. The experimental results show that the higher the backfill height is, the higher the earth pressure is without the load, and the increase range is approximately proportional to the filling thickness. With the increase of backfill thickness, the distribution of the value α along the backfill direction turns into a line going to be approximately stable from the initial approximately linear increasing trend due to the increase of filling thickness. The higher the fill thickness is, the closer the value α is to 0.1~0.15. Under the action of load, the buried shallow earth pressure cell is more sensitive to the change of pressure value. The depth affected by load is about 1.52~2.81 m. The driving direction of vehicle has no obvious influence on the earth pressure.

Keywords: high fill airport, earth pressure cell, soil pressure, load of construction vehicle

Study on Index of Road Traffic Simulation Evaluation Method WU Qingdong (290)

Abstract: With the rapid development of modern automation industry technology now, the development of automotive electronics and intelligence has been further accelerated. The cutting-edge technology of road traffic driving has gradually become a necessary prerequisite for the safe operation of vehicles. Based on the new situation faced by the modern automotive intelligent research and development, and testing field, it is proposed to adopt the Carsim simulation evaluation method as the mainstream of automotive intelligent technology research and development, and measure the feasibility of its method indicators through three-dimensional modeling in order to provide a feasible reference for development of modern automotive industry.

Keywords: road traffic, evaluation method, Carsim simulation

APPLICATION OF ACHIEVEMENTS

Development and Application of Multivariable Fusion Control Technology of Slurry Pneumatic Balance Shield

..... HU Yang (292)

Abstract: Combined with the main control object of surface settlement and the multivariable construction parameter characteristics of slurry pneumatic balance shield in the tunnel construction, combined with the technical research project of "Development and Service of Surface Settlement Evaluation Analysis Software Based on deep learning", the modern control theory is used to establish a set of multivariable fusion control self-learning method for slurry pneumatic balance shield. Through programming simulation test and practical engineering demonstration application, the result shows that this established shield multivariable fusion control self-learning method has the technical performance of stabilizing the surface settlement quality.

Keywords: shield, surface settlement, multivariable fusion, self-learning control

Application of Ground Penetrating Radar Advanced Prediction Technology in Shield Engineering

..... JIANG Lingpeng (295)

Abstract: The technology of ground penetrating radar (GPR) used for detecting the geological anomalies ahead in the process of metro shield tunneling is discussed. The bad geology ahead of shield is detected by engineering example for the convoy of shield tunneling. Its result can be referred for the similar projects.

Keywords: ground penetrating radar (GPR), shield interval, advanced prediction, geological anomaly

THE RELATIVE SPECIALITIES

Establishment of Benefit Evaluation Index System for Implementation of Modern Tram Planning

..... YU Huan (297)

Abstract: On the basis of interpreting the urban modern tram planning and construction process, the main

tasks of modern tram planning are clarified, and then the direction of implementing benefit evaluation is proposed from four levels of passenger service, urban development, operational effect and macro effect. The evaluation index system and corresponding survey methods are established from five aspects of passenger flow efficiency, operational service improvement, traffic impact analysis, quality image improvement and development guidance.

Keywords: modern tram, benefit evaluation, index, survey method

Analysis of Fire Protection Design for Pudong Airport Phase III Satellite Hall XU Dong (301)

Abstract: Pudong Airport Phase III Satellite Hall is the first satellite hall in China, the largest one in the world and the single one with the most comprehensive coverage function. The design of fire protection system is the focus and difficulty of the project. In order to solve the "big" problem, the plane zoning of fire protection, setting of fire pumping house, determination of fire water system and design parameters, recheck of fire water source and water supply capacity, selection of gas fire-extinguishing system and the countermeasures are introduced in order to provide the reference for the similar projects, for the fire protection design of super-large volume and oversized space with the complex functions.

Keywords: airport, satellite hall, super-large volume, oversized space, fire protection design, fire water system, gas fire extinguishing system

Analysis on Mechanical Characteristics of Rectangular Corrugated Steel Underground Utility Tunnel Structure

..... ZHOU Jianmin (306)

Abstract: Aiming at the structure of rectangular corrugated steel underground utility tunnel, 3D refined numerical model is established by large finite element software to explore the influence rule of three key factors of overload, geological condition and burial depth on the mechanical and deformation characteristics of rectangular corrugated steel underground utility tunnel structure in detail, and systematically to reveal the most unfavorable stress position of rectangular corrugated steel underground utility tunnel structure. The study result shows that the stress peak of rectangular corrugated steel underground utility tunnel structure under the condition of overload increases by 45.2% compared with its stress peak under no overload condition. The geological conditions have a great impact on the structure deformation and stress. The structure stress, lateral extension deformation and structure settlement will increase with the increase of burial depth.

Keywords: rectangular corrugated steel underground utility tunnel, numerical model, geological condition, stress deformation

Analysis on Application of Composite Wall in Large-sized Underground Space XU Ning (311)

Abstract: In order to study the stress conditions of the structure side wall in underground composite wall system, taking a large-sized underground space in the region of Yangtze River Delta as an example, two 2D calculation models are divided according to the different stress forms and modeling methods to obtain the shear value controlling the side wall section of the structure. And 3D calculation is used to recheck.

Keywords: large-sized underground space, composite wall, structural calculation, analysis of internal force

Discussion on Planning and Design of Development and Utilization of Low Hill Gentle Slope

..... ZHANG Kun, LI Wenjing (314)

Abstract: The development and utilization of low hill gentle slope are the important measures for the land reform in China, and are the important starting point of priority strategy for land resource conservation. Taking a typical project built in Zhejiang Province as an example, the important matters of development intensity, site leveling mode, slope direction control, vertical design, entrance and exit design, earthwork deploy and earthwork balance for attention in the planning and design of development and utilization of low hill gentle slope are summarized, and the relative suggestions are put forward, which can be referred for the related professionals.

Keywords: low hill gentle slope, development intensity, site leveling, coefficient of loosened soil

Study on Application of Point Cloud Data Regular Surface Extraction and Spatial Simulation

..... ZHAO Peiming (317)

Abstract: With the continuous development of engineering digitization and BIM design, the application of 3D measurement in project is indispensable. In 3D laser scanner point cloud processing, taking the normal vector and principal curvatures of a regular surface (plane, cylindrical surface and spherical surface) as the parameters, the mathematical model of regular geometric surface automatic extraction is established. The distance of surface namesake point and the ranging result of precision total station extracted by this model are compared and analyzed for model precision. The noise reduction, downsampling and regular geometric surface automatic extraction are carried out through point cloud data. Combined with the operation of 3d chartlet and rendering, taking the spatial simulation of a building as an example, an application method of centimeter-level point cloud data regular surface extraction spatial simulation is obtained.

Keywords: 3D laser scanner, pre-processing, regular surface, automatic extraction, spatial simulation

Design and Application of Pile Foundation Counterfort Wall

..... OUYANG Guobin (320)

Abstract: The utility tunnel built in the place with large hypsographical undulation is often located in the high fill subgrade. At this time, the retaining walls are often required to ensure the safety of road slopes and utility tunnel. In order to ensure the safety of the utility tunnel, the requirements for the design of retaining wall outside the utility tunnel are generally higher. To illustrate the design process of such retaining walls, taking a pile foundation counterfort wall outside the underground utility tunnel in Qingbao Road of Bashan City in Yunnan Province as an example, its design method is briefly analyzed.

Keywords: utility tunnel, counterfort wall, pile foundation, analysis

Analysis on Self-inspection Essentials of Common Problems in Preparation of Design Budget Estimate

..... LIANG Chen (324)

Abstract: The design budget estimate is the main basis and the maximum limit of construction project investment control, and is also one of the result documents in the preliminary design stage. At the same time, it can be used as the basis for the preparation and control of construction drawing budget, bidding control price, tender quote and contract price. Therefore, it is very important to master the accuracy (quality) of design budge estimate. The quality problems leading to "no" of design budget estimate, i.e. the preparation contents inconsistent with the design documents and drawings in the preparation of design

budget estimate are analyzed. On the basis of the arithmetic error in the calculation of engineering quantity, and the calculation rules inconsistent with stipulations, taking the projects of road, bridge, drainage and tunnel in Shanghai as the examples, the preparation members are guided how to apply the "exclusive method" and "empirical method" for the self-check (self-correction) in order to evade the arithmetic errors and "stupid mistakes", and improve the preparation accuracy and precision of design budget estimate.

Keywords: design budget estimate, quality, self-correction

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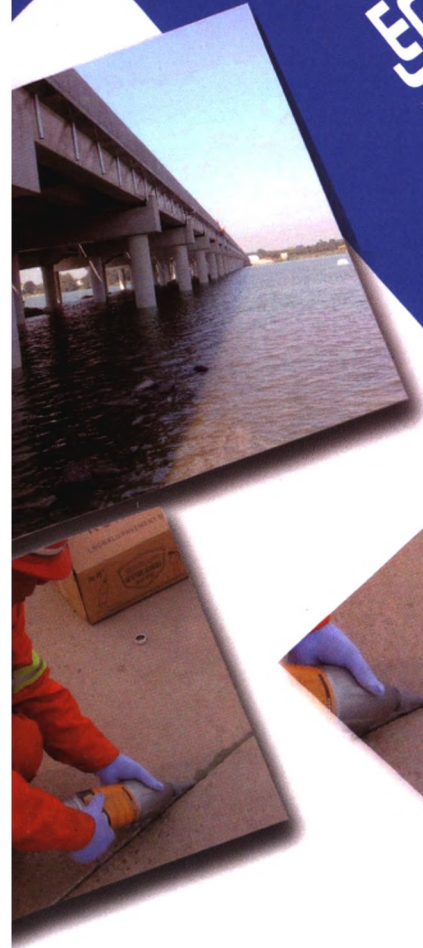
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