

# 城市道桥与防洪

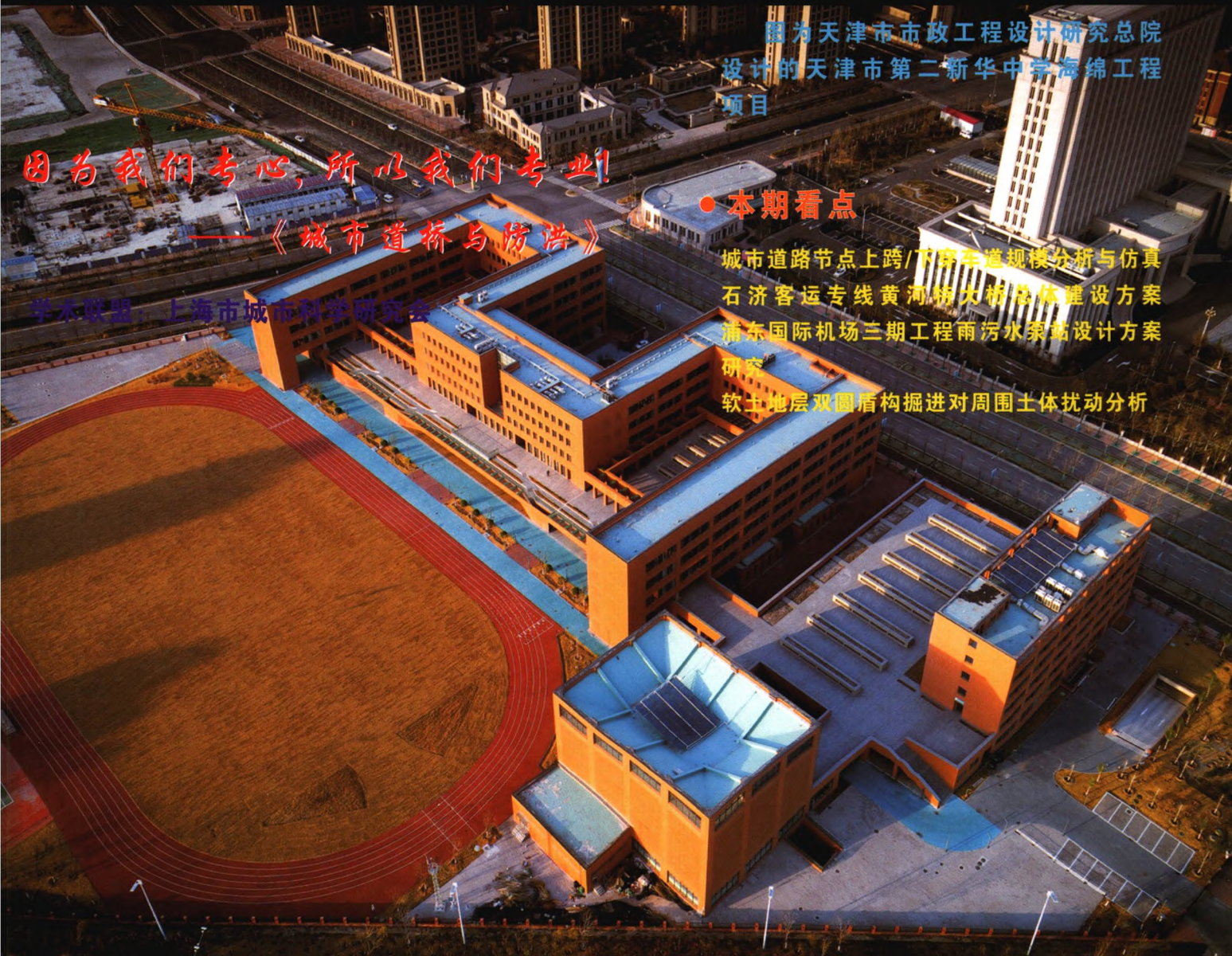


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《城市道桥与防洪》

### ● 本期看点

- 城市道路节点上跨/下穿车道规模分析仿真
- 石济客运专线黄河特大桥总体建设方案
- 浦东国际机场三期工程雨污水泵站设计方案研究
- 软土地层双圆盾构掘进对周围土体扰动分析

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**封面工程**

本期封面工程为天津市第二新华中学海绵工程项目,由天津市市政工程设计研究总院设计。

第二新华中学位于国家海绵城市试点区——解放南路试点片区内,是天津市海绵城市建设的样板项目,也是天津市第一个将海绵城市建设理念贯穿于整个项目的规划、设计和施工各个阶段的公建项目。

项目建设理念先进,涉及的低影响措施齐全,完善度较高,是2019年住建部海绵城市建设验收的重点项目。通过对校区雨水排水分区进行合理划分,对雨水产汇流特点进行梳理,优化了海绵设施空间布局,完成了整个片区径流总量控制率78%和径流污染控制率65%的目标,基本达到了“小雨不积水,大雨不内涝,水体不黑臭,热岛有缓解”的建设目的。

在此基础上,学校以“海绵校园”为环境育人载体,尝试成立“海绵校园研究兴趣小组”,学习海绵理念,通过与项目咨询单位天津市市政工程设计研究总院合作,开展兴趣研究,力争让每一位新华的孩子都能知海绵、懂环保,为将来海绵城市建设及人与自然的和谐发展做出自己的努力。

# Urban Roads, Bridges & Flood Control

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### ROADS & COMMUNICATION

Analysis and Simulation of Overpass / Underpass Lane Scale on Node of Urban Road .....

..... Zhang Haijun, Xue Changsong, Shen Lei ( 1 )

**Abstract:** The setup of overpass / underpass of the main line is a common means to alleviate the contradiction between the traffic supply and demand of urban road nodes. The main influencing factors on the overpass / underpass lane scale are analyzed. Based on an actual case, the paper restricts the land condition of road, sets up the different overpass / underpass lane scale schemes of the main line and the traffic demands, carries out the traffic simulation to analyze the traffic adaptabilities of the different lane scales, and gives the relative advices for the relevant practitioners and decision makers.

**Keywords:** overpass / underpass of node, limited land, lane scale, traffic adaptability, traffic simulation

Elementary Analysis on Design of Relieved Road for Rail Transit .....

Shi Xijin, Bian Jun ( 5 )

**Abstract:** The rail transit route passes through the urban center area, and the layout of its stations is diversified. The station construction has a great influence on the urban road traffic. Taking the stations along the Changzhou Rail Transit Line 1 as an example, this paper sets forth the layout principle of relieved road, the mode of traffic organization by stages, the traffic guidance of the surrounding roads, and the design of road structure. The actual operation effect is good after the completion of the relieved road, and ensures the smooth and orderly urban traffic during the construction of rail transit.

**Keywords:** rail transit, relieved road, design

Analysis on Design of Urban Trunk Road Jointed Board of Main and Auxiliary Roads .....

Yang Youzhang ( 9 )

**Abstract:** This paper introduces the theoretical basis of construction form of the urban trunk road jointed board of main and auxiliary roads, analyzes its functional characteristics, applicable conditions, construction scale and design thinking, sets forth the design emphasis on this kind of road – the design of entrance and exit of main and auxiliary roads, and the design of traffic organization of intersection, and finally analyzes the

example of Nanchang Changdong Avenue Reconstruction Upgrading Project.

**Keywords:** urban trunk road, jointed board of main and auxiliary roads, entrance and exit of main and auxiliary roads, traffic organization of intersection

Research on Alignment Design of Municipal High-risk Road Sections ..... Xiao Shaohua ( 14 )

**Abstract:** As a carrier of urban traffic accidents, the own defects of municipal roads can also lead to the traffic accidents while undertaking the service functions. Combined with the incidence of urban traffic accidents, this paper expounds the high-risk sections of the four areas of curved downhill, poor visibility, impeded drainage and multiple intersections, and analyzes the shortcomings of route design in the areas. Based on the design experience, this paper studies and analyzes the alignment, and puts forward the improvement countermeasures. The relative experience can be referred for the similar projects.

**Keywords:** municipal road, high-risk road section, alignment design, alignment combination

Overall Design of Riyue Avenue (Chengwen Road) Expressway Reconstruction Project .....

..... Tang Yunhua, Deng Xuefeng ( 17 )

**Abstract:** Riyue Avenue (Chengwen Road) is one of “double-express” (expressway and bus rapid transit) ray roads. This project will directly link up with Ring Road II, Ring Road III and Belt Expressway after reconstructed, and realize the fast conversion, greatly improve the traffic capacity of road and can effectively remit the traffic pressure in the western urban area. This project covers a large number of professional municipal integrated projects and has the wide profession intersection. According to the present investigation, this paper analyzes and predicts the traffic volume, and summarizes the road network of area. Combined with the relative superior planning and specialized plan, this paper introduces the professional coordination and overall design, which is very important significance for the engineering construction, and also actively promotes the application of the new technology and new process in this project.

**Keywords:** Riyue Avenue, professional coordination, overall design, new technology, new process

Overall Scheme Design of Ganzhou Golden Avenue Expressway Project ..... Zhan Chao ( 21 )

**Abstract:** The golden Avenue Expressway is an important component of the expressway network system in the central urban area of Ganzhou City. Through the analysis of its functional position, and combined with the traffic demand and forecast, this paper studies the overall scheme and various key nodes of the Golden Avenue Expressway, which provides references for the design of the similar urban expressways.

**Keywords:** expressway, interchange, overall scheme, node scheme

Scheme Design of Connection Interchange on South Bank of Dalian Bay Subsea Tunnel ..... Li Hongping ( 25 )

**Abstract:** Dalian Bay Subsea Tunnel is the expressway to connect the south and the north bank of the bay in the core area of Dalian, and is also an expressway into and outside of the core area. The connection interchange on its south bank is the hub to realize the traffic transformation of the newly built expressway and the road network in the old urban area of Zhongshan District, and will undertake the traffic transformation function of the extension line (expressway) of Shugang Road in the future. This paper comprehensively analyzes the functional orientation of the project, the planning condition of the south bank, the traffic demand and the surrounding construction conditions. On the basis of traffic organization design, this paper introduces the recommended overall scheme of interchange. Based on the combination of the short term and the long term in the scheme, the traffic organizational strategy of "two-stage turnoff, three-way separation" is proposed in the short term, and the three-point collecting and distributing deformed Y-shaped underground interchange is recommended to connect the surrounding road network. Combined with Shugang Road Extension Project, the dicotyledon-shaped ground interchange will be added in the long term to realize the interchange between two expressways.

**Keywords:** subsea tunnel, connection interchange, planning of road network, expressway, Dalian Bay

Study on Scheme of South Taibai Road, East Zhangba Road and Urban Ring Expressway Combined Interchange in Xian ..... Lv Tianhua ( 30 )

**Abstract:** The Xian South Taibai Road, East Zhangba Road and Urban Ring Expressway Combined Interchange is an important node in the expressway system of Xian. This paper introduces the project background, construction conditions, restriction factors and main technical standards, and studies the design scheme of the interchange on the basis of traffic flow prediction and construction scale analysis, and project design scheme, which lay the foundation for the later design and implementation of this interchange.

**Keywords:** urban ring expressway, combined interchange, restriction factor, prediction of traffic flow, overall layout scheme

Type Selection and Layout of Shenzhen Yangangdong Interchange Project ..... Zhang Zhanling, Liu Lifen, Xu Guanghui ( 33 )

**Abstract:** Aiming at more and more crossing situation of multiple expressway network, this paper discusses the multiple traffic functions of interchange designed under the condition of dense road network and limited land, and analyzes the interchange function, road network structure and traffic volume of Shenzhen Yangangdong Interchange Project. Combined with the present boundary conditions of site, the underground pipe network, the surrounding buildings and the environmental landscape, this paper carries out the qualitative and quantitative analysis, and selects the suitable interchange type to make the design not only meet the

use function demand, but also achieve the requirements of beautiful shape, smooth traffic organization and small land scale, and also able to upgrade the operation benefit of road network.

**Keywords:** urban interchange, five-road crossing, interchange modeling, speed-change lane

"Heart of Jiangmen City" – Design of Dongjia Interchange ..... Zhou Peng, Zhang Zhanling, Liu Lifen ( 36 )

**Abstract:** The hub-type interchange is an important means to realize the function of fast traffic transformation in road network. Combined with the construction conditions and traffic analysis of Dongjia Interchange in Guangzhou, Foshan and Jiangmen Expressway, this paper fully demonstrates the traffic function and engineering scale of the node, and puts forward several schemes for comparison and demonstration to ensure the economy and reasonability of the design schemes. The study idea and demonstration process can be referred for the design of hub-type interchange under the complex conditions.

**Keywords:** interchange, scheme design, construction condition, traffic analysis

Study on Collinear Scheme of Expressway at East of Zhishi City and Interurban Railway ..... Zhang Dawei ( 40 )

**Abstract:** The study on the collinear scheme of expressway at the east of Zhishi City and interurban railway makes the both compose the integral cross section under the consistent horizontal and longitudinal alignment condition. This paper discusses the collinear possibility of interurban railway and urban expressway in order to reach the objective of saving the land and beautifying the landscape. Based on the current national regulations and technical standards, this paper compares and analyzes the relevant technical parameters of horizontal alignment index and longitudinal section index of two different traffic modes, optimizes the layout of cross section, analyzes various possible collinear modes and points out that the collinear technology is not only necessary, but also feasible in order to better adapt the development of city, which have the good reference for the similar projects.

**Keywords:** collinear scheme, urban expressway, interurban railway, plane, longitudinal section

Analysis on Design of New Construction Line of Jiangpu Road Cross-river Tunnel ..... Yu Hong ( 43 )

**Abstract:** Owing to the more complex control conditions along two banks of the river for Jiangpu Road Tunnel, it is necessary to comprehensively consider the relationship between the tunnel and the relevant structures combined with the construction methods in the process of scheme design. After the coordination with the multiple parties, and comprehensive considering the construction difficulties, implementation feasibility, scheme cost and construction period, the scheme of tunnel line is determined. The shield scheme is hard to meet the requirements because of the casingsoil problem in river. The original scheme is to adopt the sinking pipe scheme when crossing the Huangpu River. It is found that the sinking scheme of tunnel has the greater



influence on the navigation channel in the implementation of the project, and there are more uncontrollable factors and the implementation risk is higher. It is considered to adopt the shield scheme to cross Huangpu River, and to handle and coordinate with the related structures.

**Keywords:** Jiangpu Road Cross-river Tunnel, east-west channel, Metro Line 14 and Metro Line 18, sinking pipe, shield

Construction of Hankou Railway Station North Square and Its Traffic Organization Scheme ..... Cui Sai ( 46 )

**Abstract:** According to the design of Hankou Railway Station North Square Construction Scheme, this paper studies the traffic space of railway station square in the large cities and solves the functional layout, traffic interchange and auxiliary facilities in the station square in order to form the function of traffic organization mainly and landscape beautifying secondarily, and essentially to satisfy the interchange convenience and comfort of passengers, which provides the effective solving scheme for building the reasonable traffic space of the railway station square.

**Keywords:** Hankou Railway Station, station square, underground space

Analysis on Present Situation and Problems of Setting up Traffic Signs and Markings of Underground Roads ..... Ye Jianliang ( 49 )

**Abstract:** At present, there are still some imperfections in the technical standards and regulations of traffic signs and markings of underground roads in China. Taking 17 typical underground roads in Shanghai and 6 typical international underground roads as the main study objects, this paper analyzes the problems and summarizes the experience in the setup of traffic signs and markings of underground roads in China from the guiding signs in front of underground road entrances, the signs at the entrance, the signs and markings of basic road sections in tunnel, the signs and markings of separating and combining ends in tunnel, and the material qualities of various signs. Combined with the setup of signs and markings of the international underground roads, this paper puts forward the relevant reference, which has a certain reference for the further improvement of the sign and marking setup standards of the underground roads in China.

**Keywords:** underground road, traffic sign, guiding signs, design standard

Study on Overhaul Scheme of Hangzhou Bay Avenue in Jinshan District of Shanghai ..... Lu Kaiquan,Wang Peng ( 55 )

**Abstract:** With the rapid development of traffic volume, more and more roads have been suffered various degrees of damage and need to be overhauled. According to the overhaul engineering case of Hangzhou Bay Avenue in Jinshan District of Shanghai, this paper analyzes and discusses the current situation investigation and inspection, road condition evaluation standard and geometric design principle in the road overhaul

project, and provides the basis for the determination of overhaul design scheme.

**Keywords:** road overhaul, test and inspection, evaluation, overhaul design

Analysis on Road Disease Treatment Scheme of Jingshisan Road in New District of Lanzhou .....

..... Ma Tianbin, He Aicui ( 59 )

**Abstract:** The new district of Lanzhou is the first national-level new area in the northwest China. After six years of development, from the planning to construction until now, the new district has been changed from a badland of the loess plateau to a modern city with brilliance. Because of its location in the loess plateau, the most of roadbed filling materials in these areas are loess (with the different degrees of collapsibility). Through many years of operation, many kinds of diseases will appear on the roadbed and pavement. Combined with the engineering cases, this paper analyzes the disease causes by the technical means of electromagnetic exploration, and puts forward that high-pressure rotary jet grouting pile as the main engineering measures, which has the important reference for the maintenance and treatment of road disease caused by the weak collapsibility of roadbed soil.

**Keywords:** road diseases, investigation of road condition, wave subsidence, collapsible weak roadbed, scheme selection, jet grouting pile

Engineering Application and Elementary Analysis on Modification of Roadbed Stuffing Strength(CBR Value )

..... Wang Jun, Gao Xiang ( 64 )

**Abstract:** The California bearing ratio (CBR) value is an important engineering index to measure the roadbed stuffing strength property. The measurement of CBR value in the construction can effectively guarantee the strength and stability properties of roadbed filling. Combined with a practical project, this paper puts forward the modification scheme of stuffing whose CBR value does not meet the standard requirements. Combined with the factors of technical performance and economic index, this paper analyzes and compares the modification schemes, and gives the final treatment method, and according to the understanding and application method of CBR value in the practical projects, puts forward own undertaking.

**Keywords:** CBR value, limestone soil, depth of roadbed working zone

Consideration on Application of Cement Mixing Pile in Soft Foundation Treatment of Urban Road .....

..... Deng Yanrong ( 67 )

**Abstract:** Soft soil is widely distributed in Zhuhai City. The use of cement mixing pile composite foundation is a common treatment scheme because of the high natural water content, large natural void ratio, low shear strength and high compressibility of soft soil foundation. Taking the application of the cement mixing pile in

an urban road of Zhuhai as an example, this paper summarizes and thinks deeply the selection of design code, quality acceptance items and design process in order to provide the reference for the other project. The design of urban road cement mixing pile composite foundation should be not only based on the urban road or highway foundation standards, but also need to refer to the building foundation and composite foundation standards. The final determination of design parameters needs to three aspects of design, survey and construction feedback each other.

**Keywords:** cement mixing pile, urban road, standard, quality acceptance, dynamic design

Stability Analysis and Application of Bridgehead Treatment in Soft Soil Foundation ..... Wang Linsong ( 71 )

**Abstract:** The application of foam light soil and geogrid in the soft soil foundation is an important technical improvement, and is of great significance to improve the slope stability coefficient, reduce the post-construction settlement, save the land resource and protect the ecological environment. Taking the soft foundation treatment of a bridgehead in Tongtuo County as the study object, this paper calculates the slope stability by the legal copy of Lizheng geotechnical calculation software 6.5PB3, and selects the single HDPE geogird with the ultimate tensile strength of 90 kN/m as the reinforcement material to carry out the reinforcement calculation of fill slope. Based on the design scheme, the minimum safety coefficient of slope is calculated. The slope scheme of the foundation is finally determined after the comparison and selection. The use of geogrid reinforcement and the selection of foam light soil material can improve the stability of fill foundation under the complex topographic condition. At the same time, the reasonable adjustment of reinforcement material can improve the stability of fill foundation slope.

**Keywords:** soft soil foundation, stability, analysis, application

Comparison and Design of CFG Pile and Gravel Pile ..... Long Kai, Wang Hanwei ( 73 )

**Abstract:** Taking Hainan Province Wenchang City Wendong Road Phase II Tender Section B Project as an example, according to the bad roadbed treatment methods provided in the current design code and the relative calculation formula, and combined with the engineering investment, this paper compares and analyzes the roadbed treatment schemes of CFG pile and gravel pile in the thick and soft soil stratum. The treatment effect of CFG pile is better than the gravel pile. The unit price of CFG pile is higher, but the economic effect is more excellent for the thicker soft foundation. The roadbed compactness and deflection value of this project all meet the standard and design requirements after treated. And the service effect is good.

**Keywords:** bad roadbed, CFG pile gravel pile

Application of Old Road Technical Condition Detection and Assessment in “White to Black” Engineering  
..... Xiang Yandong ( 76 )

**Abstract:** At present, in order to improve the driving condition and reduce the noise pollution, the cement concrete pavement (named as the white pavement) is been reconstructing into the asphalt concrete pavement (named as the black pavement) step by step in Shanghai. Before reconstruction, the management and maintenance units are required to master the technical condition of old road, and accordingly adopt the relevant reconstruction scheme. This paper introduces the contents and methods of old road technical condition detection. The application example of the "white to black" in the engineering explains its feasibility and significance.

**Keywords:** "white to black", reconstruction engineering, old road detection, resonance broken, significance

## BRIDGES & STRUCTURES

Overall Construction Scheme of Yellow River Bridge in Shijiazhuang – Jinan Passenger Railway Line .....

..... Gao Yongqiang ( 79 )

**Abstract:** Jinan Yellow River Highway–Railway Bridge is a public bridge for the Shijiazhuang – Jinan Passenger Railway Line Project, the Handan – Changzhi and Handan – Jinan Railway Expansion Reconstruction Project, and the Jinan City "North Spaning" Urban Spatial Development Northward Cross–river Channel. Relying on the construction of Yellow River Bridge for Shijiazhuang – Jinan Passenger Railway Line, this paper discusses the overall construction scheme of location selection, type selection, bridge structure, construction scheme and inspection monitoring in operation period of the large–sized cross–river highway–railway bridge.

**Keywords:** highway–railway bridge, selection of bridge type, construction scheme

Scheme Design of Dalian Changxing Island – Jiaoliu Island Cross–sea Bridge Project .....

Qi Qingxiang ( 83 )

**Abstract:** In order to open up the vital communication line between Changxing Island and Jiaoliu Island in the Dalian Changxing Island Economic Zone, to promote the connection among the Changxing Island Economic Zone and the islands in the Xizhong Island Petrochemical Zone, to achieve the resource complementarity, benefit sharing and construction synchronization, and to solve the traffic dilemma where the distance is no more than 1 km but only across the ocean, the construction of a cross–sea bridge between Changxing Island and Jiaoliu Island is proposed, and the corresponding scheme is designed. The construction of rapid, safe and convenient transportation can promote the further development of the Dalian Changxing Island Economic Zone.

**Keywords:** bridge engineering, cross–sea bridge, urban trunk road, Changxing Island

Overall Design of Main Bridge of Xicungang Cross-sea Bridge in Beihai City ..... Wei Zhipeng ( 87 )

**Abstract:** Xicungang Cross-sea Bridge in Beihai City spans the water area of Xicungang. The total length of this bridge is 1.78 km, in which the main bridge is a double-pylon double-plane composite beam cable-stayed bridge. Its span is arranged by 455.8 m (38.9 m+70 m+238 m+70 m+38.9 m). This paper introduces the scheme design, overall layout and calculation contents of the main bridge, which can be referred for the similar bridges. The calculation result shows that the structural stiffness is high, and various steel structural stresses are less than the standard limits, the deck slab meets the requirements of Class B pre-stressed concrete and the integral stability coefficient has the greater safety, which all meet the standard requirements.

**Keywords:** overall design, cable-stayed bridge, composite beam

Design of Xinlibao Bridge in Shenyang ..... Wang Xiaowei ( 90 )

**Abstract:** The main bridge of Xinlibao Bridge in Shenyang is a 370-m (47 m+80 m+116 m+80 m+47 m) pre-stressed concrete continuous box beam bridge. Its approach bridge is a 35-m span pre-stressed concrete continuous box beam bridge. This paper introduces the overall design of this bridge.

**Keywords:** pre-stressed concrete, box beam bridge, overall design

Design of Rule Lake Bridge ..... Zhou Xihui ( 93 )

**Abstract:** Taking Rule Lake Bridge as the engineering background, this paper introduces the comparison, calculation and analysis of design schemes for this bridge. This bridge is a 410-m (25 m+40 m+50 m+3 × 60 m+50 m+40 m+25 m)-span continuous beam arch composite bridge. The MIDAS Civil software is used to simulate and analyze the V-support arch foot of this bridge. The significant conclusion is achieved. Based on the calculation result, the arch rib of this bridge has the sufficient security under the design load effect, and has a certain capacity of bearing the overload.

**Keywords:** arch and beam combination, bridge design, structure analysis

Comparison of Economical Efficiencies and Stress Performances of Corrugated Steel Web and Concrete Box Beam Bridges ..... Zhou Tao ( 95 )

**Abstract:** In the comparison stage of engineering scheme for a project, the economical efficiencies and stress performances of a corrugated steel web PC composite beam bridge and a traditional PC box-beam bridge are compared. The corrugated steel web PC composite beam bridge can greatly decrease the usage of bridge concrete, save the cost and fully play the performance advantages of two materials. This kind of material has been applied in this project.

**Keywords:** corrugated steel web PC composite beam bridge, steel-concrete composite structure, economical efficiency

Analysis and Detection on Steel-concrete Composite Section of Steel-concrete Composite Continuous Beam Bridge ..... Xu Min ( 97 )

**Abstract:** As a new composite structure, the partial beam section of the main span in the steel-concrete continuous beam bridge is the steel structure to replace the traditional concrete structure in order to reduce the dead load of bridge structure, to increase the spanning capacity and to improve the stress performance of structure. The steel-concrete composite section is the key point in the steel-concrete continuous beam. Taking a steel-concrete continuous beam bridge as the background, this paper establishes the spatial finite element model of the steel-concrete composite section to carry out the local stress analysis, and combined with the detection result of load test of this bridge, analyzes the stress situation of steel-concrete composite section and evaluates its technical conditions.

**Keywords:** continuous beam bridge, steel-concrete composite section, stress analysis, detection and evaluation

Application of Practical Refinement Model in Design of Long-span Cable-stayed Bridge ..... Li Sheng, Liu Bin ( 101 )

**Abstract:** A three-span double-pylon double-plane cable-stayed bridge is a municipal bridge. Its main span is 400 m. The main beam is a mid-span composite beam. The side span is a pre-stressed reinforced concrete box beam. The main pylon is an A-type reinforced concrete and steel pylon composite structure. The upper pylon is 100 m high and the lower pylon is 22 m high. In order to study the structure stress of this bridge, the single-beam model and the beam grillage model of this bridge are established to carry out the simulative calculation and comparison of finished bridge state and to analyze the internal forces and deformations of the structure under various operating conditions. The comparison and calculation results of single-beam model and beam grillage model can show that the stress, stabilization and rigidity of this bridge all meet the standard requirements.

**Keywords:** cable-stayed bridge composite beam, static analysis, dynamic analysis, beam grillage, internal force, deformation

Fine Design of Small-radius Curved Bridge ..... Yang Qingwei ( 106 )

**Abstract:** The small-radius curved bridge is inescapable in the projects. And its fault frequency is higher than the conventional structures. Taking a radius  $R=85$  loop ramp as the background, referring the design

experience of the built curved bridges and combined with the comparison of economy, this paper determines the standard span, preliminary structure and reinforcement. According to the calculation and comparison of single-beam model, beam grillage model and solid model, this paper analyzes the counter force of support, the uneven stresses at the inside and outside, and the horizontal force of support in order to provide the basis for the fine design. The anti-overturning and anti-bending shear checking calculations are carried out according to the new standards. The engineering experience provides the reference for the design of structures.

**Keywords:** small-radius curved bridge, beam grillage model, solid model, fine design

Design and Analysis of Concrete Continuous Curve Box Beam Bridge ..... Li Sen ( 111 )

**Abstract:** Combined with an engineering example, this paper analyzes the mechanical characteristics of curve beam bridge and its influence. The results show that the reasonable setup of support form can improve the mechanical performance of concrete curve bridges and optimize the design of the bridge.

**Keywords:** bending-torsional coupling, curve beam bridge, bearing spacing, bearing eccentricity, bending radius

Calculation and Analysis on Continuous Steel Box Girder of Interchange ..... Wang Kun ( 115 )

**Abstract:** Taking an interchange in the ring expressway of Baoshan City as an example, the finite element analysis model is established by MIDAS Civil software to calculate and analyze the continuous steel box girder structure of an interchange in detail. The checking calculation and analysis of the longitudinal, lateral and support stiffening ribs, the stiffness and the overturning resistance can achieve the conclusion that various indexes all meet the standard requirements. The analysis can provide reference for the design of other similar bridges.

**Keywords:** interchange, steel box girder, continuous beam, finite element analysis

Calculation and Analysis on Anti-overturning Security of Single-pedestal Pier Continuous Box Girder .....  
..... Liu Fangfang ( 119 )

**Abstract:** For the single-pedestal pier continuous box girder bridge, the anti-overturning stability coefficient is usually used as the index to evaluate the anti-overturning capacity of bridge. The anti-overturning stability coefficients have two different definitions. The stability coefficient calculated by the different definition is not the same. The limit overturning live loads of the single-pedestal pier continuous box girder are separately achieved through the two different definitions of anti-overturning stability capacity, which can be referred for the evaluation of anti-overturning security of the same bridge structure.

**Keywords:** single-pedestal pier, continuous box girder, anti-overturning stability coefficient, limit overturning live load

Analysis on Design of Through Bowstring Arch Bridge ..... Yang Shengqi ( 122 )

**Abstract:** Taking the design of a bowstring arch bridge in a river treatment project of Hunan Province as the background, this paper summarizes the technical standards and overall layout of this bridge, introduces the main construction contents and the calculation essentials of its main arch, suspender and main beam, and calculates and analyzes the structural stress of this bridge. The result shows that the design of bridge structure is reasonable and the checking calculation result meets the requirements, which can be referred for the design and calculation of the similar bridges.

**Keywords:** bowstring arch bridge, bridge design, structure calculation

Elementary Analysis on Design and Calculation of Through Bowstring Arch Structure ..... Cai Min ( 127 )

**Abstract:** The through bowstring arch bridge is beautifully and gracefully designed, its construction technology is mature and its application is wide. Taking a waterway bridge as an example, this paper analyzes the structure by a 3D finite element analysis software, and introduces the overall layout of the through bowstring arch, the structural design of main components, the static calculation and the stability analysis of finished bridge. The result shows that the structural dimensions of various main components is reasonably selected, and the stress and stability conditions are ideal, which is a successful application and practice of through bowstring arch bridge.

**Keywords:** through bowstring arch, structural design, stability analysis

Design and Stress Analysis of a Three-arch-rib Bowstring Arch Bridge ..... Li Wenzhi ( 130 )

**Abstract:** In the construction of urban bridges, the three-arch-rib bowstring arch bridge is commonly used for the wider deck and middle partition zone limited by the overall layout of road. Compared with the common two-arch-rib bowstring arch bridge, the three-arch-rib bowstring arch bridge leads to its stress more complex because of the difference of stiffness between the middle arch and side arch in space. Taking a 88-m three-arch-rib bowstring arch bridge as an example, this paper preliminarily analyzes and discusses the key design nodes of three-arch-rib bowstring arch bridge by the methods of finite element integral analysis and local analysis. The analysis result shows that this bridge meets the requirements under the conditions of normal service and suspender cracked by accident, and the structure is safe and reliable.

**Keywords:** three-arch-rib, bowstring arch bridge, key node



Analysis on Effect of Crossbeam Erection Sequence on Longitudinal Beam Stress of Super-wide Long-span Bowstring Arch Bridge ..... Xiao Jinbao ( 134 )

**Abstract:** The tension of the closure steel cable of crossbeam will make the longitudinal beam produce an out-of-plane bending moment because of the crossbeam and longitudinal beam of the ultra-wide bowstring arch bridge respectively prefabricated and hoisted, which will affect the stress of longitudinal beam and cause the difference between the intermediate position stress and the edge position stress at the same section height of the longitudinal beam. This difference is likely to make the calculation of longitudinal beam become a key control node for the calculation of bridge structure. In order to seek a better solution and avoid blindly increasing the section or steel bundle, which will cause a waste of resources, this paper tests several construction procedures from the viewpoint of crossbeam construction procedure according to the background of the new construction project of Huanyang Bridge in Huzhou Economic Development Zone, and tries to find out the most favorable construction procedure of the longitudinal beam stress as the final crossbeam erection sequence of the project, to maximize the reduction of the above stress differences and to achieve the goal of structural design economy and stress rationality.

**Keywords:** bowstring arch, super-wide, long span, crossbeam erection, longitudinal beam stress

Brief Introduction on Design of Special-shaped Steel Structure Arch Bridge ..... Lu Jun ( 139 )

**Abstract:** Taking an urban 97.8 m-span half through special-shaped steel structure arched cross-river bridge as an example, this paper introduces the design technical standard, structural design, construction process, structure calculation and other contents of this bridge, separately introduces the arch ring, main girder, suspender and substructure in the aspect of structure design, and analyzes the calculation model, permanent design state and seismic design situation in detail. This bridge completely shows the abundant spatial dimension and the flexible curve form with the good landscape effect. The structure calculation and optimization design have the appropriate reliability and better economy.

**Keywords:** special-shaped, steel structure, arch bridge

Static Load Test of Steel Structure Bowstring Arch Bridge ..... Fang Shiwei ( 142 )

**Abstract:** MIDAS/Civil analysis software is used to establish the finite element model of a steel structure bowstring arch bridge. A scheme for the static load of steel structure bowstring arch bridge is formulated. The test section, measuring point, loading position, loading condition and loading weight are determined. The stress and deflection of each test section are tested and analyzed under the static load, and compared with the theoretical value so as to know whether or not the practical working state of bridge structure meets the design requirements under the test load.

**Keywords:** steel structure bowstring arch bridge, static load test, MIDAS, strength, stiffness

Study on Design Method of Anchorage Frame for Steel Bridge Pier under Seismic Action . . . Zhang Dawei ( 146 )

**Abstract:** The anchorage between the steel bridge pier and the concrete base slab is the key position designed for the steel bridge pier. In order to verify its design rationality, this paper describes the local design of this position, and studies the design of the anchorage between the steel bridge pier and concrete base slab under the seismic action by the combined mode of overall finite element model and local finite element model. The result shows that the stress level of steel structure at the anchorage is lower under the seismic action, and the separation will be caused between the grouted concrete and the pressure-bearing steel plate because of too big tensile stress. The calculation shows that the anchor bolt between the steel bridge pier and concrete base slab combined with anchorage frame is reliable in the force transmission, and the structure is safe and reasonable.

**Keywords:** steel bridge pier, anchorage frame, anchor bolt, seismic design

Anti-seismic Analysis of Irregular Multi-span Long Continuous Girder in High Intensity Earthquake Region .....

..... Mai Zihao ( 149 )

**Abstract:** In order to study the anti-seismic performance of a multi-span long continuous girder bridge in high intensity earthquake region by the different anti-seismic schemes, taking the main (36+4 × 60+36)-m continuous girder bridge of Beixi Bridge as the background, this paper adopts the different composite schemes of traditional pot bearing, high and low damping pencil lead bearing, and cable bearing, and establishes the finite element model of the whole bridge by the Midas Civil 2017 software in order to compares the seismic responses of the different bearing layout schemes in the rare earthquake action.

**Keywords:** anti-seismic bridge, multi-span long continuous girder, pencil lead bearing, cable bearing

Seismic Response Analysis of a Continuous Rigid-frame Bridge under Non-uniform Excitation .....

..... Wang Ping ( 152 )

**Abstract:** Considering the traveling wave effect, the seismic response of a continuous rigid-frame bridge under non-uniform excitation is analyzed, and the calculation result is compared with the seismic input under uniform excitation. The analysis shows that the internal force and displacement of the key positions are increased more obviously under non-uniform excitation and traveling wave effect than the seismic input under uniform excitation, which indicates that it is necessary to analyze the seismic response of bridge under non-uniform excitation.

**Keywords:** continuous rigid-frame bridge, non-uniform excitation, traveling wave effect, seismic analysis of bridge

Calculation of Internal Force of Hole-side Beam by Reverse Construction Method ..... Huang Chunmei ( 156 )

**Abstract:** The horizontal structure in the reverse construction method is required to meet the requirements of bearing capacity and deformation in the construction stage and service stage at the same time. The horizontal structure is in the double-way stress state of horizontal pressure stress and vertical bending stress in the construction stage. And considering the factors of excavated outlet, altitude difference and different construction methods, its stress state is extremely complex. For a long time, the horizontal structure in the reverse construction method is all analyzed through the engineering experience, which is bad for the projects. This paper analyzes the distribution of internal force of excavated hole-side beam very concerned in a project, and introduces the practical internal force calculation formula of hole-side beam.

**Keywords:** deep foundation pit, reverse construction method, hole-side beam

Mechanical Analysis on Cantilever Construction of Long-span Corrugated Steel Web Composite Box Girder .....

..... Xu Tianhua ( 159 )

**Abstract:** Taking a 13-span corrugated steel web continuous girder bridge as an example, this paper studies two key mechanical issues of temperature effect and stress state in the cast-in-cantilever construction process of corrugated steel web composite box girder bridge by the practical monitoring method and the finite element numerical simulation method. The study result shows that the atmosphere temperature change can cause the girder body to produce the non-neglectful displacement in the cast-in-cantilever construction process of corrugated steel web composite box girder bridge. The longitudinal normal stress of concrete top slab and baseplate presents the uneven distribution in the construction process, but the shear stress of web is evenly distributed and is not basically affected by the pre-stressing application.

**Keywords:** corrugated steel web composite box girder, cantilever construction, temperature effect, shearing force lag

Design and Construction of Long-span Small-radius Variable-width Three-span Variable Cross-section Pre-stressed Concrete Continuous Girder ..... Zhou Yanfeng, Wang Lixin, Zheng Jiyan, Shi Xianfei ( 163 )

**Abstract:** Loujiang River Bridge is a (83+145+83)-m three-span variable cross-section pre-stressed concrete continuous box-girder bridge on the waterway of Loujiang River. It has the characteristics of large-span small-radius variable width structure. The conventional construction schemes are difficult and risky. In this project, the segment cantilever pouring construction of form traveler is adopted for the middle span and the bracket segment cast-in-place construction is adopted for the edge span, which successfully solves the of design and construction problems of long-span small-radius variable-width three-span variable cross-section pre-stressed concrete continuous girder bridge under the continuous navigation conditions. It is

proposed to use the beam grillage model or spatial mesh model as an added checking calculation. The empirical coefficient used for the spatial beam element model is further checked and calculated after amendment.

**Keywords:** long-span small-radius variable width, design, construction

Application of Pile Foundation Underpinning in Ordos Avenue Bridge Extension Project .....  
..... Wang Xuesong, Li Yanna ( 167 )

**Abstract:** Combined with the demonstration and implementation of the pile foundation underpinning technical scheme for Ordos Avenue Bridge Extension Project, this paper sets forth the relative influence factors and the relevant solving measures of pile foundation underpinning. The preliminary planning and design of pile foundation underpinning should strive to have the globality, foresight and feasibility, can effectively solve the conflicting problems between the old and new structure foundations in this extension project, should pay attention to the process control of engineering design and construction, and synthesize the multidisciplinary technological superiority and technical means. The application of pile foundation underpinning technology has achieved the good engineering effect in this project.

**Keywords:** pile foundation underpinning, synchronized jacking, extension project

Analysis and Study on Diseases of Continuous Girder Bridge Based on Detection Result ..... Chen Mengda ( 170 )

**Abstract:** This paper firstly sets forth the present situation of cracking and the causes of diseases of the variable cross-section continuous girder bridge, and introduces the significance of complete and further detection before the bridge reinforcement, which provides the intuitive and critical evidence for the calculation and analysis of the disease causes. Then taking a failure bridge as the background, this paper describes the detection result and preliminarily analyzes the crack causes, and on this basis, analyzes the stress status of the present structure. This paper specially explains the deficiency of bearing capacity and the extent of overstressing from the viewpoints of bearing capacity and stress in order to know the main cause of cracking. The process analysis can provide the significant guidance for the design of reinforcement scheme of the similar box girder structures.

**Keywords:** box girder, cracking, detection, bearing capacity, cause analysis

## FLOOD CONTROL & DRAINAGE

Study on Design Scheme of Rainwater and Sewage Pumping Station for Pudong International Airport Phase III Project  
..... Chen Zhongyuan ( 174 )

**Abstract:** The design standard and design method of the relevant drainage project in the airport construction will directly influence the safety operation of airport. Combined with the construction of Shanghai Pudong International Airport Phase III Project, this paper sets forth the partition of rainwater drainage system and sewage drainage system, the reasonable utilization of regulating space of drainage channel of rainwater drainage system, the reduction of design scale of rainwater pumping station and the reasonable design of sewage pumping station in detail. The engineering scheme not only reduces the engineering scale, but also improves the environmental benefit and social benefit of the project.

**Keywords:** airport engineering, rainwater pumping station, sewage pumping station, design scheme

Discussion on Design of Sponge City Scheme in Sewage Pumping Station Project .....

..... Li Zhiyuan, Yang Lili, Zheng Boyi ( 178 )

**Abstract:** The design idea of "sponge city" is integrated into the design of sewage pumping station. Taking a sewage pumping station project as an example, this paper introduces the setup of low-impact development facility – low elevation greenbelt and permeable pavement in order to meet the requirement of annual runoff control rate and annual runoff pollution control rate in the project, which provide the reference for the "sponge city" design idea to be applied in the similar projects of sewage pumping station.

**Keywords:** sewage pumping station, sponge city, low-impact development, annual runoff control rate, annual runoff pollution control rate

Application of HEC-RAS Model in the Flood Control Project of Mountain Rivers ..... Mao Qianqian ( 181 )

**Abstract:** Aiming at the complex characteristics of river regime change in the mountain river, and taking the design of Beixi City Area River Flood Control Project as an example, the HEC-RAS software is used to establish one-dimensional hydrodynamic model for the simulation of the measured terrain in the mountainous area and the flood flow profile under the condition of water buildings existing along the river. The original flood control projects are rechecked, the optimization design measures are proposed and the river flood discharging capacity is improved, which provide a basis for the design of flood control projects of mountain river with the complex section form.

**Keywords:** HEC-RAS model, flood control engineering, flow profile, mountain river

Study on Design of Subgrade Treatment for Sluice Wing Wall ..... Zhou Ya ( 185 )

**Abstract:** The baseplate of sluice wing wall for a project is located in the mucky silty clay layer. After calculation, the bearing capacity of subgrade for retaining wall, the overall stability safety coefficient and the base stress ratio do not meet the standard requirements. Three subgrade treatment schemes of

cement-soil mixing pile, precast pile and cast-in-place pile are compared. The referenced standard shows that the current national standard and the local standard of Zhejiang Province have not explicitly given the calculation method of shear strength indexes of the composite subgrade after the treatment of cement-soil mixing pile. Therefore, based on the related data, the cement-soil sticky cohesion 100 kPa and the internal friction angle 20° are taken for calculation. The selection of cement-soil mixing pile scheme can improve the subgrade soil quality and can make the subgrade bearing capacity and integral stability meet the requirements. But the base stress ratio of retaining wall could not be substantially solved. After the comparison of structures, the selection of precast pile and cast-in-place pile schemes are all feasible. According to the comprehensive consideration from the construction time, cost and construction quality, the front sheet pile and rear square pile treatment scheme of precast pile is adopted for the retaining wall, which can be referred for the design of the similar projects.

**Keywords:** soft soil subgrade, sluice wing wall, cement-soil mixing pile, precast pile, cast-in-place pile

## MANAGEMENT & CONSTRUCTION

Study on Soil-stone Filling Technology for High-fill Area of Municipal Road ..... Li Mengxi ( 190 )

**Abstract:** Taking a high-fill subgrade filling of Songkun Road (K18 + 900 - K19 + 800) as an example, this paper analyzes the first-phase preparations and technical control essentials of soil-stone filling construction, which can be referred for the construction management of soil-stone filling subgrade.

**Keywords:** soil-stone filling, impact rolling compaction, high fill

Brief Analysis on Rationality of Road Overhaul "Whiter to Black" Regulation Scheme ..... Li Jinhua ( 192 )

**Abstract:** In the design of the road "white to black" overhaul regulation engineering project based on the construction requirements, there are often the situations of the cement concrete pavement in the good condition and the structural strength meeting the requirement. At this moment, according to the road maintenance technical specification and standards, it is hard to determine whether this road should be converted from white to black. In order to improve the rationality of the "white to black" regulation scheme used in this kind of project design, this paper puts forward this concept of "road environment index" selectively to be introduced into the analysis and evaluation of pavement condition.

**Keywords:** cement concrete pavement, "white to black", rationality of regulation scheme, pavement condition index, pavement structural strength index, "road environment index"

Economic Analysis on Selection of Facilities for Life Security Protection Engineering of Highway - - - Yu Di ( 197 )

**Abstract:** The life security protection engineering of highway has been carried out in various regions, improved the security level of highway, strengthened the security basis of highway and perfected the traffic security environment of highway. However, there is a relative lack of study on how to select the facilities for the life security protection engineering especially from the economic viewpoint. Taking the G312 Wuxi Section as an example, this paper sets forth the selection principle of traffic security facilities, and carries out the economic and quantitative analysis on two facilities of traffic sign reflective film and road traffic marking, which provide a theoretical basis for the implementation of highway life security protection engineering.

**Keywords:** highway, security, life security protection engineering, traffic security facilities, economic analysis

Study on Measures to Improve Pile Foundation Quality of Maogang Bridge .....

..... Wang Tonghua, Gan Lu ( 200 )

**Abstract:** Maogang Bridge is a three-span Variable-height Steel-concrete Composite Continuous Beam Bridge. Its total length is 265 m. The cast-in-place pile is used for this bridge. The diameter of pile foundation is 1.2 m. The pile length is 64 m. In order to improve the quality of finished pile foundation, the excellent standard is proposed on the basis of standard requirements. According to the statistical analysis of pile foundation quality, the determination of "hole diameter and "hole depth" cannot reach the excellent standard and is the crux of the low good rate of pile foundation. Four factors of "old drill", "too fast drilling speed", "reverse circulation alone not able to meet the requirements of hole cleaning" and "high sand content in situ mud" are the essential factors not up to the excellent standard. The 5W1H method is adopted to formulate the countermeasures of "updating the drill equipment in time", "controlling the drilling speed", "adopting the artificial pulping" and "increasing the sand removing machines". The quality of finished pile foundation is improved and the good rate is obviously promoted through the filed implementation and inspection.

**Keywords:** cast-in-place pile, quality of finished pile foundation, hole diameter, hole depth

Analysis on Application of Lifting Construction Support System for Old Yonglongyong Bridge in Foshan – Jiangmen Expressway .....

..... Li Shenghua ( 203 )

**Abstract:** According to the lifting construction support system of old Yonglongyong Bridge in Foshan – Jiangmen Expressway, this paper compares and discusses the lifting schemes and support methods of bridge, introduces the stress checking calculation of support system, and defines the key control essentials of lifting construction support system.

**Keywords:** lifting of old bridge, support system, application analysis

Study on Key Technology of Pipe-jacking Construction in Complex Stratum of Yellow River Flooding Area ·····

····· Su Jun ( 207 )

**Abstract:** The strata in Yellow River Flooding Area are mostly deposited silt and mealy sand. The mealy sand stratum is mostly sandwiched with calcareous nodules, commonly known as the pulp stones. The spewing, jacking pressure surge and poor excavation of pipe jacking are of common occurrence in the construction of this stratum, and seriously affect the normal construction of pipe jacking. Combined with the construction of Tender Section 1 in Zhengzhou New Area Wastewater Treatment Plant External Trunk Sewer Project as a case, the effective muck modification of deposited silt and mealy sand is implemented to be convenient for the slurry transport and also for the reduction of tool wear and to improve the construction efficiency. The variation of jacking force is larger because of the thixotropic slurry in the mealy sand mixed with a large number of pulp stones in the stratum. The efficient thixotropic slurry has been developed and its anti-drag effect is better. A large number of pulp stones block the slurry draining pipe, and are deposited at the soil outlet of screw conveyor, which seriously restrict the efficiency of pipe-jacking construction. The simple crushing device has been invented to improve the transport efficiency.

**Keywords:** Yellow River Flooding Area, pipe jacking, muck modification, thixotropic slurry, crushing device

Elementary Discussion on Post-grouting Technology of Cast-in-place Pile and Its Application in Zhengzhou Ring Line III Expressway Project ····· Li Yongzhi, Wu Jidong ( 210 )

**Abstract:** This paper introduces the development situation, application scope and function mechanism of cast-in-place pile post-grouting technology. Taking Zhengzhou Ring Line III Expressway Project as an example, this paper introduces the static load test, construction technology, grouting parameter and technical requirement of this technology, and meanwhile explains its economic benefit by the engineering data. The vertical compression bearing capacity of cast-in-place pile is greatly improved after the use of pile foundation post-grouting technology. The pile length can be shortened or the pile diameter can be decreased at the same requirements of bearing capacity, which greatly reduce the engineering cost.

**Keywords:** post-grouting, function mechanism, grouting parameter, static load test

Control and Grouting Treatment Technology of Concrete Structure Crack ····· Xu Peili ( 215 )

**Abstract:** This paper briefly analyzes the concrete crack cause, crack control measures, other measures taken in the design and construction, and the common treatment methods of concrete crack. Taking the crack treatment of box culvert and tunnel engineering as an example, this paper introduces the grouting treatment



technology. The result shows that the appearance cracks at the crack inspection site basically disappear, meeting the standard requirement. The drilling and coring detection are carried out subsequently. The original cracks are fully filled and compacted. The appearance effect is good. The compression test of core also meets the design requirements, and the expected objective is achieved.

**Keywords:** concrete crack, crack cause, control, measures, grouting

Analysis and Maintenance of Hinge Joint Disease of Fabricated Hollow Slab Girder ..... Sheng Lingli( 218 )

**Abstract:** The hinge joint performance of fabricated hollow slab girder will directly influence the whole working performance of slab girder. More attention should be paid to this kind of disease in the process of bridge inspection and maintenance. This paper summarizes the apparent disease caused by the failure of hinge joint, analyzes the causes of hinge joint failure and puts forward the maintenance method of hinge joint.

**Keywords:** hollow slab girder, inspection and maintenance, apparent disease, maintenance of hinge joint

Discussion on Design and Construction Problems of Maintenance Channel Reconstruction Scheme for Main Girder Side Span Weight Zone of Guanhe River Bridge in Yancheng ..... Gao Naixiang ( 221 )

**Abstract:** The Guanhe River Bridge in Yancheng is a large steel-concrete composite beam cable-stayed bridge operated for more than 10 years in the coastal expressway of Jiangsu. There is no similar precedent to add a fixed maintenance channel on this kind of bridge in Jiangsu Province. Combined with the reconstruction design scheme of the maintenance channel for this large bridge, this paper introduces the design thought and idea of the maintenance channel of this bridge, discusses some problems existing in the design and construction. The achievements can be referred for the similar bridges.

**Keywords:** overlarge bridge, maintenance channel, maintenance, saddle weight

Analysis on Typical Diseases of Old and New Spliced Bridges on Soft Soil Foundation ..... Wang Lidong ( 225 )

**Abstract:** This paper introduces the significance and the commend methods to widen and reconstruct the old bridges, analyzes the differential settlement between the old and new bridges caused by the change of external environment and from this the caused typical diseases by an example of an old and new spliced bridge on the soft soil foundation in Shanghai, introduces the tracking monitoring of bridge settlement trend, and puts forward the reasonable treatment proposal. The formulation of the old bridge widening and reconstruction scheme should not only consider various present design and construction factors, but also consider the problems possibly caused in the later operation stage. All the work should be done well according to the relative laws, standards and regulations, and the operation safety of bridge should be ensured.

**Keywords:** soft soil foundation, widening of old bridge, splicing, disease analysis, settlement

Study on Comprehensive Treatment Scheme of Inverted Arch Cracking in Wuzi Mountain Tunnel .....

..... Wang Kejun ( 228 )

**Abstract:** Based on the investigation of the cracks in the inverted arch of Wuzi Mountain Tunnel of Tianyong Expressway, and analysis of the crack causes, this paper comprehensively considers four aspects of dewatering drainage, foundation reinforcement, lining structure strengthening and pavement reinforcement of the tunnel, and formulates the inverted arch crack treatment scheme. And the in-tunnel convergence and vault settlement deformation are monitored during the implementation of the scheme. The result shows that the tunnel inverted arch crack treatment scheme formulated according to the above four aspects is reasonable and feasible. After the tunnel is treated according to the scheme, the development of tunnel cracks is effectively inhibited, which provides a guarantee for the safe operation of the tunnel in the later stage. It also provides valuable reference materials for the formulation of the similar engineering treatment schemes.

**Keywords:** tunnel engineering, disease of inverted arch, treatment scheme, monitoring measurement

## STUDY ON SCIENCE & TECHNOLOGY

Analysis of Soil Disturbance Caused by Tunneling of Double-circle Shield Tunnel (DOT) in Soft Soil Stratum .....

..... Chen Xiaoliang, Zhou Songguo, Zhu Shiyu ( 232 )

**Abstract:** DOT has the characteristics of special section and relatively large excavation area. Its tunneling will cause the larger disturbance of stratum. And too large soil disturbance usually leads to a series of environmental diseases. Relying on a DOT project of metro in Shanghai, 3D elastic-plastic finite difference model is established to calculate and analyze the distribution of surface displacement field and soil mass stress field caused by DOT tunneling. The calculation result of the numerical model and the field monitoring data are compared and verified. The study results show that the transverse distribution of surface deformation caused by the DOT construction is basically in line with the normal distribution. And the influence area is mainly concentrated in the 2 times of the shield width on both sides of the axis. At the time of the incision, the surface of the earth is raised, while the rear soil mass is sinking after the shield tail leaves. The longitudinal settlement of the ground surface is stabilized gradually from 20 rings. The influence of shield tunneling on the lower soil is relatively small, the earth pressure at the bottom of the shield is the minimum and the earth pressure increment is the maximum in the upper part of the axis in shield. The study results can provide some theoretical basis and prophase guidance for the similar projects in the future.

**Keywords:** soft soil stratum, double-circle shield tunnel (DOT), surface settlement, earth pressure distribution, finite difference method

Analysis on Mechanical Performance of Precast Assembled Pervious Concrete Sidewalk Slab .....

..... Huang Ming, Wen Xuejun, Lu Hewei( 237 )

**Abstract:** Recently, the assembly technology has made great progress. It is a fire-new direction to apply the pervious concrete in the prefabricated form in the sidewalk. Based on traffic load, hoisting demand and technical economy, four experimental mixing ratios of prefabricated pervious concrete for sidewalk slabs are proposed. The basic mechanical characteristics of pervious concrete are determined by the void ratio, apparent density, compressive strength and flexural strength tests, and the strength grade of concrete is determined. The mechanical property at the most adverse position is determined through the mechanical calculation of hoisting process. Finally, the reinforcement scheme is proposed and the safety factor of concrete hoisting based on test gradation is calculated.

**Keywords:** precast assembled, pervious concrete, sidewalk, mechanical properties

Study on Vibration Reduction Isolation Performance of Anti-vibration Bearing Based on ANSYS-UM Joint Simulation .....

..... Liang Wenwei, Zhong Yuping, Wang Yong ( 241 )

**Abstract:** The train will make a huge vibration as it passes over a bridge. The vehicle-induced bridge vibration is transmitted to the bridge pier through the bearing, and then transmitted to the foundation and the surrounding environment through the pier and finally to cause the vibration pollution of environment. The ANSYS software and UM software are used to establish the vehicle-line-bridge coupled vibration system in order to carry out the vehicle-bridge coupling joint simulation. The calculation achieves the dynamic response data of beam bottom and pier at the connection of bearing when the ordinary ball bearing and the new vibration reduction ball bearing are respectively used. The results show that the vibration isolation effect is obvious when the vibration of the upper part of bridge is transmitted to the pier by using the vibration reduction ball bearing.

**Keywords:** vehicle-line-bridge coupled vibration, joint simulation analysis, vibration reduction bearing vibration, dynamic response, vibration reduction isolation

Influence of Sounding Pipe on Integrality of Pile Body Inspected by Acoustic Transmission Method .....

..... Yang Bijiang ( 245 )

**Abstract:** As the main component bearing the upper load of construction engineering (industrial and civil construction engineering, bridge engineering), the quality of foundation pile will directly affect the overall safety and service functions. At present, the acoustic transmission method of engineering pile foundation is one of common inspection methods for the integrality of pile body, and has the preponderant characteristics for the inspection of the integrality of the pile body with the longer length and lager diameter. This inspection

method is required that the inspection capacity and of equipment and the availability of data collection are very important in the field inspection. In addition, the installation and preparation of sounding pipe as the inspection channel are directly related to the success of the inspection. The examples explain the result of its influence, the influence of installation of sounding pipe and shortcoming of pipe on the waveform of acoustic transmission method, and the supplementary verification method.

**Keywords:** foundation pile, acoustic transmission method, integrality inspection of pile body, sounding pipe

Study of Sound Velocity Correction Coefficient in CECS 02 Standard ..... Dong Yu ( 251 )

**Abstract:** In order to revise *Technical Specification for Concrete Strength Detection by Ultrasonic Rebound Method* (CECS 02:2019), the ultrasonic sound velocity correction coefficient  $\beta$  in the current *Technical Specification for Concrete Strength Detection by Ultrasonic Rebound Method* (CECS 02:2005) edition standard is systematically tested. The study shows that the relationship between the measured sound velocities on the side – side and the top – bottom surfaces of the concrete does not exist in the correction coefficient  $\beta = 1.034$  stipulated in the current CECS 02:2005. At the same time, the ratios of measured sound velocity on the side and top surfaces, and the side and bottom surfaces of concrete achieved by the test data are no more than 2%, that is, when the top or bottom surfaces of concrete pouring stipulated in the current CECS 02:2005 standard are measured, the representative value of sound velocity in concrete of tested zone is rather large, and should be corrected by  $\pm 5\%$ .

**Keywords:** ultrasonic inspection, sound velocity, correction coefficient

Study on Influence Factor and Application of Nitrogen and Phosphorus Removal by Struvite Method .....

..... Zheng Jun( 254 )

**Abstract:** The struvite ( $MgNH_4PO_4 \cdot 6H_2O$ ) method can realize both removal and recovery of nitrogen and phosphorus pollution in the wastewater, and has the engineering utilization potentiality. This paper introduces the current study on the factors influencing the reaction of struvite formation and the struvite technological system, and analyzes the utilization potentiality of struvite. The struvite reaction influencing factors are mainly the ion concentration and ratio, pH, reaction time, reaction temperature and foreign ion. The application study of struvite is mainly focused on the optimization design of technological system structure and the strengthening trapping measures of struvite product.

**Keywords:** struvite, nitrogen removal, phosphorus removal

Analysis and Application on Synthetic Slope of Super-elevation Transition Section of Highway ... Song Shilei ( 258 )

**Abstract:** When a highway is designed in accordance with the current specifications and standards, the

synthetic slope of the general section and the full super-elevation section can all meet the requirements. But the synthetic slope of super-elevation transition section is ignored usually. As a result, the waterlogged sections of the existing highways are mostly at the curves, which affect the traffic safety. Therefore, the calculation method and influencing factors of the synthetic slope are analyzed theoretically, and the application of the synthetic slope is analyzed.

**Keywords:** highway, super-elevation transition ratio, super-elevation transition section, synthetic slope

Experimental Research on Molding Method of Large-grain Large-porous Asphalt Mixtures ..... Gao Xiang ( 261 )

**Abstract:** The road performances of large-grain large-porous asphalt mixtures are significantly affected by molding temperature and compaction numbers. In order to determine the indoor molding method of MAC modified asphalt large-grain larger-porous asphalt mixtures, the softening point test is firstly used to analyze the effect of heating temperature on the softening point test result of MAC modified asphalt and to recommend the heating temperature of MAC modified asphalt. Then the large Marshall Compaction Test is used to analyze the effect of compaction numbers on the volume indicators of large-grain large-porous asphalt mixtures. The test results show that softening point growth trend of MAC modified asphalt is first rapid and then slow at the temperature node of 195℃ with the increment of heating temperature. With the increment of compaction number, the bulk-volume relative density of large-grain large-porous asphalt mixture is firstly increased and then decreased, and accordingly the void ratio is firstly decreased and then increased. All reach the extreme values at 112 compaction numbers. The asphalt heating temperature of 195℃ and the compaction numbers of 112 times are recommended as the indoor molding method of large-grain large-porous asphalt mixtures.

**Keywords:** large-grain large-porous asphalt mixture, molding method, molding temperature, compaction numbers

Aging Performance and Regeneration Technology of RAP Material ..... Min Tianyi ( 264 )

**Abstract:** Considering the pavement asphalt bearing the load pressure aging, ultraviolet ray light aging and temperature heat aging at the same time under the natural condition, this paper proposes the synthesis simulation aging test of asphalt on the basis of the single factor aging testing method of asphalt in *Testing Regulations of Asphalt and Bituminous Mixture for Highway Engineering*. The asphalt penetration and ductility are reduced, and the softening points are increased after laboratory synthesis simulation aging. This paper introduces the recovery method, grading design and regeneration function of RAP material, and studies the difference of four different RAP material regeneration technologies.

**Keywords:** RAP, aging performance, regeneration technology, preparation technology

Influence of Cracks on Safety Performance of Concrete Barriers .....

..... Liu Rui, Chen Jiulong, Gao Jianyu, Gong Shuai, Wang Yuan ( 267 )

**Abstract:** The influence of cracks on the safety performances of the 280 KJ single-slope and F-type slope reinforced concrete barriers and 520 KJ composite barriers are calculated and analyzed by the finite element simulation method. The test section of the cracked 280 KJ single-slope and F-type slope reinforced concrete barriers, and 520 KJ composite barriers, and the test section of 520 KJ fiberglass reinforced concrete barriers are set up. The real vehicle crash test is sued to further analyze the influence of cracks on the safety performance of concrete barriers. The study result shows that concrete barriers are discontinuous at the cracks, but the existence of concrete longitudinal and vertical reinforcements makes the integral safety capacity of the barriers as the longitudinal continuous structure not yet weakened. Therefore, the cracks of concrete barriers have little influence on its integral safety performance.

**Keywords:** crack, concrete barrier, fiberglass reinforced, safety performance, finite element simulation, real vehicle crash test

Study on Depth and Construction Quality Control of Gravel Subgrade Working Area in Low Filling and Shallow Excavation Section .....

..... Guo Yanjun ( 272 )

**Abstract:** This paper discusses the geotechnical parameters and strength performance of gravel subgrade stuffing in low filling and shallow excavation section. According to the characteristics of loose material, the ratio of additional load stress to dead weight stress of subgrade is calculated numerically based on ABAQUS finite element software. The working area depth of gravel subgrade under overload and multi-axis loading is analyzed in depth. It is found that the range of subgrade under standard axle load is 10~20 cm deeper than that under current specification, and the overload will have more adverse effect on the gravel subgrade than the change of axle shape. The modulus of subgrade has a certain effect on the depth of working area, but too large modulus has no obvious effect on improving the subgrade stress environment, but it should strictly meet the design modulus of resilience of the top surface of subgrade. This paper points out that the compactness index is not suitable for the quality control of gravel subgrade construction. From the viewpoint of ensuring the basic functions of subgrade deformation resistance and bearing capacity, a double-index control method and corresponding standards based on settlement difference of key points in subgrade cross-section and FWD linear inversion modulus are established. The dynamic inversion modulus and the static resilience modulus measured by the bearing plate are analyzed and compared. This paper puts forward the modulus correction coefficient convenient for the application in the construction of gravel subgrade.

**Keywords:** gravel, subgrade working area, overload, construction quality, settlement difference, FWD

Experimental Study on Hole Sealing Device of Pipe Curtain in Soft Soil Stratum ..... Zheng Jie ( 276 )

**Abstract:** The hole sealing water stop is an important link in the construction technology of pipe curtain box culvert method. The sealing performance and the water stop effect will be related to the propulsion of pipe curtain, construction of box culvert and settlement control of surrounding stratum. Taking Tianlin Road Subway underpassing Middle Ring Line as an example, this paper sets forth the hole sealing used in this project and its action, and on this basis, introduces the design of hole sealing device and the research and development of the supporting new type of macromolecule polymer slurry in order to verify the effects of the new hole sealing device and high-performance slurry. The experimental study shows that the new type of high-performance slurry can play a better water-stop role under 0.6 MPa ambient pressure, and there is a little overflowing of slurry between the pipe curtain. This experimental study can be referred for the hole sealing construction in the soft soil stratum, and also prove the feasibility of hole sealing water stop device by the pipe curtain box culvert construction method used in the deeper soil stratum.

**Keywords:** pipe curtain box culvert method, hole sealing device, water-stop performance, new type of macromolecule slurry

## APPLICATION OF ACHIEVEMENTS

Application of CFD Simulation Technology in Design of Main Structure of Full-enclosed Acoustic Barrier in Caidian Line of Wuhan Metro ..... Chen Hang ( 280 )

**Abstract:** With the wider and wider application of the full-enclosed acoustic barrier in the urban rail transit projects, how to reasonably design the main structure type of full-enclosed acoustic barrier is very important. The wind tunnel experiment is the mainstream test to measure the effect of piston wind resistance for the main structure of acoustic barrier in recent years, and the CFD simulation technology is the theoretical basis for the wind tunnel experiment.

**Keywords:** CFD simulation technology, rail transit, full-enclosed acoustic barrier

Flexible Application of a Fast Elevation Encryption Method in Municipal Engineering ..... Hu Qinhu ( 283 )

**Abstract:** The traditional municipal surveying method has been hard to meet the working demand of the current social municipal encryption survey in the roadbed and pavement construction because of its low work efficiency and many constraints. The modern surveying and mapping technology guarantees the accuracy of municipal engineering surveying work to some extent and provides the elevation requirements in real time, and solves the defect of the traditional municipal engineering survey hard to provide the coordinate and elevation in

real time. Both the traditional and modern surveying technologies play an extremely important role to provide the control point in the large-area and long-range local area. But after the engineering construction comes into the construction stage, the particularity of engineering construction and the long period of construction make the construction layout of construction stage, especially the fast encryption work of elevation be under a difficult circumstance. Therefore, a "set square" is researched and developed to provide the encryption elevation method, which can better solve the disadvantage of both traditional and modern survey methods hard to quickly provide the accuracy and elevation. The "set square" is used to encrypt the elevation at an optional position between two points and to decrease the multifarious procedure of the ordinary level gage when the elevation point is encrypted. The popularization and the successful application of the "set square" in the engineering speed up the construction progress, improve the engineering quality and achieve the good economic and social benefits.

**Keywords:** "set square", encrypting elevation, quality, progress

Application of Vibration Compaction Method in Mix Ratio Design of Cement Stabilized Macadam .....  
..... Yang Guohong ( 287 )

**Abstract:** The cement stabilized macadam is a common material in pavement base. The vibration compaction of inorganic binder stabilized material is used to design the mix proportion of cement stabilized macadam. This paper introduces the design principle method and characteristics of vibration compaction test for the cement stabilized macadam mix ratio by the Hangzhou – Shaoxing – Taizhou Expressway Project.

**Keywords:** cement stabilized macadam, vibration compaction test method, optimum moisture content, maximum dry density, unconfined compressive strength

## THE RELATIVE SPECIALITIES

Analysis on Cross-section Form of Super-large Span Underground Channel of Airport Road in Yiwu .....  
..... Lin Xiaochen ( 290 )

**Abstract:** Taking the Yiwu Airport Road Underground Channel Project as an example, this paper analyzes and compares the possibly adopted section forms, and analyzes the parameters influencing the structure stress, i.e. arch height of folded plate, width of folded plate and dead weight of folded plate. The result shows that the stress is more reasonable and the economy is higher for the super-large span about 25 m underground channel project when the arch height of folded plate is 2.5 m, the width is 5.0 m and the thickness of folded plate is 1.2 m. The achieved result can be referred for the design of the similar projects.

**Keywords:** underground channel, section form, straight-wall folded plate arch, super-large span



Design of Underground Excavated Working Shaft of Station in Soft Soil Region ..... Tang Xiang ( 294 )

**Abstract:** In order to solve the contradiction of metro station construction and urban traffic congestion, the pipe-jacking method is adopted in the area under the section of Middle Yanan Road at Jingan Temple Station of Shanghai Metro Line 14. This paper introduces the structural design scheme of the large-section pipe-jacking working shaft at Jingan Temple Station. The composite wall-type frame system of construction supporting beam and temporary concrete diagonal bracing is adopted to carry out the level underpinning of headwall structure in order to solve the contradiction of unable combination and setup of the level frame beam in construction stage and the floor slab in service stage. And 3D finite element analysis is adopted for the verification.

**Keywords:** pipe-jacking working shaft, buttress column, construction supporting beam, underpinning, finite element analysis

Design and Analysis on Floating Resistance of Urban Underground Tunnel ..... Zhou Qianru ( 298 )

**Abstract:** This paper firstly analyzes the theoretical basis of anti-floating checking calculation of underground tunnel from the viewpoint of anti-floating calculation theory, then summarizes the anti-floating checking calculation steps from the theoretical basis, and finally analyzes an example of the anti-floating checking calculation of Guimiao Road Tunnel in Nanshan District of Shenzhen to achieve the calculation methods commonly used in the practical projects, which provide the corresponding reference for the checking calculation of the anti-floating stability of the relative urban underground tunnels.

**Keywords:** underground tunnel, underground load, anti-floating, anti-floating pile

Analysis and Research on Value of Vehicle Load in Underground Structure ..... Xu Jianbao, Liu Mingtao ( 301 )

**Abstract:** Through the analysis on the vertical force generated by vehicle load under the different overburden conditions, the calculation method of equivalent force of the vehicle load in underground structure is clarified. By analyzing the mechanism of the horizontal force exerted by vehicle load on the underground retaining structure, the value of vehicle load in underground retaining structure is discussed.

**Keywords:** underground structure, vehicle load, vertical force, horizontal force

Elementary Analysis on Layout Planning of Urban Underground Utility Tunnel .....

..... Zhang Wenzhong, Jiang Ke ( 305 )

**Abstract:** Taking Changzhou as an example, this paper further analyzes the demand of its pipelines into the utility tunnel from the present situation of the municipal pipeline system in Changzhou, and uses the multifactor superposition method reasonably to determine the layout system of urban utility tunnel in

Changzhou.

**Keywords:** utility tunnel, pipelines into utility tunnel, layout planning

Calculation and Analysis on Metro Station Structure Constructed Together with Electric Power Tower .....  
..... Wang Yan ( 309 )

**Abstract:** Combined with a metro station constructed together with an electric power tower, the Midas Gen is used to establish a 3D integral model for calculation and analysis. The calculation result shows that the structure type of "separation and combined construction" used for the metro station and the electric power tower is feasible, the bearing capacity and crack width of the structure all meet the standard requirements, and the deformation meets the requirements of vertical settlement control value. The calculation and analysis results can be referred for the similar projects.

**Keywords:** metro station, electric power tower, combined construction, analysis of internal force, deformation analysis

Design and Analysis on Engineering Enclosure of Foundation Pit Adjacent to Metro ..... Xu Tieou ( 312 )

**Abstract:** The environmental protection is higher required for a foundation pit adjacent to a metro tunnel. This paper introduces the subarea excavation method of a foundation pit used for the protection of metro tunnel. The single-block excavation area is controlled in a place near the metro, and the cast-in-place pile enclosure is used so as to decrease the influence on the metro. The numerical simulation data and the engineering measured data are compared and analyzed. The results are closer. The influence of foundation pit excavation on the surrounding environment meets the standard requirements. The design of foundation pit enclosure has achieved the good implementation effect in the foundation pit engineering practice of protecting the surrounding metro, which can be referred for the similar projects.

**Keywords:** adjacent metro, foundation pit engineering, subarea excavation

Analysis on Parking Demand of Metabolic Disease Hospital Removal Construction Project of Tianjin Medical University ..... Meng Weiwei, Luo Ruiqi ( 316 )

**Abstract:** Taking a practical project as an example, and based on the actual data of the project, this paper divides the hospital staff into three groups of outpatient and emergency patients, visiting personnel and staff. According to the needs of all kinds of constituent personnel, the parking spaces are predicted, the travel characteristics and parking characteristics of each group are analyzed, and the parking demand is calculated, which provides the reference experience for the future prediction of hospital parking demand.

**Keywords:** transportation system engineering, demand analysis, parking characteristics, mode sharing rate, travelling volume

Influences of Different Aging Conditions on Performances of High-viscosity SBS Modified Asphalt ..... Ji Shuzhen ( 319 )

**Abstract:** Several different ageing modes are used to age the high-viscosity SBS modified asphalt, and the fluorescence microscope technology is used to compare and analyze the asphalt specimens before and after aged. A series of related microscopic parameters are achieved by the images after MATLAB and image-plus processing calculation. The loss ratio of SBS after the short-term aging is 77.7% (RTFOT) and 69.8% (TFOT) respectively, and the loss ratio of SBS after the long-term aging is 84.7% (RTFOT+PAV) and 85% (TFOT+PAV) respectively. At the same time, this paper compares and studies the macroscopic indexes of high-viscosity SBS modified asphalt. The macroscopic performances of high-viscosity SBS modified asphalt will be obviously different by two aging modes of TFOT and RTFOT. The aging degree of the asphalt by RTFOT aging mode is higher than TFOT. This kind of difference still remains after the long-term aging.

**Keywords:** high-viscosity SBS modified asphalt, aging, fluorescence microscope, SBS phase area ratio, macroscopic index

Treatment Measures for Sliding Slope of Foundation Pit in Collapsible Loess Area ..... Wei Feng ( 322 )

**Abstract:** The collapsible loess is widely distributed in the northwest regions of China. As a kind of special soil, it is prone to strength failure under the influence of external load and rainfall. In view of this, taking a sliding slope of loess foundation pit in Lanzhou as an example, this paper introduces the application of the treatment measures of brushing slope + solid steel pipe pile + soil nail, and verifies the rationality of this reinforcement measures through the numerical simulation method. The results can provide the effective reference experience for the treatment of the similar engineering slopes in the similar areas.

**Keywords:** collapsible loess, foundation pit, sliding slope, treatment measures

Analysis on Application of PVsyst Software in Photovoltaic System ..... Huang Xufeng ( 326 )

**Abstract:** The calculation of generating capacity of the photovoltaic (PV) system is the important basis to design and optimize the photovoltaic system. But there are many problems in the traditional method of PV system capacity calculation. In order to solve the problems, this paper analyzes the feasibility of PVsyst software for calculation and puts forward the solution of calculation through the PVsyst software.

**Keywords:** photovoltaic system, generating capacity, PVsyst

Elementary Analysis on Exploration and Practice of Landscape Standardization in Zhangjiang Science City ..... Dong Zhiwei ( 330 )

**Abstract:** In order to upgrade the public green space construction level of Zhangjiang Science City, the refined management objective is achieved. From the design, construction and maintenance of three dimensions of standardization, and cooperated with the management system of landscape standardization, the exploration and practice of landscape standardization can make the landscape standardization implemented. Finally, this paper summarizes a set of public green space engineering management method suitable for Zhangjiang Science City.

**Keywords:** Zhangjiang Science City, landscape standardization, green space grading system, practice and application, management system

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