

城市道桥与防洪

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城市隧道与地下空间协同建设模式及技术研究

中华人民共和国住房和城乡建设部优秀期刊

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目 次

道路交通

站城一体化的高铁车站客流特征及规划要点 池 磊(1)

上海普通干线公路与城市道路网衔接规划设计策略研究 龚柳青(5)

福州市城区骨干路网快速化提升方案研究 杨 骞(9)

海南环新英湾地区综合交通发展与规划思路 付跃龙(14)

济宁市济曲快速路总体方案设计 秦方方(19)

敦煌市花雨路总体设计方案 张伟强, 童景盛, 李文栋, 曹苏陇(26)

上海市杨高路改建工程总体方案研究 张欣婷(30)

奥体立交交通节点改造方案研究 刘 明, 赵 凡(34)

长沙市金星北路、腾飞路与地铁 4 号线立交节点方案研究 吴 栋, 禹 伟, 黄 佳, 曹 彬, 门玉宝(38)

主辅道出口与相交道路的交通组织研究 曾菲圆, 段俊锴, 何剑荣, 王周全(43)

共享单车在山地城市道路的适应性研究 杨 进, 龚华凤, 赵聪霄, 肖 洁, 刘 芳(46)

自行车专用路设计要点分析 葛 诚(52)

基于以打造文旅开发为主的风景道路设计要点浅析 王万鹏(58)

浙江省单建式地下停车场设计研究 张建红, 方 浩(61)

沙漠公路风积沙台背回填技术研究 王金国, 孙跃轩, 杜 洋, 李瑞杰, 张利军, 王进宏(67)

建筑垃圾在城市道路修筑中的再生利用——以温岭市某城市支路为例 朱庆浩, 吴运立, 候 尧(70)

湿陷性黄土地层市政道路改扩建路基差异沉降现场试验研究 王志强(74)

桥梁结构

异形岔道梁桥有限元分析与抗倾覆研究 郭太军, 薛瑞杰, 何 鹏(77)

独塔斜拉桥的抗震分析及减隔震措施研究 马军伟(82)

简支预制槽形钢混组合梁在城市桥梁中的应用 张利平(87)

斜跨拱桥的受力分析及斜拉索布置方式比选 庞有贵(91)

兴隆76路中承式异形钢管拱桥总体设计 梅 宇(95)

赣州楼梯岭大桥跨江通道总体设计 康卉锦(100)

宽幅钢箱梁若干设计要点研究 李泽霖(104)

钢结构景观人行桥梁高和铺装对人行致振动和阻尼器设计的影响 张 笑(110)

中美规范防落梁搭接长度比较与参数分析 李守胜(114)

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复杂环境小半径桥梁设计选型及施工方案研究 严 搏(118)
基于文化生态学的城市桥梁景观设计 王鹏举,董 辉(121)

防洪排水

不同措施在城中湖水环境治理中的效能分析——以武汉市
武昌区沙湖为例 闫爱萍,王 浩,吴 思(124)
海绵城市建设效果评价方法研究
..... 刘 标,姜家良,赵 芳,艾庆华,付 雄(128)
北京市京新沙阳路桥积水点治理方案研究
..... 冯朝阳,邓卫东,葛学伟,林宏军(132)
地道桥雨水泵站原位升级改造设计 卢文凯(136)
中心城某雨水泵站及初雨调蓄池提质增效探索
..... 钱 露(140)
平原河网地区某片区污水管网排查实践及整治对策分析
..... 吉 驰,李奕岍(144)
排水管网测量在城镇排水系统病害排查和诊断中的应用
..... 谢宏桥,田 旦(148)
玻璃防汛墙在苏州河上的应用思考 翟 晶(153)
AO 工艺处理工业污水的运行研究
..... 孙文博,孙文刚,孙虎平(156)

管理施工

深厚软土区基坑施工对临近地铁隧道影响分析
..... 熊永华,裴启涛,程文健,杨兴闯(160)
软土地基深基坑拉森钢板桩支护关键技术研究——以北洋
泾路为例 施伟东(165)
建筑密集区城市快速路上跨高铁转体桥方案优化研究
..... 肖华裕(170)
小曲率半径盾构隧道施工中辅助油缸千斤顶推力计算模型
研究 袁 红(173)
不间断运营的地下通道改扩建技术研究 高 扬(179)
装配式混凝土结构在竹园污水处理厂四期工程建设中的
应用 李明杰(183)
小跨径圬工板拱加固设计与施工方法研究
..... 陈 锋,徐文豪(186)
智慧工地平台在超大基坑群工程管理中的应用
..... 薛烨烨(189)
浅析城市桥下空间综合利用的思路和方法 刘 茗(193)

科技研究

基于文献计量的步行交通研究现状与趋势分析
..... 姜 恒,郭淑霞(196)
老城区交通微循环的双层规划模型 蒋 宏(202)
行人激励荷载下大跨径异形天桥抗震支座设计研究
..... 孙良凤(206)
钢混组合梁力学性能的研究 张宏云(210)
降雨强度对透水沥青混凝土净污能力影响研究
..... 吴建兵,陈子恺(214)
SBS 沥青胶浆的黏附性及混合料抗水损性能研究
..... 郭仪南,肖嘉庆,底江天,龚修平,胡 航(220)
砭砂岩遇水失稳对公路影响试验研究 缙振国(224)
矿物掺合料对复合注浆材料性能优化研究 张 移(229)

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抗冰添加剂改性乳化沥青黏结料稳定性研究 刘 杰,王志宏,潘岳林,刘 进(234)

沥青再生过程中界面新旧沥青混溶成效对混合料疲劳性能的影响 崔 宇,徐腾飞,韩方元,贾小龙(238)

SBS 改性沥青老化过程性能预测方程研究 江舒扬,祁文洋,王利俊(241)

共振碎石化路面有限元分析及优化设计研究 洪 莹(244)

成果应用

基于 BIM 模型的桥梁力学分析融合应用研究 孟祥荫,元 宇(248)

BIM 技术在地下污水厂结构设计中的应用 王子豪(252)

装配式水泥混凝土道面在机场抢修中的应用 吴世涛,乔 栋(258)

液压提升式缆载吊机在恰纳卡莱大桥中的应用 赫 勇(263)

多波束测深系统在河床变化分析中的应用 付盈盈(266)

RAP 精细化油石分离技术及其工程应用 朱 磊,张 扬,唐 伟,庄 园,李 宁,王德玉(270)

相关专业

城市隧道与地下空间协同建设模式及技术研究 孙 立,赵 光,黄 俊,李 奥,杨 奎,董 飞(274)

地铁与上盖超地下室共建基坑围护设计研究 丁宇能,张 扬(279)

合肥花园大道隧道总体方案设计 张 伟(283)

城市大断面浅埋暗挖隧道施工与既有建筑物的响应分析研究 毛化冰,张 涛,张 文,郑召怡,王 晓(286)

城市隧道火灾报警系统潜在问题分析及优化 辛奇峰(292)

软土超深基坑开挖对紧邻结构影响分析 南文文(298)

多层桩锚支护深基坑开挖全过程数值模拟 王 胜,李陆海,黄俊文(304)

危险废物刚性填埋场工艺设计要点探讨 施孟帕,曹伟华,王艳明(310)

上海市临港新片区绿化土壤质量评价 王华栋(314)

水利设计企业“十四五”战略发展思考和实践 疏正宏(319)

政策规范

贯彻落实党的二十大精神 谋划加快建设交通强国未来五年重点工作——《加快建设交通强国五年行动计划(2023—2027年)》解读 (322)

常任理事单位名单 (前插2)

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编委成员单位名单 (目次2)

封面工程 (目次3)

《城市道桥与防洪》杂志投稿须知 (目次28)

广告索引

广 1 上海陈政市政工程有限公司(封 2)

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广 3 《城市道桥与防洪》杂志公益广告(封 3)

广 4 青岛润邦防水建材有限公司(封 4)

广 5~27 《城市道桥与防洪》杂志(补白)

封面工程

本期封面工程为广东省韶关市曲江大道工程,由广东省建筑设计研究院有限公司设计,中铁七局集团有限公司施工。

曲江大道工程功能定位为城市主干路,设计车速 60 km/h,道路红线宽 60 m,路线全长约 5.941 km,是韶关市曲江区与芙蓉新城和旧城中心区重要的联系通道,在统筹曲江融入韶关主城区,实现韶关“三区融合”一体化发展中发挥着重要作用。

韶州大桥是曲江大道关键控制性工程,跨径组合为 33 m+102 m+183 m,为三跨连续半漂浮钢混组合梁结构体系。桥梁全宽 44.5 m,为国内同类型桥梁桥面最宽的独塔斜拉桥;主塔为拱形主塔,塔高 109.5 m,为国内独塔斜拉桥中最高的拱塔;塔柱线形顺桥向、横桥向分别为直线、多曲线,整体为组合线形。

曲江大道工程获得中国公路建设领域最高工程质量奖——李春奖,相关研究课题获得广东省市政行业协会科学技术一等奖,相关技术获得 16 项国家专利。工程建设中有创新工法 4 项,并取得软件著作权 1 项。

曲江大道工程于 2018 年 8 月完成设计,2021 年 7 月完成施工。

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Urban Roads, Bridges & Flood Control

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CONTENTS

ROADS & COMMUNICATION

Passenger Flow Characteristics and Planning Essentials of High-speed Railway Stations with Station-City Integration CHI Lei (1)

Abstract: With the rapid development of railway construction in China, the new round of high-speed railway station planning and design have been gradually introduced into the development concept of "integration of stations and cities" and been paid more attention to the spatial and traffic links between "stations" and "cities", which bring the new problems to the planning and design of high-speed railway station buildings. The characteristics of high-speed railway stations in the era of 4.0 are sorted out and summarized. And the traffic characteristics and development trends of various passenger flows in high-speed railway stations under the development mode of "station-city integration" are analyzed including the problems that need to be focused and solved in planning and construction. The solutions are proposed.

Keywords: integration of station and city; station-city integration; pedestrian traffic; high-speed railway station

Study on Planning and Design Strategy of Connection between Ordinary Trunk Highway and Urban Road Network in Shanghai GONG Liuqing (5)

Abstract: With the development of peripheral new cities, main urban expansion areas and new towns in Shanghai, the boundaries between the urban and rural areas are becoming increasingly blurred. The difference between the residents in urban-rural areas and urban areas is becoming smaller and smaller in the travel characteristics, travel quality requirements and the other aspects. Some ordinary trunk roads can no longer meet the growing demand of urbanization traffic. Under the new land spatial planning background and the premise of strict control of the total amount of construction land, it is urgent to optimize the connection and integration modes of ordinary trunk roads and urban roads in the suburb of Shanghai. Through sorting out the current situation of the connection between ordinary trunk roads and urban roads in Shanghai, focusing on the problems such as the inappropriate location of the current connection points and the mismatched design of the facilities before and after the connection points, and according to the traffic characteristics of different districts in Shanghai, the design requirements for the connection between ordinary trunk roads and urban roads are discussed from the aspects of layout connection, functional connection and standard connection.

Keywords: ordinary trunk road; urban road; urbanization; connection design

Research on Rapid Upgrading Scheme of Urban Trunk Road Network in Fuzhou YANG Qian (9)

Abstract: The "spatial agglomeration" effect of the ultra-large and large cities brings the huge pressure to the urban traffic system. The rapid upgrading of urban road is an effective solution. The urban development stage and urban road network form of Fuzhou are very typical. The rapid methods of the trunk road network in

Fuzhou are studied. The construction development situation of the trunk road network in Fuzhou is analyzed. Combined with the site survey and traffic big-data analysis, a rapid upgrading scheme of road network system is put forward. And the efficiency of the overall scheme is analyzed from adding 2.5 rings, north expanding Ring III, speeding up Gongye Road – Guohuo Road and the other aspects.

Keywords: road design; expressway; traffic bid data; road network planning

Comprehensive Traffic Development and Planning Ideas for Xinying Bay Area in Hainan FU Yuelong (14)

Abstract: Xinying Bay Area in Hainan is the core bearing area of the integrated development strategy of Danyang in Hainan Province. Relying on the national port logistics hub – Yangpu Port and adjoining towns, the area has the characteristics of typical port–industry–city integration development. Based on the regional characteristics, a comprehensive analysis is conducted on the problems and development situation of the transportation system around the Xinying Bay Area, and the transportation demand is classified and scientifically calculated by layer. Based on the principles of connection, integration, collaboration and support, taking the external transportation system, internal road system and freight system as the main contents, and taking into account the needs of the city, population and industries, the comprehensive transportation development plan suitable for the regional coordinated development is formulated, which provides the solid support for the regional social and economic development.

Keywords: Xinying Bay Area; port collecting and distributing; port–industry–city integration; transportation planning

Overall Scheme Design of Jiqu Expressway in Jining QIN Fangfang (19)

Abstract: Take the overall scheme design of Jiqu Expressway in Jining as an example, and based on the collinear characteristics of urban expressways, national highways and provincial highways in urbanization areas, the demonstration method and process of function orientation, service object, route scheme, traffic demand analysis and other aspects of the project are introduced. The cross–section layout, key node design and public traffic organization of the project are analyzed and discussed. The design essentials of the collinear roads are summarized. The design fully embodies the design concept of intensification, people–oriented and green traffic, which can be referred for the relative projects.

Keywords: urbanization expressway; collinear road; intensification

Overall Design Scheme of Huayu Road in Dunhuang
..... ZHANG Weiqiang, TONG Jingsheng, LI Wendong, CAO Sulong (26)

Abstract: Huayu Road is an important part of the "one horizontal" in the "nine–horizontal and fourteen–vertical" road network of Dunhuang City. The road grade is the urban trunk road, which is located in the south of the main urban area of Dunhuang City. In recent years, with the gradual southward development of Dunhuang City and the rapid growth of Dunhuang tourism, the construction of Huayu Road has become urgent. In combination with the terrain, landform, land nature, urban planning and urban development along Huayu Road, the vertical and horizontal, important nodes and landscape schemes are introduced.

Keywords: urban trunk road; vertical and horizontal; important nodes, landscape scheme

Study on Overall Scheme of Shanghai Yanggao Road Reconstruction Project ZHANG Xinting (30)

Abstract: Aiming at the project background and functional orientation of Shanghai Yanggao Road Reconstruction Project, the construction form of the short–term scheme combined with the long–term scheme is used for the reconstruction and expansion of Yanggao Road. The overall design scheme of South Yanggao Road (Longyang Road Interchange – West Gaoke Road), Yanggao Middle Road (Luoshan Road Interchange –

Middle Ring Interchange) and Yanggao Middle Road (Middle Ring Interchange - Jinhai Road), and the design scheme of interchange nodes are expounded. The design schemes play the promoting effects of adapting the new traffic pattern in the new district, accelerating the reform and opening up again, alleviating the current congestion, upgrading the service level, perfecting the road network system, facilitating the communication among Inner Ring, Middle Ring and Outer Ring, and improving the travel conditions and traffic environment of residents along the line.

Keywords: urban road; overall design; interchange design; node

Study on Reconstruction Scheme of Traffic Node for Olympic Sports Interchange LIU Ming, ZHAO Fan (34)

Abstract: The Olympic Sports interchange is located near the Olympic Sports Center of Guangdong Province. It is an important transportation hub in the east of Guangzhou. It can connect Guangzhou, Foshan, Dongguan and Shenzhen in the east-west direction, and connect Baiyun Airport and the southeast area of Guangzhou in the north-south direction. It is responsible for the traffic transformation of urban trunk roads such as Guangyuan Expressway, Chebe Road, the north extension of Chebe Road and Daguan Road, the ring expressway and the second expressway of Guangzhou New Baiyun International Airport. The scheme is very important for the road network function of the southeast area of Guangzhou. Based on the existing traffic function of the Olympic Sports Interchange and combined with the prediction of traffic flow, the existing interchange of Olympic Sports is upgraded and reconstructed. Also the schemes are compared and selected for the important nodes, and the design scheme is optimized.

Keywords: interchange; reconstruction of traffic nodes; functional orientation; scheme comparison

Study on Interchange Node Scheme of North Jinxing Road, Tengfei Road and Metro Line 4 in Changsha
..... WU Dong, YU Wei, HUANG Jia, CAO Bin, MEN Yubao (38)

Abstract: Taking the interchange node to be built of Metro Line 4, North Jinxing Road and Tengfei Road in Dazehu Area of Wangcheng District in Changsha City as the research object, according to the planning, previous design experience, department opinions and expert suggestions, and combined with the actual situation, four comparative schemes of bridge and tunnel are proposed for the main road expressway of Jinxing Road. After the comprehensive comparison and selection, the framing tunnel scheme is adopted, which is unanimously recognized by all relevant units. The reference and experience are provided for the subsequent municipal road, bridge, tunnel and subway interchanges.

Keywords: scheme design; interchange node; subway; bridge tunnel

Research on Traffic Organization of Main and Auxiliary Road Exits and Intersecting Roads
..... ZENG Feiyuan, DUAN Junkai, HE Jianrong, WANG Zhouquan (43)

Abstract: With the rapid development of urbanization and the increasing traffic volume, the locations of the main and auxiliary road exits and intersecting roads in urban roads have the great impact on the regional traffic organization. Taking the main and auxiliary road exits of the two roads as the actual cases, through the different traffic organization forms and measured data for the qualitative and quantitative analysis, and by using VISSIM simulation model for data analysis, the traffic capacity and traffic efficiency of the main and auxiliary road entrances and exits under the different traffic flow and different traffic organization conditions are comparatively studied, and the traffic organization schemes under the different traffic flows, distances between the exits and intersecting roads are put forward.

Keywords: traffic organization; traffic engineering; main and auxiliary road exits; VISSIM

Research on Adaptability of Shared Electric Bikes on Mountainous City Roads

..... YANG Jin, GONG Huafeng, ZHAO Congxiao, XIAO Jie, LIU Fang (46)

Abstract: As a better travel choice for the last kilometer, the shared electric bike has the higher potential travel needs in the large road grade of mountainous cities because of its good power and convenience. However, as an emerging mode of travel, there is still no relevant research now on the shared electric bike whether or not to adapt the mountainous cities and the mountainous urban roads how to adapt and promote the development and popularization of shared electric bike. To fill in the research blank in this field, the travel safety of users is improved, the popularization of shared electric bikes is promoted in the mountainous cities and the planning layout of shared electric bike in mountainous city is optimized. Through the methods of questionnaire survey, field test and big-data operation analysis, the information and data of cycling experience, cycling preference, road gradeability and travel distribution of sheared electric bike users are analyzed. It is believed that the shared electric bike cycling experience of users on sidewalk is generally inferior to the cycling experience on roadway. In road planning and design process, combined with the situation of way right of on-site road, the safe bicycle lane should be set on the roadway as far as possible. The shared electric bikes can climb on mountainous urban roads with a slope less than 12%. But when the slope is more than 11% , the cycling speed is greatly affected. It is recommended that the maximum longitudinal slope of roadway with cycling lanes should be controlled within 11%. The electric bike users mainly choose the routes according to the travel purposes, and prefer to ride on broad main and secondary roads. It is suggested that commuting cycling lanes should be placed with main and secondary roads when the slope is less than 11%. Considering the characteristics of mountainous city roads, the equipment of shared electric bikes should be added and improved, such as adding the reflectors and the brightness of taillight at night.

Keywords: shared electric bikes; mountainous city; green travel; gradeability

Analysis on Design Essentials of Dedicated Bike Road GE Cheng (52)

Abstract: In recent years, the green and low-carbon traffic is the international development tendency, and is the developmental consensus in the world. The green traffic development is being greatly promoted in China. The green and low-carbon traffic system is perfected and demonstrative project of green traffic is built. The project of the dedicated bike road from Huilongguan of Changping to Shangdi of Haidian in Beijing has been constructed. According to the design concept of the safe and comfortable travel environment, convenient and efficient traffic efficiency and people oriented, it rapidly becomes a road of "internet popularity" after the road is open for operation, and is highly recognized by the general public and public opinion at home and abroad. At present, the relevant norms and standards are not perfect in China. The design essentials are systematically sorted out, analyzed and summarized through the engineering practice of the dedicated bike road from Huilongguan of Changping to Shangdi of Dinghai. Aiming at the design essentials of the dedicated bike road, the traffic demand analysis of dedicated bike road, selection of key alignment indexes, hierarcical classification of intersection design principle and marking guidance system, and the design thinking of supporting assistance system, parking facilities, rest station, supervisory control, broadcast, counting and help alarm intercom system are described in detail, especially the selection of key alignment indexes. The relevant norms at home and abroad are sorted out and listed.

Keywords: dedicated bike road; alignment; intersection; guidance system

Brief Analysis on Design Essentials of Scenic Road Based on Development of Cultural Tourism
..... WANG Wanpeng (58)

Abstract: With the rapid development of tourism, the advent of the era of self-driving tour and the vigorous implementation of the strategy of building a powerful transportation country the integration of transportation

and tourism has become the trend of the times. The single traffic function of road can no longer meet the needs of tourism-oriented urban development. Thus, it is particularly important to create a comprehensive high-quality scenic road integrating the traffic, culture, landscape, ecology and recreation, and make it a linear tourism that is different from the traditional wall type scenic areas. Based on the example of Kaifeng Kailiu Road Widening and Reconstruction Project, the design essentials of scenic road are briefly analyzed, and the functional orientation, section scale, presentation form, and the short-term and long-term combination of key nodes are discussed in detail in order to provide design ideas of scenic road with the cultural tourism development as the main purpose.

Keywords: scenic road; planning and design; cultural tourism

Brief Discussion on Design and Research of Single-building Underground Parking Lot in Zhejiang Province ZHANG Jianhong, FANG Hao (61)

Abstract: Aiming at the problem of parking difficulty in cities, taking Zhejiang Province, which is economically developed, as the background, and combined with the existing standards and norms, the specific design ideas and methods are put forward. At the same time, the single-building underground parking lot is analyzed from the aspects of policy supports, practical needs, social influences and design essentials so as to provide the reference for the design of the subsequent similar projects.

Keywords: compact car; single-building; underground parking lot; design

Research on Backfilling Technology behind Aeolian Sand Abutment on Desert Highway WANG Jinguo, SUN Yuexuan, DU YANG, LI Ruijie, ZHANG Lijun, WANG Jinhong (67)

Abstract: Aiming at the difficulty of backfilling behind culvert abutment on the desert expressway, combined with the characteristics of the engineering environment in the rich aeolian sand of desert area, the key technology of backfilling behind the aeolian abutment is studied. The best compaction method and the rolling processes of backfilling behind the aeolian sand abutment are evaluated by testing the influence of two rolling processes under the hydraulic sprinkling and compaction method of one static press of road roller + one vibration press and one static press of the bulldozer + one finish of the scraper on the compaction degree behind the aeolian sand abutment, and the influence of two rolling processes of non-rolling by water sinking method or one static press by loader on the compaction degree behind the aeolian sand abutment. The stability behind the aeolian sand abutment is evaluated by using the overloading method to preload the section behind the abutment and to observe its settlement value. The study result shows that compared with the water sinking method, the watering rolling method only needs to wet the surface aeolian sand. Its water consumption is less than one tenth of that of water sinking method, and its economic benefits are remarkable. Compared with the rolling process of the bulldozer static press once + the scraper truck receiving the light once, the method of one static press of road roller + one vibration press is low in mechanical resource demands. Moreover, it can meet the needs of continuous operation and the construction efficiency is remarkable. In addition, the stability of backfilling behind the Aeolian sand abutment by this method is good, and the differential settlement risk behind the abutment is reduced. At the same time, the water damage can be greatly avoided because of the Aeolian sand material with the good water permeability.

Keywords: desert highway; aeolian sand; backfill behind abutment; vibrating dry pressing method; compaction degree

Recycling of Construction Wastes in Urban Road Construction for Wenling City ZHU Qinghao, WU Yunli, HOU Yao (70)

Abstract: In recent decades, the global production of construction wastes has increased significantly, and the

recycling of construction wastes has become a worldwide problem of global concern. Based on a branch road in Wenling City, a series of laboratory tests are carried out to evaluate the feasibility of using the aggregate recycled from the construction wastes for the urban road subgrades. The results show that the construction wastes have the characteristics of high strength and remarkable stability after simple treatment, and further illustrate that it is feasible to use these materials for urban road subgrade. It is further to explain that it is feasible to reuse these materials for the urban road subgrades. There are some reference values for reasonably and effectively promoting the application of the recycled aggregates from the construction wastes in road subgrade.

Keywords: construction waste; recycling; sustainable development; urban road subgrade

Field Experimental Study on Differential Settlement of Municipal Road Reconstruction and Expansion Subgrade in Collapsible Loess Stratum WANG Zhiqiang (74)

Abstract: Relying on the Shuozhou South Ring Road Reconstruction and Expansion Project, the field experimental analysis method is used to study the law of differential settlement deformation of the municipal road reconstruction and expansion subgrade in the collapsible loess stratum. The result shows that before the whole subgrade soil filling is completed, the most important part is the foundation compression deformation. The foundation settlement still increases after the completion of subgrade soil filling, but the velocity slows down and it is mainly the subgrade consolidation settlement, which can provide a scientific basis for the selection of design and construction schemes of the reconstruction and expansion projects.

Keywords: reconstruction and expansion; differential settlement; field test; collapsible loess

BRIDGES & STRUCTURES

Finite Element Analysis and Anti-overturning Research of Special-shaped Turnout-beam Bridge GUO Taijun, XUE Ruijie, HE Peng (77)

Abstract: In order to ensure anti-overturning stability of the special-shaped turnout-beam bridge with overhanging beams, and combined with an engineering example, four structural measures such as setting overhanging beams are adopted. Midas Civil 2021 is used to establish the full bridge grillage model and the full bridge plate element model, and the models are analyzed and compared. The overturning failure mechanism of the span structure is analyzed. And the practical anti-overturning calculation method is proposed. The study results show that the calculation accuracy of grillage method for this kind of bridge can meet the requirements of engineering application. The bending failure of the overhanging beam and B turnout root is the final stage and prerequisite of bridge overturning. The shorter the overhanging beam, the greater the anti-overturning moment provided. All four structural measures adopted in this design can effectively improve the anti-overturning stability of structure. The safety factor is 10.1, larger than 2.5, which meets the specifications. The basis and reference can be provided for the anti-overturning optimization design of the similar bridges (i.e. reducing the number of overhanging beams and adjusting the structural size of overhanging beams).

Keywords: special-shaped turnout bridge; old bridge utilization; overhanging beam; anti-overturning stability; failure mechanism; calculation method; grillage method

Analysis and Study on Seismic Resistance and Isolation Measures of Single-pylon Cable-stayed Bridge MA Junwei (82)

Abstract: For the long-span cable-stayed bridges, there are many influential factors on the seismic calculation. It is required to base on its own characteristics for the special study. Taking Minpu Bridge III in

Kunyang Road as the study object, the response spectrum method and time-procedure analysis method are used to compare and analyze the structural seismic response of semi-floating single-pylon cable-stayed bridge. The suitable seismic wave and damping parameters are selected. Under the E2 earthquake, the time-procedure analysis method is used to analyze two different stress systems before and after the bad shear of the vertical restraint support between the pylon and beam. The result shows that the main pylon supports bear the large horizontal force for the vertical restraint system before the bad shear of support. The displacement at the top of the main pylon and the longitudinal displacement at the end of the main girder are all large for the vertical activity system after the bad shear of the supports. Aiming at the scheme characteristics of long-span single-pylon cable-stayed bridge, the composite system of seismic mitigation and absorption is used to greatly reduce the longitudinal stress of pylon bottom and also to control the vertical displacements of the pylon top and beam end within the reasonable range, which is the ideal seismic isolation restraint system.

Keywords: single-pylon cable-stayed bridge; semi-floating system; seismic analysis; preset shearing force of support; composite system of seismic mitigation and absorption

Application of Simple-supported Precast Channel-section Steel Concrete Composite Beam in Urban Bridges ZHANG Liping (87)

Abstract: In the urban viaducts, the steel-concrete composite structure beam bridge is widely used abroad because of its high structural strength, fast construction speed, simple maintenance and other advantages. At present, this type of bridge is the main bridge type of urban viaducts in Europe and America. But there are no many composite structural bridges under construction in China. Taking a bridge project in Taiyuan, Shanxi Province as the background, the design of precast channel-section steel-concrete composite beams with a standard span of about 30m is introduced, and also provides some reference value for the engineering design and practice of this type of bridge structure in the future.

Keywords: urban viaduct; steel-concrete composite beam; engineering design

Stress Analysis of Inclined-span Arch Bridge and Comparison of Layout Forms of Stayed Cable PANG Yougui (91)

Abstract: Take the Taiyuan East Middle Ring North Extension Expressway Project spanning Beijian River as an example, the stress analysis and the bridge type comparison of the inclined-span arch bridge are introduced. The large-scale general finite element analysis software Midas Civil is used to establish the spatial finite element calculation model to analyze and compare the stresses of three cable systems (harp type, warped surface type and fishing net type) of inclined-span arch bridges. The characteristics of each system are obtained, which can guide the stress analysis and bridge type comparison of inclined-span arch bridge.

Keywords: inclined-span arch bridge; stress analysis; system comparison; bridge type selection

Overall Design of Half-through Special-shaped Steel Pipe Arch Bridge in Xinglong 76 Road MEI Yu (95)

Abstract: A half-through special-shaped steel pipe arch bridge in Xinglong 76 Road is a landmark landscape bridge in Chuanfa Ecological Science and Technology Park in Tianfu New District of Chengdu City. Its span is 32 m+96 m+32 m. The overall shape of the main arch ring is herringbone, and the cross section is shaped like a peach. Except the intersection of the left and right arch rings is the variable cross section, the other sections are of equal section. The main beam is a continuous steel box girder of equal height and width. The bridge deck is of orthotropic plate structure. The upper and lower ends of

the suspender are anchored with the steel anchor box, main arch ring and main beam. The finite element software is used to analyze the overall static force and stability of the main bridge. The results show that the bearing capacities of the main arch and main beam in the construction stage and the operation stage meet the requirements of the design specifications, and the bridge has the good static performance. By summarizing the design form and stress characteristics of this kind of bridge structure, the experience and reference can be provided for the design of other similar bridges.

Keywords: arch bridge; special-shaped steel pipe arch; structural calculation; bridge design; static analysis

Overall Design of River-crossing Channel of Loutiling Bridge in Ganzhou KANG Huijin (100)

Abstract: With the continuous development of the social economy and the development along the river in Ganzhou, the traffic pressure across the river is increasing. The construction of the Loutiling Bridge is an inevitable requirement for the development of the both banks. With the continuous growth of people's spiritual needs, the transportation functions are no longer the only requirement, and the landscape factors and harmonious development between the human and nature should also be considered. The project of Loutiling Bridge is introduced from the project background, function orientation, traffic forecast, overall design, key nodes and other aspects, which provides the engineering experience and design reference for the design of river-crossing channels.

Keywords: river-crossing channel; overall design; bridge; landscape

Research on Design Essentials of Wide-width Steel Box Girder LI Zelin (104)

Abstract: With the development of economic construction, the width of bridges is increasing. The wide-width steel box girder is widely used in various engineering practices. To explore the stress mode of such structures, taking a 2×40 m span wide-width steel box girder as an example, a 3D numerical analysis model is established. Based on the loading condition of a typical construction, the design accuracies of single-girder method, beam grillage method and shell element method are verified. On this basis, the stress characteristics of wide-width steel box girder are analyzed and summarized. Combined with the finite element analysis results and the standards at home and abroad, the stress mode and the simplified computation method of the cross beam of the wide-width steel box girder are specially discussed. The design proposal for the wide-width steel box girder is put forward, which can be referred for the design of the similar structures.

Keywords: wide-width steel box girder; beam grillage method; shell element method; distribution of shear force; cross beam; shearing force lag; local stability

Effects of Height and Pavement of Steel Structural Landscape Footbridge on Human-induced Vibration and Damper Design ZHANG Xiao (110)

Abstract: Taking the circular landscape footbridge in Shanghai Lingang Top New Scientist Park as an example, the pedestrian comfort level evaluation of the footbridge and the design process of tuned mass damper (TMD) are analyzed in detail. Under the constraints of external landscape conditions such as span, beam height and bridge deck attachment, and aiming at the owners' requirements of the main beam height and deck paving thickness of the footbridge, the rational layout of TMD and the optimization of TMD number are studied. The experience of pedestrian vibration calculation and TMD design is summarized.

Keywords: landscape footbridge; circular steel structural continuous beam; evaluation of pedestrian vibration comfort level; tuned mass damper (TMD)

Comparison and Parameter Analysis of Anti-falling Beam Overlap Length in Chinese and American Codes
..... LI Shousheng (114)

Abstract: Under the action of earthquake, the falling beam failure of bridge is the main form of bridge failure. It is one of the most effective measures to avoid the falling beam failure by providing the sufficient overlap length. Based on the parameter comparison and the finite element model, the calculation requirements of the overlap length stipulated in the codes of China and the United States, and the differences from the actual bridge seismic analysis results are studied. The results show that for the simple-supported bridge directly supported on the abutment, the seismic code of highway bridge on the overlap length is more suitable and economical to the design concept. The variation trends of overlap length calculated to obtain through the anti-seismic code for highway bridges and ASSHTO code are basically the same. But the overlap length specified in the anti-seismic code for highway bridges is more conservative, and the overlap length specified in ASSHTO code is more sensitive to the change of pier height. The overlap lengths stipulated in the anti-seismic code for highway bridges and ASSHTO code can basically meet the requirements of the bridges not dropping the beams under the most earthquake actions (the peak acceleration reaches 0.8g), and have the wide applicability.

Keywords: bridge engineering; anti-falling beam measures; anti-seismic code; overlap length; seismic response effect

Research on Design, Type-selection and Construction Scheme of Minor-radius Bridges in Complex Environment YAN Bo (118)

Abstract: Combined with the design example of Hengqin Port Lianhua Bridge Reconstruction Project, the comparison and selection of the design and construction schemes of the minor-radius bridges in the complex environment are introduced. The integrated structural scheme and the suitable construction scheme of using the composite girder and using the steel box girder when locally spanning the temporarily retained ramps are put forward, which has the certain referring values for the design of the similar minor-radius bridges.

Keywords: complex environment; minor-radius bridge; design and type-selection; construction scheme

Design of Urban Landscape Bridge Based on Cultural Ecology WANG Pengju, DONG Hui (121)

Abstract: As an important transportation channel of riverside cities, the urban bridge plays a role in connecting the economy and culture on both sides of the river, is also a unique scenery line of the city, is an important component of the external image and internal environment of the city, and is a special carrier of urban civilization. By exploring the relationship between the urban bridge landscape design, urban environment and cultural ecology, a countermeasure mechanism to incorporate the cultural factors into the bridge landscape design is built.

Keywords: cultural ecology; urban bridges; landscape design

FLOOD CONTROL & DRAINAGE

Analysis on Efficiency of Different Measures in Urban Lake Water Environment Treatment for Wuhan YAN Aiping, WANG Hao, WU Si (124)

Abstract: In view of the current problems of high construction intensity, large population density and water quality hard to meet the standard in the catchment area of the lakes in the city, taking Sha Lake in Wuchang District of Wuhan as an example, the effectiveness of the five measures such as "building park", "cut-off point source", "water system connection", "controlling non-point source" and "reducing internal sources" in

the treatment of the water environment of the Sha Lake is analyzed. It is proposed that the causes of water pollution the treatment of the water environment of the urban lakes should be analyzed. The measures are tailored due to lake conditions, and precise and powerful.

Keywords: urban lake; water environment treatment; internal pollution control

Study on Evaluation Method of Sponge City Construction Effect
..... LIU Biao, JIANG Jialiang, ZHAO Fang, AI Qinghua, FU Xiong (128)

Abstract: In order to quantitatively evaluate the construction effect of sponge city, the construction effect of sponge city is evaluated and studied by analytic hierarchy process and set pair analysis process. Firstly, according to the characteristics of sponge city construction, the evaluation indexes of sponge city construction effect are screened out. Then, the analytic hierarchy process is used to determine the weight of evaluation indexes at all levels, and the set pair analysis method is used to determine the connection degree of evaluation indexes at all levels. Accordingly, the effect evaluation is carried out. Finally, the construction effect of sponge city in a city is comprehensively analyzed, evaluated and compared from the perspectives of water ecology, water environment, water resources and water security. On this basis, the improvement measures and construction opinions are put forward to guide the construction of sponge city.

Keywords: sponge city; construction effect; evaluation index; analytic hierarchy process; set pair analysis

Research on Treatment Scheme of Waterlogging Spots at Shayang Road Bridge of G7 in Beijing
..... FENG Zhaoyang, DENG Weidong, GE Xuewei, LIN Hongjun (132)

Abstract: Aiming at the waterlogging situation very easily caused by the rainfall in the section of Shayang Road Bridge of G7 in Haidian District of Beijing, the historical rainfall and waterlogging data are used to carry out the investigating analysis and the watershed terrain analysis. Finally, the technical route of research on the waterlogging causes is analyzed. Based on the principle of respecting and maintaining the original natural drainage system and the problem-oriented, the waterlogging treatment scheme is formulated.

Keywords: Shayang Road; waterlogging; treatment

In-situ Upgrading and Reconstruction Design of Rainwater Pumping Station for Tunnel Bridge
..... LU Wenkai (136)

Abstract: Taking the Jianguo Road Tunnel Bridge Rainwater Pumping Station in Baoding City as an example, by analyzing the main cause of waterlogging in the tunnel bridge area, the upgrading and reconstruction schemes of the drainage system are reasonably determined. On the basis of the original land unchanged, the scale of the pumping station is increased from 0.83 m³/s to 3.0 m³/s, and an initial rainwater storage tank with a volume of 1 200 m³ is added in order to realize the purpose of alleviate the waterlogging in the bridge area and improving the water environment together, at the same time to create the favorable conditions for the thorough reconstruction of the drainage system in the surrounding area for the future.

Keywords: rainwater pumping station; initial rainwater storage tank; upgrading and reconstruction, co-construction style

Exploration on Improving Quality and Efficiency of a Rainwater Pumping Station and Initial Rainwater Storage Tank in Central Urban Area QIAN Lu (140)

Abstract: The state attaches great importance to the water pollution. Facing the problem of poor water quality in the discharging river of urban drainage pumping stations, a number of initial rain storage tanks is planned to construct in Shanghai. The design of pumping station and storage tank should be considered

further to reduce the pollution discharge, fully to treat and reuse the rainwater in storage tanks, and make full use of land. Taking an all-underground drainage pumping station and initial rainwater storage tank in the central urban area of Shanghai as an example, through the all-round reconstruction, such as the sponge reconstruction of pumping station, local treatment of rainwater storage, comprehensive utilization of return water (fountain landscape replenishment, greening irrigation and road cleaning), landscape upgrading and opening, etc. the method and mode to improve the quality and efficiency of terminal facilities of urban drainage system are explored.

Keywords: spongy reconstruction; local treatment; landscape upgrading; popular science exhibition; initial rainwater storage; open to the public

Investigation Practice and Regulating Countermeasure Analysis of Sewage Pipeline Network in an Area of Plain River Network Area JI Chi, LI Yiqian (144)

Abstract: Taking the investigation of sewage pipeline network in an area of the plain river network area as an example, the methods of CCTV detection, sonar detection, periscope detection and etc. are used to detect the sewage pipeline network in the area, and the key and difficult points of pipe network investigation are summarized. Based on the investigation results of the pipe network, the regulating countermeasures for the sewage pipeline network in the area are analyzed. The relevant implementing proposals for investigating and regulating the sewage pipeline network in the area are put forward in order to provide the reference for the similar projects and to help the treatment of municipal sewage to improve the quality and efficiency.

Keywords: sewage pipeline network; investigation; regulating; improving quality and efficiency

Application of Drainage Pipe Network Survey in Disease Investigation and Diagnosis of Urban Drainage System XIE Hongqiao, TIAN Dan (148)

Abstract: Pipe network investigation and diagnosis work is a professional and collaborative work. The work contents mainly include multiple professional contents. Various work contents are linked to each other, and are indispensable. The quality of drainage pipe network investigation is directly related to the correctness and integrity of the conclusion of the whole investigation and diagnosis work. The working method and function of drainage pipe network survey in the investigation and diagnosis of pipe network are expounded through engineering cases.

Keywords: pipeline survey; drainage investigation and diagnosis; waterlogging

Thinking on Application of Glass Flood Control Wall on Suzhou River ZHAI Jing (153)

Abstract: With the basic connection of Suzhou River in 2020, there are still difficulties of low elevation behind the flood control wall, no hinterland lifting waterfront space and landscape vision blocked by hard flood control wall in the next stage of upgrading the quality. Based on the statistics of the current elevation distribution of Suzhou River (Changshou Road bridge – Henan Road bridge), the reconstruction scheme of glass flood control wall on Suzhou River is proposed, and the strength and stability of glass flood control wall are simulated. Combined with the reconstruction process of the glass flood control wall on Huangpu River, the application difficulties of glass flood control wall are analyzed, and the flood prevention emergency plan and daily maintenance requirements for glass flood wall are put forward, which provides the reference for the reconstruction of waterfront space in Shanghai.

Keywords: glass flood control wall; laminated glass; flood prevention emergency plan

Operation Study of Industrial Wastewater Treatment by AO Process

..... SUN Wenbo, SUN Wengang, SUN Huping (156)

Abstract: In order to facilitate the regulation and control of the wastewater from the pharmaceutical and chemical industry, aiming at the common problems of unstable ammonia nitrogen, unstable DO and high turbidity of the effluent in the operation stage, the reconstruction methods meeting the economic benefits are screened. In this study, the ammonia nitrogen concentration in the effluent is controlled by regulating the reproductive cycle of nitrifying bacteria and its external environment. The engineering technical reconstruction is supported by the theoretical oxygen demand to ensure the stability of DO. By changing the discharge period of sludge and the precise control, the turbidity of the effluent can be reduced, which can provide the technical support for the strict process selection and the operation control.

Keywords: propagation cycle of nitrifying bacteria; biochemical oxygen demand; sludge discharge cycle

MANAGEMENT & CONSTRUCITON

Analysis on Influence of Foundation Pit Construction on Adjacent Subway Tunnels in Deep Soft Soil Area
..... XIONG Yonghua, PEI Qitao, CHENG Wenjie, YANG Xingyue (160)

Abstract: In view of the influence of foundation pit excavation on the structure of adjacent operational subway tunnels under the unfavorable conditions of deep muddy soft soil area and high confined water, taking the foundation pit construction of a utility tunnel near Wuhan Metro Line 2 as the background, a three-dimensional numerical analysis model is built systematically to analyze the influence of the foundation pit construction on the deformation of its enclosing structure, and the displacement and stress of the subway tunnel structure. The results show that the maximum horizontal and vertical displacements of the enclosing structures caused by the foundation pit excavation are 11.5 mm and 1.44 mm respectively, the maximum horizontal and vertical displacements of the subway tunnel structure are 0.42 mm and 0.21 mm respectively, and the maximum axial force, shear force and bending moment of the shield segment are 1 479.65 kN/m, 48.38 kN/m and 109.77 kN/m respectively. The numerical analysis results are all within the standard limiting values. The research results can be referred for the safety risk assessment of the adjacent buildings and structures in the similar constructions of foundation pits.

Keywords: deep soft soil area; foundation pit construction; subway tunnels; enclosing structure; numerical analysis

Research on Key Technologies of Larsen Steel Sheet Pile Support for Deep Foundation Pits on Soft Soil Ground in North Yangjing Road SHI Weidong (165)

Abstract: Relying on Shanghai North Yangjing Road Extension Project, the key technologies and safety management measures of using Larsen steel sheet piles as the pit support for the deep foundation pits on soft soil ground are specially studied. According to the geological conditions and support scheme of the project, the difficulties of Larsen sheet pile support construction for the deep foundation pits on soft soil ground are summarized. Combined with the support construction scheme, the key technologies of Larsen steel sheet pile construction are analyzed step by step. On this basis, the construction control technical parameters and the corresponding safety precautions are proposed to provide the reference for the application of Larsen steel sheet pile in deep foundation pit support on the soft soil ground.

Keywords: soft soil ground; deep foundation pit; Larsen steel sheet pile; key construction technology; safety precautions

Research on Scheme Optimization of Urban Expressway Swivel Bridge Spanning High-speed Railway in Densely Built-up Areas XIAO Huayu (170)

Abstract: Taking Ningbo Yinzhou Avenue – Fuqing Road (Dongqian Lake Section) Expressway Phase II Project spanning Hangzhou – Shenzhen Railway as an example, the construction scheme of the swivel bridge of urban expressway spanning the high-speed railway in the densely built-up areas is optimized and studied so as to minimize the adverse social impact caused by the engineering construction under the premise of ensuring the operation safety of railway business line, which provides the reference for the similar engineering projects.

Keywords: densely built-up areas; urban expressway; spanning high-speed railway; swivel bridge

Research on Thrust Calculation Model of Auxiliary Oil Cylinder Jack in Small Curvature Radius Shield Tunneling YUAN Hong (173)

Abstract: During the shield tunneling with small curvature radius, due to the role of jack thrust, the segments will shift and stagger, which will lead to the safety accidents. In order to effectively solve the adverse impact of jack thrust on the segment during the construction of shield tunnel with small curvature radius, the tunneling mode of double-mode shield tunneling machine is analyzed. The calculation model of the thrust of the auxiliary oil cylinder jack in the shield tunneling process for the shield tunnel is established. And the model is applied in the engineering practice. The jack thrust is calculated and analyzed. The relevant measures to reduce or avoid the adverse effects of the jack thrust on the segment are proposed. The results show that during the construction of double-mode shield machine, the value of the thrust of the auxiliary oil cylinder jack in the different construction sections is different, and the thrust value should be determined according to the actual situation of the project. During the construction of single-mode shield machine, the thrust of the auxiliary oil cylinder jack increases with the increase of penetration, and the increasing rate gradually shows a decreasing trend. It is proposed to control and reduce the adverse impact of the jack thrust on the segment from the construction correction, segment assembly control, reasonable selection of tunneling parameters, shield machine attitude control, shield machine thrust control, setting of tunnel longitudinal stiffness and segment quality so as to ensure the safety of shield construction and provide the theoretical guidance and reference for the construction of similar projects.

Keywords: shield tunnel; small curvature radius; segment; tunneling mode; jack thrust of auxiliary cylinder; computational model

Study on Reconstruction and Expansion Technology of Underpass under Uninterrupted Operation GAO Yang (179)

Abstract: Taking an underpass reconstruction project of the access road in Pudong Airport as an example, the stress analysis and construction sequence research of the underpass structure are carried out in order to meet the uninterrupted operation of underpass. The problem that the traditional underpass reconstruction and expansion project is required to close the underground road traffic is solved, that is, the underground traffic can still operate continuously during the whole construction period, which has the symbolic significance.

Keywords: underpass; uninterrupted operation; construction procedure; reconstruction and expansion; steel support conversion

Application of Prefabricated Concrete Structure in Construction of Zhuyuan Wastewater Treatment Plant Phase

IV Project LI Mingjie (183)

Abstract: The 1 200 000 m³/d sewage treatment facilities and supporting sludge facilities are newly built in Zhuyuan Wastewater Treatment Plant Phase IV Project. The project is divided into two plant areas of 500 000 m³/d and 700 000 m³/d. In order to achieve the engineering goals of improving the engineering quality, shortening the construction period and reducing the environmental impact, while highlighting the purpose of technological innovation, the different forms of prefabricated assembly technology are used in the anoxic section of the biological reaction tanks in the two plant areas of the project. The different forms of prefabricated assembly technology in the project are introduced, and the BIM technology is used to simulate the whole process of the design and construction of prefabricated structure. The advantages and disadvantages are analyzed from the aspects of transportation, hoisting, stress system and efficacy of the project. The differences between the prefabricated structure and the cast-in-place structure as well as among the different prefabricated structures are summarized, which expects to provide the technical accumulation and engineering experience for the prefabricated technology of wastewater treatment plant (WWTP) in China through the implementation of the prefabricated concrete structure in Zhuyuan Wastewater Treatment Plant Phase IV Project.

Keywords: water engineering; prefabricated assembly technology; BIM technology; implementation organization; efficacy analysis

Study on Reinforcement Design and Construction Methods of Small-span Masonry Slab Arch CHEN Feng, XU Wenhao (186)

Abstract: Aiming at the small-span masonry slab arch bridge without the design and construction drawings, the feasibility of the reinforcement design and construction methods of this kind of bridge are verified through the determination of the basic parameters of the original bridge, the analysis of reinforcement design and construction methods and combined with the engineering practices. A complete set of reinforcement design and construction methods is provided. The successful engineering cases to reinforce the masonry slab arch indicate that the whole reinforcement process technology is feasible. The reinforcement design and construction technologies can be referred for the reinforcement design and construction of the similar bridges.

Keywords: masonry slab arch; design and construction; maintenance and reinforcement

Application of Smart Construction Site Platform in Management of Oversized Foundation Pit Group Engineering XUE Yeye (189)

Abstract: In recent years, the management mode of construction projects is moving towards the development of intelligence, digitization and informatization. The smart construction site management platform is an indispensable part of it. By the "BIM + smart construction site" platform suitable for the entire life cycle of construction, through all-round 3D visual control of the projects, the refined management of construction projects is realized to make the efficiency of cooperative work among various departments of construction site effectively upgrade, which can effectively realize the intelligent decision-making and management based on projects.

Keywords: oversized foundation pit engineering; smart construction site; refined management

Brief Analysis on Thoughts and Methods of Comprehensive Utilization of Space under Urban Bridges LIU Ming (193)

Abstract: With the rapid development of urbanization in Shanghai and the continuous improvement of people's living standards, the contradiction between the urban residents' demand for various spaces and

the limited urban land is becoming more and more prominent. To a certain extent, the space under bridge has become the surplus space of a city that does not do too much use. Some of the space under bridge has certain potential safety hazards, and even has been illegally occupied, which has a negative effect on the urban safety, urban landscape, urban space resources and other aspects. Therefore, the comprehensive utilization of the space under bridge aims to eliminate the potential safety hazards, improve the urban landscape configuration, improve the urban land use efficiency, and adaptively utilize and develop the space under bridge according to the local conditions, which is a useful supplement to the current relevant laws and regulations.

Keywords: urbanization; space under bridge; comprehensive utilization; urban landscape; land use; urban safety

STUDY ON SCIENCE & TECHNOLOGY

Current Study and Trend Analysis of Pedestrian Traffic Based on Literature Metrology JIANG Heng, GUO Shuxia (196)

Abstract: The statistical methods and the scientific knowledge atlas software CiteSpace are used to analyze the literature information of CNKI and WOS walking research from 2012 to 2021. By analyzing the number of papers published over the years, the core journals, main authors and institutions are found out, and the research overview of the field is understood. Through the keyword frequency statistics and burst word detection, the hot spots and trends of walking research at home and abroad are analyzed. And the focus of pedestrian traffic is determined to be the "pedestrian crossing", "traffic safety", and pedestrian "intelligent transportation". Finally, through the literature reading, the research achievements and development trends of the three directions in recent years are summarized and sorted out.

Keywords: CNKI; WOS; CiteSpace; walk; pedestrian crossing; traffic safety; intelligent transportation

Bi-level Programing Model of Traffic Microcirculation for Old City JIANG Hong (202)

Abstract: The old city has a dense network of roads and lanes. The utilization of traffic microcirculation can relieve traffic pressures on the trunk roads and improve the bearing capacity and accessibility of the regional road network. Taking the saturation of trunk roads and traffic index of street level as the optimization objective and the non-congestion of branch roads as the constraint condition, the upper-level model is built. The lower-level model is solved by using the equilibrium traffic assignment of user and in virtue of TranCAD. The bi-level programming model of traffic microcirculation is established for the old city. An example is given to illustrate the process of building and solving the model.

Keywords: old city; urban renewal; traffic microcirculation; bi-level programing model

Research on Aseismatic Bearing Design of Long-span Special-shaped Flyover under Pedestrian Excitation Load SUN Liangfeng (206)

Abstract: In order to solve the problem of the bending moment of the aseismatic bearing affected by the uncertain excitation load of pedestrian to cause the phenomenon of incomplete parameter acquisition and the poor seismic effect of the bearing, the aseismatic bearing design of long-span special-shaped flyovers under the pedestrian excitation load is studied. Firstly, by considering the uncertainty of pedestrian excitation on the bridge, multiple load excitation types are set. The interval process method is used to describe the uncertain excitation of pedestrians on the bridge. The autocorrelation coefficient function is used to analyze the non-random vibration of the bridge under the excitation load of pedestrians. Secondly, the aseismatic bearing model is constructed by using the elements in the finite element software. And the

bridge displacement, pier bending moment and pile foundation bending moment are numerically simulated. Finally, the numerical simulation results of the bearing parameters are substituted into the finite element model to design a hyperboloid spherical aseismatic bearing structure. The results show that the maximum errors between the longitudinal bending moment and the actual data of the designed bearing are 25 kN·m and 250 kN·m respectively under the conditions of jogging and fast running. The transverse bending moment is consistent with the actual data, which shows that the designed bearing can play a good anti-seismic effect according to the data.

Keywords: pedestrian excitation load; long span; special-shaped flyover; aseismatic bearing

Study on Mechanical Properties of Steel-concrete Composite Beam ZHANG Hongyun (210)

Abstract: There are many forms of steel-concrete composite beams. Taking a corrugated steel web and flat steel web composite slot-type beams as the study object, the mechanical properties of two kinds of composite beam are compared and analyzed. Relying on a test beam, the solid finite element modes of flat steel web and corrugated steel web are established. And the destruction and loading are carried out to compare the cross-section strain distribution, load-displacement curve and rigidity of the both. The mechanical behavior of the whole process of the steel web is analyzed. The results show that the influence of corrugated steel webs on the strength is not obvious. However, the flat steel webs are prone to buckling failure. On the whole, the load-displacement curves of the corrugated steel web concrete slot-type composite beams and the flat steel web concrete slot-type composite beams have the significant elastic stage, elastic-plastic stage and weakening stage. The displacement of flat steel web composite beams increases rapidly in elastic-plastic stage, and its strength decreases rapidly in weakening stage. The rigidity and Mises stress are all less than that of the corrugated steel webs in the loading process.

Keywords: corrugated steel web; flat steel web; secant rigidity; buckling failure

Study on Influence of Rainfall Intensity on Purifying Capacity of Permeable Asphalt Concrete
..... WU Jianbing, CHEN Zikai (214)

Abstract: To quantitatively evaluate the impact of rainfall intensity on the ability of permeable asphalt mixtures (PAM) to purify the pavement runoff, the artificial rainfall simulation tests of the single-layer and double-layer PAM under five rainfall intensities are designed according to the erected full-scale road pavement platform to detect the representative pollutant concentrations of the simulated runoff rainwater before and after flowing through PAM. The results show that PAM can effectively purify the runoff pollution, and the pollution purifying capacity of double-layer PAM is significantly better than that of single-layer PAM. The removal rates of suspended solids (SS), total phosphorus compounds (TP), heavy metal zinc (Zn), heavy metal plumbum (Pb), total nitrogen compounds (TN) and chemical oxygen demand (COD) by PAM are 80.25%, 74.13%, 70.30%, 65.14%, 63.75% and 61.38% respectively. With the increase of rainfall intensity, the purification capacity of PAM to runoff pollutants is gradually weakened. The layer coefficient α and rainfall intensity reduction coefficient β are proposed by analyzing the impact of layer coefficient and rainfall intensity on the pollutant purifying rate of PAM. The pollutant purifying capacity of the actual PAM pavement under certain of rainfall intensity can be calculated by the test results of artificial rainfall simulation, which provides the basis for the quantitative environmental evaluation of PAM pavement.

Keywords: permeable asphalt mixtures; rainfall intensity; pavement layers; full-scale road pavement platform; artificial rainfall simulation tests

Study on Adhesiveness of SBS Asphalt Mortar and Water Loss Resistance of Mixture

..... GUO Yinan, XIAO Jiaqing, DI Jiangtian, GONG Xiuping, HU Hang (220)

Abstract: The SBS modified asphalt mortar and mixture with the different SBS contents and stabilizer contents are prepared respectively. And the adhesiveness of SBS modified asphalt mortar and the water loss resistances of its mixture are systematically studied through BBS pull-out test, freeze-thaw splitting test and Hamburg rutting test to explore the relationship between the two. The study results show that the addition of SBS enhances and improve the adhesiveness of the asphalt and the water resistance sensitivity of the asphalt mortar. The adhesiveness and water loss resistance of SBS modified asphalt mortar are constantly improved with the increase of SBS content, and the both increase first and then decrease with the increase of stabilizer content. The optimal stabilizer content of the modified asphalt with SBS content of 4.5% is 0.15%. The freeze-thaw splitting tensile strength ratio TSR can better reflect the sensitivity of asphalt mixture to water than the damage deformation rate MR. The freeze-thaw splitting test is more suitable to evaluate the water loss resistance of SBS modified asphalt than Hamburg rutting test.

Keywords: SBS modified asphalt mortar; adhesiveness; water loss resistance; evaluation method

Experimental Study on Influence of Water-induced Instability of Arsenic Sandstone on Highway
..... GOU Zhenguo (224)

Abstract: In some sections of the G327 Line from Zhenyuan to Wangzuizi in the Longdong region of Gansu Province, there is a typical binary geological structure of arsenic sandstone-loess, which may cause the instability and deformation after contact water. To study the impact of this deformation on highways, the indoor models are used to measure the displacement of arsenic sandstone under the different overlying loads and different water contents, and the arsenic sandstone disintegration tests are conducted. The results show that the strength of arsenic sandstone is higher in the natural state and the deformation gradually increases after contacting water. After reaching a certain value, it quickly loses stability and fails, thus leading to the instability and deformation of the upper loess. The deformation of the roadbed and the residual accumulation on the pavement caused from this will have a serious impact on the entire highway construction and later operation. Therefore, in the construction process of such highways, the engineering measures should be taken to prevent the deformation and instability of the arsenic sandstone-loess binary structure by blocking the water holes developed in the top loess layer, supporting the slope surface of the loess-arsenic sandstone binary structure, and setting the interception and drainage ditches at the bottom in order to ensure the safe operation of the highway.

Keywords: highway engineering; loess; arsenic sandstone; model test; roadbed deformation

Study on Performance Optimization of Mineral Admixtures for Composite Grouting Materials
..... ZHANG Yi (229)

Abstract: Aiming at the disease of slab bottom cavity of cement concrete pavement, the impacts of silica fume, fly ash and the other mineral admixtures, and water reducer content and emulsified asphalt content on the properties of the composite grouting materials are systematically studied. The initial fluidity of the studied composite grouting material is not larger than 20 s, and the fluidity in 30 min is not higher than 30 s. Compared with the cement stabilized materials, the 7 d unconfined compressive strength of the consolidated body of composite grouting material is slightly lower, but the deflection and water stability are significantly improved.

Keywords: slab bottom cavity; asphalt; grouting; mix proportion

Study on Stability of Emulsified Asphalt Binder Modified by Anti-ice Additives
..... LIU Jie, WANG Zhihong, PAN Yuelin, LIU Jin (234)

Abstract: The influences of anti-ice additive content, Zeta potential, fineness modulus, bulk density and other factors as well as the type of emulsifier on the anti-freezing performance and stability of emulsified asphalt binder are studied. The results show that the stability time of cationic emulsified asphalt binder decreases with the increase of anti-ice additive content. The stability of cationic anti-ice additive emulsified asphalt binder is better than that of anionic anti-ice additive emulsified asphalt binder. And the stability of cationic emulsified asphalt binder is proportional to the increase of Zeta potential of anti-ice additive. The smaller the bulk density and the finer the particle size, the worse the stability of the anti-ice additive after mixed with the cationic emulsified asphalt.

Keywords: anti-ice additive; modified emulsified asphalt; binder; anti-freezing performance; stability

Influence of Mixing Effect of Old and New Asphalts at Interface on Fatigue Properties of Mixture during Asphalt Regeneration CUI Yu, XU Tengfei, HAN Fangyuan, JIA Xiaolong (238)

Abstract: In order to study the influence of mixing effect of old and new asphalts at the interface of recycled asphalt mixture on the fatigue properties of mixture under same grading and different mixing factors, and based on the infrared spectroscopy, the qualitative problem of "partial mixing" of new and old asphalt during the regeneration process is turned to quantitative problem, and a quantitative evaluation scheme of the mixing effect of recycled asphalt mixture is established, and the relationship between the mixing effect of the new and old asphalts at the interface and the fatigue life of the recycled materials under the factors of different RAP content, mixing temperature and dry mixing time is studied, and then the mixing scheme is optimized. The results show that under the different mixing factors, the fatigue performance of the mixture changes with the mixing effect change of new and old asphalts at the interface. The best mixing scheme is 40% RAP content, 165℃ mixing temperature and 90 s dry mixing time.

Keywords: recycled asphalt mixture; infrared spectroscopy; quantification of mixing effect; fatigue property

Research on Prediction Equation of SBS Modified Asphalt Performance in Process of Aging JIANG Shuyang, QI Wenyang, WANG Lijun (241)

Abstract: A nonlinear prediction equation of performance disintegration of SBS modified asphalt in the process of aging is established. The reliability of the prediction equation is validated by thin-film oven test. Based on the prediction equation, the change rate of performance indexes of SBS modified asphalt in the process of aging is analyzed. The research results show that the non-linear equation $x(t) = (L_{\infty})/[1+(L-1)e^{-t}]$ can be used to predict the change law of the penetration, softening point and ductility in the aging process of SBS modified asphalt. The change rate of penetration, softening point and ductility of SBS modified asphalt declines gradually with the lengthening of aging time, in which the change rate of ductility index decreases the most in the early aging period. The relationship equation between the macro performance index and the infrared spectrum a_{1700}/a_{1600} can be established to predict and evaluate the aging degree of SBS modified asphalt.

Keywords: road engineering; SBS modified asphalt; prediction equation; aging rate; infrared spectrum

Study on Finite Element Analysis and Optimal Design of Resonant Crushed Pavement HONG Ying (244)

Abstract: Based on the rise of overhaul and reconstruction of cement concrete pavements on rural roads, the finite element ABAQUS is used to establish the models of various pavement structure types for the mechanical research from the perspective of available resources and sustainable development. And the advantages of the resonant crushed pavement structure are discussed. The feasibility and rationality of the

resonant crushed pavement structure to be applied in the rural road reconstruction in the future are verified through the finite element analysis. In addition, the experiment and studying methods are used to explore the impact of adjusting the cement content and used material content on the strength of recycled cement stabilized macadam base. The best content is determined and the design parameters are optimized. The conclusion shows that it can be used widely on the rural roads of heavy, medium, and light traffics.

Keywords: resonant crushed pavement; finite element analysis; recycled; optimization design

APPLICATION OF ACHIEVEMENTS

Research on Integrated Application of Bridge Mechanics Analysis Based on BIM Model MENG Xiangyin, YUAN Yu (248)

Abstract: With the proposal of a series of policies such as the digital transportation power, BIM technology has been an important starting point for the information technology. By analyzing the relationship between BIM and mechanical analysis data, the mechanical basic information based on BIM component concept is classified. At the same time, the dynamic visual analysis of mechanical data is realized through the rapid analysis method of bridge mechanical response based on BIM. Through this system, the dynamic comparison of monitoring results can be greatly perfected, the designers can be assisted to make the rapid decisions, and a certain theoretical basis is provided for the determination of construction schemes.

Keywords: BIM; bridge; mechanical analysis; data integration; visual analysis

Application of BIM Technology in Structural Design of Underground Wastewater Treatment Plant WANG Zihao (252)

Abstract: With the development of BIM technology, the design of water supply and drainage structures is trying to apply BIM technology into the practice. The Xiaoshan Qianjiang Wastewater Treatment Plant Phase IV Extension Project is located in Xiaoshan Qianjiang Farm, Hangzhou City, Zhejiang Province. Its design scale is 400 000 m³/d. and it is a semi-underground box-type wastewater treatment plant (WWTP). Revit software is used to establish a three-dimensional model. Combined with YJK software, the structural calculation of underground WWPT structures is explored to prove the possibility of using the three-dimensional model for overall calculation of underground WWTP projects.

Keywords: BIM; Revit; YJK; underground wastewater treatment plant (WWTP); structural calculation

Application of Fabricated Cement Concrete Pavement in Airport Repair WU Shitao, QIAO Dong (258)

Abstract: Cement pavement is the most widely used pavement type in domestic airports. With a large number of airport cement pavement entering the maintenance period, the problems of difficult repair after cement pavement damage is becoming more and more prominent. The fabricated cement concrete pavement has the characteristics of centralized prefabrication and decentralized installation, and has the advantages of fast and strong environmental adaptability and economy, which is a good solution for the maintenance of the existing cement pavement. The research status of fabricated cement concrete pavement technologies at home and abroad are investigated and studied. The successful application cases in Pudong Airport and Yichun Airport are introduced. The main construction technology and technical requirements of its application in the airport pavement repair are pointed out. It is proposed that the technical difficulty of the fabricated cement pavement is to ensure the full filling of the slab bottom, the recovery of the force transmission at the pavement joints and the smoothness of the pavement surface. Through the analysis, it is believed that the development of relevant special equipment and the realization of pavement technology

industrialization can solve the problems in the implementation of fabricated cement concrete pavement technology.

Keywords: fabrication; pavement; airport; repair; construction technology

Application of Hydraulic Lifting Cable Crane in Canakkale Bridge HE Yong (263)

Abstract: Taking the application of 450 t hydraulic lifting cable crane in 1915 Chanakale Bridge in Turkey as the research object, the structure design and the main engineering machinery technology of the cable crane are introduced firstly. Then the principle of cable crane walking on the main cable in the air is analyzed. Finally, the key technologies of self-installation and self-disassembly of cable crane are discussed respectively in order to provide the reference for the design and site construction of the cable crane.

Keywords: cable crane; structure design; self-installation; self-disassembly; key technology

Application of Multi-beam Sounding System in Analysis of Riverbed Change FU Yingying (266)

Abstract: The change situation and change trend of river are the important factors in the analysis on the flood control, navigation and hydrology of river. Especially in the river water situation complex and dangerous sections, the changes of the riverbed are complicated and the rules are difficult to find, which have a far-reaching influence on the navigation safety, flood control, waterlogging drainage, and the stability of hydraulic engineering facilities. The application of multi-beam sounding system in the analysis of riverbed change is studied according to the detailed measured data. The methods of multi-beam sounding system in the topographic data collection, data processing and data analysis of the inland river bottoms are explored. And a method of inverse analysis of riverbed changes based on the data of river bottom topography from the multi-beam sounding system is developed.

Keywords: riverbed change; multi-beam measurement; measurement of river bottom topography

RAP Refined Oilstone Separation Technology and Its Engineering Application
..... ZHU Lei, ZHANG Yang, TANG Wei, ZHUANG Yuan, LI Ning, WANG Deyu (270)

Abstract: The variability of reclaimed asphalt mixtures (RAP) is one of the important factors to affect the mix design and pavement performances of the reclaimed asphalt mixtures. Therefore, in the engineering practice, it is urgently to pretreat RAP material and separate the aged asphalt and aggregates in order to reduce the variability. Based on this, a new separation method of RAP oilstone named the refined oilstone separation technology is introduced including its technological process. The separation effect is experimentally evaluated. The refined separated RAP material is used to prepare the reclaimed mixture and to apply in the practical projects. The result shows that the RAP material after refined separated and treated is even and stable, and the variability meets the requirements. The performance indexes of used aggregates are basically same as the new aggregates. Various pavement performances of reclaimed asphalt mixture all satisfy the requirement. The construction quality of high-class pavement is controllable and reclaiming effect is good.

Keywords: reclaimed asphalt mixtures (RAP); refined oilstone separation; reclaimed mixtures; construction process; pavement maintenance

THE RELATIVE SPECIALITIES

Study on Cooperative Construction Mode and Technology of Urban Tunnel and Underground Space
..... SUN Li, ZHAO Guang, HUANG Jun, LI Ao, YANG Kui, DONG Fei (274)

Abstract: With the scale development of city, the development and reconstruction of multiple underground spaces are in the ascendant. At present, the cooperative construction of urban tunnel and underground space has become the basic trend of development, but at the same time, the problems of safety and efficiency in cooperative construction must be solved. Based on various problems in the development process of tunnel and underground space, the connotation in the cooperative construction of urban tunnel and underground space is revealed. The cooperative construction modes of urban tunnel and underground space are put forward, such as the co-construction cooperation, reserved cooperation and protective cooperation respectively. The process and goal of various cooperative modes are revealed, and the study on cooperative construction technology of urban tunnel and underground space is carried out, which provides the technical support for the cooperative construction, intensive utilization and safety control of tunnel and underground space.

Keywords: tunnel and underground space; cooperative construction; cooperative goal; cooperative mode; cooperative technology

Study on Design of Co-construction of Foundations Pit Enclosure for Subway and Super-large Basement DING Yuneng, ZHANG Yang (279)

Abstract: With the development of economy and culture in China, the demand for the integration of rail transit, regional commercial and cultural functional facilities is increasingly strong. There have been many large building complexes built on subways. Taking the co-construction project of Gouyang Road Station – Jinjiadu Station in Hangzhou Metro Line 4 and Plot No.35 [2019]in the listed transfer notice of Hangzhou Yuhang District Government Land Reserve Center as an example, the design scheme of enclosure co-constructed for the subway and the building basement is discussed and studied. And the key problems are analyzed from the perspective of design and construction, which can be referred for the similar projects in the future.

Keywords: super-large basement; subway; co-construction of foundation pit; enclosure design

Design of Overall Scheme for Huayuan Avenue Tunnel in Hefei ZHANG Wei (283)

Abstract: Taking the overall design of Huayuan Avenue Tunnel Project as an example, and by planning and analyzing the regional road network, the traffic function of Huayuan Avenue is analyzed and the necessity of the project construction is demonstrated. Combining the requirements of overall park planning and the current construction conditions, it is intended to explore the conception and idea of urban tunnel design in the alignment and portal location, tunnel on/off ramp layout, double-deck overpass tunnel, and "pipe curtain + jacking" process so as to provide the reference for the similar projects in the future.

Keywords: overall design of tunnel; underground interchange; tunnel on/off ramp; pipe curtain + jacking

Analysis and Study on Response of Large-section Shallow-buried Tunnel Construction and Existing Buildings in Urban Areas MAO Huabing, ZHANG Tao, ZHANG Wen, ZHENG Zhaoyi, WANG Xiao (286)

Abstract: Urban underground road has the characteristics of large section, shallow burying and complex construction environment, and often causes the adverse effects on the existing buildings on the ground. Relying on the Jinan Yuhuan Road Tunnel Project, the field monitoring data and numerical simulation method are used to study the response of large-section ultra-shallow buried tunnel construction and the existing buildings with the different directions. The study result shows that the building damage would be caused by the difference settlement of pile foundation closing to the tunnel if the long edge of the existing building is perpendicular to the tunnel. The failure form is inclined failure if the long edge of the existing buildings runs parallel to the tunnel. The non-uniform settlement relative maximum of the building pile

foundation parallel to the tunnel will happen in the tunneling process, and the non-uniform settlement relative maximum of the building pile foundation perpendicular to the tunnel is likely to occur at each stage of the whole process. When the buildings on the ground exist, the variation trend of characteristic point settlement is basically consistent with that of natural ground settlement. During the tunneling construction under the action of building load, the stress releasing process becomes longer, and the later consolidation settlement will also relevantly increase, which results that the land surface settlement is obviously greater than that of natural land surface settlement.

Keywords: urban tunnel; building settlement; numerical simulation; monitoring measurement

Analysis of Potential Problems and Optimization of Fire Alarm System in Urban Tunnel XIN Qifeng (292)

Abstract: By analyzing and studying the historical fire cases of urban tunnels, the potential problems in the fire alarm system are summarized. The optimization and solving schemes are specially proposed. The problems are studied and solved through the intelligent means. The man-machine monitoring graphical interface of the system is optimized. The emergency backup functions are added. The second alignment between each rain valve group and monitoring camera is carried out to improve the fault tolerance rate and alignment accuracy of the system. The effects are tested through the test cases. When the on-site fire alarm (fiber grating, dual-wavelength flame detector) fails to detect the fire signal due to the environmental reasons, but the video event detection or manual work through the large screen video to judge the fire situation, the on-site rain valve group can be reserved and accurately opened. And the relevant pre-arranged planning can be started through the digital twin technology.

Keywords: tunnel fire; combined fire fighting; system optimization

Analysis on Influence of Excavation of Ultra-deep Foundation Pit in Soft Soil on Adjacent Structures NAN Wenwen (298)

Abstract: The shield working shaft of Shanghai Beiheng Channel Screen Factory and the foundation pit of the adjacent buried section are located in a typical soft soil stratum. The depth of the foundation pit is 32.5 meters. There is a five-story commercial building at 6.7 meters from the pit edge. The excavation and reconstruction of the foundation pit must ensure the structural safety of the building. Taking the foundation pit as an example, and aiming at the physical condition, protection requirements, geological condition and surroundings of the building, the targeted measures are taken to reduce the impact of foundation pit excavation on the adjacent buildings. The design scheme of the foundation pit is introduced, and the validity of the scheme is verified by comparing the monitoring results of the foundation pit. The influence law of ultra-deep foundation pit excavation on the surrounding soil and the adjacent buildings and structures is studied. The effective measures to increase the safety of the buildings and structures beside the pit are put forward including the reinforcement of the soil inside and outside the pit, the addition of temporary steel supports, etc. The conclusions can be referred for the similar projects.

Keywords: ultra-deep foundation pit; building protection; environmental impact; deformation control of foundation pit

Overall-process Numerical Simulation of Deep Foundation Pit Excavation Supported by Multi-layer Piles and Anchors WANG Sheng, LI Luhai, HUANG Junwen (304)

Abstract: In order to get the deformation and stress characteristics of the pile-anchor supported foundation pit during the excavation more intuitively and feed back to the actual design and construction, taking a pile-anchor supported deep foundation pit project in Zhuhai as an example, a refined numerical

model is established based on the finite difference software FLAC^{3D} to calculate and analyze the deformation and stress characteristics of the foundation pit under various working conditions. The analysis results show that with the excavation of the foundation pit, the ground surface settlement at the top of the pit gradually increases, and the maximum surface settlement occurs at the position 28 m away from the pile top. The slow increase of ground surface settlement at the top of the pit indicates that the addition of prestressed anchor cables has a good effect on limiting the deformation of the foundation pit. The pullout resistance required by the anchor cable gradually increases with the excavation, and the pullout resistance required by the first level anchor cable is the largest, followed by the third level anchor cable. It is reasonable to use the established numerical model to analyze the excavation process of the foundation pit. The calculation results can provide reference for the actual construction and design.

Keywords: deep foundation pits; pile–anchor support; numerical simulation

Discussion on Technological Design Essentials of Rigid Landfill for hazardous Waste
..... SHI Mengpa, CAO Weihua, WANG Yanming (310)

Abstract: The construction of rigid landfills has become a hot topic for the hazardous waste treatment now along with the implementation of new standards for the pollution of hazardous waste landfills. As the main treatment method for the hazardous wastes such as the industrial waste salt in China, the rigid landfill not only preserves the possibility of waste resources recycling in the future, but also effectively reduces the risk of soil and groundwater pollution as the important way. Taking Chengdu Hazardous Waste Disposal Center Phase III Project (100 000 m² rigid landfill project) as a case, aiming at the essentials of rigid landfill in the technological design, the landfill operation methods, canopy forms, anti–seepage system design, leachate drainage system design and the others are completely analyzed and expounded, which can be referred for the practical engineering application of rigid landfill.

Keywords: hazardous waste; rigid landfill; Landfill operation; anti–seepage system; leachate drainage

Evaluation on Greening Soil Quality in Lingang New Area of Shanghai WANG Huadong (314)

Abstract: Soil is the carrier of urban green space function, and is closely related to the urban livability, environmental quality and human life quality. Taking a large community of Lingang New Area in Shanghai as an example, the main control indicators (pH, salinity, EC value, organic matter, texture, infiltration rate and germination index) of greening planting soil and greening topsoil are investigated and analyzed to evaluate the soil quality status. The analysis results show that the salt contents of greening planting soil and greening topsoil mostly meet the requirements, and the sample exceeding the standard rate is less than 4%. The texture is mainly loamy sandy soil and sandy loam soil, and no samples exceed the standard. The rates of pH, organic matter and EC value exceeding the standard are higher, and especially the rate of EC exceeding the standard is as high as 88%. The two soils are seriously salinized, and the EC values and organic matter are generally lower. The soil improvement is all required.

Keywords: Lingang New Area; green space soil; greening topsoil; quality evaluation

Thinking and Practice on Strategic Development of "14th Five–Year Plan" for Water Conservancy Design Enterprise SHU Zhenghong (319)

Abstract: Since the "14 th Five–Year Plan", a new round of investment in the water conservancy industry of China has grown rapidly. How to grasp the development peak of water conservancy industry and how to make the enterprise development to a new stage, firstly, the business characteristics and competition pattern of the water conservancy enterprise, and the problems existing in the scale growth, market exploitation, technological development and other aspects are analyzed. Then, the strategic development

Keywords: water conservancy design enterprise; the 14th Five-Year Plan; strategic guideline; development thinking

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