

城市道桥与防洪

主管：中华人民共和国住房和城乡建设部
主办：上海市政工程设计研究总院(集团)有限公司

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● 本期看点

- 双层立体复合高速公路与两条相邻城市道路互通立交改扩建方案设计
- 基于工业化建造的整体预制连续架设型钢-混凝土组合梁设计
- 软土地区大断面矩形顶管浅覆土下穿高速变形控制分析研究
- 智能网联汽车测试场场景设计方法研究



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目 次

道路交通

- 双层立体复合高速公路与两条相邻城市道路
互通立交改扩建方案设计
..... 许江杰, 田 瑞, 陈炯昭(1)
- 苏州绕城高速公路天池山互通改造方案研究
..... 王 健, 沈学芳(4)
- 南宁市快速环路邕武立交改扩建设计研究
..... 庞赞龙, 岑祚氏(8)
- 东莞市松山湖大道入城段拥堵分析与治理措施
..... 林 洋, 刘永平(12)
- 城市滨水道路建设研究及实践
..... 吴 坤, 苏 凯(15)
- 城市快速路规划建设应重视的几个问题——
以无锡市为例 杨 炜(18)
- 北京经济技术开发区太和东桥主线拓宽改造
方案研究 陈 娜(22)
- 武汉市高新大道综合改造路面结构方案设计
..... 程小亮, 王 阳, 赵乾文, 赵 宇(26)
- 建筑垃圾回填道路基层材料关键技术研究
..... 余 萌, 廖 鑫(30)
- 建筑弃土在道路工程中资源化利用关键技术
..... 景 啸(34)
- 道路软基路堤的沉降动态控制方法研究
..... 沈 蕴, 徐 亮(39)
- 单斜岩质地层重力式挡墙抗滑移合理性设计
..... 文继涛(42)
- 基于 5G+ 智慧灯杆的区域交通协调优化控制
系统功能分析与研究 步春江(45)
- 智能网联汽车测试场景设计方法研究
..... 孔令旗, 陈天姿, 冀建波(49)

桥梁结构

- 瑞士城市桥梁建设印象 穆祥纯(52)
- 基于工业化建造的整体预制连续架设型钢-
混凝土组合梁设计
..... 张春雷, 颜 海, 程 斌(56)
- 大跨度钢桁拱桥设计关键技术 孙 亮(61)
- 鱼腹式连续箱梁桥设计 解文光(65)
- 荆州楚都大道跨海子湖特大桥设计
..... 黄权锋(69)
- 杭州市运河主跨 145 m 人行桥反向芬克式桁架
方案技术可行性论证 姚 政(72)
- 大跨度拱桥吊杆索力的测试研究
..... 林天然(75)

期刊基本参数: CN 31-1602/U * 1984 * m * A4 * 230 * zh * P * ¥25.00 * 5000 * 60 * 2021-04

- 曲线桥梁抗倾覆稳定参数分析 顾晓毅(78)
- 城市云道的人致振动舒适度分析
..... 徐家慧, 黄永辉(81)
- CAD 和 Midas/Civil 用于异形结构杆板单元混合建模
设计 刘勇, 赵毓欣, 张海鹏(84)
- 桥梁景观设计实践与分析 邢洪扬(88)

防洪排水

- 淄博新暴雨强度公式下 LID 建设影响探讨
..... 徐继伟(91)
- 上海堤防工程钢板桩围堰标准研究与应用探析
..... 田爱平, 张郁琢, 毋冬青(94)
- 雨水口截污挂篮和球形垃圾拦截器削减泵站放江
污染物研究 李臻, 陈忱(98)
- 浅谈嘉定新城健康科技有限公司研发中心项目防汛
论证 胡振栋(101)
- 浅谈城市轨道交通建设项目水土保持防治措施
..... 任涓(104)

管理施工

- 软土地区大断面矩形顶管浅覆土下穿高速变形控制
分析研究 胡文(108)
- 地下车站的混凝土开裂数值分析及抗裂试验研究
..... 朱继文, 成琨, 李兆华, 戴慧丽(115)
- 溇藻浜大桥主缆系统施工方法 王培晓(121)
- 波形钢腹板 PC 组合箱梁双挂篮合龙技术
..... 王兵(125)
- 沪苏通长江大桥主塔钢锚梁定位技术
..... 黄红林(128)
- 合铜黄高速特大桥制造安装工艺
..... 吕正东, 桂文涛, 叶顺(132)
- 基于移动钢模板的小箱梁流水预制技术
..... 李宝山, 石峰, 杨岳彪, 谢翔宇(135)
- 道路隧道工程钢管幕超前支护施工技术
..... 钱晓晖(138)
- 桥梁预制拼装体外预应力损耗及转向块功效探讨
..... 王会文(143)
- 上海浏港大桥主桥施工关键工艺技术
..... 王鹏, 桂文涛, 叶顺(148)
- 泵闸工程大体积混凝土结构裂缝控制关键技术研究
..... 潘源(153)
- 山丘区行洪河道汛期清淤施工方案分析——以合肥
二十埠河为例
..... 王宁, 杨蕾, 张力, 刘邦俊, 徐玉亭(157)
- 外环运河综合整治工程施工技术研究
..... 陈云兰(160)
- 快速分区围堰法装配式改造箱涵便道桥施工
..... 张弛, 龙莉波, 陆锴, 杨寅君(163)

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钢-混组合梁桥面铺装 UHPC 施工要点研究
 苏凯, 杨媛媛, 程斌, 何昌轩, 许严(167)
 沿海地区软弱下卧层地基处理方式浅析
 李雪峰, 徐辉, 孙晨然(170)
 对老路改造过程中现状浅埋管线保护技术的改进
 睦封云(173)
 提篮拱桥拱座外表面养护技术的研究
 赵宁宁, 蔡海波(175)
 云龙湾自锚式悬索桥桥梁管理微信小程序开发
 杨文慧, 任清顺(178)

科技研究

不同含水率下石灰改良红层泥岩土的力学特性试验
 研究 李俊峰(181)
 不同应力路径下上海地区软黏土三轴试验研究
 胡立明(186)
 钢筋混凝土结构正截面承载力统一算法研究
 张泉(190)
 UHPC 在连续组合梁负弯矩区的受力性能研究
 张策(195)
 超大断面隧道设计计算方法研究 陈福斌(200)

成果应用

跨座式单轨交通 PC 轨道梁预制技术研究及应用
 焦国臣(204)
 初探 BIM 技术在装配式桥梁工程中的应用
 张捷(209)

相关专业

基于乌鲁木齐市某综合管廊项目的相关设计问题
 探讨 张海银(213)
 倾斜 PHC 管桩的处理方法及剩余承载力研究
 何稼超(217)
 浅析依托工程的科研项目实施与经费管理方式
 张任杰(221)
 工程项目审计问题与环境现状分析及对策研究
 丁琳(224)

政策规范

今年将从八方面全力实施城市更新 全国政协常委、
 住房和城乡建设部副部长黄艳专访 (226)
 2021年3月实施的工程建设标准 (229)

常任理事单位名单 (前插3)
 理事单位名单 (前插4)
 编委成员单位名单 (目次2)
 封面工程 (目次3)

广告索引

广1 乌鲁木齐市城建设计研究院(封2)
 广2 合肥市规划设计研究院(前插1)
 广3 上海陈政市政工程有限公司(前插2)
 广4 《城市道桥与防洪》杂志公益广告(封3)
 广5 青岛润邦防水建材有限公司(封4)
 广6 南塑建材塑胶制品(深圳)有限公司(后插1)
 广7~21 《城市道桥与防洪》杂志(补白)

封面工程

本期封面工程为泸州市沱江四桥及连接线工程,建设单位为泸州市住房与城乡建设局,设计单位为林同棧国际工程咨询(中国)有限公司。

泸州市沱江四桥及连接线工程位于沱江与长江交汇处上游,起于泸州马屋基立交,止于蜀泸立交,是泸州二环快速路的一段,路线全长约 3.8 km。

该项目是跨越沱江的重要过江通道,采用了城市快速路与轨道交通线路平层合建、近远期结合使用模式。主线近期横断面为双向 8 车道,远期横断面为双向 6 车道 + 轨道交通通道。全线包含跨江大桥 1 座、互通式立交 1 座,高架桥梁 4 座。跨江主桥为独塔双索面混合梁斜拉桥,跨径布置为 55 m+200 m+58 m+50 m。

该项目于 2014 年 12 月开工建设,2018 年 1 月建成通车。作为跨越沱江的地标性城市桥梁,沱江四桥的桥梁造型与酒城泸州的地域文化相融合,交通功能近远期结合,功能分区与桥梁造型融合,实现了桥梁在功能、美学、文化传承与工艺、技术方面的融合统一。

项目获奖:2018 年度“四川省公路科学技术奖”二等奖,2018 年度“中国公路学会科学技术奖”三等奖,2019 年度“重庆市优秀工程勘察设计一等奖”。

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Urban Roads, Bridges & Flood Control

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Number 4, 2021(Total Number 264)

CONTENTS

ROADS & COMMUNICATION

Design of Interchange Reconstruction and Expansion Scheme

..... XU Jiangjie, TIAN Rui, CHEN Jiongzha(1)

Abstract: The reconstruction and extension project of Shenzhen Jihe Expressway is the first project of double-layer three-dimensional composite expressway in China. As there are many interchanges along the expressway, it is necessary to study and design its reconstruction and expansion scheme. In this paper, the present situation of the expressway is analyzed and the traffic volume is forecasted. Under the overall scheme of rebuilding and expanding the main line into a double-layer three-dimensional composite expressway, and combined with the traffic function, traffic volume and surrounding conditions along the line, it is compared and contrasted in this paper of the design scheme of rebuilding and expanding the interchanges between Jihe Expressway and two adjacent urban roads. The recommended scheme is thus determined. Through simulation and evaluation, it is found that the overall service level of the proposed interchange is good, the traffic operation is smooth and the two adjacent roads meet the annual traffic demand in the long term. Therefore, the traffic pressure is relieved.

Keywords: double-layer three-dimensional composite highway, interchange, reconstruction and extension design

Study on the Reconstruction Scheme of Tianchi Mountain Interchange of the Ring Expressway

..... WANG Jian, SHEN Xuefang(4)

Abstract: Studied in this paper is the reconstruction scheme of the Tianchi Mountain Interchange Project of Suzhou Belt Expressway. The problems existing in current Jianchi Mountain Interchange are analyzed herein and five reconstruction principles are proposed. On this basis, four transformation schemes are put forward, which are "leaf type double-layer interchange + straight level crossing", "Y-type three-story interchange + straight up span", "B-type single trumpet interchange + straight level crossing" and "optimized B-type single trumpet interchange + straight level crossing". The comprehensive comparison and selection are made from the aspects of interchange capacity, driving safety, interchange floor space and aesthetics of interchange alignment. Finally, the optimal design method is selected. The implementation of the reconstruction project brings about the following good effects: It meets the steering function of the interchange, makes the best use of the original interchange facilities, saves resources, ensures traffic safety and meets the carrying capacity. It has become the first gateway of the high-tech zone for entering and leaving the belt expressway, promoting the integrated development of highway and urban expressway.

Keywords: belt expressway, interchange, entrance and exit, reconstruction, tramcar

Research on Reconstruction and Extension Design of Yongwu Interchange in Nanning City Ring Expressway

..... PANG Zanlong, CEN Zuomin(8)

Abstract: In order to solve the traffic dilemma of "fast ring but not fast" in Nanning, it is necessary to improve the traffic nodes along the route. Taking the reconstruction and extension project of Yongwu interchange in Nanning City Ring Expressway as an example, a research is made on the design of the reconstruction and extension of urban interchange. Based on the analysis of the current situation, existing problems, functions and traffic characteristics of Yongwu Interchange, the idea of interchange transformation is combed and the key points of the interchange scheme selection are summarized. Micro-simulation models were established based on the respective current situation and the improved interchange type for the analysis of the effect of the improved interchange reconstruction. It is concluded that the traffic is smooth and continuous, the service level is upgraded from F to C, and the improvement effect is significant after the interchange transformation. It is finally concluded that the function orientation of urban interchange reconstruction and expansion should be adapted to the overall urban traffic planning and the existing interchange, and the existing interchange should be comprehensively investigated and analyzed. On the premise of meeting the traffic demand, the scheme comparison should be carried out from the aspects of land acquisition, demolition and removal, project investment, and etc. The design scheme should be convenient for construction and organization so as to reduce the negative impact of reconstruction and extension of the project on the existing road traffic and the production and life of residents along the route.

Keywords: urban interchange, reconstruction and extension design, scheme selection, model simulation evaluation

Analyses on Traffic Jam on Urban Section of Songshanhu Arterial in Dongguan and Treatment Measures

..... LIN Yang, LIU Yongping(12)

Abstract: In view of the frequent traffic congestion in the entry section of Songshanhe Avenue during rush hours, the causes of traffic congestion are analyzed in this paper from the three aspects of mode of travel, layout of road network and road intersections. According to the development objectives of urban traffic efficiency, the overall strategy of road traffic development and the strategy of road traffic control that are proposed in the *White Paper on Traffic Development of Dongguan*, it is proposed that the traffic management measures are the main technical means for recent traffic congestion control, engineering measures are mainly taken in the medium term, and in the long run, the local palliative measures in the short and medium term will be upgraded to the systematic fundamental measures based on urban layout structure, optimizing and perfecting road network planning and building high-quality traffic corridors. Finally, the mode of urban traffic congestion management in the future is at prospect.

Keywords: urban arterial, traffic jam, treatment measure

Research and Practice of Urban Waterfront Road Construction

..... WU Kun, SU Kai(15)

Abstract: The existing problems of the current waterfront of Suzhou Creek in Jingan District are analyzed in this paper for the improvement of the design of waterfront on both banks of the creek. Combined with the construction plan and current situation of both banks of Suzhou Creek, it is identified that the main function of waterfront roads is the walking leisure and landscape function, supplemented by the traffic function of motor vehicles. It is determined that the design concept is weakening the traffic function,

releasing the slow traffic space, diversifying the design of platforms close to water. On this basis, the concrete implementation plan is studied from the aspects of the overall cross section's reconstruction, breakpoints' connection, bright spots' creation and traffic needs. Finally, it is concluded that the construction of waterfront roads should improve the environmental quality of public space based on demands and carry out engineering technology treatment based on space-experience.

Keywords: waterfront roads, waterfront space planning, functional positioning, design concept, slow traffic System

Problems for Attention in Planning and Construction of Urban Expressway in Wuxi
..... YANG Wei(18)

Abstract: Urban expressways are the main means to alleviate urban congestion. In this paper, the urban characteristics of Wuxi are introduced and the evolution of Wuxi's urban expressway network is reviewed. Based on the experience of Wuxi expressway network construction, the issues that should be paid attention to in expressway planning and construction are summarized. The expressway planning was discussed from the four aspects of construction necessity, urban planning, passenger and freight separation and route selection. At the implementation level, the importance of the timing and setting form of expressway construction is emphasized, and the concept of "slow-in and fast-out" is followed.

Keywords: urban expressway, evolution, planning and construction, route selection, construction sequence

Study on Widening and Reconstruction of the Main Line of Taihedong Bridge in Beijing Economic and Technological Development Zone CHEN Na(22)

Abstract: In order to increase the traffic capacity of the interchange node of Taihedong Bridge, a scheme analysis and study was carried out on the project of widening and reconstructing the main line of Taihedong Bridge. After combing the current conditions, interpreting the planned scheme and analysing the project function, the design principles for the widening and reconstruction of project are determined. In this paper, the three reconstruction schemes of widening on both sides, building on both sides and building on the east side are compared and contrasted. The recommended scheme of building on the east side is reviewed from the three aspects of flat line position, vertical section, cross-section and pavement structure. It is summarized in this paper how to transform the interchange node to meet the traffic demand on the basis of using existing resources and avoiding large scale demolition and construction.

Keywords: interchange node, main line, widening and reconstruction, scheme design, scheme comparison and selection

Design of Comprehensive Reconstruction Pavement Structure of Gaoxin Avenue in Wuhan
..... CHENG Xiaoliang, WANG Yang, ZHAO Qianwen, ZHAO Yu(26)

Abstract: With the introduction of the current pavement technology of Gaoxin Avenue, the causes of the disease are analyzed. The design parameter is estimated according to the monitoring data. Based on the design concept of long-life pavement, the technical and economic comparison is made among three pavement reconstruction schemes, namely overlay construction to repair old roads, reconstruction of fully demolished old roads and reconstruction of partially demolished old roads. Finally, the overall design scheme of continuous reinforced concrete composite asphalt pavement is determined. On this basis, the

local disease treatment of the existing road and the pavement structure of special sections are further designed.

Keywords: road engineering, pavement reconstruction, design scheme, continuous reinforced concrete, composite pavement

Research on key technology of Road Base Material Backfilled with Construction Waste
..... YU Meng, LIAO Xin(30)

Abstract: With the improvement of low-carbon recyclable construction technology, the application technology of construction waste for road base backfilling is becoming more and more mature. In this paper, the recycled cement with 0% ~ 50% recycled aggregate of different content is used to stabilize macadam, and its maximum dry density, optimum moisture content, unconfined compressive strength, frost resistance and scour resistance are studied. The results show that the maximum dry density, the unconfined compressive strength, frost resistance and scour resistance of the stabilized macadam decrease with the increase of recycled aggregate. Among them, the frost resistance is the most sensitive to changes in the content of the recycled aggregate. Based on the main performance changes, it is suggested that the amount of recycled aggregate should be controlled within 30% in the base material of construction waste backfilling road.

Keywords: construction waste, recycled aggregate, base material, unconfined compressive strength, frost resistance

Key Technologies of Resourced Utilization for Construction Waste Soil in Road Projects
..... JING Xiao(34)

Abstract: Through research, analysis, theoretical calculations, laboratory tests and engineering applications, a complete set of design and construction techniques is formed for local reinforcement of weak foundation and treatment of abandoned soil as road subgrade or site filler. The technical bottleneck is broken by solving the difficulties in both of the utilization of abandoned high water-containing soil from urban construction projects and resource promotion. Both of the on-site comprehensive utilization of abandoned soil and the "zero waste" balance of earthwork of single or multiple projects are achieved. Meanwhile, after combination with the implementation verification and tracking observation of the test section of Xihong Bridge in Ningbo, the technology and complete process are proposed for subgrade filling after solidifying soft foundation and waste silt soil(mud) in soft soil area. This research has the extensive popularization value for the utilization of abandoned soil and earthwork balance in soft soil areas.

Keywords: construction waste soil, high water content, road project, solidification using

Study on Dynamic Settlement Control Method of Road Embankment with Soft Foundation
..... SHEN Yun, XU Liang (39)

Abstract: These two factors of geological survey and foundation treatment scheme will influence the calculation of construction settlement. Based on this, combined with a municipal road soft foundation embankment treatment project, the dynamic settlement control method is discussed. The significance of soft foundation quality exploration is made clearly. The common soft foundation schemes of replacement method, riprapping method, preloading method and cement mixing pile method are discussed. The preloading method as an example is analyzed. The design of construction scheme and the calculation of

consolidation settlement are introduced in detail. Finally, the dynamic settlement control method is proposed, which can be referred for the similar projects.

Keywords: municipal road engineering, soft foundation embankment, settlement control, preloading

Rational Design of Anti Sliding of Heavy Retaining Wall in Monoclinic Rock Stratum WEN Jitao(42)

Abstract: Rational Design of Anti Sliding of Heavy Retaining Wall in Monoclinic Rock Stratum Wen JitaoAbstract;This paper is based on the construction of gravity retaining wall on monoclinic rock stratum which is more common in mountainous areas of Southwest China. A reasonable design scheme for anti-slide displacement of foundation is proposed after economic and technical comparison of the six foundation treatment methods of horizontal base, inclined base, anchor rod foundation, step foundation, increasement of embedded depth, step and anchor combined foundation and analysis on the advantages and disadvantages of these respective approaches.

Keywords: Unilaterally dipping strata; gravity retaining wall; foundation treatment; anti sliding; economy

Function Analysis and Research of Regional Traffic Coordination Optimization Control System Based on 5G Smart Light Pole BU Chunjiang(45)

Abstract: With the steady progress of domestic urbanization, the concept of smart transportation has been gradually and widely concerned. In the construction of smart transportation, on-board sensors cannot play a key role in avoiding road congestion and optimizing driving routes due to the limitations of their carriers. The model of vehicle-road collaboration has attracted more and more attention from researchers. Smart light poles become the best sensing carrier in the construction of smart transportation due to their scalability. A series of sensing devices such as monitoring facilities, broadcasting, large screens, various sensors and detectors can be installed on the poles. Relying on 5G technology, the relevant traffic management departments can control the real-time traffic operation more timely. By establishing both of the traffic-flow prediction model and the regional traffic coordination optimization model, the operation of road traffic flow in the short and medium term is predicted in advance. Relying on the city perception network and directional broadcasting system woven by 5G+ smart light poles, it can make quantitative decisions on vehicle owners along the way and carry out efficient and effective management of urban road traffic. Based on the engineering example of Shanghai 5G + smart light pole, analysis and research are made on the system of regional traffic coordination and optimization control, which is developed on the basis of traffic flow prediction model.

Keywords: 5G technology, smart light poles, vehicle-road coordination, traffic flow prediction model, directional traffic guidance, regional traffic coordination control system.

Study on Scenario Design of Intelligent and Networked Automobile Test Field KONG Lingqi, CHEN Tianzi, JI Jianbo(49)

Abstract: The intelligent networked automobile test field is the infrastructure for the safty test of driverless vehicles. The core of test field design is to build test scenarios and to analyze the design elements and technical specifications of the test field. Based on the classification of the test scenario of "car-road-environment ", the construction method and requirements are proposed, which can be used to support the overall design of the test field of intelligent networked vehicles.

Keywords: intelligent connected vehicle, test field, safety test, test scenarios

BRIDGES & STRUCTURES

Impression of Urban Bridge Construction in Switzerland MU Xiangchun(52)

Abstract: Introduced in this paper is the general impression of the bridge study in Bern and Lucerne, Switzerland. Bridges in Switzerland are divided into three different kinds, which are "Swiss ancient urban bridges", "Swiss urban long span bridges" and "Swiss urban pedestrian bridges". It reflects the concept and level of bridge construction of the Swiss people in respective ancient and modern times, highlights the customs and habits, life style and national emotion of a multicultural country and also reflects the profound bridge culture of Switzerland.

Keywords: Sweden, urban bridge, ancient bridge, long-span bridge, pedestrian bridge

Design of Integral Prefabricated Continuous Erection Shaped Steel-concrete Composite Girder Based on Industrialized Construction ZHANG Chunlei, YAN Hai, CHENG Bin(56)

Abstract: The steel-concrete composite girder is easy to be prefabricated and assembled, and is a kind of bridge adapted for the requirements of industrialized construction. Based on the industrialized construction thinking, the H-steel with the maximum height of 1.1m or so is used. An integral prefabricated continuous erection shaped steel-concrete composite girder is proposed. Taking 5 × 30 continuous girder as an example, the design concept, structural construction and construction steps are introduced. The mechanical performances of structure are calculated, analyzed and studied including the bearing capacity, integral stability and rigidity of structure, and the lateral stress of bridge deck and the crack width of hogging moment area. The shaped steel-concrete composite girder has the strong economic efficiency and competitive power because of its high factory manufacturing efficiency, fast field construction speed and good stress performance. By taking the proper structural measures, its span can be further extended on the basis of 30 m.

Keywords: industrialized construction, composite girder, shaped steel, integral prefabricated, continuous erection.

Key Technique for Design of Long-span Steel Truss Arch Bridge SUN Liang(61)

Abstract: Liuzhou Bailu Bridge is a continuous steel truss arch bridge with a main span of 288 m, using two main trusses with a center distance of 37 m. In view of the characteristics of the side span truss beam with low height and large transverse width, the web members are designed as variable cross-sections, and the adverse effects of the transverse frame effect are eliminated by reducing the linear stiffness and increasing the cross-sectional area. The relatively simple rhombus truss design is adopted in longitudinal connection, taking into account the mechanical rationality and aesthetic properties of the structure. The orthotropic integral bridge deck with dense beam system is adopted to avoid the out-of-plane bending of the beam during the interaction between the deck and the main truss. Flexible suspenders are adopted for the improvement of the aerodynamic performance of the structure and the reduction of influence of wind-induced vibration. The side-span flat-chord main truss is constructed with the bracket and semi-cantilever method. The construction plan of cantilever erection by arch crane with assistance of temporary piers is adopted for the middle-span arch ring,

and the bridge deck is erected synchronously with the main truss.

Keywords: bridge engineering, steel truss arch bridge, large spacing main truss, integral bridge deck with dense beam, flexible suspender, cantilever construction.

Design of fish-belly continuous box girder Bridge XIE Wenguang(65)

Abstract: The negative bending moment at the fulcrum of continuous beam bridge is used to reduce the positive bending moment in the middle of the span, which effectively disperses the stress of each section, and thus increases the span of the bridge. The side webs of fish bellied continuous box girder bridge are streamline in shape, which not only increases the bending and torsional stiffness of the interface, but also has an aesthetic appearance. The development of cast-in-place continuous box girder bridge enables the bridge to adapt to a variety of cross-sectional forms and alignment designs, but at the same time increases the complexity of the structure. Therefore, the precise calculation and adjustment of the fish-belly continuous girder bridge are needed to ensure its safety and reliability. Through an example of fish-belly continuous box girder bridge, the plane and spatial finite element model is applied to calculate, adjust and optimize the bridge structure, so as to ensure that the longitudinal, transverse and bridge panel meet the requirements of stress and crack resistance, and provide reference for the design of similar bridges.

Keywords: fish bellied, continuous box girder bridge, prestress, finite element simulation

Design of Cross Haizi Lake Bridge on Chu Du Avenue, Jingzhou HUANG Quanfeng(69)

Abstract: Chudu Avenue is the main road for Jingzhou City to develop northward. It is also the main passage to Jingzhou Garden Expo. The scheme of multi-span variable-section continuous beam bridge is adopted with an overall arrangement. The span of the bridge is 65 m + 123 m + 156 m + 123 m + 10 × 90 m + 55 m, with a total length of 1 434 m (including abutment). There are no mature engineering examples of bridges with such span and length. The length of the continuous beam of the bridge is the first of the total length of the same type of bridges at home and abroad.

Keywords: landscape bridge, superlong continuous beams, concrete structure, suspension construction

Demonstration of the Technical Feasibility of the Reverse Fink Truss Scheme of the Main 145 m Walk Bridge Across the Canal in Hangzhou City YAO Zheng(72)

Abstract: Hangzhou Canal Pedestrian Bridge is an Inverted Fink truss bridge of 22.5 m+145 m+22.5 m. It has been widely praised by the public for its scientific and reasonable mechanical characteristics, fine slender shape and for the novel and beautiful structure. The design characteristics, internal force analysis and main calculation results are expounded, and the construction points are briefly introduced.

Keywords: inverted Fink truss bridge, bridge tower, cables, support bar, main beam, design, construction

Research on Test of Suspender Cable Force of Long-span Arch Bridge LIN Tianran(75)

Abstract: Taking the test of suspender cable force of a long span arch bridge as an example, this paper introduces the test methods of suspender cable force, and on the basis of measuring cable force with frequency method, a unified correction value of the calculated length of a suspender is used to correct the measured cable force. The results show that: this method is simple and reliable, and can be used for reference for the cable force measurement of similar arch bridges.

Keywords: arch bridge, suspender cable force, frequency method, corrected length

Analysis on Anti-overturning Stability Parameters of Curved Bridge GU Xiaoyi (78)

Abstract: Based on the parameter analysis, the influence of support layout, plane central angle and curvature radius of curved bridge on its anti-overturning stability is discussed. The result shows that the adoption of double support and the reduction of single-bridge central angle of the middle pier can effectively improve the anti-overturning stability of curved bridge. When the central angle $\varphi < 21.5^\circ \sim 34^\circ$, the anti-overturning stability coefficient tends to stabilize.

Keywords: curved bridge, anti-overturning stability, support, central angle, curvature radius

Analysis of Human Induced Vibration Comfort of Urban Skywalk XU Jiahui, HUANG Yonghui(81)

Abstract: In this paper, the domestic and foreign specifications on the traffic comfort of pedestrian bridges are compared comprehensively. Based on the research background of the engineering of pedestrian bridge in a city, the finite element model of the background engineering is built with the use of the large general finite element analysis software Midas/Civil. Its acceleration response under crowd load is calculated. Finally, the evaluation of the comfort of footbridges is performed with reference to the comfort evaluation method of the German pedestrian bridge design specification and some related suggestions are put forward.

Keywords: skywalk, pedestrian bridge, people to vibration, comfort

Application of CAD and MIDAS /Civil to Hybrid Modeling Design of Rod and Plate Elements of Special-shaped Structure LIU Yong, ZHAO Yuxin, ZHANG Haipeng(84)

Abstract: Taking the load-bearing arch truss with cable hanging basket and bottom basket as an example, this paper mainly introduces the implementation process of the case of mixed modeling of rod and plate elements of the heteromorphic structure by using CAD and Midas/Civil to potimize the temporary structure, which provides some ideas for the optimal design of similar temporary structure.

Keywords: heteromorphic structure, cable hanging basket bottom basket bearing arch truss, rod and plate element hybrid modeling, Midas/Civil

Practice and Analysis of Bridge Landscape Design XING Hongyang(88)

Abstract: The importance of bridge landscape design is analyzed with the aim of building beautiful China and beautiful highway. It is discussed in detail about the selection of structure of the three big bridges of Dawu bridge, Beijing-Hangzhou Grand Canal Bridge at the Provincial Highway 344 and Jinma Bridge, and about the package design of decorative arch, decorative suspension, decorative cable of the four small and medium sized bridges of Chuanxingang Bridge, Yingjiang Bridge, Zhoupan Zhonggou Bridge and Nanma Zhonggou Bridge. The design experience and application prospect are analysed further.

Keywords: beautiful China, beautiful highway, bridge landscape, design practice, design experience, application prospect

FLOOD CONTROL & DRAINAGE

Discussion on the Impact of LID Construction under the New Rainstorm Intensity Formula in Zibo

..... XU Jiwei(91)

Abstract: The current formula of rainstorm intensity in Zibo City was compiled in the early 1980s. With the implementation of the spirit of *Notice of the General Office of the State Council on the Construction of Urban Drainage and Waterlogging Prevention Facilities* (GBF [2013] No. 23), significant changes have taken place in the intensity and distribution characteristics of regional short-duration heavy precipitation in the context of climate change and rapid urbanization. In December 2014, the new version of rainstorm intensity formula for the main urban area, which was compiled by Zibo Meteorological Bureau and reviewed by Zibo Meteorological Bureau and Zibo Housing and Development Bureau, began to be applied to practice. By comparing the old and new formulas with the urban development, and combining with the concept of urban low-impact development, the issues that require attention in design are discussed.

Keywords: rainstorm intensity formula, LID low impact development, design

Research on Standard and Application of Steel Sheet Pile Cofferdam in Shanghai Levee Project

..... TIAN Aiping, ZHANG Yuzhuo, MU Dongqing(94)

Abstract: The construction of cofferdam is an important temporary project to create dry land construction conditions for levee engineering. In recent years, steel sheet pile cofferdam has been widely used because of its safety, reliability, strong adaptability, green environmental protection and other characteristics. However, the construction design of steel sheet pile cofferdam is still based on experience judgment, and the methods of engineering analogy and theoretical calculation are usually adopted. In view of the lack of standard for cofferdam construction in levee engineering in Shanghai, the main points of design and construction of steel sheet pile cofferdam are pointed out in this paper, based on the actual operation and management of levee in Shanghai. It is put forward in this paper of the application assumption of steel sheet pile cofferdam and temporary flood wall in combination with the actual levee engineering. This study provides an effective way for standardizing cofferdam design, shortening construction period, reducing construction cost and improving the level of fine management of levee engineering.

Keywords: levee engineering in Shanghai, steel sheet pile cofferdam, design points, construction points, temporary floodwall

Study on Reduction of Pollutants from Pumping Stations with Hanging Basket for Sewage Interception at Storm Inlet

..... LI Zhen, CHEN Chen(98)

Abstract: For the purpose to solve the problem of black and smelly river caused by mixed sewage and initial rainwater discharged through rainwater pumping station, the rainwater sewage interception hanging basket device and the spherical garbage interception device were studied and installed in some areas. The structure, installation method and technical points of two kinds of trash interceptors are introduced. According to the practical effect of the application of trash interceptors, the benefits are analysed, the existing problems of the trash interceptors are pointed out, and the proposal is made to further increase the specifications and categories of the product so as to reduce both of the different pollutants and the water pollution caused by pumping station discharge.

Keywords: garbage interceptor, hanging basket for sewage interception, storm inlet, river course

Discussion on Flood Prevention Demonstration of R & D Center Project of Jiading Xincheng Health Technology Co., Ltd

..... HU Zhendong(101)

Abstract: Based on the analysis of the necessity of the special demonstration of the impact of flood control on the underground public works in specific project, The flood control safety impact during the construction period and the service period is studied respectively. The finite element software is used to analyze the impact of the construction period on the surrounding flood control facilities. Some reasonable suggestions are put forward for the hidden dangers of flood control safety during both of the construction period and service period of the underground public works. Finally, the conclusion of flood control demonstration is drawn.

Keywords: Flood control demonstration, underground public works, flood control facilities

Discussion on Prevention and Control Measures of Soil and Water Conservation in Urban Rail Transit Construction Project REN Juan(104)

Abstract: Taking a rail transit project in Xuhui District of Shanghai as an example, this paper analyzes the characteristics of both soil erosion and that of the prevention and control zones in the construction of this type of production project. The overall layout of water and soil conservation measures is planned, which ensures the full and effective functioning of the city water and soil conservation measures for rail transit projects.

Keywords: urban rail transit, soil and water conservation, prevention zone, measures

MANAGEMENT & CONSTRUCTION

Settlement Control Investigation on Large Quasi-Rectangular Pipe Jacking Tunnelling under Expressway with Shallow Overburden in Soft Soil Areas HU Wen(108)

Abstract: Based on the connecting project of Luxiang Road-Qilianshan Road in Shanghai, settlement control measures of large quasi-rectangular pipe jacking tunnelling under S20 expressway with shallow overburden is discussed. Design and engineering application of steel pipe roof is introduced. The deformation caused by high-speed construction under the outer ring of S20 is analyzed by using three-dimensional numerical simulation. The numerical prediction of S20 expressway settlement coincides with the in-situ measured data. Successful application of this project confirms the feasibility of steel pipe roof to attenuate the unfavorable effect caused by large Quasi-Rectangular Pipe Jacking. Thus high referential value will be offered for future engineering projects undercrossing expressway in soft soil areas.

Keywords: quasi-rectangular pipe jacking tunnel, steel pipe roof, expressway undercrossing, numerical analysis

Numerical analysis and experimental study on concrete cracking of underground station

..... ZHU Jiwen, CHENG Kun, LI Zhaohua, DAI Huili(115)

Abstract: For the leakage problem of underground station in water-rich soft soil layer in Shanghai and based on the analysis of concrete cracking principle, the finite element damage model of concrete structure of subway station is established. It reveals the characteristics of concrete crack initiation, the distribution and development law of concrete cracks under load of soil and water. In this paper, the temperature-strain field experiment of concrete is carried out by using fiber grating monitoring technology, and the temperature of concrete structure and law of its strain variation in the whole process of construction is obtained. Impact analysis of the temperature, maintenance time, anti-crack agent and other factors is made

on the issue of the concrete cracking. The research shows that there are through and non-through cracks according to their morphological characteristics, in which the through cracks can cause the leakage of the station structure. Because of the constraints, the through-crack mainly occurs in the sidewall near the middle plate and soleplate. Adding anti-crack agent and prolonging maintenance time can effectively improve concrete crack resistance and waterproof impermeability.

Keywords: subway station; concrete crack; numerical analysis; field monitoring; anti-crack agent

Construction Method for the Main Cable System of Yunzaobang Bridge WANG Peixiao(121)

Abstract: The construction for the main cable system of self-anchored suspension bridge is the important part of construction control. Higher construction requirements are expected as the spatial cable changes greatly along with the changes of cable stress of spatial cable plane self-anchored suspension bridge from free cable state to finished bridge state. By taking pertinent construction control measures, the construction difficulties of the main cable system of spatial cable plane self-anchored suspension bridge can be solved effectively.

Keywords: self-anchored suspension bridge, main cable system, spatial cable plane, construction method

Double Hanging Basket Closure Technology of PC Composite Box Girder with Corrugated Steel Webs

..... WANG Bing(125)

Abstract: Corrugated steel web-PC (prestressed concrete) composite box girder originated in France in the 1980s, was accepted and popularized in Japan in the early 1990s, and has become the recommended bridge type for Japan's expressways now. In recent years, the domestic corrugated steel web PC box girder has been gradually applied to the long-span continuous beam bridge and cable-stayed bridge from the small and medium span at the beginning, and the commonly used construction methods are bracket method, cantilever method and push method. The construction of the closure section, as the most critical working procedure of the cantilever construction, is directly related to the linearity of the main beam and the overall stress state of the bridge.

Keywords: cable-stayed bridge, corrugated steel web PC composite box girder, double hanging basket, closure

Positioning Technology of Steel Anchor Beam of Main Tower of Shanghai-Suzhou-Nantong Yangtze River Bridge

..... HUANG Honglin(128)

Abstract: For cable-stayed bridges, steel anchor beam is a component connecting cable and main tower. It is arranged in the tower column layer by layer. The stay cable is anchored to the steel anchor beam after passing through the conduit pipe. The main tower of Shanghai-Suzhou-Nantong Yangtze River Bridge is far from the shore and is characteristic with large span, high tower and big plane size. Introduced in this paper are the method and technology of accurate positioning of steel anchor beam under the adverse conditions of strong wind, sunshine temperature change, tower torsion deformation, complex construction environment, etc. The research results can be used for reference to other similar cable-stayed bridges.

Keywords: Shanghai-Nantong River Bridge, main tower, steel anchor beam; location

Brief Analysis of the Manufacturing and Installation Process of Yetonghuang Large High-Speed Bridge

..... LYU Zhengdong, GUI Wentao, YE Shun(132)

Abstract: Hetonghuang Bridge is a box- cross-section basket arch bridge spanning 280m. Within the scope of the main bridge project, the plane linear circular curve is connected to the straight line, which is located on the 2.074% one-way longitudinal slope. The steel box section is adopted for the arch rib. The width of the main bridge deck structure is 31.0 m, and the outside of the bridge is on the left and right. Based on this project, the key technology of manufacture and installation of box cross section basket arch bridge is discussed.

Keywords: basket arch bridge, steel-concrete composite beam, assembly matching fabrication, bridge construction, manufacturing technology

Prefabrication Technology of Small Box Girder Based on Mobile Steel Formwork

..... LI Baoshan, SHI Feng, YANG Yuebiao, XIE Xiangyu(135)

Abstract: The common steel formwork used in the traditional box girder prefabrication requires coordination of manpower and machinery during the assembly process, which limits the construction efficiency. With the support of prefabricated bridge technology, a higher automatic assembly line based on moving hydraulic steel formwork and prefabrication technology is established. The formwork can be quickly transferred and installed through the rail system, which can improve the prefabrication efficiency of box girder. The example of the reconstruction and extension project of Nanjing urban area is taken in this paper to discuss mainly the application of moving hydraulic steel formwork in the precast construction of small box girder and to analyze its function and applicability in the precast construction of modern box girder.

Keywords: prefabricated bridges, moving hydraulic steel formwork, prestressed small box girder, assembly line construction management

Construction Technology of Steel Pipes Advance Support in Road Tunnel Engineering

..... QIAN Xiaohui(138)

Abstract: Based on the connecting project of Luxiang Road and Qilianshan Road, the construction technology of steel pipes advance support in road tunnel engineering is demonstrated in this paper, when the pipe jacking section of the project passes through the S20 Outer-Ring Expressway. The key technologies such as the pavement deformation control and steel pipes attitude control during the jacking process are solved to ensure the normal traffic of S20 Outer-Ring Expressway. The technical requirements for the advanced support of steel pipe curtain, construction technology and monitoring results are the useful reference for similar projects.

Keywords: road tunnel, advance support, steel pipes, construction technology

Loss of External Prestressing Force and Effect of Steering Block in Prefabricated Bridge Assembly

..... WANG Huiwen(143)

Abstract: In this paper, compaction loss, friction loss and shrinkage and creep loss of the joint are calculated, and the application of finite element ANSYS system to block and rib steering block is used to analyze the effect of prestress loss and two types of steering block structure on engineering technology realization and structural safety in construction. It is valuable for technical reference in the construction of similar bridges.

Keywords: bridge construction, precast assembly, prestress loss, steering block efficiency, analysis and exploration

Key Construction Technology of Shanghai Maogang Bridge WANG Peng, GUI Wentao, YE Shun(148)

Abstract: The main bridge of Shanghai Maogang Bridge is a 225 m long cable-stayed bridge with double tower parallel single cable plane steel tower and steel box girder. The bridge adopts the structural system of fixed connection of tower and beam and separation of tower and pier. A combination of orthotropic deck UHPC is adopted for the main girder bridge deck. Based on this project, the key technology of the manufacture and installation of steel box girder cable-stayed bridge is discussed.

Keywords: cable stayed bridge, large section steel box girder, steel tower, matching manufacturing, bridge construction, manufacturing technology

Research on Key Technologies for Crack Control of Mass Concrete Structure in Pump Sluice Project
..... PAN Yuan(153)

Abstract: Temperature load is one of the main causes for cracks in concrete structure of pump gate. The size of the inlet and outlet channel structure, bottom plate and pier wall in pump gate often belongs to the category of mass concrete. It is complex and heterogeneous with large size and outstanding individuality. If the temperature control measures are unreasonable and the temperature difference between the inside and outside of the concrete pouring block is too large, the structure is prone to produce excessive tensile stress under the effect of deformation constraint and temperature load, which significantly increases the risk of structural cracking.

Keywords: pump gate, temperature control and crack prevention, mass concrete

Analysis of the Construction Plan for the Dredging of the Flood Channel in the Hilly Area— Take the Twenty Bu River in Hefei as an Example WANG Ning, YANG Lei, ZHANG Li, LIU Bangjun, XU Yuting(157)

Abstract: For the desilting construction scheme of flood discharge river course in hilly area in flood season, it is necessary to overcome the difficulties caused by large river discharge volume, high velocity and high water level in flood season, ensure the construction safety, and consider the impact of the construction of the project on the flood discharge of river course. If there are multi-level water storage buildings along the river course, the daily flow of the river is large and the surrounding land-use situation is complex, thus increasing the construction difficulties further. Taking the 20Bu River in Hefei as an example, this paper analyzes the characteristics and difficulties of desilting construction in flood season in hilly area under complex conditions, and expounds how to formulate reasonable construction scheme under such conditions, in order to provide reference for similar projects.

Keywords: flood channel, hilly area, flood season, desilting, construction scheme

Study on Construction Technology of Comprehensive Renovation Project of Outer Ring Canal
..... CHEN Yunlan(160)

Abstract: With the progress of the society, the construction technology has been developed rapidly. The rationality of construction technology has a very important impact on the completion of construction schedule and the economic rationality of the scheme. Canal is an indispensable element of transportation network in modern society. Compared with highway construction, more attention should be paid by all

related organizations to the the safety requirements for water operation on the canal project. Taking the comprehensive renovation project of the outer ring canal as an example, an omnibearing research on engineering was made from the introduction of the initial working conditions of the project, the calculation of construction resources, the arrangement of construction schedule and the guarantee of construction, which can play a guiding role in the smooth construction of the project. The research findings can provide a feasible reference for the construction management of the same type of canals.

Keywords: rainwater and sewage pipe network, construction technology, municipal pipeline

Prefabricated Reconstruction of Box Culvert Shortcut Bridge by Rapid Partition Cofferdam Method
..... ZHANG Chi, LONG Libo, LU Kai, YANG Yinjun(163)

Abstract: On the river where shipping service cannot be suspended, partitioned cofferdam method is used to rapidly reconstruct and expand the simply-supported prefabricated beam bridge to meet the needs of transportation and flood control. At the same time, the original pipeline will be relocated, displaced and protected. Newly constructed bridges with higher vehicle load capacity require foundation treatment and protection behind the abutment.

Keywords: flood prevention, partitioned cofferdam method, prefabricated simply-supported beam bridge, box culvert access road bridge

Study on the Construction Points of UHPC for Steel-Concrete Composite Beam Pavement
..... SU Kai, YANG Yuanyuan, CHENG Bin, HE Changxuan, XU Yan(167)

Abstract: The results of relevant theoretical research in China show that UHPC can effectively inhibit the cracking of the panel of steel-concrete combination beam bridge and improve the crack resistance performance. However, due to the lack of engineering application research in this direction, the practical demonstration results are insufficient. Therefore, taking the rapid reconstruction project of Jiyang Road as the carrier, this paper not only explores and analyzes the construction points of UHPC including on-site mixing, pouring and maintenance, but also indirectly verifies the scientificity and reliability of relevant theoretical research results.

Keywords: UHPC, steel - concrete, bridge panel, Jiyang Road, rapid reconstruction

Analysis on the Treatment of Soft Substratum Foundation in Coastal Area
..... LI Xuefeng, XU Hui, SUN Chenran(170)

Abstract: Either weak or bad soil is often encountered in the engineering construction projects of coastal areas. It is a difficult problem, especially when the construction site is limited by the boundary of underground structures such as rail transit. The soft foundation to be treated in this paper is that of a planned urban rail transit line in the coastal area of Jiangsu Province. Because the long-term planned rail transit line is buried under the foundation, the treatment depth is limited, and the final treatment method is determined to be the interlocking pile arrangement. The solid deep foundation method and Midas GTS software are used for the design and checking calculation.

Keywords: soft soil foundation, high pressure jet grouting pile, diffusion angle

Improvement of the Technology for Protecting Current Shallow Buried Pipeline in the Process of Old Road Reconstruction SUI Fengyun(173)

Abstract: At present, a variety of underground pipelines are buried under the built urban roads. Pipelines of power, telecommunication, gas, water supply and others are buried relatively shallow underground. When the old roads are reconstructed and expanded or new roads are built, the existing pipelines need to be protected after excavation. There are potential safety hazards with traditional protection measures. The improved protection measures can not only eliminate the potential safety hazards, but also facilitate the repair and maintenance of buried pipelines. The construction is simple, fast and efficient. It is easy to operate and improves the development of green economy. Judging from the use of several roads that have been implemented so far, the results are good.

Keywords: old road, current pipeline, protection, potential safety hazard

Research on the Outside Surface Maintenance Technology of the Arch Seat of Basket Arch Bridge

..... ZHAO Ningning,CAI Haibo(175)

Abstract: At present, the anti-corrosion protection measures of bridge concrete are not perfect in our country. The reinforced concrete structures is far from reaching the expected design life due to the lack of necessary protective measures. Elastic coating is a new material which has been developed rapidly in recent years. It has a certain amount of elongation and can satisfy the expansion and contraction of concrete. Compared with common coatings, elastic coatings can work better with concrete to avoid failure of anti-corrosion coating as a result of the tensile crack of coating surface caused by thermal expansion and cold contraction of concrete. The purpose of this project is to explore the anti-corrosion effect and long-term performance of elastic coating on the surface of arch seat of Mingzhou Bridge, and to provide certain reference for other mass concrete engineering anti-corrosion coating.

Keywords: M Mingzhou Bridge, elastic coating, arch seat, arch rib

The Development of Bridge Management Wechat Applet based on Yunlongwan Self-anchored Suspension Bridge

..... YANG Wenhui, REN Qingshun(178)

Abstract: With the growing scale of urban infrastructure construction, infrastructure information management has become a new demand. The life-cycle management of bridge engineering from design and construction to operation and maintenance can greatly improve the efficiency of bridge management by realizing information integrated processing through the Internet. The prosperity of mobile communication technology provides the technical basis for mobile terminals to intervene in the Internet, close the gap between the Internet and the daily work and life. Both of the connection of the mobile terminal to the Internet and the development of bridge life-span management system with lightweight application programs can not only improve the bridge information flow and transmission rate but also provide a theoretical basis for decision-making in the later operation stage of the bridge through effective information integration. Through the application of mobile terminal, the development and use of wechat small program of bridge life cycle management system are studied. The results show that: Based on wechat small program, the establishment of bridge life management system can greatly improve the efficiency of bridge management, provide information basis for decision-making of bridge operation stage, and realize efficient and convenient bridge life management.

Keywords: wechat applet, bridge, bridge management

STUDY ON SCIENCE & TECHNOLOGY

Experimental Study on Mechanical Properties of Lime Modified Red Mudstone Soil with Different Moisture Content LI Junfeng(181)

Abstract: In order to be specialized in the mechanical properties of lime-modified red-bed mudstone under different water content in Qianzhang-Changzhou high-speed rail area, compaction tests were carried out on red-bed mudstone and its lime-modified soil, and the mechanical tests of unconfined compression, CBR, direct shear and others were carried out afterwards considering both of the optimal water content and saturated water content. The test result shows that the optimal water content of the modified red mudstone gradually increases while the maximum dry density gradually decreases with the increase of lime content. Lime can significantly improve the strength and bearing capacity of the red mudstone. However, the improvement effect is related to the water content of the red mudstone itself. In the saturated state, the increase of lime content will improve the CBR value and cohesive force, while the improvement effect of unconfined compressive strength and internal friction angle is not as obvious as the former. On the condition of optimal moisture content, the unconfined compressive strength, cohesion and CBR value gradually get high when the amount of lime blending increases, but the improvement effect on the internal friction angle is not obvious. In addition, the internal friction angle decreases slightly when the lime content exceeds 6%. So it is recommended to use lime to improve the red mudstone in Qianzhangchang area with an optimal mixing ratio of 6%.

Keywords: red mudstone, lime-improved soil, mechanical properties, Qianzhangchang Railway

Triaxial Test of Soft Clay in Shanghai under Different Stress Paths HU Liming(186)

Abstract: The excavation of soil in deep foundation pit is an unloading process, in which the stress state of soil changes constantly. In order to consider the effect of stress path on soil, the undisturbed soft clay of Shanghai deep tunnel project was tested by GDS triaxial apparatus under different stress paths. The stress-strain relationship, pore water pressure variation law, effective stress path and deformation characteristics of soil under different stress paths were analyzed. The results show that the stress path has great influence on the characteristics of soil such as peak strength, pore pressure, effective stress path and sample deformation, which should be considered in engineering. Moreover, special attention should be paid to the possibility of damage when excavating and unloading, even if the deformation is small. Sudden damage should be prevented.

Keywords: stress path, triaxial test, stress-strain relationship, pore water pressure

Analysis on Calculation Method of Section Capacity of Reinforced Concrete ZHANG Quan(190)

Abstract: On the issue that different formulas should be selected when calculating the carrying capacity of rectangular, T-shaped, I-shaped and circular sections according to the current Specifications for *Design of Highway Reinforced Concrete and Prestressed Concrete Bridges and Culverts* (JTG 3362-2018), an improved concrete stress integral method is proposed in this paper with reference to Appendix E.0.1 of *Code for Design of Concrete Structures* (2015 Edition). The application of this unified algorithm to the design work can improve the design efficiency greatly.

Keywords: reinforced concrete, bridge design, pile foundation, Dr.Bridge

A Study on Force Performance of UHPC in Negative Moment Zone of Continuous Composite Beam

..... ZHANG Ce(195)

Abstract: By modeling and impact analysis of negative moment zone of composite continuous beam, it is suggested that the ratio of thickness of UHPC deck to the height of composite beam is 1/5~1/9, the ratio of height of composite beam to the span is 1/18~1/22, and the ratio of rigidity of steel beam to UHPC deck is 2~10. The height of steel-UHPC composite continuous beam structure is much lower than that of steel-concrete composite continuous beam structure, and the UHPC deck in the negative moment zone of the structure does not crack.

Keywords: UHPC, continuous composite beam bridge, negative moment

Study on Design and Calculation Method of Super Large Section Tunnel

..... CHEN Fubin(200)

Abstract: In view of the key nodes of the super-large section tunnel of the transit expressway link project in Shenzhen, the stress-strain relationship after the excavation of the surrounding rock of the tunnel is analyzed by means of numerical simulation, and a new method of load calculation is proposed. According to the geology of the project, the design method, key points and problems that should be paid attention to in the design of tunnel structure are discussed. The calculation results show that the method of judging the load of loose arch by strain index is a more reliable method for calculating the load of large section. The construction method for excavation of multiple pilot tunnels is safer, and the deformation of surrounding rock is also controllable. This design method can provide reference for the design of such structure.

Keywords: super large section, tunnel, load structure method, stratum structure method

APPLICATION OF ACHIEVEMENTS

Research and Application of PC Guidebeam Prefabrication Technologyfor Straddle Monorail Transit

..... JIAO Guochen(204)

Abstract: The PC track beam of straddle monorail is a structure of beam and rail integration. The horizontal and vertical curves, transverse superelevation and pre arch are realized on the one-time pouring beam body. Its alignment and accuracy directly determine the comfort of the running train. In the case of lack of mature experience in China for Wuhu's monorail project, the construction scheme is innovated, the special production line for straight curved beam was set up, intelligent three-dimensional adjustable formwork was developed, linear dynamic control method was studied, and the high-standard track beam was successfully manufactured. The summarized mature technology and method is valuable for popularization.

Keywords: straddle monorail, PC track beam, prefabrication technology

Application of BIM Technology in Assembly Bridge Engineering

..... ZHANG Jie(209)

Abstract: Under the background of the gradual popularization of BIM technology, this technology has also been applied in the building construction and good results have achieved. This paper expounds the basic characteristics of BIM technology and the advantages of its application in prefabricated bridge engineering, analyzes the problems existing in the application process and the application in each link, so

as to promote the development of prefabricated bridge to a new height.

Keywords: assembled bridges, engineering construction, BIM technology

THE RELATIVE SPECIALITIES

Discussion on Design Problems of a Comprehensive Pipe Gallery Project in Urumqi ZHANG Haiyin(213)

Abstract: Since 2012, the construction of integrated pipe gallery has been greatly developed in Urumqi, with nearly 550 km of integrated pipe gallery planned. At present, the completed pipe gallery is tens of kilometers long. Due to different engineering characteristics, geological and boundary conditions, new problems will be encountered in the building process of a new project. Based on an engineering example of an integrated pipe gallery in Urumqi, this paper discusses the related problems in the design process. Some problems are put forward mainly in this paper, including the new method for the feeding port of two compartment pipe gallery, the anchoring problem of longitudinal reinforcement at the support of standard section, the stress problem of pipe gallery when passing through the new vehicle underpass and the additional load of pipe gallery caused by the retaining wall near the viaduct approach. Through analysis, the corresponding solutions are obtained for reference in similar engineering design.

Keywords: underground pipe gallery, design; feeding port, anchorage, passing through, additional load

Study on Treatment Method and Residual Bearing Capacity of Inclined PHC Pipe Pile HE Jiachao(217)

Abstract: The completed PHC pipe pile bears the unforeseen horizontal load due to lack of protection and so on. The pile body usually inclines to a certain extent, which will cause cracks, fracture, bending or inclination of the PHC pipe pile body. As a result, the carrying capacity of the PHC pipe pile is reduced or failed. Thus has a significant and negative impact on the project quality and safety. With the example of PHC pipe pile slope treatment caused by foundation pit landslide in a certain project, based on the existing theoretical analysis results and combined with the countermeasures of engineering practice, the conclusion with guiding significance for the engineering practice is obtained, which provides an effective scheme for the treatment of similar engineering defective pile.

Keywords: PHC pile inclination, detection method, remaining capacity bearing

The Implementation Mode and Fund Management of Scientific Research Projects Based on Engineering ZHANG Renjie(221)

Abstract: Some engineering enterprises, especially small or medium-sized ones, have relatively low willingness to carry out research on scientific engineering around projects as they are lack of in-depth understanding of the implementation mode of scientific research and focus on short-term economic benefits. Through a brief analysis of the main implementation methods of scientific research based on engineering projects and combined with engineering cases, the fund management of scientific research projects including fund raising, distribution, payment and process management are discussed and analyzed in this paper, so as to improve the enthusiasm of some engineering enterprises to participate in scientific research around projects.

Keywords: engineering, scientific research project, implementation, mode, funding

Abstract: Based on the analysis of the problems existing in the internal audit system of each participant in the current project and the current situation of audit environment, the countermeasures for the construction of internal audit system and for the innovation of the audit work model are proposed, so as to provide reference for the auditors to work better for the project.

Keywords: engineering, project, audit, innovation, measures.

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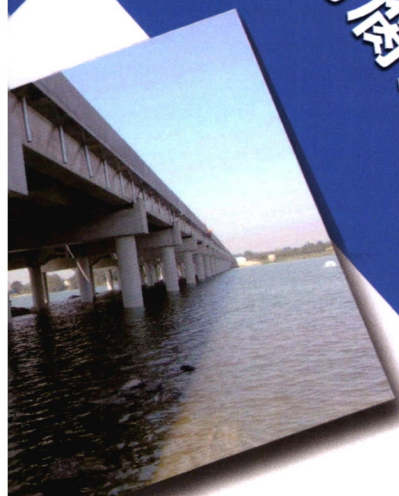
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