

# 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：上海市工程设计研究总院(集团)有限公司

2023



第8期 总第292期 月刊  
2023年8月

万方数据-数字化期刊群  
清华同方-中国期刊全文数据库  
维普资讯-中文科技期刊数据库  
中国核心期刊(遴选)数据库  
中国学术期刊综合评价数据库  
日本科学技术振兴机构数据库(JST)

全文收录  
全文收录  
全文收录  
收录期刊  
统计源期刊  
收录期刊

图为南京市水利规划设计院股份有限公司设计的南京市溧水区天生桥套闸除险加固工程

因为我们专心，所以我们专业！

——《城市道桥与防洪》

学术联盟：上海市城市科学研究会

● 本期看点

- 绿色低碳理念下城市次支路网建设规划思考
- 下承式钢箱系杆拱桥BIM正向设计
- 江底隧道防排水关键技术设计与应用
- 基于机器视觉对交通场景中车辆速度的识别研究

城市道桥与防洪  
月刊

2023年第8期(总第292期)  
2023年8月



万方数据

中华人民共和国住房和城乡建设部优秀期刊

中华人民共和国住房和城乡建设部优秀期刊

# 城市道桥与防洪 (月刊)

CHENGSHI DAOQIAO YU FANGHONG

2023 年 第 8 期(总第 292 期)

2023 年 8 月 15 日出版

1984 年创刊

主管单位: 中华人民共和国住房和城乡建设部

主办单位: 上海市政工程设计研究总院(集团)有限公司

出版单位: 《城市道桥与防洪》编辑部

编辑委员会(第九届)

主任委员: 王士林

副主任委员: 刘旭籍 和坤玲

委员(排名不分先后):

马国纲 宋华茂 卢永成 宁平华 李建民  
 李军代 李克平 李 东 徐一峰 朱晓东  
 朱海鹏 王永兴 杨红卫 陈翰新 陈 伟  
 张东权 王建光 张澎湃 杨 斌 蒋海里  
 陈 军 葛景春 钟 翔 骆燕妮 赵乐军  
 赵林强 徐 波 高中俊 黄永春 童景盛  
 周 俊 蒋中贵 潘怡宏 徐 辉 汪 勇  
 陈 谱

编辑出版: 《城市道桥与防洪》编辑部

总 编 辑: 骆燕妮

副 总 编: 赵晓燕

责任编辑: 叶 露 龚雪菲

美术编辑: 杨建华

英文校审: 孙宁萍

地址: 上海市中山北二路 901 号 邮编: 200092

电话: (021)55008850 传真: (021)55008850

投稿网址: <http://www.csdqyfh.com>

联系邮箱: [cdq@smmedi.com](mailto:cdq@smmedi.com)

国内发行: 《城市道桥与防洪》编辑部

国外发行: 中国国际图书贸易总公司 代号: BM 1859

印 刷: 上海商务联西印刷有限公司

地 址: 上海市春和路 1350 号 7 号楼

中国标准连续出版物号: ISSN 1009-7716  
CN 31-1602/U

广告发布登记号: 3101020130030

# 目 次

## 道路交通

绿色低碳理念下城市次支路网建设规划思考 ..... 陈 军,唐晓辉,吕麦霞,邱进杰,杨 菁(1)

基于整体空间设计理念的城市道路改造设计 ..... 高力侠(4)

精细化设计街道整体空间环境——以南昌市象山路  
综合改造工程为例 ..... 陆黄超(8)

通城大道快速路总体设计 ..... 赵炜锋(11)

广州白云国际机场 T3 航站楼陆侧市政交通总体设计  
..... 刘 明,黄沐阳(15)

关键交叉口优化对路网运行效率的影响研究 ..... 龚华凤,陈俊成,刘 庆,肖 洁,丁梦娇(19)

敞开式下沉道路立交设计实际案例分析 ..... 吴远志(23)

城市道路穿越重要建筑物方案研究——以临夏市环城  
北路穿越万寿观、古河州酒厂为例 ..... 吴 平,张雪梅(26)

基于改进遗传算法的城市街道空间布局优化研究 ..... 杨国宝(30)

关于几种设计情况下道路建筑限界问题的探讨 ..... 赵莉莉(34)

干线一级公路交通组织设计研究 ..... 吴佳华(38)

基于交通安全的乡村道路设计技术研究 ..... 彭 翔(45)

基于长寿命路面的固化土路基设计研究 ..... 王 振(49)

水泥混凝土路面断面改造及加铺方案研究——以金巢  
大道为例 ..... 张 伟(53)

基于 FLAC<sup>3D</sup> 的堆载预压结合塑料排水板软土路基复合  
加固研究 ..... 潘岳林,程 朋,刘 杰(56)

## 桥梁结构

大跨径斜拉桥主梁选型及分析 ..... 张士红(61)

自锚式悬索桥钢-混结合段受力性能研究 ..... 王 博(67)

下承式钢箱系杆拱桥 BIM 正向设计 ..... 胡智敏,李 萌,宁鑫森(71)

基于三维实景模型公路桥梁 BIM 正向设计研究 ..... 王晓芳,杨洪图,李长洙(75)

基于挠度理论的自锚式悬索桥受力特性分析 ..... 崔存玉(80)

宽幅异形钢板组合梁的设计与研究 ..... 王 霖(84)

主跨 136 m 空间钢桁拱与预应力混凝土梁组合桥受力  
性能分析 ..... 王 鹏(88)

地铁保护区域内立交桥建设关键技术研究 ..... 林智敏,罗 天(93)

宽墩窄塔独塔斜拉桥塔梁墩结合段设计与受力分析  
..... 王 凯,尹 超(97)

大跨度预应力地下通道结构设计 ..... 王彩花(100)

长跨变坡连续钢箱梁顶推受力特性分析 ..... 马义云,王皓平,周贤军,邓鹏飞(104)

期刊基本参数: CN 31-1602/U \* 1984 \* m \* A4 \* 302 \* zh \* P \* ¥ 25.00 \* 5000 \* 74 \* 2023-08

深汕特别合作区望鹏大桥斜拉桥抗震性能分析 ..... 王伟臣(108)

考虑河谷场地效应的大跨度拱桥的地震响应分析 ..... 张东, 宛俊舟(111)

高烈度地区连续刚构桥地震响应分析 ..... 李松, 何茂维(115)

基于偏载作用下的 Y 形墩受力分析方法与优化设计研究 ..... 刘江军, 石兆敏, 余茂峰(120)

双曲面球型减隔震支座在连续梁桥的应用研究 ..... 王振南(124)

冲击破坏的桥梁下部结构应急抢险修复设计 ..... 杨志雄(128)

某长江公路大桥防船撞设施研究 ..... 周雨立, 张安宇, 唐茂皓(131)

**防洪排水**

上海浦东新区外环以内排水(雨水)防涝综合规划研究 ..... 施侠, 郑弘, 施萍(135)

江底隧道防排水关键技术设计与应用 ..... 许华东, 朱汉容(140)

基于 TAP 模型的前海-南山排水深隧浪涌分析 ..... 杨园晶, 黄鹤, 孙海峰, 黄瑜, 王醒(144)

排水系统水力模型建模则有关规定的探讨 ..... 陶贤成, 孙晓峰, 曹燕东, 刘雨新(148)

半地上河道背景下的小城镇防洪排涝规划浅析 ..... 张彦光(151)

基于 BIM 技术的闸后流态优化水工模型试验 ..... 曹恒亮(156)

污泥处理厂站 BIM 正向设计应用 ..... 李思博(161)

临港水厂管线工程对大治河护岸的影响分析 ..... 王帆(165)

土堤填筑控制标准及工程应用 ..... 兰士刚(169)

高密度聚乙烯板内衬钢筋混凝土管接口构造研究 ..... 张威(171)

植物法修复污染河道底泥 ..... 李范竹(174)

通启运河水利枢纽工程选址研究 ..... 王家骥(178)

**管理施工**

市政道路穿跨铁路车辆段方案研究——以下盐公路涉铁段为例 ..... 陈永樑(184)

桥梁快速化施工技术在宿迁市迎宾大道高架工程中的应用 ..... 费夏(188)

三江口大桥扩大基础设计及施工 ..... 李晓琴(192)

峡谷地区大跨度贝雷桥施工技术研究 ..... 熊涛, 罗朝贵, 李佳宾(196)

市政道路路基处理及边坡防护典型工程实例 ..... 刘生涛(201)

临近高压电塔的滑坡综合处治方案研究 ..... 栗飞, 杨瑞, 么炜(204)

基于工程实践的接头箱被埋后处理措施研究 ..... 叶兵兵(209)

上海崇明海塘建设对 G40 长江大桥影响分析 ..... 黄伟(213)

体外预应力碳纤维板加固技术研究 ..... 王振航, 徐响华, 周青松(217)

某桥梁墩柱环向裂缝成因分析与加固方案 ..... 徐建(221)

**编委成员单位(排列不分前后)**

**主任编委单位:**

上海市政工程设计研究总院(集团)有限公司

**副主任编委单位:**

北京市市政工程设计研究总院有限公司

天津市政工程设计研究总院有限公司

**编委单位:**

南京市水利规划设计院股份有限公司

中国市政工程西南设计研究总院有限公司

同济大学交通运输工程学院

上海市市政规划设计研究院有限公司

广东省建筑设计研究院有限公司

广州市市政工程设计研究总院有限公司

沈阳市市政工程设计研究院有限公司

中国市政工程西北设计研究院有限公司

中国市政工程华北设计研究总院有限公司

中国市政工程中南设计研究总院有限公司

上海市城市建设设计研究总院(集团)有限公司

武汉市市政工程设计研究院有限责任公司

西安市政设计研究院有限公司

重庆市设计院有限公司

重庆市勘测院

林同棧国际工程咨询(中国)有限公司

中机中联工程有限公司

济南市市政工程设计研究院(集团)有限责任公司

成都市市政工程设计研究院有限公司

上海公路桥梁(集团)有限公司

上海城建市政工程(集团)有限公司

杭州市市政工程集团有限公司

深圳市市政设计研究院有限公司

杭州市城建设计研究院有限公司

兰州市城市建设设计院

上海浦东路桥(集团)有限公司

上海市政交通设计研究院有限公司

上海弘路建设发展有限公司

上海奉贤建设发展集团市政公路工程有限公司

上海市市政工程建设发展有限公司

大连市市政设计研究院有限责任公司

|   |  |
|---|--|
| 公路建设项目集约节约用地措施及探讨 .....                 | 刘 伟(225)                               |
| 山区超大跨径拱桥缆索吊装系统设计研究 .....                | 周咏凯(228)                               |
| 在城市建成区的市政桥梁施工过程中桩基避让地下管线的<br>处理方案 ..... | 胡奕彬(232)                               |
| 盾构隧道通缝拼装管片错台的理论分析 .....                 | 张 强, 阳定涛(235)                          |
| 深入岩地下连续墙成槽施工关键技术的应用 .....               | 胡小波(239)                               |
| 地下连续墙钢箱/钢筋笼吊装施工安全管理 .....               | 孙 杰(243)                               |
| 城市大直径管道多维联合检测方法研究 .....                 | 胡丹枫, 何国峰, 于 哲, 程维敬, 陈人杰, 郭宏智, 余景坤(246) |

#### 科技研究

|                                |                         |
|--------------------------------|-------------------------|
| 基于特征提取和机器学习的异常数据识别算法 .....     | 赵荣欣, 贾鹏飞(250)           |
| 基于机器视觉对交通场景中车辆速度的识别研究 .....    | 付勇高(253)                |
| 山地城市螺旋匝道驾驶仿真与关键设计指标 .....      | 黄博亚, 龚华凤, 赵聪霄, 刘 庆(256) |
| 斜拉悬索协作体系桥梁塔-基钢混结合段受力分析 .....   | 王 冲, 高进进(262)           |
| 极端荷载作用下公路桥梁荷载概率模型研究 .....      | 封 伟, 郭 强, 樊 泽(266)      |
| 预制承插式桥墩受力性能研究 .....            | 傅晨曦, 苏 强(270)           |
| 基于线形控制的梁式桥部分斜拉体系加固简化计算方法 ..... | 张春明, 魏 国(275)           |
| 水泥-钢渣混合基层在冻融循环作用下性能分析 .....    | 韩晓亮(280)                |
| 城市主干路隧道段智慧化系统研究应用 .....        | 徐永祥(284)                |
| 基于某风电工程的中空式承台抗弯承载力研究 .....     | 王 林, 谢 欣(289)           |

#### 成果应用

|                                |          |
|--------------------------------|----------|
| 数字孪生技术在城市主干路改建工程的应用实践 .....    | 牟晓亮(293) |
| 基于 GIS 优化山地城市空间开发土石方应用研究 ..... | 李志辉(297) |

#### 政策规范

|   |       |
|---|-------|
| 推动水环境保护治理再上新台阶 绘就中国式现代化绿色<br>和谐新底色《重点流域水生态环境保护规划》解读一<br>..... | (301) |
|---|-------|

|                |       |
|----------------|-------|
| 常任理事单位名称 ..... | (前插2) |
| 理事单位名称 .....   | (前插3) |
| 理事单位名称 .....   | (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 广东长正建设有限公司(封 2)       |
| 广 2 《城市道桥与防洪》编辑部(前插 1)    |
| 广 3 《城市道桥与防洪》编辑部公益广告(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》编辑部(补白)   |

## 封面工程

本期封面工程为南京市溧水区天生桥套闸除险加固工程,由南京市水利规划设计院股份有限公司设计。

天生桥套闸是连接秦淮河与石臼湖水系的控制性水工建筑物,具有防洪、蓄水、引水、通航、分洪、旅游等主要功能。工程采用节制闸与套闸结合的布置形式,按防洪 50 a 一遇标准设计,节制闸设计过闸流量 276 m<sup>3</sup>/s,套闸参照 VI 级船闸设计。该工程于 2017 年 11 月开始设计,2019 年 12 月竣工验收。

天生桥套闸建成后,节制石臼、秦淮两大流域,为保障区域防汛防旱、连接水上交通、实现水陆旅游交汇、改善河道水环境发挥着重要作用。工程通水以来,累计引水 6.9 亿 m<sup>3</sup>、泄洪 3 400 万 m<sup>3</sup>、灌溉补水 1 100 万 m<sup>3</sup>,成效显著。新闸气势恢宏、环境优美,已成为周边群众休闲、锻炼的网红打卡地。

天生桥套闸除险加固工程建设全程坚持新发展理念,开展水利安全生产标准化和质量精细化管理,建设成效显著。工程施工质量被评定为优良等级,先后获得国家发明专利 2 项、外观专利 1 项、实用新型专利 6 项、水利行业工法 1 项、水利行业优秀 QC 成果 1 项,被评为江苏省优秀勘察设计、江苏省水利文明工地、江苏省水利优质工程及省建设新技术应用示范工程,获得江苏省水利科技进步二等奖、2019—2020 年度中国水利工程优质(大禹)奖。

#### 本刊声明

1. 来稿文责自负;对录用文章,本刊有权进行文字性修改或文字、图片、表格删节,如有异议,请事先声明。
2. 来稿一经刊用,视为作者已将其复制权、发行权、信息网络传播权、汇编权等相关权利授予本刊,如有异议,请事先声明。
3. 凡被本刊录用的文章,本刊均已通过万方检测系统进行查重。如本刊发表之文章涉及版权问题,请版权人与本刊联系。

# Urban Roads, Bridges & Flood Control (Monthly)

Number 8,2023 (Total Number 292)

## CONTENTS

### ROADS & COMMUNICATION

Thinking on Construction and Planning of Urban Sub-branch Road Network under Green and Low-carbon Philosophy ..... CHEN Jun, TANG Xiaohui, LYU Maixia, QIU Jinjie, YANG Jing ( 1 )

**Abstract:** From the "increment era", the scale of road network in Xian has entered the era of "increment" and "stock". Traffic congestion and environmental pollution are becoming increasingly prominent. It is necessary to follow the green and low-carbon philosophy and plan the construction of urban road network in order to reduce the impact caused by the traffic congestion and environmental pollution. By investigating the current urban road network, the major problems existed in the road network are analyzed and summarized. The targets, strategies and requirements for planning the road network construction are proposed so as to improve the operation efficiency of road network, reduce the carbon emission, enhance the sustainable development of urban traffic and construct the more flexible livable city.

**Keywords:** green and low-carbon; functional orientation; road network planning; sub-branch road network

Reconstruction Design of Urban Road Based on Overall Space Design Concept ..... GAO Lixia ( 4 )

**Abstract:** Urban roads are the public places for the urban residents, and are also the spatial carrier and inheritance of urban history and culture. Only focus on the design of motor vehicle traffic and its service level has not in line with the requirements of the current historical background and the use demands of urban residents. The corresponding design concept should be explored. The overall space design concept of road is expounded, its design objective is resolved, and the data collected for the overall space design are summarized. Taking Baoningmen Street in Changzhi City of Shanxi Province as a design case, aiming at the existing problems of the current roads, the design scheme based on the overall space design concept is proposed. The goal is to build a people-oriented, full of vitality, complete functions, comfortable activities, open and sharing, beautiful environment, highlighting culture and low-carbon wisdom road environment.

**Keywords:** overall space design concept; road reconstruction; cultural inheritance; low carbon; wisdom

Refined Design of Overall Space Environment of Street for Xiangshan Road in Nanchang ..... LU Huangchao ( 8 )

**Abstract:** In the context of the increasingly high quality requirements of urban construction, aiming at the existing problems and own characteristics of Xiangxiangshan Road in Nanchang, starting from the three parts of the traffic environment, facility environment and surrounding environment of the street, the overall space environment of the street is finely designed. The treatment schemes of setting the waiting areas of non-motor vehicles, arranging the two-way staggered pedestrian crossings, laying the multi-pole integration, integrating the street facilities into characteristic cultural symbols, invisibly treating the strong and weak electricity boxes, and refining the coordination and connection of the surrounding space of the street are put forward in order to create a people-oriented, convenient transportation, comfortable and leisure living space for the

residents along the street, and also provide the reference and experience for the construction of similar old urban streets.

**Keywords:** refined design; overall space environment of street; traffic environment; facility environment; multi-pole integration; invisibility of cabinets

Overall Design of Tongcheng Avenue Expressway ..... ZHAO Weifeng ( 11 )

**Abstract:** Under the background of "welcoming the Asian Games, making the new achievements and showing the new attitude" traffic construction, the overall design scheme for the construction of Tongcheng Avenue Expressway is studied. By analyzing the five main control points in the ground road sections and routes of Tongcheng Avenue Expressway, the alignment of expressway is determined. The overall scheme of the project is studied from three aspects of the overall layout of interchange, regional layout of ramps and layout of ground roads (auxiliary roads). The relationship between the expressway and the main lands and buildings along the expressway as well as the mutual relationship with the subway is analyzed in detail, and the relevant countermeasures are proposed.

**Keywords:** expressway; overall design; route alignment; node scheme

Overall Design on Landside Road Traffic of Terminal T3 of Baiyun International Airport in Guangzhou .....  
..... LIU Ming, HUANG Muyang ( 15 )

**Abstract:** In order to give full play to the service function of the airport, the overall design is carried out for the landside road traffic of Baiyun International Airport T3 Terminal in Guangzhou. On the basis of predicting the demand and supply of traffic facilities, the design ideas of the separate entry system of industry, the commerce and travel traffic level by level, the non-interlaced circulation flow lines, the intensive layout of comprehensive transportation hub and the relevant landside road traffic system are put forward, which can make the landside roads of Baiyun International Airport achieve a higher level of service, and make the its construction scale and standards match with the traffic demand and road functional orientation, and make the landside roads fast and smooth.

**Keywords:** Baiyun International Airport; landside road; municipal transportation; road design

Research on Impact of Key Intersection Optimization on Operation Efficiency of Road Network .....  
..... GONG Huafeng, CHEN Juncheng, LIU Qing, XIAO Jie, DING Mengjiao ( 19 )

**Abstract:** With the increase of motor vehicle population, the congestion of urban road network is becoming more and more serious. As the throat of the urban road network, the service level of the intersection directly affects the operation efficiency of the road network. Taking the intersection of Minzu Road-Xinhua Road in Chongqing as an example, the existing problems of the intersection are clarified according to the traffic survey data. The modeling analysis on this intersection is carried out by using Synchro (design software). After optimizing the signal timing and dividing the lane functions, the intersection delay is reduced by 71.6% and the level of service is improved from D to B. Meanwhile, the VISSIM (simulation software) is used to carry out the modeling analysis on the overall road network of Jiefangbei Business Area in Yuzhong District of Chongqing and the regional road network affected by this key intersection. The vehicle operation conditions before and after optimization of road network are compared. The results show that the average delay of the affected regional road network is reduced by 17.74%, the average driving time is decreased by 13.46%, and the average number of stops is reduced by 17.18%. The vehicle exhaust emission is reduced to some extent through the optimization. The optimization of the key intersection can obviously improve the operation efficiency of road network.

**Keywords:** intersection optimization; traffic simulation; signal timing; signal intersection; urban road network

Analysis on Interchange Design of Open Sinking Road ..... WU Yuanzhi ( 23 )

**Abstract:** With the development of economy, the car ownership has increased year by year in China. The traffic of urban road is getting heavier, and the road network construction is becoming complex. In order to ease the traffic pressure of cities, various designed interchanges and tunnels are constructed in various places. But the interchanges have a greater impact on the urban landscape, especially in areas where the urban environment is more sensitive. Therefore, the main road subsidence will be used to achieve a three-dimensional intersection. At present, there are two types of road subsidence. One is that the crossed road crosses the underground road by bridge. The other is to set up a frame structure on the sinking road. And the road to be crossed is located above the frame structure. The application of the sinking road with sloping slope, the measures to be taken for related problems and the matters needing attention are analyzed through the actual cases.

**Keywords:** open type; sinking road; interchange; design; principle; application discussion

Study on Scheme of Urban Roads Crossing Important Buildings in Linxia City ..... WU Ping, ZHANG Xuemei ( 26 )

**Abstract:** With the further development of urbanization and the rapid construction of road engineering, the importance of some buildings is not considered in the design stage of many urban road projects, and the study of design scheme is not detailed enough, resulting in the difficulty of project implementation or extremely slow progress. First of all, the engineering overview and construction conditions of North Huancheng Road, and the related situations of Longevity Temple and Guhezhou Distillery in Linxia City are introduced. Then combined with the characteristics of the project, aiming at four schemes of viaduct, excavated channel, mined tunnel and grade crossing proposed for this section, the advantages and disadvantages of the four schemes are analyzed from the difficulties of engineering construction, the impact of the environment along the line, the later-period management, the engineering cost and the impact on Longevity Temple and Guhezhou Distillery. Finally, the viaduct scheme is recommended. The recommended scheme is being implemented after the review of the construction drawings, which can provide some references for the engineering design of similar urban roads crossing important buildings.

**Keywords:** urban roads; important buildings; crossing mode; scheme comparison

Research on Optimization of Urban Street Space Layout Based on Improved Genetic Algorithm .....

..... YANG Guobao ( 30 )

**Abstract:** In order to optimize the space distribution of urban streets, an optimization method of urban street space layout based the improved genetic algorithm is proposed. The model of urban street space layout is built. The constraints for the optimization of the street space layout are set. The improvement of genetic algorithm is completed through the optimization of coding process. By using the improved genetic algorithm, the optimization scheme of urban street space layout is formulated from four aspects of municipal, landscape, special settings and architecture. Taking the reconstruction project of Wengang Road Block in Yancheng City as an example, the reconstruction is completed according to the new layout optimization idea. From the perspective of total score, the score of urban street space layout before optimization is in the range of 0.5~0.7, which indicates that the street space layout at this time can basically meet the expectations. The score of urban street space layout after optimization is in the range of 0.9~1.0, which indicates that the urban street space layout at this time is more excellent. The optimization effect of urban street space layout by this method is good.

**Keywords:** improved genetic algorithm; street; optimization; layout; space; city

Discussion on Boundary of Road Construction under Several Design Conditions ..... ZHAO Lili ( 34 )

**Abstract:** Based on the specific cases encountered in the review of construction drawings, the mandatory requirement of "no object intrusion within the limits of road construction" is demonstrated, and the cross section design related to the road construction limits is specially analyzed, including the correct setting of safety belts in various engineering situations and the setting of intermediate islands required for the secondary crossing in order to serve as a reminder to designers.

**Keywords:** urban road; limits of road construction; review of construction drawings

Study on Design of Traffic Organization for Trunk First-class Highway ..... WU Jiahua ( 38 )

**Abstract:** The functions of some existing first-class highways do not match the traffic demand, the grade crossings and entrances are densely arranged, and the road sections and intersections are lack of scientific and reasonable traffic organization, resulting in the low traffic efficiency and poor road safety. Taking Daye Highway as an example, the traffic organization of the trunk first-class highway is designed and studied. Based on the functional orientation of the highway, the appropriate technical indicators are selected. Through the reasonable traffic organization design of general road sections and intersections and the design of guide signs, the overall operation efficiency and traffic safety of the highway have been improved, and the certain engineering experience and design reference are provided for the subsequent construction of the trunk first-class highway.

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

Research on Design Technology of Rural Roads Based on Traffic Safety ..... PENG Xiang ( 45 )

**Abstract:** With the steady improvement of the accessibility of rural road traffic network, its traffic safety is still severe. In order to further improve the driving safety level of rural roads, firstly, the characteristics of traffic accidents on rural roads are analyzed, and the causes of accidents are systematically analyzed from the perspective of "people - vehicle - road - environment". Then, based on the results of accident analysis, the design requirements of rural road system are proposed from the perspective of road attributes. Finally, taking a rural road in a mountainous area of Guilin City as an example and combined with the accident data, the influencing factors on the traffic safety are analyzed, and the targeted improvement measures are proposed so as to adapt the construction requirements of "four-good rural roads" in the new era.

**Keywords:** rural road; traffic accident; road alignment; traffic safety device

Study on Design of Solidified Soil Subgrade Based on Long-life Pavement ..... WANG Zhen ( 49 )

**Abstract:** Subgrade design has a significant impact on the service life of pavement structure. Therefore, it is necessary to fully consider the external load, asphalt composition and other factors. Based on the parameter of different graded crushed stone layer, the parameter of asphalt layer and the load conditions, the influence of various factors on the subgrade performance is explored. And on this basis, the corresponding design points of solidified soil subgrade are proposed. The results show that the closer the reinforcement location is to the road surface, the better the reinforcement effect is. The reinforcement depth is positively related to the structural modulus. And the tensile strain equivalent of the bottom layer and the maximum strain equivalent of the structure both show an increasing trend. The reinforced subgrade can significantly affect the maximum strain of the structure.

**Keywords:** long-life pavement; stabilized soil subgrade; design study; subgrade reinforcement

Research on Cross-section Reconstruction and Overlay Scheme of Cement Concrete Road for Jinchao Avenue ..... ZHANG Wei ( 53 )

**Abstract:** Taking the Jinchao Avenue Upgrading and Reconstruction Project as an example and combined



with the functional positioning of the project, the cross section of road is re-arranged. On the basis of evaluating the old road conditions in detail, the asphalt overlay scheme is proposed. The design scheme of the asphalt overlay is specially discussed when the cross section of road is re-arranged. The selection of asphalt overlay material, thickness selection, setting of intermediate layer and overlap of binding wide plate are analyzed respectively, and the specific methods are proposed, which provides the reference for similar projects in the future.

**Keywords:** cement concrete pavement; cross-section reconstruction; asphalt overlay; reflection crack

Study on Composite Reinforcement of Soft Soil Subgrade with Preloading and Plastic Drainage Board Based on FLAC<sup>3D</sup> ..... PAN Yuelin, CHENG Peng, LIU Jie ( 56 )

**Abstract:** In the process of urban road construction, various geological conditions are usually encountered. The soft soil subgrade is one of the common geological problems. The roadbed of urban road is the foundation of pavement and should meet the requirements of strength, deformation and stability. Due to the soft soil with the characteristics of large natural water content, high compressibility, low bearing capacity and low shear strength, when soft soil is used as roadbed foundation, various subgrade reinforcement measures should be taken to treat the soft soil subgrade in order to make the urban roads able to satisfy the design requirements. Taking the South Tuanyuan Road Project in Yiyang City Economic Development Zone of Hunan Province as an example, the steps of establishing the finite difference method model of soft soil roadbed reinforced by preloading with plastic drainage board are introduced in detail through FLAC<sup>3D</sup> numerical calculation. The response of soft soil subgrade under the preloading and plastic drainage board is obtained through the numerical simulation, and the dissipation law of excess pore water pressure is obtained after preloading load is applied. The distribution characteristics of pore water pressure and consolidation settlement of soft soil roadbed under the preloading and plastic drainage board are revealed. Finally, the changes of pore water pressure, total settlement of each layer and stratified settlement of each layer in soft soil roadbed with the depth direction are obtained. The research conclusion plays a good guiding role in the treatment of soft soil subgrade.

**Keywords:** FLAC3D; soft soil roadbed; preloading; plastic drainage board; consolidation settlement.

## BRIDGES & STRUCTURES

Selection and Analysis on Main Girder of Long-span Cable-stayed Bridge ..... ZHANG Shihong ( 61 )

**Abstract:** The calculation formulas of each component cost and the main girder stress of cable-stayed bridge are deduced according to the integral method. The technologies and economies of five different girders of cable-stayed bridges are compared and analyzed. And the parameters are analyzed by the case of traditional composite girder cable-stayed bridge. The results show that the use of UHPC materials to replace the traditional concrete can greatly improve the limit span of the composite girder cable-stayed bridge. For the cable-stayed bridges with the main span of 300~750 m, the traditional composite girders are the most economical. When the main girder is 750~1 200 m, the steel box girder as for the main girder is the most economical. The square meter cost index of cable-stayed bridge decreases with the increase of bridge width. Bit it is insensitive to the change of pylon height to span ratio above the bridge deck. The economical and reasonable side to middle span ratio and the pylon height to span ratio above the bridge deck are about 0.5 and 0.3 respectively.

**Keywords:** bridge engineering; cable-stayed bridge; steel box girder; composite girder; UHPC; economy

Study on Mechanical Behavior of Steel-concrete Combined Section of Self-anchored Suspension Bridge .....

**Abstract:** The composite girder is widely used in self-anchored suspension bridge. Its steel-concrete combined section is the key part affecting the overall mechanical behavior of the structure. Taking Shanghai Jiasong Bridge with a main span of 336 m as the engineering background, a shell-solid finite element model considering the relative slippage of steel-concrete combined section is established. The distribution law of the stress of concrete and steel structure, and the shearing force of resisting shear connector is analyzed. The mechanical behavior of the combined section is studied. And the simplified calculation method of the maximum shearing force of connector is proposed.

**Keywords:** self-anchored suspension bridge; steel-concrete combined section; mechanical behavior; finite element; simplified calculation method

Research and Application of 3D Modeling of Arch Bridge Based on BIM Technology .....

**Abstract:** This article takes the example of a through type steel box tied arch bridge with a large inclination angle in Guangzhou as an example to study the application of BIM forward design and parametric modeling in bridge design. The research results indicate that BIM technology can improve the quality of construction drawings, design efficiency, optimize construction plans, avoid potential risks, save costs, and shorten construction periods. This provides a reference for the application and development of BIM in bridge engineering.

**Keywords:** BIM; top down design; Parameterization; Modeling; Refinement; Through steel box tied arch bridge

Research on BIM Forward Design of Highway Bridges Based on 3D Reality Model .....

**Abstract:** The BIM forward design of node bridge is carried out by using Midas CIM bridge 3D forward design software, relying on the main line overpass project from Puyang to Liaocheng Expressway Weicheng Hub, and based on 3D reality model. The key indexes of steel box girder output by 3D model are analyzed and compared with the results output by the traditional 2D design model. The result shows that the result of 3D forward design is reliable and the digital delivery of the BIM model in the design stage to the construction stage can be realized.

**Keywords:** BIM technology; inclined photogrammetry; 3D reality model; forward design; highway bridge

Analysis on Mechanical Behavior of Self-anchored Suspension Bridge Based on Deflection Theory .....

**Abstract:** Based on deflection theory, the influence of rise-to-span ratio, side to mid-span ratio, vertical flexural stiffness of stiffening girder, longitudinal slope of stiffening girder and integrated temperature rise or fall on the mechanical behavior of a two-pylon, three-span self-anchored suspension bridge is analyzed. In addition, the stability of the stiffening girder under the axial compressive force and its extreme span are discussed. The analysis results show that the smaller the rise-to-span ratio, the greater the main cable tension and larger the axial compressive force of stiffening girder, but the lower the overall stiffness of the structure. The larger the side-to-mid span ratio, the smaller the overall stiffness of the structure, and the worse the transverse stability of the stiffening girder under the axial compressive force. The greater the tensile stiffness of the main cable or the larger the vertical flexural stiffness of the stiffening girder is, the larger the overall stiffness of the structure is. The influence of both the longitudinal slope of the stiffening girder and the integrated temperature rise or fall is usually small on the structure

stress, which can be ignored. The extreme span of the self-anchored suspension bridge is controlled jointly by the lateral type I instability and the yield strength of the stiffening girder.

**Keywords:** self-anchored suspension bridge; stress analysis; structure stiffness; stability; extreme span

Design and Research of Wide Special-shaped Steel Plate Composite Beam ..... WANG Ben ( 84 )

**Abstract:** Taking the wide special-shaped steel plate composite beam bridge for the special ramp of interchange at the east side of Fengtai Railway Station as the research object, the composite girder bridge is analyzed from the aspects of structural optimization and safety design. Based on the principle of structure safety and economy of the bridge, the optimal design scheme is proposed. In the finite element software, the rigid arm connection is used to simulate the setting of shear nails. Combined with the concrete bridge deck and the I-shaped steel girder, the overall model of the whole bridge is established. By adjusting the number of middle beams and changing the plane layout of the supports, the bridge structure design is optimized. The stiffness, bearing capacity, buckling stability and fatigue stress of the steel girder of the bridge structure under the normal conditions are analyzed according to the actual stress of the bridge. The results show that reducing the number of middle beams will increase the structural stress and reduce the stability safety factor under the condition to satisfy the safety of the structure. The wide special-shaped steel plate composite beam is obviously affected by the shrinkage of the concrete, and the outer support is easy to be emptied. It is particularly important to optimize the support layout. Under the normal service condition, the outside girder of steel plate composite girder has the small stiffness, obvious deformation and large stress, and is prone to buckling instability at the earliest, and is sensitive to fatigue load.

**Keywords:** wide special-shaped; steel plate composite beam; optimal design

Analysis on Stress Performance of Spatial Steel Truss Arch and Prestressed Concrete Beam Composite Bridge with 136-m Main Span ..... WANG Peng ( 88 )

**Abstract:** In order to study the mechanical properties of the spatial steel truss arch and prestressed concrete beam composite bridge, taking Conghua Bridge in Guangzhou as an example, the spatial finite element analysis software is used to parametrically analyze the main control factors affecting the stability of spatial steel truss arch and the influence of the change of bending stiffness of the arch and main beam on the internal force and displacement of the structure. The results show that the stiffness of arch rib has a great influence on the overall stability of the bridge, and the stiffness of transverse and diagonal braces has little influence. When there is only middle boom, the stability of arch ribs is poor. The stiffness of the main beam has a great influence on the stress of the bridge. The initial tension of boom affects the stress state of the main beam and arch rib under constant load.

**Keywords:** spatial steel truss arch; prestressed concrete beam; stability; rigidity; parametric analysis

Study on Key Techniques of Overpass Construction in Protected Area of Metro ..... LIN Zhimin, LUO Tian ( 93 )

**Abstract:** Taking a terminal interchange in a protected area of a metro as an example, the key strategies for the construction of such interchanges are studied. The selection of interchange, the layout of bridge span, the optimization of bridge structure, the design of subgrade filling, the treatment of soft foundation, the construction of frame pier bent cap and the construction of pile foundation are expounded in detail. By adopting the reasonable design and construction strategies, the key problems such as the overlapping of interchange and metro structure, the excessive additional load and the hole collapse during pile foundation construction are successfully solved, which can provide the reference for the similar projects.

**Keywords:** metro; interchange; additional load; frame pier; foamed mixture lightweight soil; soft foundation;

full casing full rotary drilling rig

Design and Stress Analysis on Pylon-girder-pier Combination Section of Wide-pier Narrow-pylon Cable-stayed Bridge ..... WANG Kai, YIN Chao ( 97 )

**Abstract:** To solve the design problem of the pylon-girder-pier combination section of column-pylon cable-stayed bridge when the lateral dimension of the pylon column is limited, relying on Luobu River Bridge in Shanghai - Wuhan Expressway, the structural design and stress performance of the pylon-girder-pier combination section of a wide-pier narrow-pylon structure are studied through the theoretical analysis and numerical simulation. The reasonable structure and corresponding design method of the combination section of the column pylon and the main girder of the wide-pier narrow-pylon structure are studied, and the stress of this new structure is analyzed. The results show that the combination section of wide pier and narrow pylon can form a reasonable structure form by setting the reasonable connecting beams and transition structure in the connection section, which can meet the requirements of local force transmission. The rigidity transition section is set in the longitudinal direction of the bridge to increase the height of the main girder, cooperate with the transverse arc transition structure and improve the rigidity connection between the main girder and the wide pier in order to make the internal force of the main girder directly transmitted to the wide pier and to reduce the influence on the narrow pylon. The pylon-girder-pier combination section of wide pier and narrow pylon has the reliable force transmission and smooth stress transmission. The stress state is within a reasonable range. The structural form and design method of the formed wide-pier narrow-pylon combination section can provide the reference for the design of the similar combination sections when the transverse dimension of the pylon column is limited.

**Keywords:** cable-stayed bridge; wide pier and narrow pylon; pylon-girder-pier combination section; structural design; stress analysis

Structural Design of Long-span Prestressed Underpass ..... WANG Caihua ( 100 )

**Abstract:** Combined with the project background of a long-span prestressed underpass crossing the expressway in the east extension of South Inner Ring Street in Taiyuan City, firstly the characteristics and difficulties of the structure are analyzed. Then the design concepts and technology, the construction process, the late operation and economic factors are comprehensively considered and analyzed to carry out the analysis and research on theory and calculation. Finally, some suggestions and references are provided for the design of this kind of structure to be used in the future.

**Keywords:** underpass; long span; prestressing; design

Analysis on Incremental Launching Stress Characteristics of Long-span Variable-slope Continuous Steel Box Girder ..... MA Yiyun, WANG Haoping, ZHOU Xianjun, DENG Pengfei ( 104 )

**Abstract:** Relying on the project of Jingshan River Bridge, the structural stress and deformation in the incremental launching construction of steel girder are studied. The incremental launching construction process is simulated by means of numerical simulation, and the stress state of each segment model in the process is analyzed. The local stress performance of the steel box girder is specially analyzed under the influence of multi parameters such as cushion block, lateral offset, local support and so on. A multi-scale three-dimensional finite element model is established. The mechanical state and stability of the steel box girder structure are parametrically analyzed. The reasonable parameter range is determined. The lateral correction threshold is clarified. The deviation correction frequency is controlled. The safety and reliability of the structure before and after the completion of the bridge are ensured.

**Keywords:** walking-type; incremental launching construction; numerical simulation; stress analysis

Analysis on Seismic Performance of Wangpeng Bridge Cable-stayed Bridge in Shenzhen - Shantou Special Cooperation Zone ..... WANG Weichen ( 108 )

**Abstract:** In order to study the seismic performance of long-span cable-stayed bridges, taking the project of Wangpeng Bridge in Shenzhen-Shantou Special Cooperation Zone as the research object, the response spectrum method and the nonlinear time history analysis method are used to compare and analyze the seismic response of the double-arched pylon steel-concrete composite girder long-span cable-stayed bridge under E1 and E2 earthquakes. The results show that the results obtained by two analysis methods can complement and confirm each other to ensure that the structural internal force and deformation obtained by the calculation can reflect the structural response under the actual earthquake action. The seismic performance of the main bridge of Wangpeng Bridge can satisfy the expected objective and the seismic performance of the long-span cable-stayed bridge can be effectively improved by setting dampers.

**Keywords:** cable-stayed bridge; dynamic characteristics; seismic response; response spectrum analysis; nonlinear time history analysis; seismic performance.

Analysis on Seismic Response of Long-span Arch Bridge Considering River Valley Site Effect ..... ZHANG Dong, WAN Junzhou ( 111 )

**Abstract:** In order to study the influence of V-shaped river valley site effect on the seismic response of long-span concrete-filled steel tube arch bridge, taking a long-span concrete-filled steel tube arch bridge as the engineering background, the V-shaped river valley site model is simplified. The overall finite element model of river valley - arch bridge is established to discuss the seismic response effect on the bridge under SV wave. The results show that the internal force and displacement response trend of the main arch ring of the arch bridge are symmetrically distributed because the seismic load is uniformly acting on the site and the river valley - arch bridge model is an axisymmetric model. The internal force and displacement response of the main arch ring under different seismic waves are different, which are related to the ground motion intensity at the arch foot and the site connection part of arch bridge, and related to the spectral characteristics of the seismic wave. In the seismic design of bridge, the key parts of arch bridge under SV wave should be focused on.

**Keywords:** site effect; artificial boundary; seismic response; spectral characteristic

Analysis on Seismic Response of Continuous Rigid-frame Bridges in High Intensity Areas ..... LI Song, HE Maowei ( 115 )

**Abstract:** In order to explore the seismic response law of continuous rigid-frame bridges in high-intensity areas, firstly, taking a long-span continuous rigid-frame bridge in a high-intensity area in Guizhou as the research background, a three-dimensional spatial finite element model is established according to MIDAS Civil 2019, and the structural natural vibration characteristics of the bridge are explored. Secondly, based on the site conditions of the bridge, combined with the relevant specifications, the target response spectrum and artificial seismic wave are given. Finally, the results of response spectrum and time history analysis are given, and a detailed comparative analysis is made. The research shows that under the premise of ensuring the strength and stability, the long-span continuous rigid-frame bridge located in high intensity areas should have certain restraint release in the longitudinal and transverse directions, which is conducive to the structural deformation to absorb the seismic energy, and then reduce the seismic damage. Under the working condition of response spectrum calculation, the maximum longitudinal displacement and transverse displacement are 0.304 m and 0.381 m respectively, which are related to the direction of seismic excitation. The vertical displacement is about 0.05 m, which has little relationship with the direction of seismic

excitation. By comparing and analyzing the calculation results of response spectrum and time history analysis, it can be seen that the calculation results of time history analysis are larger than the calculation results of response spectrum on the whole, which also meets the requirements of relevant specifications.

**Keywords:** high intensity areas; continuous rigid-frame bridge; response spectrum; time history analysis; seismic response

Research on Stress Analysis Method and Optimization Design of Y-shaped Pier under Eccentric Load

..... LIU Jiangjun, SHI Zhaomin, YU Maofeng ( 120 )

**Abstract:** Relying on an expressway project in Jiaying of Zhejiang, through the establishment of the rod system model of Y-shaped pier of the substructure and the finite element solid model, the stress analysis and comparison under the action of eccentric load are carried out. Combined with the strut-and-tie theory, it is revealed that the rod system model is difficult to reflect the real stress situation of the structure when analyzing the Y-shaped pier. The results of the solid model analysis are more reasonable. On this basis, the optimal design criteria for the stress of Y-shaped pier are further proposed, and the optimal design is carried out accordingly, which provides a reference for the design and research of the substructure of the similar bridges in the future.

**Keywords:** Y-shaped pier; finite element analysis; model comparison; strut-and-tie theory; optimal design

Research on Application of Double Curvature Spherical Seismic Isolation Bearing in Continuous Girder Bridge

..... WANG Zhennan ( 124 )

**Abstract:** As a new type of seismic isolation device developed in China, the double curvature spherical seismic isolation bearing has the advantages of the simple structure, strong bearing ability, good durability and reliable self-recovery capability. The anti-seismic property of the long-span continuous girder bridge used by this new seismic isolation bearing is further analyzed and studied. The result shows that this new bearing has a stable and efficient seismic isolation effect, which provides the rich selections of seismic isolation parameters for the designers, and is very suitable for the seismic isolation design of the long-span continuous girder bridge in high intensity areas.

**Keywords:** bridge engineering; long-span continuous girder bridge; double curvature spherical seismic isolation bearing; seismic property

Design on Emergency Rescue and Repair of Bridge Substructure Damaged by Impact

..... YANG Zhixiong ( 128 )

**Abstract:** The brittle failure occurs in the substructure of a mountain expressway bridge because of rolling stone collision on the bank slope, which causes the traffic blocked. Firstly, the temporary reinforcement scheme is proposed to restore the traffic in time after the temporary treatment of the substructure. Then, the permanent reinforcement is carried out to ensure the safe operation of the structure within the designed service life, which provides the reference for the repair design of bridges in similar mountainous areas.

**Keywords:** highway bridge; emergency rescue; substructure; punch failure

Research on Anti-ship Collision Facilities for a Highway Bridge of Changjiang River

..... ZHOU Yuli, ZHANG Anyu, TANG Maohao ( 131 )

**Abstract:** Taking a highway bridge of Changjiang River as the object of study, the impact force of ship and the anti-collision ability of pier are calculated by the specifications and Midas /Civil software. The conclusion is obtained that the anti-collision ability of the bridge itself is not sufficient during the period of medium and

high flood stages. Therefore, according to the characteristics and anti-collision requirements of bridge pier structure, a self-floating steel clad composite material anti-collision device is designed, and LS-DYNA software is used to build the ship-bridge collision model to simulate the different working conditions. The results show that the anti-ship collision device can effectively reduce the ship impact force on bridge piers and delay the impact time, and the peak value of ship impact force can be reduced by 30%~39%, which has a good anti-collision and energy-dissipation effects.

**Keywords:** bridge anti-collision; steel clad composite material; ship impact force; finite element simulation

## FLOOD CONTROL & DRAINAGE

Research on Integrated Planning of Drainage (Rainwater) and Waterlogging Control within the Outer Ring of Pudong New District in Shanghai ..... SHI Xia, ZHENG Hong, SHI Ping ( 135 )

**Abstract:** With the rapid promotion of urbanization and the increase of extreme weather, the waterlogging problem affecting the urban safety is attracting the increasing public attention. Pudong New District is located in the eastern part of Shanghai with the uneven distribution of river channels, showing the characteristics of dense in the south and sparse in the north, dense outside the center and sparse in the center. The traditional drainage planning has been unable to fully meet the need of the current urban security. Combined with the characteristics of the city, the drainage and waterlogging control planning of Pudong New District adheres to the concept of "green-gray-blue" measures to explore the existing facilities deeply and reasonably solves the problem of source control and the combination of large and small drainage systems. By building a model to assess the risk of urban waterlogging, efficiently predict the regional flooding disasters and clarify the focus on upgrading and reconstructing the areas, the planning efficiency can be effectively improved and the planning effect can be timely fed back. The drainage system is upgraded and reconstructed by means of low-impact development of the existing system and the multi-purpose utilization of the existing drainage facilities. The ability of urban drainage and waterlogging prevention has been effectively improved, and some references are provided for the preparation of similar planning in the future.

**Keywords:** drainage and waterlogging prevention; assessment of waterlogging risk; upgrading and reconstruction; low-impact development

Design and Application of Key Technology of Waterproofing and Drainage in Tunnel under River ..... XU Huadong, ZHU Hanrong ( 140 )

**Abstract:** The waterproof and drainage design of underwater engineering is the key in the engineering design. Relying on the practical engineering design, the waterproof and drainage design of underground engineering is studied. The key technology of underwater engineering design is put forward. And fully considering the design service life of the existing waterproof materials, the waterproof remedial measures for the failure of the existing waterproof facilities are proposed. It has the important guidance and reference significance for similar waterproof and drainage design of underground engineering, which hope to promote the progress and development of underwater engineering construction.

**Keywords:** underwater engineering; waterproof and drainage design; design life; remedial measures

Analysis on Surge of Qianhai-Nanshan Drainage Deep Tunnel Based on TAP Model ..... YANG Yuanjing, HUANG Gu, SUN Haifeng, HUANG Yu, WANG Xing ( 144 )

**Abstract:** The transient analysis program (TAP) model is used to simulate the inflow process of Qianhai-Nanshan Drainage Deep Tunnel in Shenzhen. Through the simulation of design standards,

exceeding standard and accident conditions, the risk of system surge generation is analyzed, and the relevant measures to control the surge are proposed. The study shows that in the 50 a and 100 a design rainfall scenarios, the highest total head line of the system is below the ground level. And the large-diameter shaft structure and additional ventilation shafts used in the system can effectively control the impact of surges.

**Keywords:** drainage system of deep tunnel; surge; TAP model

Discussion on Guide Rules of Hydraulic Modeling for Drainage System .....

..... TAO Xiancheng, SUN Xiaofeng, CAO Yandong, LIU Yuxin ( 148 )

**Abstract:** It is necessary to make a set of standard and guide rules for hydraulic model of drainage system because of the hydraulic model of drainage system widely used in the drainage engineering project. According to the requirement of *Guide Rules for Hydraulic Modeling and Delivery Technology of Drainage System*, and taking the catchment area and rainfall as the study object, the hydraulic model is established to simulate the catchment area and rainfall. The effect of catchment area and rainfall on the hydraulic model of drainage system is analyzed and studied. The rationality of the modeling requirements of catchment area and rainfall in the hydraulic model of drainage system in the Guide Rules is proved, which provides the powerful technological support for the follow-up application of the Guide Rules and the relevant guidance for the follow-up construction of hydraulic model of the drainage system.

**Keywords:** hydraulic model; modeling; catchment area; rainfall; simulation

Brief Analysis on Flood Control and Waterlogging Drainage Planning of Small Towns under Background of Semi-terrestrial River .....

..... ZHANG Yanguang ( 151 )

**Abstract:** Flood control and waterlogging drainage planning is a huge systematic project. In order to better guide the follow-up engineering construction, taking Xiaofu River in Beijiao Town of Zibo City as an example, based on the elevation at the bottom of Xiaofu River lower than the lands on both banks, the flood level has been higher than the lands on both banks, which has formed the current situation of "semi-terrestrial river". It is planned to focus on the construction of flood control and waterlogging drainage system in three aspects of source reduction, process control and end storage. By the specific measures of improving the flood control standard, reconstructing the waterlogging drainage network, carrying out the rainwater and flood utilization, and perfecting the management facilities, many problems of flood control and waterlogging drainage caused by the current situation of "semi-terrestrial river" of Xiaofu River in the area of Beijiao Town are solved, which provide the for the similar river and urban flood control planning in North China, especially in the Yellow River Basin.

**Keywords:** Xiaofu River; Beijiao Town; semi-terrestrial river; flood control; waterlogging drainage

Hydraulic Model Test of Flow State Optimization behind Gate Based on BIM .....

..... CAO Hengliang ( 156 )

**Abstract:** The pump sluice of Hangtang Port is located at the intersection of Hangtang Port and Hangzhou Bay. The project focuses on the flood control and waterlogging control in the area of Pudong, and also has the functions of ecological environmental improvement, water resource scheduling and the others. In order to ensure the smooth and steady operation of the pump sluice of Hangtang Port, and based on BIM 3D model technology, the hydraulic model test is carried out to study the flow state behind the gate, and to study the flow state optimization scheme. The test shows that BIM technology can effectively guide the physical modeling. The rectification effect of the optimization scheme used in the project is good, which can decrease the local high flow rate and reduce the protection strength of outer rivers.

**Keywords:** pump sluice of Hangtang Port; BIM technology; optimization of flow state behind gate;



hydraulic model test

Application of BIM Forward Design in Sludge Treatment Plant ..... LI Sib0 ( 161 )

**Abstract:** Taking the sludge treatment phase II project of Shanghai Shidongkou Wastewater Treatment Plant as an example, BIM forward design is carried out specifically for the design points of complex sludge treatment systems, numerous equipment pipelines and high odor discharge standards. The design process of the project revolves around improving the overall efficiency of design and improving the design accuracy. Finally, as the deliverable, the design achievement bearing the correct design information analyzed and checked by BIM technology is formed. The design results indicate that using BIM simulation analysis software can perform complex and high-precision simulation analysis. The BIM forward design route is suitable for the engineering design of sludge treatment plants and can provide the accurate and quantifiable basis for verification and optimization of the design.

**Keywords:** BIM technology; municipal design; sludge drying incineration; forward design

Analysis on Impact of Lingang Waterworks Pipeline Project on Dazhi River Embankment .....  
..... WANG Fan ( 165 )

**Abstract:** The raw water pipeline of Shanghai Lingang Waterworks inevitably causes the stress relief and redistribution of stratum soil mass in the construction of crossing the embankment of Dazhi River. The pipe jacking and foundation pit construction will inevitably affect the safety of Dazhi River embankment. From the perspective of view of protecting the embankment safety of Dazhi River, the finite element analysis method is used to carry out the in-depth theoretical analysis, study and demonstrate the impact of construction on the embankment safety of Dazhi River under the conditions of foundation pit construction, pipe jacking construction and cofferdam construction, and put forward the relevant suggestions for reducing the impact in order to provide the effective support for ensuring the structural safety of Dazhi River embankment. The research shows that the deformation of Dazhi River embankment caused by the foundation pit construction of manhole is within the allowable range and has little influence on the current structure.

**Keywords:** pipeline engineering; underground engineering; flood control wall

Control Standard and Engineering Application of Earth Dike Filling ..... LAN Shigang ( 169 )

**Abstract:** Jinze Reservoir in the upper reaches of the Huangpu River is the second largest water source in Shanghai. The clay compaction degree is required to reach 98% in the design. Although the embankment filling height is small, there is no similar experience in quality control of high pressure solid layered rolling embankment construction in this area before. Combined with the example of reservoir engineering construction, the key technical requirements and practical application of roller earth dam construction are systematically analyzed, which improves the quality management level of such projects in Shanghai, and also provides the reference for the construction of similar major projects.

**Keywords:** dike filling; compaction degree; quality control

Study on Construction of Reinforced Concrete Pipe Joint with High-density Polyethylene Plate Lining  
..... ZHANG Wei ( 171 )

**Abstract:** The high-density polyethylene (HDPE) lining is mechanically embedded into the inner wall of the reinforced concrete pipe through the anchor key to enhance the corrosion resistance of the reinforced concrete pipe. In order to obtain the characteristics of HDPE lining under the different

treatment conditions at pipe joints, an experimental study on the resistance to external water pressure at the lined HDPE reinforced concrete pipe joint is carried out. The experimental results show that after the HDPE lining at the joint is welded, under a large external water pressure, the field welding quality cannot meet the water tightness of raw materials and the unfavorable situation of bulging and deformation occurs. According to the test results, three structural types of the unwelded, completely welded and partially welded linings at the joints of pipe joints are analyzed, and the suggestions for the selection of structural types of linings are put forward.

**Keywords:** sewage pipeline; HDPE lining; reinforced concrete pipe; pipe joint

Phytoremediation of Polluted River Sediment ..... LI Fanzhu ( 174 )

**Abstract:** In recent years, the remediation of polluted river sediment is getting more attention. The plant method has the advantages of low cost, good effect, less damage to the ecological environment and no secondary pollution, which becomes the research focus and hotspot for polluted river sediment today. Aiming at the different types of polluted sediment, the remediation characteristics of N and P nutrient contaminated sediment, organic matter contaminated sediment and heavy metal contaminated sediment are summarized and sorted out. In practical applications, it is necessary to adapt to local conditions, take into account multiple factors, select suitable plants and propose the directions required to be studied in the future.

**Keywords:** plant method; remediation; polluted river sediment

Study on Site Selection of Tongqi Canal Hydro-junction Project ..... WANG Jiaqi ( 178 )

**Abstract:** In order to improve the water environment and guarantee the water security, the solution of pumping station and sluice co-construction is usually adopted for some urban rivers constrained a lot. The site selection of hydro-junction project is directly related to the investment and benefits of its whole life cycle. Taking Tongqi Canal Hydro-junction in Nantong as an example, based on the requirements to meet its own functions, the overall construction planning of the area is coordinated. Combined with the two-dimensional flow mathematical model, the distribution of the flow state and velocity is validated, the engineering location is studied in detail and the optimal solution of engineering construction is explored.

**Keywords:** pumping station; sluice; engineering location; numerical simulation

## MANAGEMENT & CONSTRUCTION

Research on Scheme of Municipal Road across Railway Depot for Xiayan Highway .....  
..... CHEN Yongliang ( 184 )

**Abstract:** With the rapid development of infrastructures in China, the large railway ground facilities such as depot intersect with the urban trunk road network increasingly. In order to explore the characteristics and countermeasures for the interchange projects of municipal roads across the depots, taking the Xiayan Highway Project involved to the railway section in Shanghai as a case, firstly, the overall layout scheme of the project is determined, secondly, the key and difficult points of the project construction are analyzed, and then the corresponding countermeasures are put forward, and finally, several key problems of the municipal road across the railway depot are summarized.

**Keywords:** municipal road; railway related; depot; scheme; measures

Application of Rapid Construction Technology of Bridge in Viaduct of Yingbin Avenue in Suqian City .....  
..... FEI Xia ( 188 )

**Abstract:** With the progress of urbanization in China, the state is committed to the transformation of the urban development mode, the formation of urban characteristics, the improvement of urban environmental quality and the innovation of urban management services. In the meantime, the prefabricated and rapid construction technology of bridge has been developed rapidly. Combined with the Suqian Yingbin Avenue Rapid Reconstruction Project, the component prefabrication and component assembly of the superstructure and substructure of the bridge are introduced, which provides a certain reference for the application and practice of rapid construction technology in similar projects.

**Keywords:** urban elevated road; rapid construction; factory for prefabrication; small box girder; bent cap; component connection

Design and Construction of Expanded Foundation of Sanjiangkou Bridge ..... LI Xiaoqin ( 192 )

**Abstract:** Relying on the design and construction of the expanded foundation of the Sanjiangkou Bridge, the details of the expanded foundation structure, burial depth, parameter values and foundation pit backfilling of the bridge using the expanded foundation are discussed. The relevant experience is provided. The results indicate that the cost of expanding the foundation is relatively low, the construction period is short, and the construction risk is low. From the perspective of economy, construction period, and risk control, in areas with good geological conditions, the expanded foundation of the bridge is better than other foundation forms.

**Keywords:** expanded foundation structure; buried depth; anti-sliding block; sub-base; anti-sliding stability coefficient; anti-overturning stability coefficient

Study on Construction Technology of Long-span Bailey Bridge in Canyon Area .....

..... XIONG Tao, LUO Chaogui, LI Jiabin ( 196 )

**Abstract:** A prospecting road of a hydropower station is located in Qamdo, Tibet Autonomous Region, which is a necessary condition for the construction of roads and diversion tunnels within the hydropower station as soon as possible. The single-span Bailey bridge is used for the prospecting road across the Lancang River. Its net span is 54.864 m. In order to make it into use as soon as possible and to satisfy the construction period requirements of key projects of the power station, the 200-type double-deck reinforced beret steel bridge is used and is constructed by the "cantilever" push method. And the bridge is improved on the basis of the original construction method. The components of steel bridge can be used for recycling. Under the premise of not adding the guide beam components, the erection of the whole bridge can be completed within 15 days in order to save the cost and achieve the maximization of economic benefit, which can be referred for the similar projects.

**Keywords:** canyon area; long span; Bailey bridge; cantilever push method

Typical Engineering Projects of Subgrade Treatment and Slope Protection for Municipal Roads .....

..... LIU Shengtao ( 201 )

**Abstract:** Taking the engineering cases of subgrade treatment and slope protection as the examples, the applicable conditions and application scenarios of dry jet mixing (DJM) pile, SDDC pile, polymer grouting and foam light soil in the subgrade treatment, and row pile retaining wall in the slope protection are introduced in order to help the road engineers to choose the suitable, economical, reasonable and feasible engineering measures and schemes to solve the practical engineering problems according to the different engineering boundary conditions.

**Keywords:** dry jet mixing (DJM) pile; SDDC pile; trenchless treatment; polymer grouting; foam light soil; row pile retaining wall

Study on Comprehensive Treatment Scheme of Landslide near High Voltage Tower .....

..... LI Fei, YANG Rui, YAO Wei ( 204 )

**Abstract:** Landslide prevention and control is a point that must be considered in the design and construction of slope engineering. According to the provisions of the new code, the prevention and control measures for the traction-type landslide on the ancient slip mass in the main line K12+400 ~ K12+700 of the national highway G342 are introduced in detail, including the stability of the landslide under various construction conditions after earth clearing and load reduction, and the calculation explanation and rationality verification of the design process such as the size, reinforcement and layout of anti-slide piles. A integrated monitoring system has been established for the subsequent construction and operation of the highway in this section in order to prove the rationality of the treatment scheme for the landslide disposal of the project, and also provide the reference for the landslide disposal in the other related engineering examples.

**Keywords:** traction-type landslide; ancient slip mass; anti-slide pile; monitor

Study on Disposal Measures of Buried Joint Box Based on Engineering Practice .....

..... YE Bingbing ( 209 )

**Abstract:** The joint box of underground diaphragm wall is widely used in the construction of underground diaphragm wall. Accidents occur when the joint box is buried on occasion. Based on the engineering practice of the actual projects, the causes of the buried joint box are comprehensively analyzed. Two causes including the technology and construction environment are summarized. Several disposal measures for the buried joint box are proposed respectively three kinds of crane topping pulling, oil topping with crane topping pulling and lateral stripping. Based on the accident of the buried joint box in a waterworks extension project, the cause analysis, practical disposal measures and disposal results of the accident are given. Finally, some construction suggestions are put forward in order to provide the effective solutions for the relative accidents.

**Keywords:** underground diaphragm wall; joint box; disposal measures; crane topping pulling; oil topping; lateral stripping

Analysis on Influence of Seawall Construction in Chongming of Shanghai on G40 Yangtze River Bridge .....

..... HUANG Wei ( 213 )

**Abstract:** During the construction of the seawall up-to-standard project along the Chongming Island in Shanghai, it is required to analyze the influence and protect the piers during the construction near the piers of the G40 Yangtze River Bridge. Therefore, the PLAXIS finite element software is used to analyze the influence of the seawall up-to-standard reconstruction on the bridge, and the relevant reinforcing reconstruction measures are proposed.

**Keywords:** seawall; pier displacement; finite element calculation

Research on Reinforcement Technology of External Prestressed Carbon Fiber Plates .....

..... WANG Zhenhang, XU Xianghua, ZHOU Qingsong ( 217 )

**Abstract:** Taking a typical three-span prestressed concrete continuous box girder bridge in Yiwu City as the research background, the reinforcement scheme of external prestressed carbon fiber plates is put forward according to the bridge disease, and the reinforcement essentials are analyzed. The reinforcement effect of external prestressed carbon fiber plate is judged from the perspective of construction monitoring. The results show that the reinforcement of external prestressed carbon fiber plates can better improve the

alignment and stress condition of the bridge structure, improve the safety redundancy of bridge, and satisfy the requirements of reinforcement design.

**Keywords:** prestressed carbon fiber plate; old bridge reinforcement; continuous girder bridge; construction monitoring

Cause Analysis and Reinforcement Scheme of a Bridge Pier Column Circumferential Cracks ..... XU Jian ( 221 )

**Abstract:** Circumferential cracks of bridge pier column are relatively common bridge diseases. Combined with the similar problems actually occurred in a project, the field investigations of the construction site is conducted to investigate, compare, analyze and study the characteristics of cracks. With the help of finite element software, the causes of circumferential cracks of this bridge pier column are simulated and analyzed, and the reinforcement schemes of bridge pier column circumferential cracks are further proposed, which provides the reference for the prevention and reinforcement of the circumferential crack diseases of the similar bridge pier columns.

**Keywords:** bridge pier; circumferential crack; finite element; crack analysis; steel hoop reinforcement

Measures and Discussion of Intensive Land Conservation in Highway Construction Project ..... LIU Wei ( 225 )

**Abstract:** Combined with the construction practice of expressway, and national and provincial highway projects, the measures and practices of intensive land conservation in the stages of highway network planning, feasibility study, survey, design and engineering implementation are considered and summarized. Some measures and suggestions for the rational utilization and intensive land conservation are put forward, which provides some reference and experience for intensive land conservation of highway construction projects.

**Keywords:** highway; land; save; measures

Design and Research on Cable Hoisting System of Oversized-span Arch Bridge in Mountainous Area ..... ZHOU Yongkai ( 228 )

**Abstract:** The arch bridges in mountainous areas are often installed by the cable hoisting cable-stayed buckle-hanged method without supports. The reasonable arrangement of cable hoisting system plays an important role in the cost, construction period and risk control of the whole project. Combined with the unique construction environment of Suba Bridge, the arch rib is installed by the hoisting and buckle separation system. The stress is clear. At the same time, fully utilizing the site terrain conditions and based on the idea of permanent and temporary combination, the hoisting and buckle tower foundation and the anchoring system are cleverly designed to greatly save the construction period and reduce the cost. In addition, the system of self-propelled cable holder without auxiliary measures is developed, which realizes the non-power walking of cable holder and solves the problems of rope sagging and winding. Through a series of research, it is expected to provide reference for the design and construction of the cable hoisting system of the long-span arch bridge in mountainous areas.

**Keywords:** mountainous area; cable hoisting; cable-stayed buckle-hanged; design; construction; arch bridge

Treatment Scheme for Pile Foundation Avoiding Underground Pipelines during Construction of Municipal Bridges in Urban Built-up Areas ..... HU Yibin ( 232 )

**Abstract:** In the process of building the municipal bridges in urban built-up areas, it is often found that

there are the underground pipelines not mentioned in the exploration data and drawings at the bridge pile location, or the bridge foundation location directly overlaps with the pipe location, or the bridge foundation construction may cause multiple adverse effects on the existing pipelines, etc. If not handled in time, it will greatly affect the project progress and cost. The method of solving this dilemma is discussed from the perspective of supervision engineers through engineering examples, hoping to provide the different solutions for similar situations in the project.

**Keywords:** municipal bridge; pile foundation; underground pipeline; avoid; protect

Theoretical Analysis on Faulted Slabs of Straight-joint Assembled Segment for Shield Tunnel ..... ZHANG Qiang, YANG Dingtao ( 235 )

**Abstract:** With the development of shield tunneling construction technology and the solution of many problems, the problems of segment cracking, assembly difficulty and waterproof hidden danger caused by the faulted slabs of segment affect the construction and operation increasingly, which has the direct impact on the engineering quality. The faulted slabs of shield tunnel segment are mainly attributed to the differential displacement between the tunnel segments. Taking Shanghai Metro Line II West Extension Shield Tunnel Project as the background, on the basis of analyzing the stress of the different tunnel segments in detail, the D' Alembert principle is used to theoretically analyze the segment displacement. Finally, the calculation formula of the displacement for the different types of segments is analyzed and given, and the formula of faulted slabs between the segments is deduced. This formula shows out a ration relation among the faulted slab segment, segment stress, elastic gasket property and other factors in order to provide the theoretical basis for eliminating the faulted slab in the tunneling process of shield tunnel segments, ensuring the constructing precision and improving the construction quality.

**Keywords:** shield tunnel; segment; faulted slabs; D' Alembert principle; straight-joint assembly

The Application Research on Key Technology of Diaphragm Wall Trenching in Deep Rock Geological Conditions ..... HU Xiaobo ( 239 )

**Abstract:** Slotting is a key process in underground diaphragm wall construction, and slotting under deep rock geological conditions is one of the current difficult problems. This paper summarizes several slotting techniques for ultra-deep rock formation, including slotting with impact hammer, slotting with slotting milling machine, "two holes and one grasp" or "one hole and one grasp (milling)", and slotting with drill and blast. The main construction equipment and auxiliary construction equipment for slotting are introduced, and the key technologies of several combined slotting processes and their scope of application are discussed in detail. Based on the project of Songping Station, the practical application of two holes and one milling process and one hole and one milling process are introduced and compared and analyzed. The results show that the one-hole, one-milling process is 41% more efficient. This paper is a guideline for the construction of underground diaphragm walls into slots under deep rock conditions.

**Keywords:** Deep rock trenching; impact hammer trenching; trenching by trench milling machine; two drills and one mill (grab); one hole and one mill (grab); drill and blast trenching

Safety Management of Steel Box / Reinforcement Cage Hoisting Construction of Underground Diaphragm Wall ..... SUN Jie ( 243 )

**Abstract:** During the construction of underground diaphragm wall, its steel reinforced framework is mainly steel box and steel cage. At present, the problem of hoisting the extra-long and extra-heavy steel box / reinforcement cage brought by ultra-deep underground diaphragm wall has become more and more prominent. Based on a project of steel box / reinforcement cage joint test section, the safety management of

steel box/reinforcement cage hoisting construction of underground diaphragm wall is discussed. Three parts of equipment selection before hoisting, hoisting point control and safety control during hoisting are analyzed respectively. And some construction suggestions applicable to similar projects are given with the construction experience of relevant projects in order to further promote the development of steel box / reinforcement cage hoisting construction safety management in the continuous development of underground space construction.

**Keywords:** underground diaphragm wall; steel box; reinforcement cage; equipment selection; hoisting point control; safety management

Research on Multi-dimensional Joint Detection Method of Large-diameter Urban Pipelines ..... HU Danfeng, HE Guofeng, YU Zhe, CHENG Weijing, CHEN Renjie, GUO Hongzhi, YU Jingkun ( 246 )

**Abstract:** Finding out the actual operation of underground sewage pipeline is an important basis for later maintenance. However, the current detection method cannot fully grasp the accurate detection of underground pipelines. Aiming at the operation of Zhengzhou subway crossing beneath the sewage pipeline, the sewage pipeline is indirectly and intuitively detected by using the high-density electrical method and ground penetrating radar detection method, and combined with the self-developed detection technology of color imaging system floating on the water surface. The problems of leakage, cavity and dislocation of the sewage pipeline are found, and the multi-dimensional and three-dimensional monitoring of the pipeline is realized, which provides the technical support for the protection, repair and reinforcement of the underground pipeline.

**Keywords:** pipeline detection; high-density electrical method; ground penetrating radar; imaging system; leakage

## STUDY ON SCIENCE & TECHNOLOGY

Identification Algorithm of Anomaly Data Based on Feature Extraction and Machine Learning ..... ZHAO Rongxin, JIA Pengfei ( 250 )

**Abstract:** The rapid development of structural health monitoring system will generate a mass of monitoring data every day. For the structural health monitoring system, judging whether these generated monitoring data is normal is the first and crucial step in analyzing the structural health status. At the same time, the abnormality of monitoring data is also a key basis for judging whether the sensors, acquisition equipment and transmission equipment are working normally. It is a multi-classification problem to identify whether a piece of data is normal and to judge what kind of anomaly does the data belongs to. Based on the algorithm combining the feature extraction and machine learning, the time series data are classified, which can quickly judge whether the data is abnormal and the type of abnormality.

**Keywords:** structural health monitoring; machine learning; anomaly identification; K-nearest neighbor; multi-classification

Research on Vehicle Speed Recognition in Traffic Scene Based on Machine Vision ..... FU Yonggao ( 253 )

**Abstract:** The extraction of spatio-temporal information of bridge traffic vehicles and the tracking of vehicle trajectories are realized by the secondary development of YOLOv5 machine vision framework, while incorporating DeepSORT tracking algorithm. Then the traditional virtual coil method is improved to achieve the measurement of vehicle speed, which avoids the setting of threshold value due to the pixel change of detection coil in the traditional method and improves the universality of the algorithm. Finally, the algorithm is applied to the actual scene to compare with the tachymeter results, in which the average

error is within 1% and the maximum error is controlled within 15%.

**Keywords:** bridge engineering; machine vision; YOLOv5; DeepSORT; virtual coil method

Driving Simulation and Key Design Index of Helical Ramp in Mountain City .....

..... HU Boya, GONG Huafeng, ZHAO Congxiao, LIU Qing ( 256 )

**Abstract:** The helical ramp is often taken as the scheme to connect the elevation difference between the two sides of the road because of restricts of road resource and other factors in the mountain city. Due to the lack of design criteria for helical ramps in existing studies, as a result, the design of helical ramp often follows the linear standard of circular ramp or even branch road. 7 helical ramps in the main urban areas of Chongqing are selected to carry out the natural driving experiments. The environmental model of road is established through Carsim simulation software to analyze and compare the key influencing factors to cause the trajectory offset of vehicles. The research result shows that when Carsim is used to establish the driver simulation model, the simulation result of closed-loop control mode is more reliable. The trajectory deviation occurs only when the simulation running speed exceeds the measured running speed by more than 62.5%. It is recommended to increase the design speed of helical ramp appropriately. The minimum circular curve radius in the design of some helical ramps can be properly reduced according to the practical situation. For the helical ramps with the lower design speed, the actual running speed can be increased by increasing the ultra-high value.

**Keywords:** road engineering; helical ramp; Carsim; simulation model; design parameter

Analysis on Force of Bridge Pylon – Foundation Steel – Concrete Combined Segment of Stayed Suspension Cable Cooperative System .....

..... WANG Chong, GAO Jinjin ( 262 )

**Abstract:** In order to understand the force of the bridge pylon – foundation steel–concrete combined segment of stayed suspension cable cooperative system, according to a practical project, a three-dimensional solid finite element model of the pylon–foundation steel–concrete combined segment is established by ANSYS software to analyze and calculate its mechanical characteristics under the most unfavorable load conditions. The results show that the action effect combination in the operation stage is the most unfavorable load condition of the pylon – foundation steel–concrete combined segment. The stress of steel box in the steel–concrete combined segment of the pylon and foundation presents the distribution law that stress level near the base slab surface is low and the stress level near the interface on the combined segment is high. The maximum Mises stress of the steel box is less than the yield strength of material. A small area of point-like tensile stress concentration appears at the interface on the steel–concrete combined segment and at the interface on the top surface of the base slab when the concrete is filled into the steel box of the main bridge pylon due to the sudden change of size. The peak value reaches 8.5 MPa, and the maximum principal compressive stress is 16.8mpa, which are all less than the specification limit. Under the condition of not considering the stress concentration cracking at the minimum positions, the force at the pylon – foundation steel – concrete combined segment is safe.

**Keywords:** stayed suspension cable cooperative system; steel–concrete combined segment; stress concentration

Study on Load Probability Model of Highway Bridge under Extreme Load .....

..... FENG Wei, GUO Qiang, FAN Ze ( 266 )

**Abstract:** In the bridge design code of China, there is no explicit provision on the extreme load combination coefficient. In the probabilistic limit state design method based on structural reliability, due to the fact that there are many kinds of functions of highway bridges and the most of change with time, the



combination of various functions is relatively complex, and it is necessary to select a reasonable probability model to ensure that the true and reasonable structural reliability can be calculated. The probability distribution model of permanent load and effect of the highway bridge is established by consulting the literatures and combining with the vehicle data analysis of WIM system statistics; Based on the MATLAB software, on the basis that the overall vehicle weight obeys the multimodal distribution, the measured data are trained and fitted, the probability model of vehicle load effect is established, and the classification loading mode of vehicle load is determined, which lays a foundation for the reliability research of highway bridges and the solution of extreme load combination coefficient.

**Keywords:** highway bridge; extreme load; permanent load; automobile load; probability model; reliability

Study on Mechanical Performance of Prefabricated Socket-type Pier ..... FU Chenxi, SU Qiang ( 270 )

**Abstract:** The prefabricated socket-type pier has the advantages of convenient construction, large allowable error and reliable node. In order to promote the engineering application of this prefabricated pier in China, relying on a expressway reconstruction and extension project and based on ABAQUS finite element calculation platform, the full-scale solid modeling of prefabricated bridge connected by socket and spigot joints in the project is carried out. At the same time, the finite element model of cast-in-place bridge pier with the same size is established. And the monotonic displacement loading is carried out on the both. The numerical simulation results show that the socket-type connection is basically similar to the cast-in-place connection, and has the good mechanical performance. It can be considered as equivalent to the cast-in-place connection in practical projects, and has the great promotion value.

**Keywords:** prefabricated socket-type pier; numerical simulation; mechanical performance

A Simplified Calculation Method for Reinforcing Beam Bridge with Partial Cable-stayed System Based on Linear Control ..... ZHANG Chunming, WEI Guo ( 275 )

**Abstract:** Based on the influencing factors of using the partial cable-stayed system to reinforce the main girder alignment, the influence of the main girder deformation, the stayed cable elongation, and the compression and deflection of the main pylon under the external load on the deflection of the main girder is analyzed. The reinforcement calculation method of two-span continuous girder is derived. According to beams, the mechanics mechanism of partial cable-stayed reinforcement system based on linear control is expounded. According to the disease detection results of a Yellow River bridge and on the basis of analyzing the cause of disease and the internal force distribution of bridge, the reconstruction scheme of partial cable-stayed reinforcement system is proposed, and the deflection of the main girder before and after reinforced is calculated. Compared with the finite element results, the feasibility of the proposed reinforcing calculation method is verified.

**Keywords:** prestressed concrete girder bridge; bridge disease; reinforcement method; partial cable-stayed system; main girder alignment

Analysis on Performance of Cement and Steel Slag Mixed Base under Freezing and Thawing Cycle ..... HAN Xiaoliang ( 280 )

**Abstract:** In the good economic development situation in China, the industrial development has advanced by leaps and bounds, in which the steel is used as a material in all walks of life. But the steel will also produce many waste slags difficult to effectively use in the processing. The steel slag mixed with the cement according to certain gradation can be used as the roadbed filler, which can solve some problems of steel slag treatment. The bearing capacity of cement and steel slag mixture under the action of freezing-thawing cycle is mainly analyzed. The following conclusions are obtained through the laboratory

test that under the graduation meeting the requirements of highway grade, with the increase of the number of freezing–thawing cycles, the cracks of the specimen increase, showing the aggregate exposure, and the bearing capacity decreases significantly. The mass of the specimen increases first and then decreases with the number of cycles under the freezing–thawing cycles, and the strength decreases continuously with the increase of cycles. The correlation formula between the compressive strength of specimens and the number of cycles can be obtained through test and data processing, which can provide the prediction guidance for subsequent field tests and field construction.

**Keywords:** cement; steel slag; freezing–thawing cycle; compressive strength

Research and Application of Intelligent System for Tunnel Section in Urban Trunk Road .....  
..... XU Yongxiang ( 284 )

**Abstract:** With the rapid development of economy in China, the rapid growth of urban population, the year–by–year advancement of urban trunk road tunnel construction and the rapid increase of road transport capacity demand, the relevant national departments have proposed to focus on promoting the construction of intelligent transport infrastructures. It is the key for the intelligent transport development to gradually realize the intelligence, informatization, integration and green energy saving of highway tunnels in China. The actual cases are used to carry out the intelligent research and analysis on the tunnel sections in urban trunk road. Through a series of technical means such as the intelligent operation management platform, data interaction and shared information, the business capability of tunnel operation management is improved in terms of equipment control, event early warning, process management and emergency handling.

**Keywords:** road engineering; intelligent tunnel; management and control system; digital twin platform

Study on Bending Bearing Capacity of Hollow Base Slab Based on Wind Power Engineering .....  
..... WANG Lin, XIE Xin ( 289 )

**Abstract:** Wind energy is clean, abundant and renewable. The development of wind power technology is an important measure to promote "carbon neutralization and carbon peak". The bending bearing capacity of the hollow wind power base slab is studied by the means of finite element numerical analysis based on a wind power project. The distribution characteristic of internal force of hollow base slab under the bending moment is analyzed. The effect of base slab reinforcing bars on the bending bearing capacity of the structure is specially studied, and the optimization scheme of reinforcing bars is put forward in order to effectively improve the extreme bending bearing capacity of hollow base slab, which provides some theoretical support for the design and construction.

**Keywords:** wind power generation; base slab of draught fan; bending property; numerical calculation

## APPLICATION OF ACHIEVEMENTS

Application of Digital Twin Technology in Urban Trunk Road Reconstruction Project .....  
..... MOU Xiaoliang ( 293 )

**Abstract:** With the continuous development and construction of city, the road reconstruction projects are increasing gradually. Taking the application of digital twin technology in a trunk road reconstruction project in Shanghai as an example, the application ideas of digital twin technology in the road reconstruction projects is expounded, and the characteristics and difficulties of such projects are analyzed. Through the application of digital twin technology and sBIM information management platform, the data of design, construction progress, cost, quality, safety, environment, smart construction site, etc. are built to

improve the management precision, which provides the model for improving the enterprise-level platform. At the same time, the digital twin assets of the project completion are formed, which provides the reliable data support for the operation and maintenance stages.

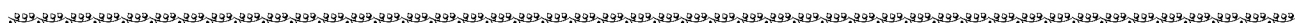
**Keywords:** digital twin; trunk road reconstruction project; BIM information management platform; smart construction site

### Study on Application of Earthwork in Optimizing Spatial Development of Mountainous City Based on GIS

..... LI Zhihui ( 297 )

**Abstract:** The application method of GIS technology is proposed in optimizing the earthwork of the surface and underground space development of mountain cities. GIS technology can not only directly show the connection of urban surface space with natural environment, but also realize the calculation of earthwork with the different design surfaces. Combined with the calculation of earthwork in the underground space, the amount of earthwork development in urban three-dimensional space is obtained, which guides the vertical optimization design of road network and land use. Taking Longxing RS standard zoning road network and land earthwork optimization as an example, after optimization, the good economic and social benefits for the urban development and construction are achieved.

**Keywords:** GIS technology; mountainous city; underground space development; earthwork optimization



Excellent Journal of the Ministry of Housing and Urban-Rural Development, PRC

## Urban Roads, Bridges & Flood Control

Monthly

Number 8,2023 (Total Number 292)

Publication on August 15<sup>th</sup>, 2023

Start Publication in 1984 Issuance Scope: Domestic and International Issuance

**Governing Body:** Ministry of Housing and Urban-Rural Development, PRC

**Sponsor:** Shanghai Municipal Engineering Design Institute (Group) Co., Ltd.

**Edition and Publication:** Editorial Office of "Urban Roads, Bridges & Flood Control"

**Editor-in-chief:** LUO Yanni

Address: 901 Zhongshan Bei Er Road, Shanghai, China

P.C.: 200092

Tel.: (021)55008850

Fax: (021)55008850

Website: <http://www.csdqyf.com>

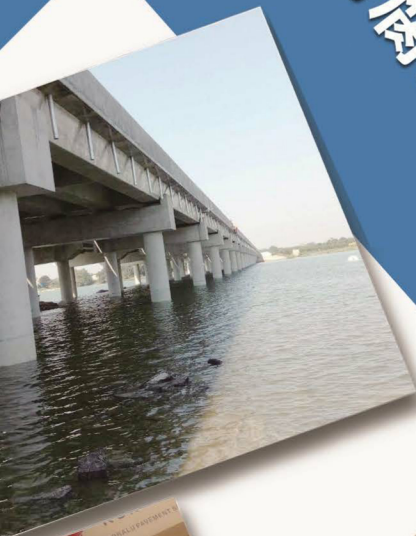
E-mail: [cdq@smedi.com](mailto:cdq@smedi.com)

China Standard Serial Numbering:  $\frac{\text{ISSN } 1009-7716}{\text{CN } 31-1602/U}$

Domestic Price: RMB 25 Yuan

# 润邦®

## 桥梁防腐涂装 请找青岛润邦



### »» 公司简介

青岛润邦防水建材有限公司是一家集科研、生产、施工、服务于一体的复合型发展的民营科技企业。拥有国家防水防腐保温工程专业承包一级资质，致力于建筑防水防腐材料、路面养护材料的研究开发和应用。公司以优质的防水材料为基础，积累了二十几年的防水施工经验，培养了大批防水施工专家。现可承接各种大型建筑防水防腐工程，以及公路、铁路桥梁防水防腐、路面养护等工程。

### »» 主营产品

#### 路桥防水养护材料：

- ◎ JBS环保型桥梁防水涂料
- ◎ JBS-C沥青路面养护涂料
- ◎ JBS-1500高渗透结晶型硅烷防水剂
- ◎ FYT-1改进型沥青防水涂料
- ◎ RBS速熔快通路面灌缝胶
- ◎ 牢巴路瓶装尖嘴式冷灌缝胶

#### 硅烷防水防腐系列产品：

- ◎ GW-301异丁基三乙氧基硅烷浸渍液
- ◎ GW-302膏体硅烷
- ◎ 硅烷防腐防水涂料
- ◎ 环氧基硅烷改进型浸渍液
- ◎ SHJS高渗透改性环氧聚碳硅氧烷系列产品

邮编：266321  
 传真：0532-86202378  
 地址：青岛胶州市洋河工业区  
 官网：<http://www.runbang.cn/>  
 E-mail: runbang2008@163.com  
 专家咨询：0532-86200474  
 客服电话：0532-86200051  
 0532-86201314

广告

ISSN 1009-7716  
CN 37-1027/U

国内发行：《城市道桥与防洪》编辑部  
国外发行：中国国际图书贸易总公司（代号：BM 1859）

定价：25.00元



本刊公众号