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第四十六卷 第八期 二〇一四年八月
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《哈尔滨工业大学学报》征稿简则

《哈尔滨工业大学学报》主要报道自然科学领域的基础理论、工程技术与应用方面的最新研究成果,欢迎省(部)级以上政府基金资助项目(国家自然科学基金、863、973、博士点基金等)相关论文。报道方向包括航天、机械、能源、动力、材料、电气、电子、信息与控制、计算机、化工、生物工程、土木工程、市政环境、暖通空调、道路、桥梁、交通工程、工程力学及有关交叉性学科。

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钢筋混凝土墙板内置无粘结钢支撑抗冲切研究

丁玉坤[1,2]

(1. 哈尔滨工业大学 结构工程灾变与控制教育部重点实验室, 150090 哈尔滨;
2. 哈尔滨工业大学 土木工程学院, 150090 哈尔滨)

摘　要: 为了改善钢筋混凝土墙板内置单斜形无粘结钢板支撑中墙板的抗冲切性能,用开孔槽钢来抗冲切,并将钢板支撑端部的加劲肋立放设置.采用拟静力试验研究了构造对试件滞回性能的影响,基于试验结果探讨了墙板的抗冲切设计方法.试验表明:与支撑周围采用加密拉结筋的抗冲切构造相比,采用开孔槽钢可避免墙板局部冲切破坏,墙板局部冲切开裂程度大幅降低;与支撑端部加劲肋平放设置相比,加劲肋立放时可减小加劲肋端墙板与支撑间空隙的宽度,从而减小端部钢板支撑对墙板的冲切作用力;试件最终发生了墙板局部冲切破坏或支撑受拉断裂,破坏前试件滞回曲线饱满稳定;依据墙板可能的冲切破坏模式,给出了抗冲切验算方法.

关键词: 防屈曲支撑;钢筋混凝土墙板内置无粘结钢板支撑;滞回性能;冲切破坏;受拉断裂;腹板开孔槽钢
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Study on punching shear for unbonded steel brace encased in reinforced concrete panel

DING Yukun[1,2]

(1. Key Lab of Structures Dynamic Behavior and Control, Ministry of Education, Harbin Institute of Technology, 150090 Harbin, China; 2. School of Civil Engineering, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: Perforated channels and upright stiffeners were employed in the diagonal unbonded steel plate brace encased in reinforced concrete panel, referred to as panel buckling restrained brace (panel BRB), to improve the punching shear capacity of panel. Quasi-static tests were carried out to investigate effects of constructional details on the hysteretic behavior of panel BRBs. Punching shear design methods for the panels were examined based on test results. Tests reveal that the perforated channels can avoid the punching shear failure of panel and greatly decrease the punching shear cracks, as compared with the additional steel bars used around the brace. Besides, compared with flat stiffeners, the upright stiffeners used in a brace can decrease the width of gap between the panel and the brace near the tips of stiffeners and therefore decrease the punching shear forces applied to the panel by the ends of brace. Punching shear failure of panel or tension fracture of brace occurred at the end of tests. All specimens exhibited stable hysteretic behavior before the failure of panel BRBs occurred. The punching shear design methods for the panels were proposed based on the possible failure modes of panels.
Keywords: buckling restrained brace; unbonded steel plate brace encased in reinforced concrete panel; hysteretic behavior; punching shear failure; tensile fracture; steel channel with perforated web

轻钢活动房结构抗火性能分析

王洪欣[1,2]，查晓雄[1]，王锦文[2]，张梅松[2]

（1.哈尔滨工业大学 深圳研究生院，518055 广东 深圳；2.筑博设计股份有限公司，518029 广东 深圳）

摘　要：为了得到轻钢活动房结构的抗火性能，采用理论推导和有限元分析相结合的方法对其进行研究.首先，从活动房单榀框架出发，基于临界温度相等的原则，将结构变形曲线简化为弹性段和垂直段，来代替原有的弹塑性模型；然后推导得到弹性段的变形公式，给出了分界点的确定方法，进而求得单榀结构火灾下的临界温度计算公式；最后，通过有限元比较了单榀框架和整体结构的抗火性能，并分析了框架榀数和着火位置对结构抗火性能的影响.分析结果表明：整体结构的抗火性能与单榀结构相近，框架榀数对整体抗火性能影响不大，最不利的火灾位置为中部房间.

关键词：活动房；抗火性能；有限元；临界温度；着火位置

中图分类号：TU352.5　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0010-06

Fire resistance performance of mobile house

WANG Hongxin[1,2], ZHA Xiaoxiong[1], WANG Jinwen[2], ZHANG Meisong[2]

(1. Harbin Institute of Technology Shenzhen Graduate School, 518055 Shenzhen, Guangdong, China;
2. Zhubo Design Group & Research Institute Co', Ltd', 518029 Shenzhen, Guangdong, China)

Abstract: Theoretical derivation and finite element method were developed in this paper to study the fire resistance performance of mobile house. First, based on the equivalent principle of the critical temperature, the structural deformation curve was simplified as elastic and vertical segments instead of the original elastic-plastic model. Then, deformation formula of the elastic segment was obtained by theoretical derivation, and the method of determining the dividing point was also provided. To this end, the critical temperature formula of frame under fire was obtained. Finally, the fire resistant performance of the entirety house structure and the single frame were analyzed and compared through finite element method. It shows that, the fire resistance performance of the entirety house structure is similar to single frame structure, the number of frame have little effect on the fire resistant performance of entirety house, and the most unfavorable fire location is the middle room.

Keywords: mobile house; fire resistance performance; finite element method; critical temperature; fire location

均布荷载作用下保温龙骨足尺墙体的抗弯性能

耿　悦[1,2]，王玉银[1,2]，林敬木[1]

（1.哈尔滨工业大学 土木工程学院，150090 哈尔滨；2. 哈尔滨工业大学 结构工程灾变与控制教育部重点实验室，150090 哈尔滨）

摘　要：为研究腹板开孔的轻钢龙骨墙体在均布荷载作用下的抗弯性能，考虑腹板高度的影响，进行 3.0 m×3.0 m 足尺试件试验研究.分析了不同腹板高度的墙体在均布荷载作用下的破坏模式及腹板高度对墙体抗弯性能的影响.在此基础上，采用 ABAQUS 建立墙体的有限元模型，与试验结果进行对比分析，验证了有限元模型的可靠性.分析结果表明：石膏板可很好地限制竖龙骨的整体屈曲，当龙骨腹板高度为 150 mm 时，墙体竖龙骨在支座附近发生腹板剪切屈曲，同时在跨中位置发生畸变与局部屈曲的相关屈曲破坏；当龙骨腹板高度为 100 mm 时，墙体竖龙骨在跨中位置发生畸变与局部屈曲的相关屈曲破坏；当不考虑窗洞口影响时，腹板高度为 100 mm 的保温龙骨外围护墙体可满足我国全部地区建筑高度不超过 50 m 的城市建筑外围护墙体的抗风要求.

关键词：腹板开孔轻钢龙骨；抗弯；足尺；试验研究；ABAQUS

中图分类号：TU392　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0016-05

Bending behaviour of full-scale walls with light-gauge slotted steel studs subjected to distributed loading

GENG Yue[1,2], WANG Yuyin[1,2], LIN Jingmu[1]

(1.School of Civil Engineering, Harbin Institute of Technology, 150090 Harbin, China; 2. Key Lab of Structures Dynamic Behavior and Control, Ministry of Education, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: Full-scale experiments were carried out to investigate the static responses of light-gauge slotted steel stud walls with different web heights subjected to uniformly distributed transverse loading. The failure modes for the walls were depicted. The influence of the web height on the static behaviour of this new kind of light-gauge steel stud walls was analyzed. By means of ABAQUS, finite element model was built to numerically investigate the bending behaviour of the full-scale light-gauge slotted steel stud walls. The analysis results were benchmarked against the experimental ones. It was concluded that the gypsum board can prevent the studs from overall buckling. The stud wall with web height of 150 mm failed in shear mode at the support and buckled in both the local and distortional mode at the mid span, while the stud wall with web height of 100 mm only failed with local and distortional buckling at the mid span. When there is no window hole, the slotted steel stud wall with a web height of 100 mm can resist the wind loading in China for the building with the height lower than 50 m.

Keywords: light-gauge slotted steel studs; bending resistance; full scale; experimental investigation; ABAQUS

混凝滤布过滤-缺氧滤池/生物滴滤工艺处理生活污水

赵庆良[1], 李江雯[1,2], 魏亮亮[1], 王　琨[1], 李　伟[1]

(1.哈尔滨工业大学 市政环境工程学院, 150090 哈尔滨; 2.铁道第三勘察设计院集团有限公司, 300142 天津)

摘　要: 为实现小城镇污水高效、节能、低耗处理,建立混凝滤布过滤-缺氧滤池/生物滴滤污水处理组合工艺.在优选实验装置及材料的基础上,探究各部分工艺最优运行参数. 在研究系统对常规污染物去除的同时,重点分析生物滤池启动过程对氨氮和总氮的去除能力.结果表明:当粉煤灰基混凝剂投加量为 1 mL/L 时,混凝-滤布过滤对 COD_{cr} 的去除率可达 54%,对 TP 的去除率达 81%,且具有工作周期长、耗能少等特点;生物滤池在水力负荷为 15 L/d、硝化液回流比为 150% 时运行效果最好,可保证系统出水氨氮、COD_{cr}、TP、TN 均达到 GB18918—2002 的一级 A 标准.

关键词: 小城镇;污水;混凝-滤布过滤;生物滴滤池;脱氮

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Treatment of domestic wastewater by combined processes of coagulation cloth media filtration-anaerobic filter/trickling filter

ZHAO Qingliang[1], LI Jiangwen[1,2], WEI Liangliang[1], WANG Kun[1], LI Wei[1]

(1.School of Municipal and Environmental Engineering, Harbin Institute of Technology, 150090 Harbin, China;
2. The Third Railway Survey and Design Institute Group Corporation, 300142 Tianjin, China)

Abstract: In order to treat the small town sewage wastewater with high efficiency, energy saving and low power consumption, a combined coagulation cloth media filtration-anaerobic filter/trickling filter system was established at experimental condition. Via the experimental optimization of equipments and materials, the optimal operation parameters of each part, especially the nitrogen removal ability during the start-up of the trickling filter had been investigated. Experimental results showed that at 1 mL/L fly ash coagulant dosage, 54% removal of COD_{cr} and 81% of TP would be removed by the combined system. The optimal hydraulic loading was 15 L/d and the optimal reflux ratio was 150%, which would guarantee the effluent ammonia, COD_{cr}, TP reach A standard.

Keywords: small town; domestic sewage; coagulation-cloth media filtration; trickling filter; nitrification

养猪废水厌氧消化液 SBR 短程硝化系统影响因素

李建政[1,2]，孟　佳[1]，赵博玮[1]，艾斌凌[1]

（1. 哈尔滨工业大学 市政环境工程学院，150090 哈尔滨；
2. 哈尔滨工业大学 城市水资源与水环境国家重点实验室，150090 哈尔滨）

摘　要：针对养猪废水厌氧消化液较高残留的氨氮，为开发短程硝化-反硝化脱氮工艺，以序批式活性污泥反应器（SBR）的运行为基础，探讨温度、氨氮负荷（R_{nl}）和曝气时间对活性污泥系统短程硝化特征的影响.结果表明：在 28 和 15 ℃ 条件下，将溶解氧控制为 1.0~2.0 mg·L^{-1}时，SBR 系统均能实现良好的短程硝化功能；但在 15 ℃条件下，氨氮去除率和亚硝酸盐积累率（R_{na}）较 28 ℃均有显著下降，分别从 71.1%和 96.7%降到 52.8%和 85.4%；在 28 ℃条件下，氨氮负荷由 0.56 kg·m^{-3}·d^{-1}大幅提高到 2.18 kg·m^{-3}·d^{-1}后，SBR 系统的氨氮去除率显著降为 48.6%，但 R_{na} 仍然高达 96.8%，保持了良好的短程硝化性能. R_{nl} 较高时，可适当延长曝气时间以强化 SBR 系统的氨氮氧化能力. 但曝气时间过长会导致大量 NO_2^--N 的氧化，R_{na} 显著下降.

关键词：养猪废水；厌氧消化液；序批式活性污泥反应器；短程硝化

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Main influence factors for shortcut nitrification in a SBR treating anaerobic digested piggery wastewater

LI Jianzheng[1,2], MENG Jia[1], ZHAO Bowei[1], AI Binling[1]

(1. School of Municipal and Environmental Engineering, Harbin Institute of Technology, 150090 Harbin, China;
2. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: To develop a shortcut nitrification process for treating anaerobic digested piggery wastewater with a high ammonia concentration, a sequencing batch reactor (SBR) was introduced, and the temperature, ammonia nitrogen loading rate (R_{nl}) and aeration time were investigated as the significant influence factors of the shortcut nitrification. The shortcut nitrification process could be established in the SBR at 28 ℃ or 15 ℃ with the identical dissolved oxygen (DO), ranged from 1 to 2 mg·L^{-1}. But the ammonia removal and nitrite accumulation rate R_{na} were decreased from 71.1% and 96.7% to 52.8% and 85.4%, respectively, when the temperature was dropped from 28 ℃ to 15 ℃. Though the ammonia removal rate was decreased to 48.6% since the R_{nl} had been increased from 0.56 to 2.18 kg·m^{-3}·d^{-1} at 28 ℃, a R_{na} as high as 96.8% was obtained, indicating that an excellent shortcut nitrification occurred in the SBR. To obtain a superior ammonia oxidation with a higher R_{nl}, extension of aeration time would be supportive. But an excessive aeration could result in an increase in nitrate and a decrease in R_{na}, which was unfeasible for the shortcut nitrification process in the SBR.

Keywords: piggery wastewater; anaerobic digestion liquor; sequencing batch reactor (SBR); shortcut nitrification process

反硝化脱硫工艺中生物硫分布特征及分离方法

远　野[1,2], 王爱杰[1,2], 马素丽[1,2], 陈　川[1,2], 赵友康[1,2], 谭文勃[1,2],
黄　聪[1,2], 徐熙俊[1,2], 孙德智[1,2]

(1. 哈尔滨工业大学 市政环境工程学院, 150090 哈尔滨;
2. 哈尔滨工业大学 城市水资源与水环境国家重点实验室, 150090 哈尔滨)

摘　要: 为探寻反硝化脱硫工艺生物硫分离方法,运行反硝化脱硫系统获得生物硫在系统中分布特征,并对生物硫进行粒径分布、Zeta 电位、能谱及电镜扫描分析,确定了一种分离生物硫的新方法.结果表明,生物硫在反硝化脱硫系统中水相占 65%,污泥相占 35%.能谱分析表明,生物硫硫元素占 60%以上,电镜分析显示生物硫表面具有多聚糖、蛋白质等官能团,生物硫 Zeta 电位平均为-20 mV 带负电(在± 30 mV 之间),得出生物硫具有胶体特性.进一步用阳离子絮凝剂实验分离生物硫获得 99%分离率.混凝沉淀方法能有效地分离回收生物硫.

关键词: 生物硫;分布特征;胶体特性;混凝沉淀
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Distribution characteristics and separation of biological sulfur in denitrifying sulfide removal process

YUAN Ye[1,2], WANG Aijie[1,2], MA Suli[1,2], CHEN Chuan[1,2], ZHAO Youkang[1,2], TAN Wenbo[1,2], HUANG Cong[1,2], XU Xijun[1,2], SUN Dezhi[1,2]

(1.School of Municipal and Environmental Engineering, Harbin Institute of Technology, 150090 Harbin, China;
2. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: To better separate biological sulfur from denitrifying sulfide removal (DSR) process, we determined a new method by researching on the distribution characteristics of biological sulfur in this process system, Zeta potential, particle size distribution, scanning electron microscope and energy spectrum analysis. The results showed that the biological sulfur in the effluent and sludge accounted for 65% and 35% of the total sulfur production, respectively. S content of biological sulfur particles is no less than 60%. Zeta potential value is approximately -20 mV (between ±30 mV); Biological sulfur particles are spherical with rough surfaces, with many functional groups on the surface such as polysaccharide and proteins. The above biological properties indicate that it has characteristics of colloid. The biological sulfur flocculation rate is approximately 99% when using cationic coagulant to separate biological sulfur. Coagulation is an effective method of separating biological sulfur form (DSR) process.

Keywords: biological sulfur; distribution characteristics; characteristics of colloid; coagulation

催化氧化-芬顿工艺处理表面活性剂生产废水中试研究

邱　珊[1,2]，曾红云[3]，刘子述[1]，徐善文[2]，马　放[1,2]

（1. 哈尔滨工业大学 市政环境工程学院，150090 哈尔滨；2.哈尔滨工业大学 城市水资源与水环境国家重点实验室，150090 哈尔滨；3.黑龙江省环境保护科学研究院，150027 哈尔滨）

摘　要：针对重烷基苯磺酸盐（HABS）生产废水高 pH、高 COD、高亚硫酸盐的特点，应用催化氧化-芬顿联合处理工艺进行现场中试实验及参数确定.中试规模为 5 t/d，通过优化参数得到催化氧化最优条件为 pH=8，曝气量为 50 $m^3 \cdot h^{-1}$，停留时间为 90 min；芬顿氧化段最优条件为 30%双氧水投加量 1.00 mL/L.采用上述工艺运行方案处理 HABS 生产废水，出水水质满足 GB8978—1996 中的 I 级排放标准，是一种经济可行的工艺.

关键词：重烷基苯磺酸盐工业废水；催化氧化；芬顿

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The pilot test on the treatment of surfactants production wastewater by catalytic oxidation-Fenton process

QIU Shan[1,2], ZENG Hongyun[3], LIU Zishu[1], XU Shanwen[2], MA Fang[1,2]

(1. School of Municipal and Environmental Engineering, Harbin Institute of Technology, 150090 Harbin, China; 2.State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, 150090 Harbin, China; 3.Heilongjiang Provincial Research Institute of Environmental Science, 150027 Harbin, China)

Abstract: According to the characters of HABS industrial wastewater of high pH, high COD and high concentration of sulfite, a pilot reactor with catalytic oxidation-Fenton combined treatment process was built, and the pilot scale experiments were employed to discuss the optional parameters. A pilot scale is 5 t/d. After optimized, the optimal optional parameters in catalytic oxidation stage were pH 8, aeration rate 50 m^3/h, HRT 90 min. The optimal optional parameters in Fenton stage were dosage of H_2O_2(30%) 1.00 mL/L. The effluent quality can meet the first class requirements of Sewage Discharge Standard in GB8978—1996, which suggests the process is economical and feasible.

Keywords: HABS industrial wastewater; catalytic oxidation; Fenton

基于自由振荡理论的有压管道堵塞检测方法

伍悦滨[1,2]，徐　莹[3]，汪　芬[4]

（1.哈尔滨工业大学 城市水资源与水环境国家重点实验室，150090 哈尔滨；2.哈尔滨工业大学 市政环境工程学院，150090 哈尔滨；3.哈尔滨商业大学 能源与建筑工程学院，150028 哈尔滨；4.广东省电力设计研究院，510660 广州）

摘　要：为了解决有压管道的堵塞问题，根据自由振荡理论的基本原理，提出适于检测管道堵塞的数值模拟简化模型，得出了确定管道堵塞的定位与定量的方法.基于有压瞬变流理论，结合振动理论，引入迪拉克函数，建立包含堵塞的管道瞬变流控制方程；对方程进行无量纲化并线性化，使其得到简化.在固定边界条件下，求出相对压力的解析解，对其进行傅立叶级数分析，得到各谐波在各相对周期中的振幅，由此可计算出各谐波的衰减指数.求解结果表明：堵塞衰减与管道流量成正比，管道堵塞的相对位置与堵塞衰减参数呈余弦关系，只要已知两个谐波的堵塞衰减参数即可确定堵塞位置和堵塞量级.

关键词：管道堵塞；瞬变流；自由振荡；堵塞衰减；阻尼衰减

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Blockage detection in water-supply pipelines based on auto-oscillation theory

WU Yuebin[1,2], XU Ying[3], WANG Fen[4]

(1. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, 150090 Harbin, China;
2. School of Municipal and Environmental Engineering, Harbin Institute of Technology, 150090 Harbin, China;
3. School of Energy and Civil Engineering, Harbin University of Commerce, 150028 Harbin, China;
4.Guangdong Electric Design Institute, Guangzhou 510660, China)

Abstract: Blockage in pressure pipelines has become a serious issue in the world. According to the basic principle of auto-oscillation theory, the simplified model is put forward for the numerical simulation of blockage detection. Based on the theory of transient flow, the governing equations of transients in a pipeline including blockage are established with the adoption of Dirac delta function. Non-dimensionalizing and linearizing the governing equation, the equations will be simplified. An analytical solution has been deduced under the fixed boundary conditions. By Fourier series analyzing, the amplitudes of each harmonic component in different periods are calculated, and the damping exponent of each harmonic component can be obtained. The results show that the blockage damping is direct ratio to the flow rate of pipe, and the location of damping has the cosine relation with damping parameters, so the location and magnitude of blockage can be fixed if two blockage damping parameters are known.

Keywords: blockage in pressure pipelines; transient flow; auto oscillations; blockage damping; friction damping

不同负荷单井循环地下水源热泵系统实验

宋　伟，倪　龙，姚　杨

（哈尔滨工业大学 热泵空调技术研究所，150090 哈尔滨）

摘　要：针对单井循环地下水源热泵系统，搭建了物理模拟砂箱实验台研究其地下水流动和换热规律，并开展了负荷变化的实验研究.结果表明：相同实验条件下，循环单井的取热量仅为抽灌同井的 50.3%，填砾同井的 45.9%，其径向热影响范围小于 186.5 mm；而当抽水流量从 0.54 m^3/h 降低到 0.315 m^3/h 时，循环单井、抽灌同井、填砾同井的取热量分别降低了 51.0%、31.6%和 19.5%.可见循环单井承担负荷的能力最差，但抽水流量的变化对循环单井的影响更大；提高抽水流量能够显著提高热源井的取热量，增大热影响范围，从而提高热源井承担负荷的能力.

关键词：地下水源热泵；单井循环；砂箱实验；抽水流量；负荷变化

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Experimental research on single well groundwater heat pump systems in building load variations

SONG Wei, NI Long, YAO Yang

(Institute of Heat Pump and Air Conditioning Technology, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: Because of insufficient research on single well groundwater heat pump systems, a physical simulation experiment table has been set up to study the flow and heat transfer law in these systems. Experimental research on building load variations has been carried out. The results show that in the same experimental conditions the absorption quantities of standing column well (SCW) are only 50.3% and 45.9% of pumping and recharging well (PRW) and pumping and recharging well filled with gravel (PRWFG) respectively. In addition, the radial thermal influence scope of SCW is less than 186.5 mm. However, the heat absorption quantities of SCW, PRW and PRWFG reduce to 51.0%, 31.6% and 19.5% individually, when the flow rate of outlet water drop from 0.54 m^3/h to 0.315 m^3/h. Thereby the load capacity of SCW is the least one in these three systems. However, the variation of the flow rate of outlet water can impact on SCW more significantly. It is more obvious that increasing the flow rate of the outlet water can improve the load capacity and the thermal influence scope of the thermal source wells. Thus, the load capacity of thermal source wells can be increased.

Keywords: groundwater heat pump; single well; sand tank experiment; flow rate of outlet water; building load variations

水平管内汽液两相流流型及换热特性数值模拟

李书磊，蔡伟华，李凤臣

（哈尔滨工业大学 能源科学与工程学院，150001 哈尔滨）

摘　要：为研究水平管内相变汽液两相流动流型变化，使用 VOF 模型和 RSM 湍流模型对其进行了数值模拟，分析了水平管内对流换热、压降及流型的变化.模拟结果表明：VOF 模型和 RSM 湍流模型可用于模拟两相流流型中的泡状流、分层流、波状流、弹状流以及环状流；模拟结果与 Mandhane 流型图基本吻合；对流换热系数及压降与已有关联式吻合较好.

关键词：汽液两相流；流型；VOF；雷诺应力模型

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Numerical simulation on flow pattern and heat transfer of vapor-liquid two-phase flow in horizontal pipe

LI Shulei，CAI Weihua，LI Fengchen

（School of Energy Science and Engineering，Harbin Institute of Technology，150001 Harbin，China）

Abstract：In order to study the evolution of the flow pattern in a phase-transition vapor-liquid two-phase flow in a horizontal pipe，numerical simulation based on volume-of-fluid（VOF）model and the Reynolds stress turbulence model（RSM）was performed. The characteristics of convective heat transfer，pressure drop and evolution of flow patterns in the simulated horizontally pipe-flow were analyzed. It was obtained that the VOF model and RSM model can be used to simulate bubble flow，stratified flow，wavy flow，slug flow and annular flow. The simulated two-phase flow patterns are in agreement with the Mandhane flow pattern map. Furthermore，the simulated heat transfer coefficient and pressure drop are also in good agreements with the existing correlations.

Keywords：vapor-liquid two-phase flow；flow pattern；VOF；reynolds stress turbulence model

复杂局部地形中的实时路径规划算法设计

周自维[1,2], 李长乐[1], 赵　杰[1], 徐望宝[2]

(1.哈尔滨工业大学 机器人研究所,150001 哈尔滨; 2.辽宁科技大学 电子信息工程学院,114000 辽宁 鞍山)

摘　要: 针对复杂局部环境中机器人实时自主导航问题,设计了"双向搜索多边形构造算法"和"基于势场函数的机器人运动控制器"."双向搜索多边形构造算法"能够在机器人被障碍物包围的环境下搜索出障碍物的包围多边形,从而获取基于障碍的最优行进路径;"基于势场函数的机器人运动控制器"是一个多变量控制器,输入矢量由吸引势场函数和排斥势场函数组成,输出矢量由速度和转角组成,该控制器控制机器人实际运动,使机器人能够有效躲避障碍物并逐步趋向目标点;控制器还设定了机器人运动的基本速度,解决势场为零时引起的局部极小化问题.与"沿墙走算法"、"人工势场法"等方法的实验比较表明,本文算法能够获得更好的优化性和实时性,具有更加广泛的实际应用范围.

关键词: 路径规划;局部最优;运动控制器;自主导航;沿墙走算法

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A real time path planning algorithm based on local complicated environment

ZHOU Ziwei[1,2], LI Changle[1], ZHAO Jie[1], XU Wangbao[2]

(1. State Key Laboratory of Robotic and System, Harbin Institute of Technology, 150001 Harbin, China;
2. School of Electronics & Information Engineering, Liaoning University of Science and Technology, 114000 Anshan, Liaoning, China)

Abstract: A novel algorithm, which comprises with convex hull construction algorithm and robot controller is proposed for robot path planning based on complicated local data in robot's autonomous navigation system. First the algorithm searches out the local optimal path from the robot's current position to its target according to the local obstacle data. When the robot can not reach the final target directly, a temporary target point in the optimal path will be set to instruct the robot to avoid the obstacle and reach the final target. Next, a controller is design based on attractive force field and repulsive force field to control the robot's motion, the combined effect of both attractive force field and repulsive force field drives the robot move toward the objective acquired from the optimal path and avoid obstacles at the same time. The experiment results show that this method can provide a better planning path compared with traditional path planning algorithms such as artificial potential field (APF), the wall-following (Bug) and the artificial moment method, and it has a fast reaction speed that is suitable for practical applications.

Keywords: path planning; local optimal; motion controller; autonomous navigation; wall-following

超高层建筑结构竖向地震响应的谱单元分析

何　政，张昊强

（大连理工大学 土木工程学院，116024 辽宁 大连）

摘　要：为研究脉冲型强震中的竖向分量对超高层建筑结构动力响应的影响，针对常见的框架——核心筒体系，应用谱单元分析其简化的主结构体系模型在脉冲型强震竖向分量作用下的波动效应，并与基于振动力学的动力时程分析结果进行比较.为反映结构体系中巨型水平联系构件中剪切变形的影响，推导了考虑剪切变形的 Timoshenko 梁谱单元，竖向构件的轴向反应则用谱单元中的杆单元来模拟，在分析中通过对波动方程的修正来反映地震波传播的时延性.算例分析结果表明：在脉冲型强震竖向分量作用下，竖向构件的轴力波动较为明显，内部核心筒与外部巨型柱的相对错动效应显著，横向构件剪切问题不容忽视，此类损伤与后继水平地震分量作用的非线性耦合效应更须注意.

关键词：超高层建筑；脉冲型激励；竖向地震；谱单元方法；波动效应；剪切变形；Timoshenko 梁

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Spectrum elements for simulating responses of ultra high-rise building structures excited by vertical component of impulse-type strong earthquakes

HE Zheng, ZHANG Haoqiang

(Dept. of Civil Engineering, Dalian University of Technology, 116024 Dalian, Liaoning, China)

Abstract: To investigate the influence of the vertical component of impulse-type strong earthquakes on the dynamic responses of ultra high-rise buildings, spectral elements are applied to analyze the wave effect of a simplified computational model for the main structure of typical frame core-wall structural system excited by the vertical component of impulse-type strong earthquakes. Then, the dynamic time-history results from this method are compared with those from classical vibration mechanics. In the wave propagation analysis, the spectral element using the Timoshenko's beam theory is developed to reflect shear deformation in mega horizontal transverse link members. The axial responses of vertical members are modeled by rod spectral element and the dynamic wave equilibrium is modified to account for the time delay as earthquake waves propagating through structures. The results from examples analysis indicate obvious fluctuation of axial force in vertical members and significant relative displacement between core walls and external mega columns. Hence, shear problem in transverse link elements cannot be ignored. Such shear-induced damage would be nonlinearily coupled with the subsequent horizontal component of impulse-type strong earthquakes, requiring special attention.

Keywords: ultra high-rise building; impulse-type excitation; vertical earthquake; spectral element method; wave propagation effect; shear deformation; Timoshenko beam

间歇通电模式影响电渗效果的试验

陶燕丽[1,2], 周　建[2], 龚晓南[2], 陈　卓[2]

(1 天津市软土特性与工程环境重点实验室, 300384 天津; 2.浙江大学 滨海和城市岩土工程研究中心, 310058 杭州)

摘　要: 为了研究间歇通电模式对电渗加固效果的影响,采用实验室一维模型箱,在不同通断模式下开展电渗试验.试验分两个阶段,第一阶段固定通断时间比,研究不同通电周期对电渗的影响,同时与连续通电对比;第二阶段,固定通电周期,研究通断时间比对电渗的影响.测量试验过程中的电流、阴极排水量,试验结束时的抗剪强度以及含水量分布,并给出不同组试验的阳极板腐蚀图.结果表明:间歇通电能否有效以及通电周期和通断比对电渗效果的影响会因试验时间的不同而存在差异;采用适当的通电周期和通断时间比,间歇通电可以减缓电极腐蚀,提高电渗效果.文章最后对已有文献中的分歧作出了解释,并指出电渗法实际工程应用中,建议通电周期选取 1~4 h,通断时间比取 2.0.

关键词: 间歇通电;电渗效果;通电周期;通断时间比

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Experimental research of the influence of current intermittence on electro-osmotic effect

TAO Yanli[1,2], ZHOU Jian[2], GONG Xiaonan[2], CHEN Zhuo[2]

(1. Tianjin Key Laboratory of Soft Soil Characteristics and Engineering Environment, 300384 Tianjin , China;
2.Research Center of Coastal and Urban Geotechnical Engineering,Zhejiang University, 310058 Hangzhou, China)

Abstract: Series of one-dimensional electro-osmotic laboratory tests were conducted in a self-made tank to investigate the impact of current intermittence on electro-osmotic effect. The tests were divided into two stages. In the first stage, time ratio of power on and off was fixed to study the effects of different power on periods, which were also compared with the result of continuous conduction. In the second stage, the power on period was fixed to study how different time ratios of power on and off affect electro-osmotic process. Currents and drainages were monitored every certain time during the test, while the distributions of shear strength, water content were measured after the test. The results suggest that the testing time possesses key influence on the effectiveness of current intermittence and the distinction of electro-osmotic effects obtained. With appropriate power on period and time ratio, current intermittence can result in lighter electrode corrosion and enhance electro-osmosis efficiency excessively. Finally, reasonable explanations of the different results in existing literature were given, and it is recommended to employ current intermittence for engineering application of the electro-osmosis technique, with the optimal power on period and time ratio of power on and off being 1 – 4 h and 2.0 respectively.

Keywords: current intermittence; electro-osmosis effect; power on period; time ratio of power on and off

室内成型试件与路面芯样的抗车辙差异性评价

张肖宁，肖　鑫

（华南理工大学 土木与交通学院，510640 广州）

摘　要：为了评价室内成型试件与路面芯样抗车辙能力的差异，利用多轮车辙仪（RLWT）获取车辙变形量，从宏观角度研究室内成型试件与路面芯样的抗车辙能力；采用工业 CT 获取沥青混合料断面扫描图像，从细观角度探讨室内成型试件与路面芯样的粗集料颗粒与面空隙率沿深度方向的分布状况.结果表明：由于压实方式不同，两种试件的空隙率相差甚大，从而导致其抗车辙能力也有明显差异；路面芯样的粗集料颗粒与面空隙率在深度方向分布的均匀性较差；路面芯样的平均面空隙率及上端的面空隙率明显大于室内成型试件，从细观角度证明了宏观研究成果的准确性.

关键词：道路工程；路面芯样；工业 CT；空隙率分布；车辙

中图分类号：U416.217　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0084-06

Evaluation of rutting resistance differences of indoor samples and pavement cores

ZHANG Xiaoning，XIAO Xin

（School of Civil Engineering and Transportation，South China of Technology，510640 Guangzhou，China）

Abstract：To evaluate the rutting resistance differences of indoor samples and pavement cores，Rotary Loaded Wheel Tester（RLWT）was used to acquire rutting deformation，and rutting resistance of indoor samples and pavement cores was researched from the macro perspective. Industrial CT was utilized to obtain asphalt mixture sectional scanning images，the distribution along the depth direction of coarse aggregate particles and area porosity of indoor samples and pavement cores from the micro angle were explored. The results show that the air porosity of the two kinds of samples vary greatly due to the different manners of compaction，leading to the significant discrepancy in the capability of rutting resistance. The uniformity of the distribution along the depth of coarse aggregate particles and area porosity of pavement cores are poor，and the average area porosity and area porosity in the upper part of the pavement cores are obviously greater than those of indoor samples，which proves the accuracy of the macro research from the micro perspective.

Keywords：road engineering；pavement core；industrial CT；area ratio of air void；rutting

由混凝或气浮构成的组合工艺处理太湖原水比较

高梦鸿[1]，高乃云[1]，周金金[1]，戎文磊[2]，陆纳新[2]，袁　君[2]

（1.同济大学 污染控制与资源化研究国家重点实验室，200092 上海；2.无锡自来水总公司，214031 江苏 无锡）

摘　要：针对低温东太湖原水，考察常规+臭氧-生物活性炭（O_3-BAC）处理中气浮和沉淀两种工艺对出水水质的影响.结果表明：气浮工艺对原水浊度的去除效果明显优于沉淀工艺，平均去除率高约 10.1%，无论是气浮还是沉淀工艺，经 O_3-BAC 深度处理后出水浊度均稳定在 1 NTU 以下；气浮工艺对有机物的去除效果略优于沉淀工艺，COD_{Mn} 和 DOC 平均去除率分别高约 5.4% 和 1.6%，常规处理工艺后出水有机物含量不能达标，O_3-BAC 工艺出水 COD_{Mn} 稳定在 0.5～2.1 mg/L，DOC 稳定在 0.3～2.0 mg/L；沉淀/气浮工艺只对腐殖质略有去除效果，砂滤对荧光物质几乎无去除作用，而 O_3-BAC工艺是去除水中荧光类物质的主要手段；气浮工艺对藻类的去除效果略优于沉淀工艺，深度处理后出水硅藻活性和叶绿素浓度降为 0，蓝藻仍保有部分活性.

关键词：太湖水；斜管沉淀；气浮工艺；O_3-BAC；去除效果

中图分类号：TU991　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0090-06

Comparison of pilot effect between sedimentation and dissolved air flocculation for the treatment of Taihu Lake water

GAO Menghong[1], GAO Naiyun[1], ZHOU Jinjin[1], RONG Wenlei[2], LU Naxin[2], YUAN Jun[2]

(1. Pollution Control and Resource Reuse State Key Laboratory, Tongji University, 200092 Shanghai, China;
2. Wuxi Water Works Co., Ltd, 214031 Wuxi, Jiangsu, China)

Abstract: The effluent quality of combined process containing O_3-BAC treatment between sedimentation process and dissolved air flocculation (DAF) process for the treatment of East Taihu Lake raw water were compared. The results showed that the removal efficiency of turbidity by DAF was 10.1% higher than that by sedimentation process, and the effluent turbidity was stabled at 1 NTU or less after the treatment of the O_3-BAC. Compared with the sedimentation process, the COD_{Mn} and DOC removal efficiencies of DAF were increased by 5.4% and 1.6%, respectively. The COD_{Mn} and DOC were stabled at 0.5-2.1 mg/L and 0.3-2.0 mg/L after O_3-BAC process respectively, while the organic concentration could not reach to effluent standard after conventional treatment. O_3-BAC process played a dominant role in the decrease of fluorescence intensity, while conventional treatment process had only a slight or no effect on the removal of fluorescent material. The experimental results indicated that the DAF was slightly better for algae removal efficiency than sedimentation process. The concentration of diatom activity and chlorophyll decreased to 0 and cyanobacteria still retained part of the activity after advanced treatment.

Keywords: Taihu Lake water; tube sedimentation process; dissolved air flocculation process; O_3-BAC; removal efficiency

氨氮与亚硝酸盐对含铁锰地下水生物净化影响

蔡言安[1], 李　冬[1], 曾辉平[1], 张　杰[1,2]

(1.北京工业大学 水质科学与水环境恢复工程北京市重点实验室, 100124 北京;
2.哈尔滨工业大学 城市水资源与水环境国家重点实验室, 150090 哈尔滨)

摘　要: 为明确氨氮与亚硝酸盐氮对生物除铁锰性能及锰氧化细菌(MnOB)的影响,采用具有成熟除铁锰能力的中试生物滤柱与 SBR 反应器进行实验.结果表明:氨氮与亚硝酸盐均不影响滤柱除铁效果;进水亚硝酸盐氮质量浓度为 0.1, 0.2,0.3 和 0.7 mg/L 时,滤柱除锰效果不受影响,SBR 实验结果进一步表明亚硝酸盐能促进 MnOB 氧化锰能力;氨氮的存在可抑制 MnOB 氧化锰能力,但对成熟滤柱,进水氨氮质量浓度为 1.2,2.2 mg/L 时,这种抑制作用不能恶化除锰效果,直至氨氮质量浓度提高至 4.5 mg/L 时,出水锰质量浓度开始超标.对于生物滤池的启动,可首先接种硝化细菌至硝化过程建立之后,再接种 MnOB 以减弱氨氮对其的不利影响.

关键词: 除铁除锰;硝化作用;地下水净化;生物滤池;锰氧化细菌活性

中图分类号: TU991.26　　**文献标志码**: A　　**文章编号**: 0367-6234(2014)08-0096-06

Influence of ammonia and nitrite on performance of Fe and Mn removal by biofilter

CAI Yanan[1], LI Dong[1], ZENG Huiping[1], ZHANG Jie[1,2]

(1.Key Laboratory of Beijing Water Quality Science and Water Environment Recovery Engineering, Beijing University of Technology, 100124 Beijing, China; 2. State Key Laboratory of Urban Water Resource and Environment, Harbin Institute of Technology, 150090 Harbin, China)

Abstract: The pilot-and lab-scale reactor was constructed, respectively, to evaluate the influence of ammonia and nitrite on the performance of Fe and Mn removal. The results of pilot-scale filter indicated that the nitrite concentration of 0.1, 0.2, 0.3, 0.7 mg/L, had no effects on Fe and Mn removal, as well the ammonia concentration of 1.2 and 2.2 mg/L. However, the ammonia concentration about 4.5 mg/L would inhibit the Mn removal, resulting in higher Mn in effluent than requirements; The lab-scale SBR experiments demonstrated that the activity of Mn oxidizing bacteria (MnOB) was enhanced by nitrite, but inhibited by ammonia, which showed the importance of nitrification in biological removal of Fe, Mn and ammonia process, especially in the period of start-up.

Keywords: Fe and Mn removal; nitrification; purification of groundwater; biological filter; Mn oxidizing bacteria activity

运动副间隙对多杆锁机构动力学特性的影响

智常建，王三民，孙远涛

（西北工业大学 机电学院，710072 西安）

摘　要：为降低因受力异常而出现飞机货舱门意外打开的概率，详细研究运动副间隙对多杆锁机构动力学特性的影响.采用无质量的等效间隙杆描述运动副的间隙，以拉格朗日动力学方程和螺旋理论为基础建立了多杆锁机构的动力学分析模型，并用 MATLAB 软件编程对模型进行了求解分析.结果表明：杆的角速度、角加速度、驱动力矩和铰链约束力对运动副间隙的大小比较敏感，在奇异位型附近受到的影响最大.间隙为 10 μm 时，其对多杆锁机构的动力学影响较小；间隙为 100 μm 时，其对多杆锁机构的动力学影响明显增强.

关键词：运动副间隙；多杆锁机构；螺旋理论；等效间隙杆；动力学特性

中图分类号：TH122　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0102-05

Effect of kinematic pairs clearance on dynamic characteristics of multi-linkage lock mechanisms

ZHI Changjian, WANG Sanmin, SUN Yuantao

(School of Mechanical Engineering, Northwestern Polytechnical University, 710072 Xi′an, China)

Abstract: To reduce the probability of aircraft cargo door opened accidently caused by abnormal stress, the dynamic characteristics of multi-linkage lock mechanisms with kinematic pairs clearance are studied in detail. The equivalent joint clearance link (the length is e) is used to describe the influence of kinematic pairs clearance. Meanwhile, the dynamic analysis model of multi-linkage lock mechanisms is built based on the Lagrange kinetic equation and the screw theory, and the procedures programmed by MATLAB are used to solve and analysis the model. Results indicate that the kinematic pairs clearance has a bigger influence on angular velocity of the rod, angular acceleration of the rod, driving moment and hinge binding kinematic, and the greatest influence appears near the singular configuration. While e is 10 μm, its impact on dynamics of the multi-linkage lock mechanisms is small, however while e is 100 μm, the impact is enhanced obviously.

Keywords: kinematic pairs clearance; multi-linkage lock mechanisms; screw theory; equivalent joint clearance link; dynamic characteristics

一种改进的非锐化掩模深度图像增强算法

冯　策，戴树岭

（北京航空航天大学 自动化与电气工程学院，100191 北京）

摘　要：针对深度图像平滑过程中会模糊细节的缺点，提出了自适应的非锐化掩模深度图像增强算法.首先将深度图对应的彩色图像作为联合双边滤波的引导图，利用彩色图像相关特征修复了深度图像的缺失和毛糙，然后将双边滤波后的深度图像与高斯滤波后的深度图像作差，提取出不含噪声的高频部分，克服了经典非锐化掩模算法放大高频噪声的缺点，最后根据边缘以及细节的模糊程度，自适应地调节叠加到图像上的高频部分.实验结果表明，设计的算法有效地增强了深度图像细节，抑制了平坦区域的噪声，并填补了边缘缺失，较好地改善了深度图像的质量.

关键词：深度图；图像增强；非锐化掩模；双边滤波；深度图修复

中图分类号：TN911.73　　**文献标志码**：A　　**文章编号**：0367-6234(2014)08-0107-06

An improved unsharp masking method for depth map enhancement

FENG Ce, DAI Shuling

(School of Automation Science and Electrical Engineering, Beijing University of Aeronautics and Astronautics, 100191 Beijing, China)

Abstract: An adaptive unsharp masking filter is proposed to enhance the details blurred in the depth map filtered. Firstly, the color image is used as guided image in joint bilateral filter to recover the lost region and reduce the noise. Then a mask is extracted by subtracting a low-pass filtered depth map from the bilateral filtered depth map, which effectively overcomes the shortcoming of traditional method that amplifies high-frequency noise. Finally, according to degree of blur, the spatial importance is adaptively added to the depth map filtered. Experimental results show that the proposed method performs better in enhancing the details, reducing noise and recovering the lost region of depth map.

Keywords: depth map; image enhancement; unsharp masking; bilateral filter; depth map inpainting

强干扰条件下的星体提取方法

踪　华[1,2,3]，高晓颖[3]，汪　渤[1]，王海罗[1]，李　磊[3]

（1.北京理工大学 自动化学院，100081 北京；2. 宇航智能控制技术国家级重点实验室，100854 北京；
3. 北京航天自动控制研究所，100854 北京）

摘　要：为了解决在强干扰条件下星体提取问题，提出了一种基于边缘检测+星体像素筛选的星体提取方法，首先用一种边缘检测算法分割星图，然后对像素进行标记，最后利用自适应阈值对星体的目标像素进一步筛选.并对像素标记算法进行改进，改进的算法在标记目标像素时，同时分析与它相邻的像素的连通性，使得属于同一星体的所有像素只分配一个标记值，提高了星图处理的效率.试验结果表明，该处理方法对强干扰噪声具有更好的鲁棒性、且运算速度更快，精度也有所提高.提出的边缘检测+星体像素筛选的星体提取方法有助于在强干扰条件下分离星体目标和背景，改进的像素标记方法，可以更快地区分不同的星体，便于工程应用.

关键词：星体提取；边缘检测；自适应阈值；像素标记；关联性

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Method of star extraction on strong interference

ZONG Hua[1,2,3], GAO Xiaoying[3], WANG Bo[1], WANG Hailuo[1], LI Lei[3]

(1. School of Automation, Beijing Institute of Technology, 100081 Beijing, China;
2. National Key Laboratory of Science and Technology on Aerospace Intelligent Control, 100854 Beijing, China;
3. Beijing Aerospace Automatic Control Institute, 100854 Beijing, China)

Abstract: To solve the problem of star extraction on the condition of strong interference, a star extraction method based on edge detection + selection for star pixels was proposed in this paper. An edge detection algorithm to segment the star image is first utilized, and then each pixel is marked. Finally, self-adaptive threshold to select the object pixels of each star is used. Also, the pixel labeling algorithm is improved, and before the pixel of target is labeled, the connectivity of its neighbors is examined so that all of the pixels of the same star only have one mark and the processing efficiency of star image is improved. Experimental results show that the method has better robustness to strange interference, higher speed and accuracy. The improved method can distinguish sensed stars more quickly, and may be more convenient for engineering applications.

Keywords: star extraction; edge detection; self-adaptive threshold; pixel labeling; connectivity

基于 BP 神经网络的驾驶精神疲劳识别方法

郭孜政[1,2],谭永刚[1],马国忠[1],潘毅润[1],陈崇双[1]

(1.西南交通大学 交通运输与物流学院,610031 成都;2.中国科学院心理研究所,100101 北京)

摘　要:为了对驾驶精神疲劳予以有效识别,基于行为绩效结合心电信号指标构建了一种驾驶精神疲劳识别方法.以驾驶行为绩效为客观测评指标,给出了驾驶精神疲劳状态的分级划分方法.在此基础上,以心率变异性的 6 项指标作为疲劳识别特征因子,采用 BP 神经网络模型,建立了驾驶精神疲劳状态分类器.最后结合实例,依据驾驶行为绩效,将疲劳状态划分为 2 级,采用 10 名驾驶员连续 4 h 的驾驶行为绩效(反应时)、心电数据,对模型、方法予以测算.结果表明,10 名驾驶员平均正确识别率在 71%~80%之间,且其平均正确识别率为 73%.BP 神经网络模型与心率变异性指标相结合可有效的识别疲劳.

关键词:驾驶行为;精神疲劳;识别方法;心率变异性;BP 神经网络

中图分类号:U491　　**文献标志码**:A　　**文章编号**:0367-6234(2014)08-0118-04

Recognition method of driving mental fatigue based on BP neural network

GUO Zizheng[1,2], TAN Yonggang[1], MA Guozhong[1], PAN Yirun[1], CHEN Chongshuang[1]

(1.School of Transportation and Logistics, Southwest Jiaotong University, 610031 Chengdu, China;
2. Institute of Psychology Chinese Academy of Sciences, 100101 Beijing, China)

Abstract: To recognize driving mental fatigue efficiently, this study constructs a recognition method based on ECG. The method proposes hierarchy partition of state of driving mental fatigue by using driving behavior performance as objective evaluation indexes. Meanwhile, taking 6 indexes of HRV as fatigue recognition characterization factors and BP artificial neural network model, this paper establishes the recognition model for state of driving mental fatigue. Finally, according to examples, the mental fatigue is divided into two classifications. Collecting 4 hours continual driving behavior performance and ECG data from 10 drivers to test the model, the result shows that the average recognition accuracy rate is between 71% and 80%, and the average accuracy rate is 73%. The combination of BP neural network model and HRV indexes could recognize fatigue effectively.

Keywords: driving behavior; mental fatigue; recognition method; HRV; BP neural network

运费无差异的多品种流交通网络最小费用算法

寇玮华，崔皓莹

（西南交通大学 交通运输与物流学院，610031 成都）

摘　要：为了解决交通网络应用中多品种流问题，对运送费用无差异的多品种流交通网络进行分析，在借鉴连续最短路算法和 Ford-Fulkerson 算法基础上，构造了复合参数和复合指标.基于设定的复合参数、复合指标以及相应的计算规则，构建了多品种流交通网络最小费用流分配算法，通过算例验证了算法的可行性.运费无差异的多品种流交通网络最小费用算法为解决交通运输领域普遍存在的运送费用无差异的多品种流最小费用流问题提供了应用基础.

关键词：多品种流；交通网络；最小费用流；复合参数和复合指标；连续最短路算法；Ford-Fulkerson 算法.

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A minimum cost algorithm for multicommodity flow traffic network which has same convey cost

KOU Weihua，CUI Haoying

（School of Transportation and Logistics，Southwest Jiaotong University，610031 Chengdu，China）

Abstract：To solve the multicommodity flow problem in traffic network，this paper analyses the multicommodity flow traffic network with same cost，and builds the composite parameters and composite indicators on account of the successive shortest path algorithm and the Ford-Fulkerson algorithm. Based on the corresponding calculation rules of composite parameters and composite indicators，this paper builds a minimum cost flow algorithm for multicommodity flow traffic network and the feasibility of this algorithm is verified by an example. This algorithm provides the basis to solve the problem of multicommodity flow minimum cost flow with same cost which is quite widespread in the field of transportation.

Keywords：the multicommodity flow；traffic network；minimum-cost flow；composite parameters and composite indicators；successive shortest path algorithm；Ford-Fulkerson algorithm