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第四十六卷 第十二期 二〇一四年十二月

柱支承无粘结预应力混凝土双向板内力重分布

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摘　要：为了研究柱支承预应力混凝土双向板中无粘结筋应力增长规律及弯矩调幅设计方法，采用 ABAQUS 大型有限元软件建立了柱支承无粘结预应力混凝土双向板的有限元分析模型.通过将双向板划分为柱上板带和跨中板带，分别考察了综合配筋指标和非预应力筋屈服强度对无粘结筋应力增量及支座控制截面弯矩调幅系数的影响规律.分析结果表明：在综合配筋指标和预应力度一定的条件下，正常使用阶段和承载能力极限状态无粘结筋应力增量随非预应力筋屈服强度的提高而增大，而支座控制截面的弯矩调幅系数随非预应力筋屈服强度的提高而减小.建立了以综合配筋指标和非预应力筋屈服强度为自变量的柱支承预应力混凝土双向板中无粘结筋应力增量和弯矩调幅系数计算公式.

关键词：预应力混凝土；柱支承板；有限元；无粘结筋应力增量；弯矩调幅系数

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Internal force redistribution of unbonded prestressed concrete flat plates

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Abstract: To explore the rule of stress increment in unbonded tendons and design method of moment redistribution, the finite element was modeled by ABAQUS soft-ware for unbonded prestressed concrete flat plates. The plates were divided into the column strips and the middle ones. Stress increment in tendons and moment redistribution coefficient of unbonded prestressed concrete flat plates were studied, which are influenced by the combined reinforcement index and grade of non-prestressing reinforcement. It is shown that the stress increment in tendons increases at the serviceability and ultimate limit states and moment redistribution coefficient in critical section of support reduces with the higher yield strength of non-prestressing reinforcements in flat plates. Then expressions of stress increment in tendons and moment redistribution coefficient in prestressed concrete flat plates were developed, in which the combined reinforcement index and grade of non-prestressing reinforcement were considered.

Keywords: prestressed concrete; flat plate; finite element; stress increment in tendon; moment redistribution coefficient

钢结构中高强螺栓连接的数值模拟方法

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摘　要：为能够对使用众多高强螺栓群拼接的钢结构大型复杂节点进行精确的有限元数值模拟分析，并揭示螺栓拼接节点在各阶段的受力性能，提出了一种以连接件单元代替螺栓的简化模拟方法.对高强螺栓单剪连接使用实体单元建模，并考虑各种非线性影响，进行精细的有限元模拟分析.在深入研究连接的弹性、滑移、强化和屈服等各个阶段受力机理的基础上，给出了代替螺栓连接件的本构关系，并将其成功应用于简化的壳单元连接模型中.针对工程中常用的不同规格连接进行了大量算例分析，并将简化模型与精细模型计算结果进行对比，验证了所提方法在高强螺栓拉剪连接有限元模拟中的可行性，为使用数值模拟方法揭示大型复杂螺栓群连接节点的真实受力状态奠定了基础.

关键词：钢结构；高强螺栓连接；数值模拟；有限元分析；本构关系

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Numerical simulation method for high-strength bolt connections in steel structures

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Abstract: To proceed finite element analysis for bolted large-scale connection in steel structures and to explore the detailed behaviors under different loadings, a simplified method is brought forward, in which the high-strength bolt can be simulated by using connector element. The non-linear shearing performance of single-shear bolted connections is investigated with accurate models where the solid elements are employed. Basing on the mechanical properties in elastic, slipping, hardening, and yielding phase under shear force, a constitutive relation for the bolt connector is established and can be applied easily in shell element model for the high-strength bolt connection. Large numbers of examples with varied parameters including plate thickness and bolt diameter are calculated respectively by using the simplified method with shell elements and the accurate method with solid elements. The result comparisons show that the simplified simulation method has a good computational efficiency and accuracy, and has a potential ability to simulate high-strength bolt connections.

Keywords: steel structure; high-strength bolt connection; numerical simulation; finite element analysis; constitutive relation

Lee 相变传质方程中传质系数取值的分析

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摘　要：针对 Lee 相变传质方程中传质系数主要依靠经验取值的问题，本文尝试提出一种确定传质系数的方法，给出了评价传质系数合理性的 2 个指标——潜热份额（潜热换热量占总换热量的份额）和饱和温差（流体温度与饱和温度的差值），建立了稳态分析模型，通过理论推导，得出了潜热份额和饱和温差的理论表达式，据此分析了传质系数对模拟结果的影响，已有特定条件下的理论解验证了本文分析结果的正确性.分析结果表明传质系数越大，计算精度越高.基于分析结果解释了不同文献对该系数取值差异很大的原因，并给出了传质系数的通用取值方法，最后推荐了常见工况模拟中传质系数的合理取值范围.

关键词：相变；传质；冷凝；沸腾；数值模拟

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Analysis on the value of coefficient of mass transfer with phase change in Lee′s equation

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Abstract: To solve the problem that the mass transfer coefficient in Lee´s equation need to be obtained depending on the experience, a method was proposed, and two indexes evaluating the rationality of the mass transfer coefficient-latent heat share (the share of latent heat flux in total heat flux) and saturation temperature difference (difference between fluid temperature and saturation temperature) were presented. A steady state model was established to analyze this problem and the expression of latent heat share and saturation temperature difference were obtained by the theoretical guidance. By the expression, the effect of mass transfer coefficient on the simulation was analyzed. The analysis result was validated by the existing theoretical result in particular cases. The results show that the calculation accuracy increases with the increase of the coefficient. Based on these results, the reason for large difference of the coefficient value in different literatures was explained, the method of how to get the coefficient value was presented, and the value range of easy-to-use was suggested.

Keywords: phase change; mass transfer; condensation; boiling; numerical simulation

水动力条件对 MBR 中超滤膜不可逆污染的影响

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摘　要：为考察 MBR 处理微污染水过程中水动力条件对超滤膜水力不可逆污染的影响，介绍了水力不可逆膜污染的计算方法，探讨曝气、反冲洗、通量、水温等运行参数的影响并进行优化.结果表明：间歇曝气时，曝气时间、强度及反冲洗时间的选取需考虑 MBR 的净水效能，实验条件下，2 min 的曝气时间是必需的，较优的曝气强度为 30~36 $m^3/(m^2 \cdot h)$；较长的反冲洗时间有利于控制膜的不可逆污染，反冲洗时间的确定尚需考虑超滤系统的产水率；过滤通量显著影响超滤膜的不可逆污染速率，PVDF、PVC 膜的过滤通量分别不应高于 31.5，14.0 $L/(m^2 \cdot h)$，长期运行中膜污染的评价尚需考虑温度的影响.

关键词：超滤膜；水力不可逆污染；曝气；反冲洗；通量；水温

中图分类号：TU991.2　　**文献标志码**：A　　**文章编号**：0367-6234(2014)12-0020-06

Effect of hydrodynamic conditions on hydraulically irreversible fouling of UF membrane in MBR

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Abstract: To investigate the effect of hydrodynamic conditions on hydraulically irreversible fouling of UF membrane in MBR for treating micro-polluted water, the method of determination of hydraulically irreversible fouling of UF membrane was introduced, and the effects of aeration, backwashing, flux and temperature on irreversible fouling were discussed. The results showed that the pollutant removal of MBR should be taken into account when selecting the time and flow of aeration. The duration of 2 min was necessary during intermittent aeration, with the optimal aeration intensity of 30-36 $m^3/(m^2 \cdot h)$. Prolonged backwashing duration was found to control the hydraulically irreversible fouling. The production of UF membrane in MBR should also be considered when determining the proper backwashing duration. The permeate fluxes influenced the hydraulically irreversible fouling rate significantly, and the values of PVDF and PVC membranes should be no more than 31.5 and 14.0 $L/(m^2 \cdot h)$ to maintain the long-term stable operation. Meanwhile, the impact of temperature on irreversible fouling should be considered.

Keywords: ultrafiltration; hydraulically irreversible fouling; aeration; backwashing; flux; temperature

贝叶斯方法的污染源季节性排放量控制和管理

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摘　要：为保证水质功能区内水质达标，必须对区域内污染源排放量进行控制和管理. 选取松花江哈尔滨段主要污染指标COD和氨氮为研究对象，利用一维水质模型构建各污染源排放量与河流水质之间的关系. 用贝叶斯方法估计水质模型中的重要参数综合降解系数（k），根据估计时期的不同，分别建立季节模型和年度模型，用以控制既定水质目标下各污染源排放量. 结果表明，季节模型的预测效果较好，能更好地表达水中污染物的综合降解浓度. 应用季节模型和贝叶斯方法开展季节性水质管理工作，可以提供给决策者更多的信息，有助于对污染源排放量的不确定性进行量化和评估. 此外，通过对比各污染源的削减水平，可得各污染源在不同时期的控制权重，从而使管理者在不同时期有针对性地对污染源排放量进行控制. 贝叶斯方法在污染源排放量控制中的应用可以增强水质模型的预测能力，有效提高水质管理的水平.

关键词：贝叶斯方法；不确定性；污染源管理；季节模型；水质管理
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A seasonal management method for controlling pollution sources discharge based on Bayesian method

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Abstract: Ammonia and COD are selected as study variables for they are the main water quality parameters and can represent water environment quality of the Harbin City Reach of the Songhua River. One-dimensional water quality model is used to set up the relationship of pollutant loadings and water quality. The comprehensive decay rate (k), a key parameter of water quality model, is estimated by Bayesian method. The seasonal model and annual model are respectively set up according to different k estimated in different period. The pollutant loadings are controlled by the models for downriver water quality can meet targeted goals. From contrasting the two models, it indicates that predicting precision of seasonal model is high than annual model for seasonal model can better express comprehensive degradation concentration of ammonia in water. Contrasting with other methods, water quality management with seasonal model can offer decision makers more useful information, and help them address uncertainties. In addition, influencing weights of the three pollution sources can be obtained by contrasting load reduced ratios. The information could inform decision makers of the required load reductions for the three time periods.

Keywords: Bayesian; uncertainty; pollution sources controlling; seasonal model; water quality management

产蛋白酶混合菌系对碱性剩余污泥水解酸化的影响

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摘　要：为提高剩余污泥水解酸化过程中挥发性脂肪酸（VFAs）的累积，从剩余污泥中分离产蛋白酶活力较高的耐碱细菌，并构建产蛋白酶混合菌系. 将其接种于碱性（pH 10.0）发酵剩余污泥的不同发酵时期，评价其对溶解性有机化合物和 VFAs 累积的影响，探讨利用剩余污泥生产 VFAs 的最佳条件. 从剩余污泥中分离到 2 株产蛋白酶活力较高的耐碱细菌，并构建产蛋白酶混合菌系. 在发酵初期接种混合菌系效果最显著，且可缩短发酵启动时间 2 d. 发酵初期接种混合菌系后，溶解性蛋白质和 VFAs 质量浓度在第 8 天均达到最高值，分别为未接种混合菌系样品中相应值的 1.25 和 1.41 倍，分别占溶解性化学需氧量（SCOD）总量的 29.87%和44.54%. 乙酸和丙酸为剩余污泥水解酸化过程中 VFAs 的主要组分，分别占 VFAs 总量的 50.69%和 18.19%.

关键词：剩余污泥；水解酸化；混合菌系；内碳源；挥发性脂肪酸

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Effect of mixed microbial consortium capable of protease-producing on hydrolysis and acidification of excess sludge under alkaline condition

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Abstract: To improve volatile fatty acids (VFAs) accumulation from hydrolysis and acidification of excess sludge (ES), alkali-tolerant bacteria capable of protease-producing were isolated from ES. A mixed microbial consortium capable of protease-producing was constructed by the isolated bacterial strains. The mixed microbial consortium was inoculated into the different fermentation periods of ES to investigate their effects on soluble organic compounds and VFAs accumulation from ES under alkaline conditions (pH 10.0). The optimal condition for VFAs accumulation from ES was investigated. The results showed that two alkali-tolerant bacterial strains capable of protease-producing were isolated from ES and constructed as a mixed microbial consortium. The soluble organic compounds concentrations and VFAs accumulation were improved significantly after the mixed microbial consortium was inoculated at the initial fermentation, and the start-up phase was shortened by 2 days. On the 8th day of fermentation, the concentrations of soluble protein and total VFAs reached their peak values, and were 1.25 times and 1.41 times higher as compared to the corresponding values from non-inoculated samples, and accounted for 29.87% and 44.54% of total SCOD concentration, respectively. Acetic and propionic acids were the most prevalent VFAs (account for 50.69% and 18.19%, respectively).

Keywords: excess sludge (ES); hydrolysis and acidification; mixed microbial consortium; internal carbon source; volatile fatty acids (VFAs)

Fe_3O_4-H_2O_2 类 Fenton 体系催化降解苯酚

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摘　要：为提出基于新型磁纳米 Fe_3O_4 催化剂的类 Fenton 体系，采用化学共沉淀法制备磁纳米 Fe_3O_4，用四甲基氢氧化铵（TMAH）对所制备的磁纳米 Fe_3O_4 进行表面改性，就 Fe_3O_4-H_2O_2 类 Fenton 体系对苯酚废水的处理效果进行探讨，考察催化剂投量、H_2O_2 浓度、pH、反应时间等因素对 COD 和挥发酚去除率的影响. 结果表明：磁纳米颗粒平均粒径为30 nm，并在 20~100 nm 内呈现良好的粒度分布. 不同剂量 TMAH 包覆的 3 种催化剂经超声预处理后，在室温（13 ℃）下对 50 mg/L苯酚（相当于 112 mg/L COD）的降解效果基本一致. 当催化剂投量为 0.8 mmol/L、H_2O_2 浓度为 2.0 mmol/L、pH 为 4.5、反应时间 180 min 时，COD 去除率最高可达 72%；催化剂投量为 0.4 mmol/L、H_2O_2 浓度为 2.0 mmol/L、pH 为 4.5、反应时间为 90 min 时，挥发酚的去除率接近 100%. 而在重复使用方面，3# Fe_3O_4-TMAH（2 mL）催化剂的回用性最好，4 次反应 COD 的去除率分别为 73%、29%、28%、26%，挥发酚去除率分别为 100%、84%、67%、54%. 该类 Fenton 体系具有不产生多余泥量的优点，且磁纳米催化剂在外磁场作用下可实现快速分离回收.

关键词：磁纳米 Fe_3O_4；类 Fenton 体系；催化降解；苯酚

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Catalyzed degradation of phenol by Fe_3O_4-H_2O_2 Fenton-like system

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Abstract：To put forward a Fenton-like system based on a new type of Fe_3O_4 magnetic nanoparticles catalyst，Fe_3O_4 magnetic nanoparticles were prepared using chemical co-precipitation ，and their surface was modified with tetramethyl ammonium hydroxide（TMAH）. The catalyzed degradation of phenol by Fe_3O_4-H_2O_2 Fenton-like system was investigated，including the effect of catalyst dosage，H_2O_2 dosage，pH value and reaction time on the removal of COD and volatile phenol. The results showed that the mean size of the Fe_3O_4 nanoparticles is 30 nm and they show a good disparity between 20 and 100 nm. Three different doses of TMAH coated catalysts after ultrasonic pretreatment，revealed almost the same treatment efficiency of 50 mg/L phenol（112 mg/L COD equivalent）under the room temperature（13 ℃）. Under the condition of 0.8 mmol/L catalyst dosage，2.0 mmol/L H_2O_2 dosage，pH 4.5 and the reaction time of 180 minutes，the highest COD removal efficiency was 72%；while under the condition of 0.4 mmol/L catalyst dosage，2.0 mmol/L H_2O_2 dosage，pH 4.5 and the reaction time of 90 minutes，the removal rate of volatile phenol was close to 100%. 3# Fe_3O_4-TMAH（2 mL）catalysts revealed optimal reuse efficiency，the removal rate of COD were 73%，29%，28%，26%，the removal rate of volatile phenol were 100%，84%，67%，54%. The Fenton-like system has the advantage of no redundant excess sludge producing，and the magnetic catalyst can realize quick separation and recycling under the action of outside magnetic field.

Keywords：Fe_3O_4 magnetic nanoparticles；Fenton-like system；catalyzed degradation；phenol

低温好氧反硝化菌群强化生活污水脱氮效能

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摘　要：为强化低温脱氮效能，通过快速富集驯化得到一组低温好氧反硝化菌群，其在 10 ℃好氧环境下可实现氨氮、总氮和有机物的高效同步去除.低温好氧反硝化菌群与聚氨酯载体结合后投加进行生物强化，氨氮去除率提升 10.31%～16.89%，总氮去除率提升 25.07%～32.44%，且各项指标出水均达一级 A 标准；停止强化 10 d 后，强化反应器较未强化反应器氨氮、硝氮、总氮和 COD_{Cr} 出水质量浓度仍分别下降 2.43，3.07，6.02 和 3.63 mg/L，说明低温好氧反硝化菌群强化具有显著高效和持续时间长的优点.

关键词：低温；生活污水；脱氮；生物强化；好氧反硝化

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Performance of bioaugmented nitrogen removal by aerobic denitrfication consortium for treating the domestic sewage at low temperatures

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Abstract: Low temperature inhibits the performance of nitrogen removal efficiency during the biological treatment of municipal wastewater. Therefore, the effluent could hardly meet the emission standard. To enhance the performance of nitrogen removal at low temperature, a psychrotolerant aerobic denitrification consortium by fast enrichment and domestication was obtained, which could remove the ammonia, nitrate and organic matter simultaneously and efficiently in aeration environment under 10 ℃. The results showed that the removal efficiency of ammonium and total nitrogen by bioaugmentation was improved by 10.31%-16.89% and 25.07%-32.44%, respectively. It made the effluent quality meet the grade1A level of national discharge standard. After bioaugmentation terminating for 10 days, the remained consortium could still improve the reactor that the effluent of ammonium, nitrate, total nitrogen and COD_{Cr} concentrations was decreased about 2.43, 3.07, 6.02 and 3.63 mg/L, respectively. The results indicated that bioaugmentation performed well and persistently.

Keywords: low temperature; domestic sewage; nitrogen removal; bioaugmentation; aerobic denitrification

严重雾霾期大气 $PM_{2.5}$ 和 PM_{10} 中水溶性离子污染特征

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摘　要：为掌握雾霾期大气 $PM_{2.5}$ 和 PM_{10} 中水溶性离子污染特征，采集东北某市 2013 年 10 月 20~31 日发生严重雾霾期间大气 $PM_{2.5}$ 和 PM_{10} 样品，分析颗粒物样品中 9 种水溶性离子（F^-、Cl^-、NO_3^-、SO_4^{2-}、Na^+、NH_4^+、K^+、Mg^{2+} 和 Ca^{2+}）的质量浓度.结果表明：各水溶性离子均表现为夜间质量浓度大于日间质量浓度，其在雾霾期 $PM_{2.5}$ 中的昼、夜质量浓度比为 1.68；NO_3^-、SO_4^{2-}、NH_4^+ 等 3 种离子质量浓度较高，雾霾期 $PM_{2.5}$ 中质量分数分别为 11.03%、8.3% 和 7.39%，PM_{10} 中也有类似结果.K^+ 和 Ca^{2+} 在 $PM_{2.5}$ 和 PM_{10} 中，雾霾期和非雾霾期质量分数变化不大. 根据各离子比值，可以判定雾霾期固定源对颗粒物污染的贡献更大，说明雾霾期城市气象因素对大气颗粒物污染影响较大.对比 2009 年 10、11 月水溶性离子数据发现移动源污染贡献在增加.

关键词：$PM_{2.5}$；PM_{10}；质量浓度；水溶性离子；雾霾

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Pollution characteristics of water-soluble ions in $PM_{2.5}$ and PM_{10} under severe haze days

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Abstract: To investigate the pollution characteristics of water soluble ions in $PM_{2.5}$ and PM_{10} under severe haze days, both $PM_{2.5}$ and PM_{10} samples were collected in a city of northeast China under severe haze days during October 20-22, 2013. Nine water-soluble ions in $PM_{2.5}$ and PM_{10} including F^-, Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+} and Ca^{2+} were analyzed. The results showed that the concentrations of all water-soluble ions mass concentration in night were higher than those in day time, with a ratio of 1.68 for $PM_{2.5}$ in haze days. The concentrations of SO_4^{2-}, NO_3^- and NH_4^+ were higher and their percentage in $PM_{2.5}$ were 11.03%, 8.3% and 7.39% in haze days, the same results in PM_{10} were obtained. The percentages of K^+ and Ca^{2+} in haze and non-haze periods were similar. Based on the ratio of different ions, the pollution from stationary sources were higher than that from mobile sources in haze days, this showed that meteorological factors had greater influences. In comparison with the data of water soluble ions during October and November of 2009, the concentrations from mobile sources were on the rise.

Keywords: $PM_{2.5}$; PM_{10}; mass concentration; water-soluble ions; haze

城市客运交通运营者经济决策双层规划模型

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摘　要：为分析客运经济政策在不同运营者间的作用规律，应用博弈论分析了城市客运交通运营者之间的 Nash 均衡，构建了双层规划模型来描述运营者之间的经济决策行为，分析了不同策略下运营者的效益和社会总成本，包括时间、能源消耗和空气污染等成本，其中上层模型分析管理者优化不同客运方式的费率，下层模型分析运营者在限定费率下确定各自的服务频率以获得最大利润.采用 GAMS 和遗传算法分别构建了双层规划模型的求解算法，算例分析验证了模型的有效性.引入轨道交通服务，可以提高城市公共交通客运份额，有效降低环境、能源等外部性成本.

关键词：交通运输经济；城市客运交通；博弈论；双层规划模型；经济决策模型

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Economic decision-making bi-level programming model for urban passenger transportation operators

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Abstract: To analyze the law of passenger transportation economic policy in different operators, based on game theory to describe the Nash equilibrium among urban passenger transportation operators, a bi-level programming model is proposed to model urban passenger transportation operators' economic decision-making, operators' profit and social cost have been discussed, including the travel time cost, air pollution cost and energy consumption cost. The upper-level model describes the management authority' regulation on the fares of each mode, the lower-level model describes the operators' maximum profit by determining the service frequency. Based on GAMS and genetic algorithm, a numerical example verifies the validity of the proposed model. The introduction of subway service will increase the total market share of passenger public transportation, and effectively reduce the external cost, including the environmental emission cost and energy consumption cost.

Keywords: transportation economy; urban passenger transportation; game theory; bi-level programming model; economic decision-making model

交通电子执法威慑水平量化分析

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摘　要：为了探析交通电子执法在抑制交通违法行为方面的威慑成效和水平，以描述气体扩散效应的烟羽模型为基础，分析影响交通电子执法威慑成效的相关因素在时空作用域上的特征，修正并重新定义了烟羽模型中各因子的含义及表达形式，构建了交通电子执法威慑水平量化分析模型，并用交通调查数据标定了模型中常量的取值.案例分析表明，该模型的计算结果与交通违法率的调查结果趋于一致，说明该模型能客观地量化电子执法在抑制交通违法行为方面的贡献程度. 合理布设交通电子执法设施的位置、作用方向和数量，能有效降低电子执法区域内的交通违法率.

关键词：交通电子执法；威慑水平；扩散效应；烟羽模型；交通违法

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Deterrent effect quantitative analysis of traffic automated enforcement

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Abstract: To analyze the deterrent effect and level of traffic electronic enforcement on inhibition of traffic violation, on the basis of the plume model, this paper built a quantitative analysis model of traffic electronic enforcement deterrence level. This model corrected and redefined the factor meaning and expression form of plume model, and calibrated constant values with data from traffic survey to analyze the characteristics of related factors which can influence the traffic electronic enforcement deterrence effect on the scope of time and space. The case studies showed that the calculation results of the model was consistent with the survey results of traffic violation rate, which indicated that this model can quantify the contribution degree of electronic enforcement on inhibition of traffic violation. By reasonable layout of location, direction and quantity of traffic electronic enforcement facilities, the traffic violation rate of the layout area can be effectively reduced.

Keywords: traffic automated enforcements; deterrent effect; diffusion effects; plume model; traffic violation

饱和粘土中球孔扩张问题弹塑性解析

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摘　要：为了研究静力触探试验及沉桩扩孔等工程问题，基于修正剑桥模型，推导了不排水条件下球孔扩张问题的半解析解.将扩张球孔周围土体分为临界状态区、塑性区以及弹性区三个区域.弹性区内，利用弹性理论得到应力和孔隙水压力的解答；临界状态区及塑性区内，利用相关联的流动法则、拉格朗日分析法建立了关于应力的一阶非线性常微分方程组，以弹塑性界面处的应力分量作为初值，求解微分方程组可得到应力和孔隙水压力的解答.研究结果表明：各向同性超固结比对扩孔压力、土体应力、超孔隙水压力以及塑性区范围均具有显著影响，且扩孔过程中土体剪切模量并非常量，其随扩孔半径、各向同性超固结比的变化而变化；同时通过与已有解答进行比较，对本文方法的可靠性进行了验证.

关键词：球孔扩张；剪切模量；修正剑桥模型；各向同性超固结比

中图分类号：TU473　　**文献标志码**：A　　**文章编号**：0367-6234(2014)12-0071-07

Elastic-plastic solution of sphere cavity expansion in saturated clay

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Abstract: An exact semi-analytical solution in the undrained cavity expansion can be obtained on the basis of the MCC model to research the cone penetration test and the pile driving. The field around the cavity can be divided into three zones: critical zone, plastic deformation zone and elastic deformation zone. In the elastic zone, an analytical solution for the distributions of stress and excess pore pressure is deduced according to the elastic theory. In the critical and plastic zone, a set of first-order nonlinear ordinary differential equations concerning stress can be obtained according to the associated flow rule and the lagrangian analysis method. The stressss and pore pore pressure can be solved as an initial value problem starting at the elastic-plastic boundary. The results show that the isotropic over consolidation ratio has a significant influence on the stresses and the excess pore pressure.The shear modulus vary significantly with the cavity radius and the isotropic over consolidation in the course of cavity expansion.

Keywords: sphere cavity expansion; shear modulus; modified cambridge model; isotropic over consolidation ratio

强化有限元剪力连接件的拔出数值模拟

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摘　要：剪力连接件的拔出过程伴随着混凝土的拉裂与扩展，为了准确模拟拔出过程中的非连续变形及剪力连接件抗拔承载力，本文采用基于强化有限元的无厚度 CZM 单元，以粘聚区域模型描述剪力连接件拔出过程裂纹的开裂与扩展.然后建立了剪力连接件拔出数值分析模型，对拔出过程连续-非连续变形进行模拟，得到了拔出过程的荷载位移曲线，剪力连接件的抗拔承载力以及拔出过程裂纹扩展形态.本文方法可以实现拔出过程混凝土裂纹起裂扩展的非连续变形的数值模拟.

关键词：钢-混组合结构；剪力连接件；抗拔承载力；粘聚区域模型；非连续变形；强化有限元

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Enhanced finite element analysis of shear connector pull-out based on cohesive zone model

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Abstract: During the pull-out process there exist concrete crack initiation and propagation. To accurately simulate discontinuous deformation of the pull-out process and calculate pull-out capacity of shear connectors, a zero-thickness cohesive interface element based on the enhanced finite element method was introduced in this paper. And cohesive zone model (CZM) was used to describe the crack initiation and propagation of the pull-out process. Then numerical simulation analysis of a pull-out test model was carried out. Results showed load-displacement curves of the structure, pull-out capacity, and crack propagation patterns of the concrete slab. Discontinuous deformation numerical simulation has been realized.

Keywords: steel-concrete composite structure; shear connector; pull-out capacity; cohesive zone model; discontinuous deformation; enhanced finite element

装配式混凝土双板短肢剪力墙拟静力试验

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摘　要：为综合评价装配式混凝土双板短肢剪力墙的抗震性能，对2个双板装配式和1个现浇的足尺比例短肢剪力墙试件进行了拟静力试验研究，分析了试件的滞回曲线、骨架曲线、位移延性、承载能力、刚度退化和耗能能力.结果表明：3个试件均发生弯曲破坏；构造改进后的双板装配式剪力墙具有良好的整体工作性能；利用连续矩形螺旋箍筋加强U形筋搭接连接范围混凝土的约束作用，能提高双板装配式短肢剪力墙的刚度和承载能力；双板装配式短肢剪力墙具有与现浇剪力墙相近的位移延性和刚度退化，具有良好的耗能能力.

关键词：装配式混凝土双板短肢剪力墙；拟静力试验；承载力；延性；耗能

中图分类号：TU375　　**文献标志码**：A　　**文章编号**：0367-6234(2014)12-0084-05

Quasi-static test for double-wall precast concrete short-leg shear walls

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Abstract: To comprehensively evaluate the seismic behavior of double-wall precast concrete (DWPC) short-leg shear walls, quasi-static test of two full-scale DWPC short-leg shear walls and one normal cast-in-situ (CIS) short-leg shear wall were carried out. Systematic analyses were made on hysteretic curves, skeleton curves, displacement ductility, bearing capacity, stiffness degradation and energy dissipation capacity of specimens. The result shows that all specimens fail in bending. The detail improved DWPC short-leg shear walls can work together well. The continuous rectangular spiral stirrups in the range of U-shaped connection steel bars confine the concealed column concrete; also improve the stiffness and bearing capacity of DWPC short-leg shear walls. The displacement ductility, stiffness degradation and energy dissipation capacity of DWPC short-leg shear walls are close to those of CIS short-leg shear wall.

Keywords: double-wall precast concrete short-leg shear wall; quasi-static test; bearing capacity; ductility; energy dissipation

内填部分混凝土箱形截面钢桥墩的延性影响参数

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摘　要：为了研究内填部分混凝土箱形截面钢桥墩在恒定竖向荷载与柱顶水平往复荷载作用下的延性性能，建立三维弹塑性有限元模型，通过比较模拟结果与试验结果的水平荷载-水平位移滞回曲线和破坏模态，确定了所采用有限元分析方法的准确性与有效性. 以翼缘宽厚比、柱长细比、混凝土填充率和柱轴压比为变化参数，建立 56 个三维弹塑性有限元分析模型，归纳总结了钢桥墩可能出现的各破坏模态：对于纯钢桥墩，局部屈曲发生在试件底部；对于内填部分混凝土钢桥墩，当混凝土填充率较小时，局部屈曲通常发生在内填混凝土上部钢板处；随着混凝土填充率的增大，局部屈曲出现在试件底部附近. 最后分析上述 4 个参数对钢桥墩极限承载力和延性性能的影响规律.

关键词：内填部分混凝土钢桥墩；数值模拟；破坏模态；延性性能
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Parametric study on ductility behavior of partially concrete-filled steel box-section bridge piers

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Abstract: To investigate the ductility behavior of partially concrete-filled steel box-section bridge piers subjected to a constant vertical load as well as cyclic lateral loads, a three-dimensional elastic-plastic finite element formulation is proposed for numerical simulation. By comparing the lateral load-lateral displacement hysteretic curves and failure modes of numerical results with experimental results, the proposed finite element analysis method is verified to be accurate and effective. 56 analytical models are established with four variable parameters, i.e., flange plate width-thickness ratio, column′s slenderness ratio, filled-in concrete ratio and axial load ratio. A summary of possible failure modes is given as follows. For pure steel piers, local buckling occurs near the bottom of the specimen. For partially concrete-filled steel piers, local buckling usually occurs at the upper plate adjacent to filled-in concrete in the case of small filled-in concrete ratio. With the increase of filled-in concrete ratio, local buckling will appear near the bottom of the specimen. Finally, the ultimate strength and ductility behavior of partially concrete-filled steel bridge piers are investigated on the basis of four variable parameters mentioned above.

Keywords: partially concrete-filled steel bridge pier; numerical simulation; failure mode; ductility behavior

轨道与常规公交局域换乘网络站点优化模型

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摘　要：为提高轨道交通站点与周边常规公交所构成的局域换乘网络的运行效率，首先借鉴 space P 法对所研究的局域网络进行拓扑描述，确定了合理的换乘网络规模；然后以乘客费用最小为目标，同时考虑站点容量、站间距等约束条件建立优化模型，采用复杂网络社团结构理论构造模型求解算法.最后将模型应用于长春市轨道交通 3 号线某站点及周边常规公交组成的局域换乘网络.结果表明：优化后的局域网络总换乘时间可缩短 16%，在考虑时间价值的情况下系统总费用降低了 6.16%，模型具有一定的实用价值.

关键词：交通运输工程；轨道交通；常规公交；换乘网络；站点优化

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Station optimization in local transfer network of rail transit and bus

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Abstract: To improve the transfer efficiency of local network including rail transit and bus station, local transfer network was described based on space P and a reasonable network size was determined. Considering the capacity of the station and station spacing as the constraints, optimization model was established to minimize the travel cost and model algorithm was proposed based on community structure of complex network. The model is applied to local transfer network including some station of Changchun light rail No.3 and bus stations around it. The results show that the overall transfer efficiency of the local network can be increased by 16%, and total system costs can be decreased by 6.16% considering the case of the time value.

Keywords: traffic and transportation engineering; rail transit; bus; transfer network; station optimization

基于粒子群优化与支持向量机的驾驶员疲劳等级判别

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摘　要：为客观、准确地判别驾驶员的疲劳程度，采用多项驾驶员生理指标、基于粒子群与支持向量机(SVM)算法建立驾驶疲劳等级判别模型，首先将驾驶员疲劳状态分为清醒、轻度疲劳、重度疲劳和睡意4个等级，然后将驾驶员的心电RR间期标准差、心率均值、呼吸潮气量、脑电的α波、β波和δ波功率谱密度积分等作为SVM的输入变量，驾驶疲劳等级作为输出变量，引入粒子群算法优化SVM的惩罚系数和核函数参数对判别模型进行标定，采用吉珲高速公路上的实车实验数据对模型有效性进行验证. 结果表明：本模型对4项疲劳等级的判别准确率均高于85%，对于驾驶员疲劳预警具有重要意义.通过对模型各个输入变量的敏感性分析，证明基于多项生理指标的疲劳判别较基于单生理指标的疲劳判别更加有效.

关键词：驾驶员生理指标；疲劳判别；支持向量机；粒子群；敏感性分析

中图分类号：U491.2　　**文献标志码**：A　　**文章编号**：0367-6234(2014)12-102-06

A driver fatigue level recognition model based on particle swarm optimization and support vector machine

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Abstract: To recognize driver's fatigue level accurately and objectively, a driver fatigue level recognition model that employs multiple psychological features was developed based on particle swarm optimization (PSO) and support vector machine (SVM). Firstly, the driver fatigue was divided into four levels, which were alert, mild fatigue, deep fatigue and drowsiness. Then alpha rhythm, beta rhythm, delta rhythm, mean of heart rate, and standard deviation of R-R interval were selected as input variables of the SVM model. The PSO was introduced into the model to optimize the penalty parameter and kernel function parameter of SVM. Experimental data collected in Ji-Hun freeway was used to validate the effectiveness of the recognition model. Results show that the recognition precision of the four fatigue levels are higher than 85%. Sensitive analysis of the mode is also conducted and the results prove that the model using multiple features outperforms the model using fewer features.

Keywords: driver's psychological features; fatigue recognition; support vector machine; particle swarm optimization; sensitive analysis

基于收费数据的高速公路交通拥挤自动判别方法

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摘　要：针对高速公路交通拥挤日益严重的现象，通过对收费数据的深层挖掘和高效利用，提出了基于滚动时间序列的行程时间数据合成方法，以此为基础构建了交通拥挤指数，并基于交通拥挤指数的变化特征对拥挤持续时间进行了在线估计；结合收费站布局的时空特征，设计了基本路段和复合路段融合的高速公路交通拥挤自动判别方法. 实证分析表明，该方法在判别率提高到 96.52%，误判率降低到 0.43%的同时，判别时间减少了 74%，而且收费数据的获取成本为零.

关键词：交通工程；数据合成；交通拥挤；自动判别；收费数据

中图分类号：U491.1　　**文献标志码**：A　　**文章编号**：0367-6234(2014)12-0108-06

The automatic traffic congestion identification of freeway based on charging date

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Abstract: In view of increasingly serious traffic congestion on freeway, a synthesis method of travel time date was proposed based on the rolling time sequence and charging data, and on which this paper built a traffic congestion index and estimated the duration time according to the changing characteristics of the index. Moreover, taking the spatial and temporal characteristics of toll station layout into account, a method of automatic traffic congestion identification on freeway was designed by merging basic links with composite links. Empirical analysis shows that this method can improve the recognizing rate to 96.52% and reduce the false recognizing rate to 0.43%, at the same time, the recognizing time is declined by 74%, and the cost of charging date is zero.

Keywords: traffic engineering; data synthesis; traffic congestion; automatic identification; charging date

考虑制动器温度的连续长大下坡纵坡设计方法

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摘　要：为提升连续长大下坡路段安全水平，研究一种基于制动器温度的纵坡设计方法.以 7 个典型连续长大下坡路段为研究对象，分析了下坡速度、车辆总质量对特定连续长大下坡路段货车制动器温度的影响.并以车辆到达连续长大下坡终点的制动器温度、制动器温度达到 200 ℃和 260 ℃时距连续长大下坡起点的距离为特征值，分析了采用等效平均纵坡单一坡度和设置缓坡两种展线形式对货车制动器温度的影响，提出了连续长大下坡路段区段划分量化标准和纵坡设计建议.研究表明：从降低货车制动器温度角度考虑，连续长大下坡路段应尽可能采用单一坡度展线，相邻坡段采用不同纵坡坡度时坡差不宜过大，特别是下部区段.

关键词：连续长大下坡；制动器温度；纵坡；坡差；区段划分

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Design methods for long steep downgrades considering of brake temperature of truck

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Abstract: To promote the safety level of long steep downgrades (LSD), profile design methods for LSD considering of the brake temperature of truck were studied. Seven typical LSD with different length and average grade percentage were selected. Then the influence of operating speed and gross weight on the brake temperature was analyzed. Furthermore, three characteristic values, i.e. the brake temperature of trucks at the end of the LSD, the distance to the beginning of the LSD when brake temperature up to 200 ℃ and 260 ℃ were used to analyze the influence of two different profile design alternatives, one is that unique longitudinal grade is used throughout the whole LSD, another is that different grade percentages are used in different segments, e.g. a steep grade is preceded by a gentle slope. The quantified section classification criterion was presented, and some recommendations were provided. The research shows that from the aspect of reducing the brake temperature of truck, unique grade percentage is recommended. If different grade percentages were used, the difference between any two adjacent segments should be controlled in a small range.

Keywords: long steep downgrades (LSD); brake temperature; longitudinal grade; difference of grade percentages; section classification

基于迭代平方根 CKF 的 SLAM 算法

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摘　要：在大尺度环境中，平方根容积卡尔曼同步定位与地图构建算法的非线性误差严重制约了算法的定位精度，为解决这一问题，提出了一种基于迭代平方根容积卡尔曼滤波的改进算法，该算法结合迭代理论，对平方根容积卡尔曼滤波的量测更新过程进行迭代更新，充分利用最新的观测信息，降低滤波的估计误差，从而构建精确的地图并获得高精度的定位信息.仿真实验结果表明，采用本算法后，x 轴和 y 轴方向上的位置误差均在 1.5 m 以内，估计结果明显优于 SRCKF-SLAM、CKF-SLAM 和 EKF-SLAM 算法；添加不同的环境噪声后进行仿真实验，该算法所取得的位置误差相比仍是最小的.利用该算法可以有效地减小非线性误差造成的影响，提高 SLAM 的定位精度.

关键词：迭代理论；同步定位与地图构建；非线性误差；平方根容积卡尔曼滤波；迭代平方根容积卡尔曼滤波

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Simultaneous localization and mapping based on iterated square root cubature Kalman filter

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Abstract: In large-scale conditions, the large nonlinear error of simultaneous localization and mapping (SLAM) based on square root cubature Kalman filter (SRCKF) is a serious constraint to high positional accuracy. To solve this problem, an improved SLAM algorithm based on iterated square root cubature Kalman filter (ISRCKF) is proposed. Utilizing the iteration theory, the newest observation information is in full use. Thus the estimation errors of the new algorithm will be decreased noticeably, an accurate environment map will be established and high-precision localization will be obtained as well. The simulation results show that the location errors of x axis and y axis are both less than 1.5 m by the new algorithm. The estimating accuracy of the new algorithm is higher than that of SRCKF-SLAM, CKF-SLAM and EKF-SLAM algorithms. Adding different environmental noises, the position errors of ISRCKF are the smallest.

Keywords: iterated theory; SLAM; nonlinear error; SRCKF; ISRCKF

HDPE-橡胶粉复合改性沥青应力吸收层混合料疲劳性能

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摘　要：针对反射裂缝在半刚性基层沥青路面中普遍存在问题，为延缓半刚性基层沥青路面反射裂缝的产生和扩展，本文开展了HDPE-橡胶粉复合改性沥青混合料疲劳性能的研究. 在分析了HDPE-橡胶粉复合改性沥青性能对应力吸收层疲劳寿命的影响规律的基础上，通过实体工程的监测开展了HDPE-橡胶粉复合改性沥青混合料路用性能的研究. 结果表明：HDPE-橡胶粉复合改性沥青的性质对沥青混合料疲劳特性具有显著的影响，性能良好的沥青使得混合料具有良好的抗疲劳能力，能有效延缓沥青路面反射裂缝的发生. 经过试验路的应用，也证明了HDPE-橡胶粉复合改性沥青混合料作为应力吸收层是沥青路面防止反射裂缝的有效途径之一.

关键词：HDPE；橡胶粉；改性沥青；应力吸收层；疲劳性能

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Fatigue performance of stress absorbing layerasphalt combining HDPE and rubber powder

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Abstract：To reduce the generation and development of reflection cracks of the semi-rigid base asphalt pavement，of which the fatigue performance using the HDPE-rubber powder to modify asphalt composite as a stress absorbing layer was studied. The fatigue test was carried out and the data after choosing proper test method and determining the mixture proportion and final experiment scheme was analyzed. Experimental results showed that asphalt modified by HDPE-rubber powder had excellent anti-fatigue ability and could effectively delay the generation of reflection cracksin asphalt pavement. This was verified by the observation results of indoor asphalt pavement test.

Keywords：HDPE；rubber powder；modifiedasphalt；stress absorbing layer；fatigue performance