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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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硅酸钙-聚氨酯夹芯板的抗弯性能

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摘　要: 为研究非金属面夹芯板受弯破坏时的力学性能,考虑芯材剪切变形的影响,利用力与变形的平衡微分关系,推导并简化在均布荷载和集中荷载作用下单跨简支夹芯板的弯曲变形与承载力计算公式.通过真空加载和沙袋堆载分别对硅酸钙-聚氨酯夹芯板进行了两组弯曲试验,并用软件 ABAQUS 进行了有限元模拟,分别得到其正常使用极限状态和承载能力极限状态时的变形和破坏荷载,以及相应的荷载-位移曲线.结果表明,理论计算简化公式、试验结果和有限元结果三者吻合较好,因而该理论简化公式可用于计算这种非金属面夹芯板的弯曲变形和承载力.

关键词: 硅酸钙面板;聚氨酯芯材;夹芯板;抗弯性能;弯曲变形

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Bending properties of sandwich panels with calcium-silicate faces and polyurethane cores

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Abstract: To study on mechanical properties of non-metal faced sandwich panels under bending load, the force-deformation relationships of differential equations were used to derive and simplify deformation calculate formulas and bearing capacity calculate formulas of the single-span simply supported sandwich panels under uniformly distributed load and concentrated load, considering the influence of the shear deformation of core. Bending properties of two groups of sandwich panels with calcium-silicate (CS) faces and polyurethane (PU) cores were tested through vacuum chamber loading and sandbag loading and they were analyzed through the finite element methods (FEM) with software ABAQUS. Bending deflection and bending bearing capacity of sandwich panels in serviceability limit states and bearing capacity limit states are got separately and the corresponding load-displacement curves are drew. The results show that the theoretical calculation results are identical to the experimental results and FEM results. It is concluded that the simplified formulas can be used to calculate accurately bending deflection and bending bearing capacity of non-metal faced sandwich panels.

Keywords: calcium-silicate (CS) faces; polyurethane (PU) cores; sandwich panels; bending properties; bending deflection

汶川地震钢混框排架主厂房反应特性分析

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摘　要：在对比 El Centro 波、Taft 波、汶川-江油波等不同强震主厂房反应特性的基础上，直接采用不同峰值的汶川-江油波开展动力弹塑性时程分析，探究主厂房这类典型结构在汶川这类特殊地震动下的响应特性和震损机理.结果表明：汶川-江油波作用下结构的响应偏小，但变化更不规律；主厂房能够抵御远超设防烈度的汶川-江油地震作用而不发生严重的失效破坏；结构扭转效应显著，煤斗层始终为结构薄弱层；框架部分刚度衰退快于排架部分，排架部分承担总地震作用比例先提高后不变，总体比例处于较低水平，无法成为结构的第二道抗震防线；虽汽机房网架屋面不会因杆件强度破坏而垮塌，但由于支座处承受剪力巨大且变形过大，支座的率先破坏将引发屋盖系统的失稳破坏；主厂房率先进入塑性的构件主要集中在底层和煤斗层，表现为明显的“强梁弱柱”特点.

关键词：汶川地震；框排架；主厂房；屋盖系统；地震反应

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Seismic response characteristics for R.C. frame-bent main building under Wenchuan earthquake

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Abstract: The responses of main building under different strong earthquakes, such as El Centro, Taft, Wenchuan-Jiangyou were compared, and dynamic time history analysis based on Wenchuan-Jiangyou record with different peak values was used to reveal the damage mechanism of this typical structure. The results indicate that the response of Wenchuan-Jiangyou record is the smallest, but variability is the biggest. Wenchuan earthquake, which is more than design intensity, does not cause serious damage of main building. The torsional effect is remarkable, and coal scuttle layer is always weak layer. The stiffness degradation of frame is faster than the bent part, and the proportion of bent part within total earthquake action is enhanced firstly and then remains same. But the overall proportion is still in low level and bent part is unable to become the second resistance component. Although space grid roof system in turbine hall does not collapse because of strength failure of components, the bearing carries over huge shearing force with oversized distortion, and the failure of bearing will lead to collapse of roof system. Plastic deformations mainly concentrate in the first floor and coal scuttle layer, and “strong beam and weak column” are exposed.

Keywords: wenchuan earthquake; frame-bent structure; main building; roof system; seismic response

160 000 m^3 大型 LNG 储罐的振动特性分析

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摘　要: 为了解 160 000 m^3 大型液化天然气(LNG)全容式储罐的自振振动特性,采用 ANSYS 软件建立了储罐结构的精细化有限元模型,利用直接耦合法对液体单元和罐体结构进行流固耦合约束,采用缩减法进行储罐振动特性分析,获得了空罐、正常工作时满液位以及满液位泄露、半液位泄露四种工况下钢制内罐与预应力混凝土外罐的振动特点和振动周期;分析了液体与罐体相互作用时,液体对罐体结构振动特性的影响及其规律,以及预应力、罐内气压和底板约束数量对外罐结构振动特性的影响规律.

关键词: LNG 储罐;流固耦合;自振特性;有限元分析

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Vibration characteristic analysis of 160 000 m^3 LNG storage tank

ZHAI Ximei, WANG Haosong, FAN Feng

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Abstract: To investigate the natural vibration characteristics of the 160 000 m^3 full capacity liquefied natural gas (LNG) storage tank, a fine finite element model for the tank with reasonable element types and mesh dimension was established using the finite element software (ANSYS). Using direct coupling method for the fluid-structure coupling constraints and the reduced mothed for analysis, the natural vibration characteristics of the tank is obtained when the tank is empty or full and leak at full or harf full liquid level. The liquid´s influence on the vibration characteristics of tank structure is given. Besides, the influence of the prestress, the pressure of the gas and the constraint at the bottom of the outer tank structure is considered. The research results above can provide a reference basis for engineering design of the LNG storage tanks.

Keywords: LNG storage tank; fluid-structure interaction; natural vibration characteristics; finite element analysis

纳米零价铁去除地下水中亚硒酸盐的动力学及机理

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摘　要：为解决地下水中亚硒酸盐(Se(IV))污染问题，采用纳米零价铁为还原剂，考察溶液的pH、Se(IV)初始浓度以及溶液温度等因素对Se(IV)去除效果的影响.结果表明：纳米零价铁在厌氧条件下能够在短时间内将Se(IV)完全去除，速率常数随pH和初始硒浓度的升高而降低，随温度的升高而升高，利用阿伦尼乌斯方程得到其反应活化能为26.26 kJ·mol^{-1}.X射线吸收近边结构谱(XANES)进一步证明了在不同pH和浓度下，还原产物以Se(0)为主.水中Se(IV)的去除由吸附和还原引起，反应过程是水中Se(IV)先吸附到纳米铁表面，随后被还原为零价硒.纳米零价铁还原是一种有效去除水体中Se(IV)的方法.

关键词：纳米零价铁；Se(IV)；动力学；地下水
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Reductive removal of Se(IV) by nanoscale zero-valent iron under anoxic conditions: kinetics and mechanism

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Abstract: Nano-zero valent iron (NZVI) was employed to remove Se(IV) from groundwater. The kinetics of Se(IV) removal by NZVI as functions of pH, initial selenite concentration and reaction temperature were investigated and the reaction products of Se(IV) with NZVI were determined with X-ray Absorption Near Edge Structure Spectroscopy (XANES). The results demonstrated that the Se(IV) could be rapidly removed by NZVI with pseudo first order reaction rate constants decreasing from 0.339 to 0.149 min^{-1} as pH increased from 4.0 to 7.0. Moreover, the removal rates of Se(IV) by NZVI at pH 6.0 dropped with elevating initial Se(IV) concentration. The activation energy of Se(IV) removal by NZVI was determined to be 26.26 kJ·mol^{-1}. The XANES analysis unraveled that Se(IV) was removed by NZVI via adsorption followed by reduction to Se(0).

Keywords: nano-zero valent iron; selenite; kinetics; groundwater

水处理工艺中氟喹诺酮类物质分布的检测

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摘　要：环境中残留的氟喹诺酮类物质(FQs)对人体健康构成威胁，自来水厂对阻断 FQs 进入饮用水中具有关键作用.选取长江、太湖、大溪水库和松花江水源水及江苏省 A、B 和 C 水厂的工艺出水探索同时检测诺氟沙星、环丙沙星、恩诺沙星和氧氟沙星的方法，并分析 FQs 在水处理工艺流程中的迁移规律.结果表明，长江水中 FQs 的质量浓度在 51～129 ng/L，太湖水中 65～204 ng/L，大溪水库中 62～248 ng/L，松花江水中 61～165 ng/L.水处理工艺出水 FQs 残留结果表明，常规水处理工艺对 FQs 的去除率在 20%～40%，起主导作用的是混凝沉淀过程，采用臭氧-活性炭工艺去除率可达 20%～60%.

关键词：氟喹诺酮；水处理工艺；固相萃取；液质联用

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Simultaneous determination of fluoroquinolones in drinking water treatment processes

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Abstract: An investigation was performed for the simultaneous determination of norfloxacin (NOR), ciprofloxacin (CIP), enrofloxacin (ENR), and ofloxacin (OFL). The developed method was successfully applied to analyze the fate of Fluoroquinolones (FQs) in water treatment processes. Four FQs were found in Yangtze River, Taihu Lake, Dasi Reservoir, Songhua River, and drinking water treatment processes of A, B and C in Jiangsu. Analyses of samples from Yangtze River, Taihu Lake, Dasi Reservoir and Songhua River indicated that FQs were present at concentrations of 51－129, 65－204, 62－248 and 61－165 ng/L, respectively. FQs residues in water treatment processes show that the removal efficiency of conventional water treatment processes is between 20% and 40%, and the coagulation-sedimentation process plays a dominant role. The removal efficiency of ozone-activated carbon process is about 20%－60%.

Keywords: fluoroquinolones; water treatment processes; solid phase extraction; LC-MS/MS(Q-TOF)

石墨烯薄膜修饰 TiO_2 纳米管光电极制备及性能

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摘　要: 为提高 TiO_2 光催化剂的可见光催化活性,采用阳极氧化法制备了高度有序的 TiO_2 纳米管,利用阳极电化学沉积构筑了石墨烯薄膜修饰的 TiO_2 纳米管光电极,并利用扫描电子显微镜、X-射线光电子能谱及紫外-可见漫反射光谱对其表观形貌、组成结构及光吸收性能进行表征.结果表明:石墨烯有效地修饰在 TiO_2 纳米管表面,且以透明薄膜形式存在.此外,石墨烯薄膜修饰显著拓展了 TiO_2 纳米管的可见光响应范围.以甲基蓝为探针分子,考察了阳极沉积电压及沉积时间对所制备石墨烯薄膜/TiO_2 纳米管光电极光催化性能的影响.结果表明:阳极沉积电压为+0.8 V、沉积时间为 10 min 时,制备的石墨烯薄膜/TiO_2 纳米管光电极对甲基蓝的光催化降解效果最佳.模拟太阳光下光照 120 min 对甲基蓝的降解率为 65.9%,是纯 TiO_2 纳米管光电极的 1.35 倍.

关键词: 石墨烯薄膜/TiO_2 纳米管;光电极;光催化;甲基蓝

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Preparation and performance of graphene film decorated TiO_2 nano-tubes photoelectrode

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Abstract: To improve the visible light photocatalytic (PC) activity of TiO_2 photocatalyst, the well-aligned TiO_2 nano-tubes (TiO_2 NTs) were in-situ grown by anodization of Ti foils, and the graphene film was anodic electrodeposited onto the aforementioned TiO_2 NTs to constructed graphene film decorated TiO_2 NTs (GF/TiO_2 NTs) photoelectrode. Apparent morphology, surface composition and light absorption ability of the resulting photoelectrodes were characterized by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and UV-visible light diffuse reflection spectroscopy (UV-vis DRS). It was found that the graphene were successfully decorated onto the surface of TiO_2 NTs electrode, and existed as the transparent film. In addition, the light absorption of GF/TiO_2 NTs photoelectrode was greatly red-shifted to visible light region. Furthermore, the methyl blue (MB) was served as the probing molecules, and the effects of deposition voltage and deposition time on the PC performances were mainly investigated. It was found that when the deposition voltage and applied time were +0.8 V and 10 min, respectively, the optimal photodecomposition of MB could be obtained. Under the simulated sunlight irradiation within 120 min, the 65.9% degradation rate of MB could be achieved, which was 1.35 time larger than that of pristine TiO_2 NTs photoelectrode.

Keywords: GF/TiO_2 NTs; photoelectrode; photocatalysis; methyl blue

可见光响应型 $(CuAg)_x In_{2x} Zn_{2(1-2x)} S_2$ 光催化剂的光催化制氢

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摘　要：为实现可见光下分解水制氢，用沉淀煅烧法合成系列 $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$ 光催化剂. 采用 X 射线衍射仪（XRD）、紫外可见吸收光谱（UV-Vis）、电位粒径仪（DLS）、X 射线能谱（EDS）、电感耦合等离子体质谱（ICP-MS）等方法研究了光催化剂的能带结构，评价其光催化性能.结果表明，随着组成配比 x 值的增加，光催化剂的光吸收从紫外光向可见光扩展，禁带宽度逐渐变小. 通过计算发现，光催化剂的导带电位逐渐接近氢的氧化还原电位.合成的 $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$（$x = 0.05 \sim 0.30$）在可见光下都能光催化产氢，并且 $(CuAg)_{0.15}In_{0.3}Zn_{1.4}S_2$（即 $x = 0.15$）具有最高的光催化制氢活性.调节组成配比可调控光催化剂的能带结构，有助于获得具有高活性和稳定性的可见光响应型光催化剂.

关键词：光催化剂；$(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$；可见光；制氢；水分解；禁带宽度

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Photocatalytic hydrogen production of visible-light-responsive $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$ photocatalysts

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Abstract: To fulfill photocatalytic H_2 production under visible light irradiation, $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$ photocatalysts were synthesized using the precipitation and calcination. X-ray diffraction (XRD), ultraviolet-visible absorption spectra (UV-Vis), dynamic light scattering (DLS), energy-dispersive X-ray spectroscopy (EDS), and inductively coupled plasma mass spectrometry (ICP-MS) were employed to investigate band structures of the photocatalysts and evaluate photocatalytic activities. The results show that the absorption edges shift to longer wavelengths up to visible-light region and band gaps decrease with the increase of x. In addition, the conduction band potentials are close to the redox potential of H^+/H_2 with the increase of x. The prepared $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$ ($x = 0.05 - 0.30$) photocatalysts exhibit the activities of H_2 production under visible light irradiation, and $(CuAg)_{0.15}In_{0.3}Zn_{1.4}S_2$ ($x = 0.15$) shows the highest photocatalytic activity. The band structures of $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$ were manipulated by adjusting the composition ratio, which will help design visible-light-response photocatalysts with the high activity and stability.

Keywords: photocatalyst; $(CuAg)_xIn_{2x}Zn_{2(1-2x)}S_2$; visible light; hydrogen production; water splitting; band gap

低温 SBR 系统活性污泥硝化效能的 pH 调控

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摘　要：为进一步提高低温(15 ℃)SBR 系统的硝化效能，通过间歇培养实验探讨 pH 对系统活性污泥硝化效能的调控与影响.结果表明，将初始 pH 控制为 8.0~9.0，低温 SBR 系统的活性污泥(以 MLSS 计)具有最佳的氨氮氧化能力，在 NO_2^--N 积累阶段对 NH_4^+-N 的比去除速率可达 25.49 g·kg^{-1}·d^{-1}，NO_2^--N 的比生成速率达 22 g·kg^{-1}·d^{-1}；初始 pH 为 7.5~8.0 时，NO_2^--N 氧化效果最佳，NO_3^--N 的比生成速率可达 35.6 g·kg^{-1}·d^{-1}；将反应系统的 pH 维持在 8.0，可使亚硝酸菌和硝酸菌代谢活性均保持在较高水平，达到良好的硝化效果.

关键词：序批式活性污泥法；活性污泥；低温；硝化作用；pH

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Regulation of pH for enhancing nitrification efficiency of activated sludge in a low temperature sequencing batch reactor

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Abstract: To improve the nitrification efficiency of activated sludge in a low temperature (15 ℃) sequencing batch reactor (SBR), the performance and characteristics in nitrification of the activated sludge were investigated by batch culture with regulation of initial pH. The results indicated that the ammonia oxidation efficiency of the activated sludge was the best with initial pH ranged from 8.0 to 9.0. In the NO_2^--N accumulating process, the specific ammonia nitrogen (NH_4^+-N) removal rate and specific nitrite nitrogen (NO_2^--N) producing rate were 25.49 g·kg^{-1}·d^{-1} and 22 g·kg^{-1}·d^{-1}(as MLSS), respectively. For nitrite oxidation, the favorable initial pH ranged from 7.5 to 8.0, under which a specific nitrate nitrogen (NO_3^--N) producing rate of 35.6 g·kg^{-1}·d^{-1}(as MLSS) was obtained. It showed that the satisfactory ammonia oxidation and nitrite oxidation efficiency would be obtained by the enhancement of metabolic activity both of the nitrite and nitrate bacteria when the pH of wastewater was kept at about 8.0 in the nitrification process.

Keywords: sequencing batch reactor (SBR); activated sludge; low temperature; nitrification; pH

松花江水环境中多环芳烃的污染及致癌风险

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摘　要: 为研究松花江水环境中多环芳烃(PAHs)的污染特征及致癌风险, 于 2006~2010 年间对松花江流域 13 个监测断面的水样和底泥样进行了 6 次集中采集, 采样时间包括平水期、丰水期和冰封期, 采用液液萃取法和索氏提取法对样品中的 PAHs 进行提取, 采用 GC-MS 进行定性和定量分析. 结果表明, 水样中主要以低环的 PAHs 为主, 底泥中主要以高环的 PAHs 为主, 水样和底泥中 15 种 PAHs 的含量分别为(73.7 ± 27.8) ng/L 和(127 ± 117) ng/g, 同我国其他河流相比, 松花江水环境中 PAHs 的污染程度较小. 松花江水环境中 PAHs 的浓度具有明显的季节差异, 平水期和丰水期水样中的浓度较高, 冰封期水样中 PAHs 的浓度最低, 而平水期底泥中 PAHs 的浓度要远高于丰水期. 致癌风险评估模型的计算结果表明, 松花江水样中 PAHs 的致癌风险小于 10^{-6}, 致癌风险较小.

关键词: 多环芳烃; 水环境; 污染特征; 季节变化; 致癌风险

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Pollution and cancer risk of PAHs in water environment of the Songhua River, China

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Abstract: To study the pollution characteristic and cancer risk of PAHs in water environment, water and sediment samples were concurrently collected on 13 monitoring sections within the Songhua River Basin. Totally, 6 batches of sampling programs were conducted from 2006 to 2010, including the low water season, the high water season and the icebound season. Water and sediment samples were extracted by liquid-liquid extraction and Soxhlet extraction, respectively. The qualification and quantification of PAHs were analyzed by GC-MS. The compositional pattern of PAHs indicated that low ring PAHs were predominant in water samples, while high ring PAHs dominated in sediment samples. The average total concentrations of 15 PAHs were (73.7±27.8) ng/L and (127±117) ng/g, ww for water and sediment samples, respectively. The concentration of PAHs was lower than those of other rivers in China. Obviously seasonal variation of PAHs concentration was observed in the water environment of the Songhua River. For water samples, the PAHs concentrations in the low water season and the high water season were higher than those in the icebound season. For sediment samples, the PAHs concentrations in the low water season were much higher than those in the high water season. The results of the incremental lifetime cancer risk assessment model indicated that the estimated integrated lifetime cancer risks were less than for 10^{-6}, indicating low level of cancer risk for all age groups.

Keywords: PAHs; water environment; pollution characteristic; seasonal variation; cancer risk

非均相催化臭氧处理煤化工生化出水

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摘　要：煤化工生化出水属于有毒害和难以生物降解的工业废水，为此，采用非均相催化臭氧氧化技术深度处理煤化工生化出水，以负载过渡金属铜和锰的活性炭作为催化剂提高臭氧降解污染物能力.结果表明：该处理对 COD 和氨氮去除率达 60%～72%和 30%～35%，处理后出水 COD 和氨氮平均质量浓度低于 60 和 15 mg/L，显著高于单独臭氧氧化，达到 GB18918—2002 水污染排放一级 B 标准；在酸性条件下，催化剂活性受到限制，碱性条件对其具有促进作用. 与单独臭氧氧化相比，催化剂的使用均提高了臭氧对污染物的降解能力；处理后出水的可生化性得到显著提高，不会对受纳水体产生二次污染.

关键词：煤化工生化出水；臭氧氧化；催化剂

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Research on heterogeneous catalytic ozonation of coal chemical industry wastewater secondary effluent

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Abstract: Heterogeneous catalytic ozonation was applied to the treatment of coal chemical industry wastewater secondary effluent. Activated carbon-supported copper and manganese oxide were used as catalysts to assist ozone in degrading COD and NH_3-N of secondary effluent. The results indicated that the presence of catalysts significantly elevated the removal efficiency of ozone on COD and NH_3-N, as compared to the single ozone oxidation. The final effluent removal efficiency of COD and NH_3-N were 60%-72% and 30%-35% respectively, the average concentration of COD and NH_3-N was lower than 60 and 15 mg/L, and met Wastewater Discharge Standard (GB 18918—2002). The catalytic activity was restricted in acidic conditions and promoted in alkali conditions, however, catalysts improved degradation efficiency regardless of acid-base conditions as compared to the single ozone oxidation. The final effluent biodegradability was significantly improved, and no secondary pollution in the receiving water was produced.

Keywords: coal chemical industry wastewater secondary effluent; ozonation; catalyst

活性炭粉末电极电容除盐与膜电容除盐对比

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摘　要：为研究电容法除盐技术(CDI)与膜电容法除盐技术(MCDI)除盐效果的差异,获得具有较优除盐特性的电除盐体系,选用成本较低的活性碳粉末作为电容法除盐体系的电极材料,研究 CDI 与 MCDI 对不同质量浓度盐水的处理效果.结果表明,随着处理盐溶液质量浓度的提高,CDI 与 MCDI 的电吸附量均有提高,且 MCDI 电吸附效果的优势更为明显.当盐水质量浓度由 0.05 g/L 上升到 0.5 g/L 时,MCDI 的电吸附量由 99.4 μmol/g 升至 694.4 μmol/g,而 CDI 的电吸附量仅由 80.3 μmol/g 变化至 135.7 μmol/g.

关键词：电容法除盐;膜电容法除盐;电吸附量;电吸附速率

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A comparative study on capacitive deionization and membrane capacitive deionization with powdered activate carbon as electrodes

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Abstract: To get an effective electric desalination system, the electrosorption performance of a capactive deionization (CDI) and a membrane capactive deionization (MCDI) was compared. The electrosorption capacity and electrosorption rate of CDI and MCDI with different salt concentrations were studied when powdered activated carbon was used as the electrode material. The results showed that as the salt concentration increased from 0.05 to 0.5 g/L, the electrosorption capacity of MCDI increased dramatically from 99.4 to 694.4 mol/g, while the electrosorption capacity of CDI just increased from 80.3 to 135.7 μmol/g.

Keywords: capacitive deionization; membrane capacitive deionization; electrosorption capacity; elctrosorption rate

严寒地区冬季农宅室内燃烧污染及相关性

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摘　要：为了解严寒地区冬季农宅室内空气污染的现状，对哈尔滨附近两个村 10 户农宅室内污染物 $PM_{2.5}$、PM_{10}、CO、CO_2、SO_2、NO_x、TVOC 和 NH_3 进行了现场测试，并分析了其相关性.结果表明：$PM_{2.5}$、PM_{10}、CO、CO_2、SO_2 和 NO_x 污染严重，超标率分别为 93%、75%、62%、23%、99%和 64%，是室内主要的污染物；PM_{10} 与 $PM_{2.5}$，$PM_{2.5}$ 与 CO 之间皆显著线性相关，SO_2 与 CO_2、NO_x 与 SO_2 之间皆线性相关；通过室内污染物间的相关性分析，提出了严寒地区冬季农宅室内空气品质主要检测指标和简易测试方法.

关键词：室内空气污染物；检测指标；相关性；农宅；冬季

中图分类号：X508　　**文献标志码**：A　　**文章编号**：0367-6234(2014)06-0060-05

Indoor air pollutants and their correlation at rural houses in severe cold region in winter

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Abstract: To explore the indoor air pollution at rural houses in severe cold region in winter, a field study was conducted at 10 rural houses in two villages around Harbin. The indoor pollutants including $PM_{2.5}$, PM_{10}, CO, CO_2, SO_2, NO_x, TVOC and NH_3 were tested and the correlation of pollutants were analyzed. The results showed that $PM_{2.5}$, PM_{10}, SO_2, NO_x, CO_2 and CO were the main pollutants at rural houses in winter, with the overproof rates of 93%, 75%, 62%, 23%, 99%, 64%, respectively. There were good relations between PM_{10} and $PM_{2.5}$, CO and $PM_{2.5}$, respectively. In addition, the linear correlations were also found between SO_2 and CO_2, NO_x and SO_2, respectively. The main test indices of pollutants were given based on the regression analysis results. The test method of pollutants was proposed at rural houses in severe cold region in winter.

Keywords: indoor air pollutants; test indices; correlation; rural houses; winter

基于 X-ray CT 的沥青混合料空隙测试精度影响因素分析

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摘　要：为了分析细观尺度下沥青混合料空隙率测试精度的影响因素，采用德国 Phoenix v|tome|x S240 型工业 X-ray CT 机，结合正交试验设计与方差分析，研究不同 CT 参数及级配类型对沥青混合料三维重构体积参数的影响.通过对不同级配类型马歇尔试件扫描并进行三维重构与体积分析，建立影响因素与空隙率测试结果之间的关系，进而确定最优扫描参数.试验结果表明，基于细观尺度对沥青混合料进行三维体积分析是可行的；扫描电压、电流及级配类型对重构结果有不同程度的影响；适当提高电压、电流及选择恰当的滤波片可提高测试结果的准确性；在恰当的设备参数条件下，基于细观尺度与宏观尺度下得到的沥青混合料空隙率具有良好的相关性，有助于提高测试结果的准确性与试验的经济性.

关键词：细观结构；X-ray CT；沥青混合料；三维重构；测试精度

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Analysis of influencing factors of the test precision of asphalt mixture voids based on X-ray CT

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Abstract: To study the factors that influence the test precision of percent air voids of asphalt mixture based on mesoscopic scale, German Phoenix v|tome|x S240 industrial X-ray CT was utilized in combination with orthogonal test and variance analysis to study how different CT parameters and gradation types influenced the 3D reconstruction volume parameters of asphalt mixture. Marshall specimens were scanned by changing the parameters of CT and gradation types of asphalt mixture and the results were used for three-dimensional analysis, the relation between influence factors and percent air voids was also built, and then determine the optimal scanning parameters. The test results showed that it is feasible to make three-dimensional volume analysis of asphalt mixture on the basis of meso-scale; the scanning parameters and gradation types have different levels of effects on reconstruction results; the test accuracy would be improved by increasing scaning voltage and current properly and as well as choosing the appropriate filters. The percent air voids that obtained on the base of both meso-scale and macro-scale had good correlation under the condition of appropriate parameter of apparatus, in addition can improve the accuracy and economy of the test.

Keywords: meso-structure; X-ray CT; asphalt mixture; three-dimensional reconstruction; test precision

重载沥青路面结构组合的抗车辙性能分析

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摘　要：为研究结构组合对沥青混合料抗车辙性能的影响，首先对所设计的7种沥青混合料进行动态模量及单层车辙试验，得到基本材料参数及抗车辙性能；然后对7种混合料组合而成的3种路面结构在重载条件下进行双层结构车辙试验，并与单层车辙试验结果进行对比分析；最后，应用光纤光栅智能测试技术对实际路面进行现场应变测试，根据不同路面结构三向应变测试结果评价实际重载沥青路面结构的抗车辙性能.结果表明，单层车辙试验难以准确反映路面结构的抗车辙性能，而双层车辙试验效果良好.在设计抗车辙路面时要考虑不同面层的模量组合，才能最大程度地发挥各层混合料的抗车辙性能.

关键词：沥青路面；重载；车辙；结构组合；结构车辙试验；光纤光栅传感器

中图分类号：U416　　**文献标志码**：A　　**文章编号**：0367-6234(2014)06-0072-07

Rutting resistance analysis of structure combinations for asphalt pavement subjected to heavy loads

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Abstract: To study the effect of structure combinations on rutting resistance, firstly, dynamic modulus tests and single-layered wheel tracking tests were carried out to get basic parameters and anti-rutting resistance of seven asphalt mixtures designed. Secondly, double-layered structural wheel tracking tests subjected to heavy loads were conducted for three pavement structure combinations made up of asphalt mixtures utilized, and then compared the results with the single-layered ones. Finally, three-directional strain of pavement was got on site utilizing fiber Bragg grating (FBG) intelligent test technology, and the rutting resistance of actual asphalt pavement was evaluated through these results. Results show that rutting resistance of pavement structures cannot be reflected by single-layered wheel tracking test accurately, while the double-layered does. Additionally, modulus combinations with different layers must be taken into account in order to maximize the rutting resistance of asphalt mixtures.

Keywords: asphalt pavement; heavy loads; rutting; structure combination; structural wheel tracking test; fiber Bragg grating sensor

非经典阻尼的位移输入模型和多点反应谱注记

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摘　要：为注记和揭示底部单元为非经典阻尼下位移输入模型与多点反应谱的准确性与稳定性，本文涉及理论推导与计算分析两个层面.讨论了在时域模型中底部单元分别为经典与非经典阻尼的区别，在时域模型的基础上推导给出底部单元为非经典阻尼时多点反应谱公式，并通过算例验证.分析结果表明：底部单元为非经典阻尼时，位移输入模型不会出现底部单元刚度有关的阻尼项；理论上证明了在底部单元为非经典阻尼下位移输入模型和多点反应谱不存在结果不收敛问题；验证了底部单元为非经典阻尼下，采用位移输入模型计算结果的准确性和稳定性.

关键词：地震动；时域模型；位移输入模型；多点反应谱；非经典阻尼

中图分类号：P315.9　　**文献标志码**：A　　**文章编号**：0367-6234(2014)06-0079-07

Notes on displacement input model and multi-supported response spectrum of non-classical damping

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Abstract: To note and proclaim the accuracy and stability of displacement input model and multiple support response spectrum(MSRS) when non-classical damping in bottom element is adopted, this paper involves in two aspects-theoretical derivation and calculation analysis. The difference of time-domain model between classical and non-classical damping in bottom element is discussed. On the basis of time-domain model, the formula of MSRS is given and deduced, and it is verified by a numerical example. The derivation and analysis show that the stiffness-related damping term in bottom element does not appear in the displacement input model, the displacement input model and MSRS do not have problems of non-convergence, and the accuracy and stability of the displacement input mode is verified.

Keywords: seismic ground motion; time-domain model; displacement input model; multiple support response spectrum(MSRS); non-classical damping

考虑 NGA 地震动衰减关系的主余震概率损伤分析

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摘　要：为研究主余震序列作用下结构的位移响应、失效模式以及整体损伤演化等方面的影响规律，结合主震与强余震统计关系和 NGA 地震动衰减关系构造了主余震地震动序列，采用改进的截面损伤率计算方法分析了算例结构在强余震引起的附加损伤率，并从概率角度刻画了强余震造成的概率累积损伤.研究表明：强余震引起结构的附加损伤随着其超越概率的减小而呈现增加的趋势；结构的主震损伤率与余震附加损伤率呈现近似负相关关系；当结构遭受主震后的损伤率较大时，即便较小的余震造成的损伤也会导致结构概率累积损伤发生较大的变化；如果余震的卓越周期与主震下受损结构的自振周期相近时，存在类共振现象，可加重结构的附加损伤.

关键词：主余震；附加损伤；截面损伤率；超越概率；失效模式；NGA 衰减关系

中图分类号：TU352；TU355　　**文献标志码**：A　　**文章编号**：0367-6234(2014)06-0086-07

Probabilistic damage analysis of mainshock-aftershock with the consideration of next generation attenuation relationship

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Abstract：To investigate the influence of mainshock-aftershock sequences on displacement responses，failure mode，global damage evolution，etc of structures，the sequences are generated by combining the next generation attenuation（NGA）relationship for earthquakes with the relationship between main shock and strong aftershock. The modified section damage ratio model is applied to analyze additional damage of an example structure under strong aftershocks，as well as probabilistic accumulative damage. The investigation indicates that additional damage incurred by strong aftershocks tends to increase as their probabilities of exceedance（POE）decrease. Approximate negative correlation could be observed between the damage ratios of main shocks and those added by strong aftershocks. When structures experience substantial damage under main shocks，probabilistic accumulative damage of structures would change significantly even coupled with damage induced by low-level aftershocks. Additional damage would be aggravated by so-called analogous resonance phenomenon when the predominant periods of the response spectra of these aftershocks are close to the vibration periods of damaged structures under main shocks.

Keywords：main-aftershock；additional damage；section damage ratio；probability of exceedance；failure mode；next generation attenuation relationship

环向预应力加固圆形混凝土筒仓的静力性能

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摘　要：为了研究环向预应力碳纤维条带加固钢筋混凝土筒仓在贮料荷载下的受力性能，本文主要考虑了有无预应力、预应力大小、材料厚度、宽度以及加固形式对加固效果的影响，对5种针对不同影响因素的加固模型进行对比分析.结果表明：采用环向预应力加固钢筋混凝土筒仓可有效限制仓壁径向位移和混凝土、钢筋应力，并改善其整体应力水平；预应力的施加可较大程度提高碳纤维条带中的应力，使其高强特性发挥更加充分；加固时，碳纤维材料的厚度宜为0.35～0.5 mm，预应力宜为其抗拉强度的10%～15%.

关键词：钢筋混凝土筒仓；环向预应力；加固；CFRP；数值分析

中图分类号：TU37；TU33+2　　**文献标志码**：A　　**文章编号**：0367-6234(2014)06-0093-07

Static behavior of circular reinforced concrete silo strengthened with lateral pre-stressed method

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Abstract：To study static behavior of circular reinforced concrete silo strengthened with pre-stressed carbon fiber reinforced polymer（CFRP）under stored material load，considering the influence of reinforcement parameters such as strengthening method，pre-stress level，width，thickness，and reinforcement form on reinforced effect，comparative analysis were performed between reinforcement models established according to 5 different influencing factors. The results show that lateral pre-stress could effectively restrict radial displacement，concrete and steel stress of silo wall and improve the stress level of silo wall. The lateral pre-stress can largely improve the damage stress of CFRP and bringing the high-strength characteristic of CFRP into full play. The thickness of CFRP should be from 0.35 mm to 0.50 mm and the pre-stress level should be from 10 to 15 percent of its ultimate tension strength.

Keywords：reinforced concrete silo；lateral pre-stress；strengthening；CFRP；numerical analysis

光纤光栅缓粘结智能钢绞线的研制及应用

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摘　要: 针对缓粘结钢绞线应力监测用传感器和布设工艺的缺陷,本文基于光纤光栅传感技术特性,综合考虑缓粘结预应力钢绞线的结构,设计制作了一种可实现预应力状态自监测的光纤光栅缓粘结智能钢绞线.并将其应用于某礼堂改造工程缓粘结预应力混凝土单向楼板内,验证了新型光纤光栅缓粘结智能钢绞线的有效性和可靠性.结果表明:该缓粘结智能钢绞线结构简单、机理明确;与普通钢绞线相比其力学性能有所下降,极限抗拉强度约为普通钢绞线的88%;其主要传感性能指标,如迟滞、重复性、线性度、总精度等均小于3%.通过实际工程验证了该新型智能钢绞线施工工艺简单易行,鲁棒性能够满足实际工程预应力损失长期监测.

关键词: 光纤光栅;缓粘结钢绞线;预应力损失;监测评估

中图分类号: TU378　　**文献标志码**: A　　**文章编号**: 0367-6234(2014)06-0100-05

Development and application of FBG retard-bonded smart steel strands

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Abstract: In this paper, in order to solve the defects of sensors and distributed process for monitoring the stress of retard-bonded steel strand, according to characteristics of retard-bonded prestressed concrete and optical fiber sensing, novel self-monitoring retard-bonded smart steel strand was designed and manufactured. Then the FBG retard-bonded smart steel strand were applied to a retard-bonded prestressed one-way slab in a Hall, and the availability and reliability of the novel smart steel strands was verified. The results show that the retard-bonded smart steel strands have simple structure and definite mechanism. The mechanical properties of the smart steel strand are lower than ones of ordinary steel strand, and the smart strand has the ultimate tensile strength of about 88% of common strand, and the sensing properties (hysteresis, repeatability, linearity, and total accuracy) are less than 3%. It has been verified that the novel smart steel strand have the advantages of simple and easy construction process by the application in the practical project. And the robustness of the novel smart strand can meet the long-term monitoring for prestress losses in the practical engineering.

Keywords: optical fiber bragg grating; retard-bonded steel strand;loss of prestress;monitoring and evaluation

基于航模辅助观测的车辆轨迹提取方法

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摘　要:为了克服交通流定点视频观测方法在观测范围上的局限性,提出了一种基于飞行航模辅助视频观测的地面道路车辆轨迹提取方法.首先应用飞行航模在空中拍摄获得道路交通流视频,并将视频分解为连续逐帧图片;其次应用针孔成像模型和空间坐标转换算法,对逐帧航拍图片内的车辆坐标进行提取和转换,以获得车辆的运行时空轨迹数据;最后进行了该方法的3类误差分析.结果表明,该方法在标准棋盘格试验下提取坐标的相对误差小于5%,实际道路交通目标坐标提取的精度达到90%以上.航模辅助视频观测法可实现对交通目标的大范围低成本观测,能够满足交通工程的观测需求.

关键词:交通观测;车辆轨迹;模型飞机;图像处理;误差分析
中图分类号:U491.1　　**文献标志码**:A　　**文章编号**:0367-6234(2014)06-0105-06

Vehicle trajectory extraction based on traffic videotaping from model aircraft

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Abstract: To overcome the scope limitation of video observation from fixed platforms, a new method of detecting vehicular trajectory from the traffic flow video provided by model aircraft is proposed. First, model aircraft shoots the traffic flow in the air to get the video which is consequently extracted into continuous frames. Second, by using the pinhole camera model and the algorithm of space coordinate transformation, the coordinates of vehicles from the continuous frames are obtained to form the spatial temporal trajectory of vehicles. Finally, three kinds of bias of the proposed method are analyzed. The results show that the relative bias in the standard checkerboard testing is less than 5%, and the accuracy of the data collected by the system under the real road is greater than 90%. The proposed approach provides a large scope and low-cost way for traffic observation, which can meet the demand of survey in transportation engineering.

Keywords: traffic observation; vehicular trajectory; model aircraft; image processing; bias analysis

拥挤收费措施的公众可接受性与有效性

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摘　要: 为了研究系统属性对公众可接受性的影响,明确拥挤收费措施的公众可接受性与有效性之间的关系,选择拥挤收费措施的5个系统属性作为模型变量,采用有序概率模型和多项Logit模型方法构建了公众可接受性和措施有效性模型,并利用SP调查的476个样本数据对模型进行了标定,然后利用这两个模型预测了3个收费场景的可接受性与有效性.结果表明:系统属性对可接受性有较大影响,而对有效性影响较小;在集计水平上,研究中的每个收费方案都是有效的,而且拥挤收费有效性高的方案,对应的接受性都较低,但接受性较高的方案中,却有很多是有效的,这说明有效的收费方案并不都是不能被接受的.在进行拥挤收费系统设计时应当主要关注公众可接受性,以提升拥挤收费措施的可行性.

关键词: 拥挤收费;公众可接受性;有效性;有序概率模型; 多项Logit模型

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Public acceptability and effectiveness of congestion pricing

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Abstract: To discuss the impact of the system properties on the public acceptability of congestion pricing and the relationship between public acceptability and effectiveness of it,five system properties of congestion pricing are selected as the model variables, and the ordered probit model and the MNL model are used to establish the models of public acceptability and effectiveness, which are calibrated by 476 sample data from SP survey, then the acceptability and effectiveness of three pricing scenarios are predicted by the two models. The research results reveal that the system properties influence acceptability greatly, but do not significantly influence effectiveness. At the disaggregate level, all charging schemes in this research are effective, and highly effective schemes are less acceptable, whereas much of highly acceptable schemes are still effective, which indicate that not all of the effective charging schemes are unacceptable. To enhance the feasibility of congestion pricing, the design of the measure should focus on the public acceptability of it.

Keywords: congestion pricing; public acceptability; effectiveness; ordered probit model; MNL model

基于改进的迭代容积卡尔曼滤波姿态估计

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摘　要: 为了充分利用新的量测信息,提高姿态估计的精度,在分析现有迭代滤波策略存在问题的基础上,采用一种新的容积点迭代策略,将其与容积卡尔曼滤波算法相结合,提出了一种改进的迭代容积卡尔曼滤波(improved iterated cubature Kalman filter, IICKF)算法.该算法采用容积数值积分理论近似非线性函数的均值与方差,利用状态扩维理论来解决量测迭代中量测噪声与状态相关的问题,同时利用一种新的容积点迭代策略,即在量测迭代过程中直接采用容积点迭代,避免每步迭代都进行均方根计算来产生容积点,克服传统迭代策略是基于高斯近似产生采样点的局限,有效地降低扩维带来的计算量.仿真结果表明:该算法的估计精度高于乘性扩展卡尔曼滤波(multiplicative extended Kalman filter, MEKF)以及迭代容积卡尔曼滤波(iterated cubature Kalman filter, ICKF)算法,该算法的提出有助于提高姿态估计的精度.

关键词: 姿态估计;改进的迭代容积卡尔曼滤波;容积数值积分理论;状态扩维;估计精度

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Attitude estimation based on improved iterated cubature Kalman filter

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Abstract: To make use of the latest measurement information sufficiency, and to improve the accuracy of attitude estimation, based on the analysis of the current iterated filtering strategy, an improved iterated cubature Kalman filter(IICKF) is presented in this paper by combining a new cubature points iterated strategy with cubature Kalman filter. The filtering algorithm uses the cubature numerical integration theory to calculate the mean and variance of the nonlinear function, utilizing the state augmented method to solve the issue that the state is correlated with the measurement noise in the iterated process. A new cubature points iterated strategy is developed, which can directly iterate the cubature points, and thus avoids to generate cubature points by calculating the mean-squared root. It overcomes the limitation that sampling points are produced by the Gauss approximation in the traditional iterative strategy, which can reduce computational complexity. Simulation results show that IICKF is superior to multiplicative extended Kalman filter and iterated cubature Kalman filter in precision, which indicates that it can help to improve the accuracy of attitude estimation.

Keywords: attitude estimation; improved iterated cubature Kalman filter; cubature numerical integration theory; state augmented method; precision

离散时间 H_∞ 性能下界研究方法

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摘　要: 为了缩小二分法求解最优 H_∞ 性能的搜索范围,降低搜索代价,采用状态空间分析法,提出了一种获取 H_∞ 性能下界的方法.与一般方法不同,根据此方法所得的下界仅跟 H_2 Riccati 方程的解有关,而不被卷入该 Riccati 方程的计算.因此,下界的获取简单.不仅如此,该方法还能揭示最优性能与 H_∞ 性能(包括最优控制与 H_∞ 控制,最优估计与 H_∞ 估计)间的区别和联系、分析多扰动通道对 H_∞ 性能的影响以及可预演扰动的有效利用对 H_∞ 性能的改善.

关键词: H_2 控制;H_∞ 控制;Riccati 方程; 线性二次

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Lower bound for discrete-time H_∞ performance

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Abstract: The paper aims to provide an approach to obtain a lower bound of H_∞ control performance in state space. It is not involved in algebraic manipulation of Riccati equation and only concerned with the solution to the standard H_2 Riccati equation. As a consequence, the approach can help one to narrow the optimal H_∞ performance search via bisection method to a smaller range and considerably reduce the search cost. In addition, the approach enables us to have an insight into not only the link and difference between the optimal performance and the H_∞ performance including the optimal control and H_∞ control performance, the optimal estimation and the H_∞ estimation, but also the impact of the multiple-channel disturbances or previewable disturbance on the H_∞ control performance.

Keywords: H_2 control; H_∞ control; riccati equation; LQ