Highways Engineering

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Mechanical Analysis of Full-scale Accelerated Pavement Loading Facility based on Multi-body Dynamics

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ABSTRACT:

Continuously increasing traffic volumes, vehicle loads and tire pressure, especially for the channelized traffic require pavement to be designed to achieve better performance. One option of doing so is with the use of accelerated pavement testing directly to optimize the asphalt pavement design. Therefore, the quality of the accelerated pavement testing facility plays an important role in optimizing pavement design. In order to improve the success rate of the facility, there are several methods to be considered: he mechanical analysis of accelerated pavement loading facility based on multi-rigid-body dynamics is studied before the design and fabrication to make virtual prototype of loading carriage established; The multi-body dynamic equations are obtained according to the Newton-Euler formula; The force and displacement of each joint are simulated using the MSC ADAMS software, the results of stimulation meet the requirement; A full-scale accelerated loading testing(ALT) system with independent intellectual property right is developed in 2012. The ALT can be operated in single-axle or dual-axle loading mode, which is better than the existing facilities. In the experiment, the rutting data, the dynamic strain at the bottom of surface layer and the vertical compressive stress at the top of the subgrade can be collected. Test results indicate that using the multi-body dynamics to analyze the ALT according to the virtual prototype would be most appropriate.

KEYWORDS: Full-scale accelerated pavement loading facility, Multi-body dynamics, Virtual prototype, Dual-axle loading

Asphalt Pavement Mechanical Response of Accelerated Pavement Testing in Single-axle and Dual-axle Loading Modes

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ABSTRACT:

This paper aims to illustrate the influence of moving loading on asphalt pavement in response to single-axle and dual-axle loading modes using the Shandong Jiaotong University full-scale accelerated pavement testing(APT) facility. First, a test lane of pavement with four structures was constructed. Eleven strain sensors and four pressure cells were embedded at differing depths and positions. Secondly, research on the strain and stress in single-axle and dual-axle loading modes was performed. Finally, the time accumulation of strain and stress were defined to describe the degree of pavement damage. The study reached the following conclusions: (1) Strain reversal was induced as the wheels travel over the pavement, and the stress was always a positive value. (2)Both the strain and stress increase as the loading increases irregardless of whatever the loading mode was.(3) In comparing single-axle loading mode to dual-axle loading mode at the same velocity and loading, the horizontal tensile strain peak, horizontal compressive strain peak and stress peak were all greater in single-axle loading mode, but the degree of pavement damage was greater in dual-axle loading mode based on the point of the time accumulation of strain and stress each pass.

KEYWORDS: Pavement mechanical response; Full-scale APT facility; Single-axle loading; Dual-axle loading; Time accumulation of stress; Time accumulation of strain

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An Improved Design Framework for Asphalt Pavement Incorporating Functional Requirements

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ABSTRACT:

The pavement design methods currently in use in different countries basically select the types of materials to be used and the thickness design of pavement structure, that are required to withstand the impacts of design traffic loadings over a pre-determined design life. These design methods emphasize on the structural requirements of pavements. While some of these methods may impose certain indirect controls to partially address selected functional requirements of pavement operation, none has explicitly considered pavement functional requirements in the selection of materials and layer thickness determination during the pavement design process. An issue of the current design methods is that even though the pavement designed may be structurally strong and durable, its useful design life may end up shorter because of functional failures of the pavement. In this paper, an improved framework for asphalt pavement design is proposed to address this weakness of current pavement design methods. The proposed framework incorporates directly key functional requirements into the material selection, paving mix design, and thickness design of pavement to guard against premature pavement functional failures. The overall concept of the framework in first introduced. Next, it is highlighted that the incorporation of each functional requirement requires a separate consideration and a design process

unique to the functional requirement considered. This is illustrated in this paper by considering the following three main functional requirements of pavement operation: pavement roughness control for riding quality requirement, pavement deformation control for safe vehicle handling, and skid resistance control for safe traffic operations. The gaps in current design practices with respect to each of the three functional requirements, and the proposed procedures for incorporating the functional requirements into pavement design are presented and explained.

KEYWORDS: Asphalt pavement design, structural design, material selection, paving mix design, functional design, riding quality, rutting, skid resistance.

沥青道路表面构造分布的多重分形特性分析

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摘　要：利用数字图像处理技术获取AC、SMA及OGFC等6种不同的沥青道路表面构造的二值图像，验证了表面构造分布的多重分形特性，分析了表面构造分布多重分形谱参数的表征意义。研究结果表明：多重分形谱参数能从不同角度较好地描述表面构造分布情况；多重分形谱峰值fmax为表面下凹构造的分形维数，峰值fmax越大，表面也就越粗糙；谱宽$\Delta\alpha$整体反映了表面构造分布的不均匀性，沥青道路表面构造粒径越大、级配越粗，其表面构造分布越不均匀，$\Delta\alpha$也越大；同时，最大、最小奇异性标度指数的分形维数之差Δf也从下凹区域集中与分散的角度局部反映了表面构造分布不均匀性。沥青道路表面构造分布的多重分形特性能为分析表面离析状况及抗滑性能等提供一种新的方法与思路。

关键词：道路工程；多重分形；表面构造；沥青路面；数字图像处理

中图分类号：U416.217

Multifractal Distribution of Surface Texture of Asphalt Pavement

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Abstract：

Using digital image processing technology (DIP) to obtain two-value images from AC, SMA and OGFC etc. 6 asphalt road surface structures, the multifractal characteristics of surface structure distribution was verified, the meaning of multifractal spectrum parameters of surface structure distribution was analyzed. The results show that the multifractal spectrums of surface structure

distribution from different types of asphalt road are obviously different, spectral parameters can describe the surface structure distribution from different aspects; the peak of multifractal spectrum fmax presents the fractal dimension D0 of the surface concave structure, the greater fmax is, the rougher the surface is; the spectral width Δα reflects the distribution inhomogeneity of surface structure, the larger the size is or the more coarsethe gradation is, the more uneven the distribution of the surface structure is; in addition, Δf, the difference of the fractal dimension between the maximum and minimum singularity exponents, also locally reveals the distribution inhomogeneity of surface structure in the way of more and less concentrated concave. The multifractal distribution characteristics of asphalt road surface structure provides a new method and idea for surface segregation and skid resistance etc.

keywords: road engineering; multifractal; surface texture; asphalt pavement; digital image processing

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Evaluation of Segregation in Asphalt Pavement Surface Using Concave Multifractal Distribution

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Abstract：

Surface segregation of asphalt mixture is a common problem encountered when determining segregation level, which is a criterion of pavement quality evaluation. A method to evaluate segregation level of asphalt pavement surface was presented based on the concavemultifractal characteristic in a binary image of pavement surface, which was obtained by digital image processing technology and mathematical morphology. The practical value of the proposed method was verified in a newly built asphalt pavement, and the segregation level was divided into five sections based on the recommended texture ratio in practical engineering. Results show that the multifractal spectrum width ($\Delta\alpha$) quantifies the uniformity of the concave distribution. The pixel percentage of concave (P) characterizes the ratio of the occupied area. The product of $\Delta\alpha$ and P(PWP) was quantified as the surface segregation level, which has good linear relevance with texture depth evaluation result.The proposed evaluation technique (PWP) can be used as alternative to sand patch method.

Keywords:pavement engineering;surface segregation; concave; multifractal; digital image processing

基于多指标控制的沥青路面大修工程设计研究

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摘　要：本项目路线为区域内重要通道，左幅工程运输车辆多为超载车辆，右幅交通多为空载运输车辆，造成左、右幅路面使用状况具有显著差异，本次设计针对其交通荷载的特殊性，根据现有道路左、右幅交通轴载和路面损坏程度差异明显的特点，按照评价阶段、损坏原因分析阶段和解决方案阶段三阶段进行设计分析。本文提出造成现有道路使用状况差异的不同原因后，采用基于多指标控制的沥青路面设计方法对现有路面结构进行验算，预测现有路面结构的剩余寿命，提出不同服务龄期的路面设计方案，有针对性的解决重点难点问题，并采用多指标控制原则对路面设计方案进行验算。

关键词：沥青路面设计；多指标控制；路面结构验算；大修工程设计；剩余寿命

Design of Asphalt Pavement Overhaul Engineering Based on Multi Index Control

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Abstract:

The project route is the important channel in the region, left picture engineering transport vehicle for overloading of vehicles, right traffic for no-load transport vehicles, resulting in left and right plots of pavement condition has the remarkable difference, this design according to the particularity of the traffic load, according to the existing on the left of the road, right picture traffic axle load and pavement damage characteristics of differences in the extent and in accordance with the evaluation stage, the damage reason analysis and solving scheme stage in the design and analysis. In this paper, resulting in the different reasons for differences in

use of existing roads, the multi index control of asphalt pavement design method was used in the calculation of the existing pavement structure based on predicted residual life of existing pavement structure, put forward the different service age of pavement design, needle on solving the key and difficult problems, and the multi index control principle to check the answers of pavement design.

Keywords: multi index control; asphalt pavement design; overhaul engineering design; pavement structure design ; residual life

埋热管后沥青混凝土内部温度场分析

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摘　要：基于笔者前期的研究，热管在沥青混凝土中可起到良好的传热降温作用。通过建立埋设热管的沥青混凝土光照模型，检测沥青混凝土内部不同深度点温度随光照时间的变化，并通过有限元仿真模拟计算相同时刻相同点位的温度，得出实测值与仿真值的关系。结果表明，埋热管后沥青混凝土内不的温度场呈波浪形分布，仿真计算的内部点温度随时间变化曲线与实测值曲线接近，内部点位越深，光照时间越短，二者的差值越小。

关键词：道路工程；热管；沥青混凝土；温度场；有限元仿真；实测值

Internal Temperature Field Analysis of Asphalt Concrete with Heat Pipes Imbedded

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Abstract:

Based on the author's previous research, heat pipe was an excellent heat transfer and have good cooling effect on the asphalt concrete. According to the model which comprised asphalt concrete imbedded with heat pipes and infrared lamp as heat producer, temperature variations versus illumination time in different depths of asphalt concrete were measured.

Compared with those values under the same condition obtained by finite element simulation, the relation between these two values showed that the temperature field of asphalt concrete was wavy, and the temperature time curve of the simulation was close to that of actual situation. The deeper the testing point was and the less the illumination time was, the smaller the difference between them was.

Keywords: pavement engineering; heat pipe; asphalt concrete; temperature field; finite element simulation; measured value

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Gradation Segregation of Warm Mix Asphalt Mixture

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ABSTRACT:

In this study, properties of warm mix asphalt (WMA) compacted with various level of gradation segregation were evaluated in the laboratory. Six segregated gradations were designed to compare with the control gradation. Pavement quality indicator (PQI) and field coring were used to evaluate the uniformity of the WMA test sections with the statistical

method. In addition, sieve analysis of the cores was conducted to evaluate the level of segregation. The test results show that gradation segregation has a remarkable effect on water stability, high temperature stability, low temperature cracking and tensile strength of WMA mixtures. Statistical analysis results show that the levels of segregation in localized areas were quite typical, for the air void contents followed a normal distribution. Sieve analyses of the cores show that air void content increased as the gradation got coarser, which are consistent with laboratory test results.

KEYWORDS: warm-mix asphalt; gradation segregation; property; pavement quality indicator

沥青路面Top-down裂纹与车辙破坏的统一力学模式

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摘　要：在三维有限元路面力学分析的基础上，利用路面疲劳损伤潜在指数（APPDI3D）、π平面投影图及节点应力矢量图，对不同温度拥堵条件车列荷载作用下沥青路面的力学响应进行了分析。结果表明：1）主应力分布形式对路面Top-down裂纹和车辙的形成有较大影响。路表轮迹线边缘各点主应力组成方式为拉—压复合形式，拉—压复合应力模式有可能是造成Top-down裂纹和车辙在路表共生的主要原因；2）APPDI3D可以作为Top-down裂纹与车辙破坏的统一力学模式指标；3）通过反算得到沥青路面各面层设计参数：抗剪强度参数、抗压强度、直接拉伸强度及劈裂强度，这些参数可以作为沥青路面材料设计的参考依据。

关键词：沥青路面；车辙；Top-Down裂纹；有限元方法；莫尔圆

The Unified Mechanical Model of Asphalt Pavement with Top-down Cracking and Rutting

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Abstract:

　　Based on the 3D finite element analysis of pavement mechanics, the mechanical responses of pavement were analyzed by using the Asphalt Pavement Potential Damage Index (APPDI3D) and π plane projection and node stress vector diagram under different

temperatures and jams vehicle load. The results show that:1) The principal stress distribution had great influences on the formation of top-down cracking and rutting. In the pavement surface, the principal stresses of each nodes of vehicle wheels acting position was the form of tension-compression composite which is the main cause of top-down cracking and rutting symbiotic; 2) APPDI3D can be used as a unified mechanical index for top-down cracking and rutting of early asphalt pavement damage; 3) The design parameters of asphalt pavement are calculated including shear strength parameters, compressive strength, direct tensile strength and splitting strength. These parameters can be used as asphalt pavement materials design reference.

Keywords: asphalt pavement; rutting; Top-Down cracking; finite element method; mohr circles

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EME高模量沥青混合料性能指标对比试验研究及推荐

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摘　要：基于中、美、法沥青混合料设计方法的差异，对不同设计方法的级配设计、体积指标及性能指标进行了对比试验研究，并提出了EME2沥青混合料设计推荐指标及技术要求。研究发现，对于连续级配，中国方法可以代替法国筛分方法；EME沥青混合料的水损坏性能可以用冻融劈裂和AASHTOT283试验代替法国多列士试验进行评价；高温抗车辙性能的评价，可以采用中国车辙试验（温度70℃，轮压1.0Mpa）以及汉堡试验；力学性能评价，可以采用动态模量（15℃，10Hz）进行控制以及采用四点弯曲疲劳试验代替法国的两点弯曲试验进行疲劳性能评价；由于中国气候的原因，也要考虑低温性能，采用低温弯曲小梁进行低温评价。

关键词：级配设计；体积指标；性能指标；EME；动态模量

中图分类号：U238

Experimental Study and Recommendation of EME High Modulus Asphalt Mixture, Performance index

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Abstract:

China, USA and France have different design methods of asphalt mixture.This paper compares grading design, volume index and performance index ofdifferent design methods by experimental study, and proposes the design recommendation index and technical requirements of EME2 asphalt mixture.It is found that the method can be used instead of French sieving method

For continuous grading.EME asphalt mixture water´s damage performance can be measured by freeze-thaw splitting test and AASHTOT283 test instead of French Thorez test;Evaluation of high temperature rutting resistance can be used in the Chinese rut test (temperature 70 degrees, wheel pressure 1.0Mpa) and Hamburg test The Mechanical property evaluation can be controlled by the dynamic modulus (15 degrees, 10Hz), and the Fatigue performance was evaluated by using a four-point bending fatigue test in place of the two-point bending test in France. Due to the climate of China, the low temperature performance should also be considered. Low temperature bending beam was used for low temperature evaluation. As a result of China's climate, but also consider the low-temperature performance.Low temperature evaluation can be carried out using Low temperature bending of trabeculae.

Keyword: Gradation design,EME,Volume index, performance index, dynamic modulus

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高速铁路动卧夕发朝至动车运营组织创新研究

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摘　要： 开行高铁动卧夕发朝至列车是我国铁路着眼于市场需求创新高铁运营方式的具体实践，也是对客运营销组织的有益探索，在世界高铁史上也是首创。鉴于目前高铁动卧夕发朝至列车运营组织的研究还处于探索阶段，根据高铁动卧夕发朝至客流需求状况，对列车的开行条件进行了较为系统的分析，相应提出了运营组织方案，并结合2015年高铁动卧夕发朝至列车的实际开行情况进行了例证分析，以便高铁动卧列车运营组织提供理论和技术支撑。

主题词： 高速铁路；动卧列车；夕发朝至；运营组织

Research on Innovation of Operation Organization of the Train Leaving in the Evening and Arriving in the Morning of High Speed Railway

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Abstract:

The EMU train leaving in the evening and arriving in the morning of high speed railway is focus on the practice of market demand and innovative operation organization of China's railway, also is a useful exploration on the passenger transportation marketing organization and is the first matter in the world history of high speed railway. In view of the operation organization of research about the EMU train leaving in the evening and arriving in the morning of high speed railway is still in the exploratory stage, according to the demand conditions of passenger flow, the paper put forward conditions of the train

and the operation organization scheme and combined with the 2015 year acase analysis of the example to the train provide theoretical and technical support for operation organization of the EMU train leaving in the evening and arriving in the morning of high speed railway .

Keywords: high speed railway; EMU Train; leaving in the evening and arriving in the morning; Operation organization

大跨径钢桥高黏沥青桥面铺装力学分析

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摘　要：为指导大跨径钢桥高黏沥青铺装层厚度设计，开展了高黏沥青铺装层力学分析。结合国内某大跨径钢桥，选取比较常见的钢桥铺装层形式与厚度，建立局部结构的有限元模型进行力学分析。结果表明，高黏沥青铺装层的表层横向拉应力（拉应变）远大于表层纵向拉应力（拉应变），底层横向剪应力远大于底层纵向剪应力。因此，本文认为，以表层横向拉应力、表层横向拉应变和底层横向剪应力作为高黏沥青铺装层的力学控制指标更为合理。通过分析发现，形式为单层5cm的高黏沥青铺装层具有较小的应力（应变）值，故高黏沥青铺装层的最佳形式与厚度为单层5cm。

关键词：高黏沥青，大跨径钢桥，桥面铺装，力学分析，有限单元法

中图分类号：**U444**

Mechanics Analysis of High-viscosity Asphalt Deck Pavement on Long-span Steel Bridge

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Abstract:

In order to design the thickness of high-viscosity asphalt deck pavement on long-span steel bridge, the mechanics analysis of high-viscosity asphalt pavement is carried out. Combined with a domestic large-span steel bridge, we select the common forms and thickness of steel bridge pavement, and to carry out the mechanical analysis,we establish the finite element model of structure. The results show that the transverse tensile stress (tensile strain) of the asphalt overlay is much greater than the longitudinal tensile stress

(tensile strain), and the lateral shear stress is much greater than the longitudinal shear stress. Therefore, it is more reasonable to use transverse tensile stress, lateral transverse tensile strain and transverse shear stress as the mechanics control index of high-viscosity asphalt pavement. It is found that the high-viscosity asphalt pavement with a single layer of 5cm has a smaller stress (strain) value,so the best form and thickness of thehigh-viscosity asphalt pavement is the single layer of 5cm.

Keywords: High-viscosity asphalt, Long-span steel bridge,Deck pavement,Mechanics analysis,Finite element method

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Smart Self-healing Asphalt Materials Using Microcapsules Containing Rejuvenator

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ABSTRACT:

Asphalt is a self-healing material by nature. Asphalt pavement has the potential to restore its stiffness and strength by closing the micro-cracks, which occur when the pavement is subjected to traffic loads. Currently microencapsulation rejuvenator has been considered to be a promising method for increasing the self-healing capability of asphalt. To date, no studies have focused on the behaviors of microcapsules in asphalt binder between the aggregates. The aim of this work was to directly observe the states of self-healing microcapsules in asphalt binders. Asphalt samples were prepared by mixing with different weight contents of microcapsules. Experimental tests were carried out to observe the morphology, integrity, distribution, thermal stability, interface bonding and triggered rupture of microcapsules in asphalt. The results showed that microcapsules were homogenously dispersed in binders avoiding particle

aggregation and adhesion. Microcapsules survived in asphalt binder after the extreme temperature change keeping a stable state. Interface debonding phenomenon did not appear. Microscopic observation results reflected that microcapsules could be pierced by microcracks in the asphalt binder and the encapsulated flowed out under the force of capillary action.All the above conclusions indicate that microcapsules containing rejuvenator meet the application conditions and play the role of self- healing material in asphalt.

KEYWORDS: Self-healing; Asphalt; Microcapsule; Binder; Smart materials;Rejuvenator

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Research on Pavement Performance by Utilizing Cold Recycling Asphalt Mixture with Emulsified Asphalt and Concrete

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ABSTRACT:

The emulsified asphalt cold recycling technology is of great significance for recycling use of waste asphalt mixture. The emulsified asphalt and concrete mixture proportioning was designed. Through the compaction test, Marshall stability, density test, splitting test and unconfined compressive strength test, the pavement performance was evaluated, and the optimum water content and maximum dry density were acquired. The results show that all of the pavement performance evaluation technical indexes meet the requirements of specification. The density of mixing by hand is less than that by machine. Therefore, the paper suggests the mixing by machine be more adopted when mixture is made in laboratory study.

KEYWORDS: emulsified asphalt; cold recycling asphalt mixture;cement; waste asphalt mixture; pavement performance

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Fatigue Life Prediction of High Modulus Asphalt Concrete Based on the Local Stress-strain Method

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Abstract:

Previously published studies have proposed fatigue life prediction models for dense graded asphalt pavement based on flexural fatigue test. This study focused on the fatigue life prediction of High Modulus Asphalt Concrete (HMAC) pavement using the local strain-stress method and direct tension fatigue test. First, the direct tension fatigue test at various strain levels was conducted on HMAC prism samples cut from plate specimens. Afterwards, their true stress-strain loop curves were obtained and modified to develop the strain-fatigue life equation. Then the nominal strain of HMAC course determined using finite element method was

converted into local strain using the Neuber method. Finally, based on the established fatigue equation and converted local strain, a method to predict the pavement fatigue crack initiation life was proposed and the fatigue life of a typical HMAC overlay pavement which runs a risk of bottom-up cracking was predicted and validated. Results show that the proposed method was able to produce satisfactory crack initiation life.

Keywords: pavement engineering; high modulus asphalt concrete; local stress-strain; modified Neuber equation; fatigue life

基于二维浅水方程的沥青路面径流仿真研究

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摘　要：本文发展了基于二维浅水方程的路表径流仿真工具并运用该工具研究了沥青路面径流特性与路面水膜厚度的主要影响因素。首先根据二维浅水方程建立了沥青路面径流仿真工具，然后运用水膜厚度传感器测试了实际降雨条件下某高速公路沥青路面的水膜厚度发展曲线并对仿真工具进行了校核，最后运用经校核的仿真工具分析了不同设计雨强下路幅宽度、组合坡度、排水方式对沥青路面径流规律与水膜特性的影响。结果表明：在模拟降雨条件下，路面水膜厚度峰值随路宽的增大而增加。在漫排水情况下，较之于纵坡，横坡对路面径流的影响更为显著。集中排水条件下，路面径流呈现较强的二维特性，路面产生壅水现象，路面壅水区宽度随路宽的增加而逐渐缩小，对于非壅水区，各车道内的路面水膜厚度及其变化规律与漫排水时径流特性基本相同。综合路面坡度组合情况，较大的横坡与较小的纵坡组合（横坡3%纵坡0.2%）时路面水膜厚度峰值最小，相对有利于排水。

关键字：沥青路面；路面径流；水膜厚度；二维浅水方程；数值仿真

中图分类号:U416.0 文献标志码：A

Simulation of Pavement Runoff Based on Two-Dimensional Shallow Water Equations

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Abstract:

The effective design of pavementsurface drainage ensure the performance of road and traffic

safety. In order to study the characteristics of asphaltpavement surface runoff, a simulation model based on hydrodynamics is established to describe the asphalt pavement surface runoff.Based on the momentum equation and continuous equation, the two-dimensional shallow water equationsare applied to simulate the influence offactors on water film, the above factors included width, synthetic slops and drainage. The results of the numerical simulation show that the surface water film thickness increases with the increased width under the rainfall condition. Compared with the longitudinal slope, the influence of transverse slope on pavement runoff is more significant with the condition of decentralized drainage. The phenomenon of backwater existed outside lane with the condition of centralized drainage. The smallest thickness of the water film is produced by the combination of bigger transverse slope and smaller longitudinal slope (transverse slope 3% longitudinal slope 0.2%), which is the most beneficial to the pavement drainage.

Keywords: pavement surface runoff; 2D shallow water equations; water film; numerical simulation

Improving the Durability of Bridge Deck Pavement with High Modulus Asphalt Mixture

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ABSTRACT:

In order to improve the durability of asphalt pavement on cement concrete bridge, this paper presents a type of emerging bridge deck pavement structure. Firstly the effect of modulus of asphalt mixture at the bottom layer on the mechanical response of bridge deck pavement was analysed. Then, the design method and pavement performance of high modulus asphalt mixture

were investigated by laboratory and field tests. The life expectancy of the deck pavement structure was predicted based on rutting deformation. The results show that the application of high modulus asphalt mixture as the bottom asphalt layer decreases the stress level of pavement structure. The designed high modulus asphalt mixture has excellent comprehensive performance, i.e., the dynamic stability of high modulus asphalt mixture reaches 9632 times/mm, while fatigue life reaches 1.65 million cycles. Based on the rutting depth prediction, using high modulus mixtures for the bridge deck pavement prolongs the service life from the original 5 years to 10 years, which can significantly enhance the durability of pavement structure. This pavement structure has been successfully applied in the rerouting project of national highway G312 in Zhenjiang urban area. The laboratory and field research results will provide experience for similar projects.

KEYWORDS: Bridge deck pavement, Durability, High modulus asphalt mixture, Mechanical analysis, Pavement performance, Service life prediction

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基于二维图像处理方法的沥青混合料砂浆厚度谱研究

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摘　要：沥青砂浆厚度对混合料的应力应变分布及发展具有显著影响，为研究沥青混合料的砂浆厚度组成规律，本文提出了一种基于最短接触距离原则的沥青混合料砂浆厚度计算方法。采用高精度二维扫描仪获取混合料二维切片图像，定义砂浆由沥青及小于1.18mm的集料组成，并利用MATLAB相关图像处理方法进行混合料砂浆空间结构分析。提出平均砂浆厚度，砂浆厚度谱的众数及集中度指标，并对其进行统计分析，研究不同压实次数、沥青种类、最大公称粒径以及级配类型等因素对沥青混合料砂浆厚度的影响。结果表明，本文所提出的砂浆厚度计算方法适用于分析沥青混合料的砂浆厚度组成规律；砂浆厚度谱可用对数正态分布模型进行较好的拟合；压实次数、沥青种类、最大公称粒径及级配类型均对沥青混合料砂浆厚度的大小、集中度产生显著影响。

关键词：沥青混合料；细观结构；砂浆厚度谱；数字图像处理

2D Image Processing Based Study on Thickness Spectrum of Asphalt Mixture Mortar

Abstract:

Asphalt mortar thickness has a significant influence on the distribution and development of stress and strain of asphalt mixture. In order to research the law of mortar thickness constitution and overcome the defect of existing mortar thickness definition and calculation method, this paper puts forward a new asphalt mortar thickness calculation method based on the principle of shortest contact distance. In this study, High precision two-dimensional scanner was used to obtain the two-dimensional slice images of asphalt mixture. Asphalt mortar is defined as a composition of asphalt and aggregates less than 1.18 mm. MATLAB image processing method is used to analyze the microstructure of asphalt mortar. Several indexes including average mortar thickness, the mode and concentration ratio of mortar thickness spectrum were proposed and analyzed. The influences of different compaction times, asphalt type, the maximum nominal

size and gradation type on the distribution of asphalt mortar were researched. Results show that the proposed calculation method of mortar thickness is suitable for the analysis of constitution law of asphalt mixture mortar thickness; mortar thickness spectrum can be fitted well using lognormal distribution model; compaction times, asphalt type, the maximum nominal size and gradation type have significant influences on the magnitude and concentration ratio of mortar thickness.

Keywords: asphalt mixture, microstructure,mortar thickness spectrum, digital image processing

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混凝土桥桥面铺装层间结构剪切行为研究

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摘　要：针对桥面铺装层间结构病害多发的问题，将理论计算与室内试验相结合，找出层间结构最不利剪切边界，进行关键影响因素敏感性分析，并与组合结构抗剪强度建立联系，进行层间结构剪切状态分析。结果表明：层间结构最不利剪切位置是荷载作用区域沿行车方向的前端边界线；层间结构剪切状态会随着荷载水平力系数的增加而迅速恶化，不考虑材料本身剪切破坏的情况下，增加层间结构上部沥青层厚度可以在一定程度上改善其剪切状态；接地压强大于1.2 MPa的车辆紧急刹车时，采用乳化沥青粘层的层间结构一有可能发生一次性剪切破坏；采用抛丸界面的层间结构二不会出现由于车辆超载而导致的一次性剪切破坏。对于重载交通，SBS改性沥青粘层和抛丸调平层表面处治措施可显著改善层间结构剪切状态。

关键词：桥面铺装；层间结构；力学分析；抗剪强度；剪切行为

中图分类号：U443.33　　　文献标识码：A

Research on Shear Behavior of Bridge Deck Pavement Interlayer Structure

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Abstract:

In view of the problems of concrete bridge deck pavement interlayer structures, combining the theoretical calculation and laboratory test methods, the most unfavorable shear boundary of interlayer structures was found out, and sensitivity analysis of key influencing factors of which was conducted. The results showed that the most unfavorable shear position of interlayer structures is

the front boundary line of loading area along the traveling direction; The shear state of interlayer structure is rapidly deteriorated with the increase of load lateral force coefficient, and increasing the thickness of the upper layer of interlayer structures can improve the shear state; When the pressure of braking vehicle is greater than 1.2 MPa, the interlayer structure using emulsified asphalt as adhesive layer will be faced with the risk of one-time shear failure; The blasting interface structure will not appear one-time shear failure due to overloading. For the heavy traffic, SBS modified asphalt layer and blasting interface can significantly improve the interlayer structure of shear layer structure.

面向综合交通运输体系的信息服务能力建设研究

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摘　要：在国家大力推进综合交通运输体系的过程中，信息服务要求发生明显变化，信息服务能力的建设面临新的挑战。为了加强信息服务能力建设，需要从综合交通运输体制机制改革、智慧交通技术推广应用、信息服务模式创新、信息服务内容优化整合、信息服务人才队伍建设等方面着手，不断丰富信息服务内容，完善信息服务手段，创新信息服务模式，提升信息服务品质，最终实现信息服务能力的全面提高，更好的服务于行业管理和社会公众。

关键词：综合交通；信息服务；体制改革；智慧交通；服务模式；服务内容

Research on Information Service Capability Construction of Integrated Transportation System

Abstract: In the process of promoting the comprehensive transportation system, the demand of information service has changed obviously, and the construction of information service ability is facing new challenges. In order to strengthen the information service ability construction, it needs to startfrom the comprehensive transportation institutional mechanisms reform，popularization and application ofintelligent transportation technology, information service model innovation, information service content optimization and integration, Construction of information service Talent team and other aspects, to enrich the content of information service, perfect information service means, innovative information service model, improve information service quality, and ultimately improve the overall ability of information services to better serve the industry management and the public.

Keywords：comprehensive transportation; information service; Structural reform; intelligent transportation; service model; service content

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Fatigue Evaluation of Recycled Asphalt Mixture Based on Energy-controlled Mode

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ABSTRACT:

Fatigue properties of asphalt mixture are important inputs for mechanistic-empirical pavement design. In order to understand fatigue properties of asphalt mixture better and to predict the fatigue life of asphalt mixture more precisely,the energy-controlled test mode was introduced.Based on the implementation theory, laboratory practice of energy-controlled mode was realized by four-point-bending fatigue test with multiple-step loading. Under this mode, the fatigue performance of typical AC-20 asphalt specimens with various RAP contents was tested and evaluated. Results shows that the variation regulation of dissipated energy and accumulative energy is compatible with loading control principle, which proves the feasibility of the method. Besides, fatigue life of asphalt mixture under the energy-controlled mode

was between that of stress-controlled mode and strain-controlled mode. Last but not least, specimen with higher RAP content has longer fatigue life and better fatigue performance.

KEYWORDS: energy-controlled mode; fatigue performance; asphalt mixture; fatigue life

沥青混合料体积指标对其抗车辙性能的影响

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摘　要：为了研究沥青混合料的体积指标与抗车辙性能的关联，揭示不同指标对抗车辙性能的影响程度。首先，对不同AC-13型沥青混合料进行马歇尔试验，采用塑封法测量其毛体积密度，得到其体积指标；其次，对混合料进行标准车辙试验，获取了动稳定度和相对变形等车辙指标；最后，通过数据拟合建立了体积指标与抗车辙性能的函数关系，进而采用灰关联分析法建立了不同体积参数与抗车辙性能的关联度排序。研究表明：抗车辙性能随着VV的增加而增加，随着VFA的增加而降低，抗车辙性能随VMA和VCA mix指标的变化呈近似倒U型分布且拐点处混合料呈紧密嵌挤状态；动稳定度的关联度排序VV>VMA>VCA mix>VFA而相对变形的关联序VV>VCA mix>VMA>VFA，可见VV对抗车辙性能的影响最显著，VMA和VCA mix对抗车辙性能有重要影响，但其对不同车辙指标敏感性不同，而VFA的影响程度相对较小。在实际施工中，采取设置合理的空隙率及促进形成骨架密实结构等方式可在一定程度上提高路面抗车辙性能。

关键词：道路工程；　沥青路面；　灰关联分析法；　抗车辙性能；　体积指标；　空隙率

中图分类号：U416.217

Influence of Asphalt Mixture Volume Indexes on Rut Resistance Performance

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Abstract:

　　To study the relevance between volume status and rut resistance, reveal the influence degree of asphalt mixtures' different volume indexes on asphalt pavement anti-rutting performance. Firstly,

the Marshall test of different AC-13 asphalt mixtures was conducted and used encapsulation method to measure their bulk density, and volume indexes were gained. Then, the Rutting test was conducted and rut resistance ndexes such as dynamic stability and relative deformation were obtained. Finally, the function correlations between volume indexes and rut resistances were established through data fitting, and then using grey relational analysis method to build the relational degree taxis of volume indexes and rut resistance. The results indicate that: the rut resistance is increasing as increasing of VV increases and decreasing of VFA, but changes in inverted u-shaped style as VMA and VFA changes; relational degree taxis of dynamic stability and relative deformation are VV>VMA>VCA mix>VFA and VV>VCA mix>VMA>VFA respectively, which indicates that VV is the key influence factor against rut resistance, VMA and VCA mix also have significant influence on rut resistance although their influence sensitivity to different indicators are different, however, the influence degree of VFA is comparatively small. In the actual construction process, to set the reasonable void fraction and promote formation of skeleton dense structure can improve asphalt pavement anti-rutting performance in some degree.

Keywords: road engineering; asphalt pavement; grey relational analysis method; rut resistance; volume index; air void

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Effects of Loading Rate and Temperature on Fracture Resistance Characteristics of Asphalt Mixtures Using Non-notched Semicircular Bending Tests bending tests

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ABSTRACT:

Since asphalt mixtures are complex viscoelastic materials, the effects of loading rate and

temperature on the fracture resistance of asphalt mixtures under static loading were examined by a non-notched semi-circle bending (SCB) test. 24 test conditions combined by eight loading rates (0.1, 0.75, 3, 7.5, 15, 30, 50 and 80mm/min) and three temperatures (-10, 0 and 15) were selected to conduct on one stone matrix asphalt (SMA) mixture. five fracture parameters, namely peak load (Fmax), peak displacement (Dp), work of fracture (Wf), fracture failure displacement (Dff) and work of fracture failure (Wff), were proposed to evaluate the fracture resistance of asphalt mixture. According to the results of this study, the fracture failure modes of asphalt mixtures could be divided into three conditions: brittle fractures, flexible damage and fall in between. For testing condition of higher loading rate and lower temperature, the fracture failure mode would be closer to brittle fractures. Both loading rate and temperature influence the testing results of all fracture parameters in different ways. And according to the statistical analysis, peak load is sensitive to loading rate and the displacement as well as the energy parameters are sensitive to temperature variation. Overall, this study provide a solid foundation for future research in exploring the fracture mechanism of asphalt mixtures using SCB test.

KEYWORDS: asphalt mixtures; fracture resistance; SCB test; loading rate; temperature

Study on Applying of Titanium Dioxide in Open-graded Friction Course Asphalt Pavement for Air Purification

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ABSTRACT:

In recent years, there are a number ofresearchesabout applying TiO2 onto pavement to purify exhaust emissions from vehicles. However, TiO2 is used as coating on the surface of pavement. In this study, modified open-grade asphalt mixture (OGFC) was developed with conventional OGFC and TiO2, the AnastasiaNano sized TiO2 was blended into OGFC to construct the modified OGFC. The Schulenburg Binder Drainage Test and Cantabria test showed that the modified OGFC could meet the standard requirements. Besides, other performance tests show that more TiO2 blended into modified OGFC resulted in better high temperature performance and poorer water stability. By the performance evaluation tests, the optimal TiO2 content was determined.The exhaust degradation effects of modified OGFC were evaluated using self-developed exhaust detection equipment. The results showed that it had a good effect on air purification, especially CO and NOx. Etc. in the exhaust were degraded obviously. The modified OGFC was proven to be a promising technology which should further researched on.

KEYWORDS: Titanium Dioxide, OGFC,Performance Evaluation,Air Purification, TBAR

Energy Consumption And Greenhouse Gas Emissions of High Rap Central Plant Hot Recycling Technology Using Life Cycle Assessment:Case Study

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ABSTRACT: Traditional LCA of central plant hot recycling shows that, the higher RAP added, the less energy consumed. This conclusion is mainly based on the calculation of reduced raw material. However, when the content of Reclaimed asphalt pavement mixture (RAP) reaches some level, it is needed to take measures such as using additive or improved construction method for maintain the performance of asphalt pavement. For the situation of high RAP central plant hot recycling technology has become more and more widely used, in order to evaluate its effect of energy saving and emission reduction, this paper investigate and compare the life cycle energy consumption and greenhouse gas emissions with the method of LCA, with considering the matters of RAP addition, asphalt-recycling agent, warm agent and transport distance. The study results indicate that, it is not appropriate say that the higher RAP added, the less energy used. Raw material transportation distance is the key factor of energy consumption and greenhouse gas emissions, while asphalt-recycling agent is the least factor. Besides, with theoretical calculation of different warm mix method, the result show that mechanical foaming is more energy saving than the organic additive warm agent, while being used in high RAP central plant hot recycling.

Keywords: High RAP central plant hot recycling; LCA; Warm agent; Transport distance

Macro and Micro Analysis of the Influence of Cement Content on the Performance of Cold Recycled Asphalt Emulsion

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ABSTRACT:

In this paper, the microstructure and chemical composition analysis and macro performance test of emulsified asphalt cold recycling material with different cement content (0 ~ 5%) were studied. Research shows that: the composite mortar of cement hydration products and asphalt formed three-dimensional grid structure has the role of reinforcement for cold recycling emulsified asphalt mixture, which improves the early strength of emulsified asphalt cold recycled mixture. With the increase of cement content, the high temperature stability and water stability of cold recycling mixture of emulsified asphalt increased, the low temperature crack resistance increases firstly and then decreases. When the cement content is in the range of 1% to 2%, the cold recycled mixture has the best low-temperature cracking resistance.

KEYWORDS: road engineering; emulsified asphalt cold mix; SEM; micro analysis; mechanical property

寒区桥面铺装低掺聚酯纤维沥青混凝土耐久性研究

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摘　要：本文对黑龙江省已建高速公路桥面铺装层常见病害进行了实际调查，分析了病害产生的原因。并结合北方寒冷地区气候特点，以建三江至虎林高速公路的挠力河大桥沥青混凝土铺装项目为依托，通过选用优质改性沥青，降低沥青脆化点温度改善低温抗裂性能，以及采用高强度优质粗、细集料，混合料级配的调整、油石比的调整等方式，提高沥青混凝土桥面铺装层的温度稳定性、水稳性和耐久性。通过车辙试验、小梁弯曲试验、浸水马歇尔试验和冻融劈裂试验评价了不同聚酯纤维掺量对桥面铺装沥青混凝土路用性能的影响，并对其作用机理进行了简要分析。试验结果表明，聚酯纤维的掺入能够显著改善沥青混合料的高温稳定性、低温抗裂性和水稳定性，且在一定纤维掺量范围内各项路用性能随纤维掺量的增加而有所提高，在此基础上提出了最佳聚酯纤维掺量。

关键词：寒区；桥面铺装层；聚酯纤维；沥青混凝土；路用性能

The Research of Durability of Asphalt Concrete Bridge Deck with Little Polyester Fiber Content in Cold Regions

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Abstract:

In this paper，the common diseases about bridge deck pavement of the completed highway in Heilongjiang province have been made practical investigation and analyze why these diseases happen. It also combines the climate features in north cold areas,from the way of using High quality modified asphalt,reducing the catalytic point temperature of pitch to improve the low temperature anti-crack property，using high strength coarse and fine aggregate,adjusting gradation of mixture aggregate and the ratio of oil to stone to improve temperature and water stability and durability for Concrete pavement project of Nao Li river bridge connected Jian San river with Hu Lin highway .From rutting test,Trabecular bending test Immersion Marshall test and Freeze-thaw splitting test,that compares different influence on the pavement performances of bridge with Asphalt concrete bridge deck which have different polyester fiber content .The experimental result indicates the proportion of polyester fiber can clearly improve the temperature stability,low temperature anti-cracking performance and water stability of bituminous mixture .And within a certain range of polyester fiber content various road performances will be improved with the increasing of polyester fiber content and on this basis the optimum polyester fiber content is raised.

Keywords:cold region,bridge deck pavement,polyester fiber,asphalt concrete,pavement performance

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Identification and Assessment of Asphalt Fumes Inhaled by Pavement Construction Workers

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ABSTRACT:

Asphalt pavement construction workers are exposed to asphalt fumes, the health impact of asphalt fumes on workers cannot be ignored. The primary purpose of this study is to identify and assess the inhalation exposure to the respirable portions of asphalt fumes among pavement construction workers. A total of fifty-eight exposure samples were collected at the workers' breathing zone using Teflon filter with air-lite pump from twelve asphalt pavement construction sites. The chemical compositions in asphalt fume samples were detected by high performance liquid chromatography (HPLC). The results indicate that the respirable portions of particulate matters exposures in asphalt fumes were consistent with the workers' proximity to the primary source of asphalt fumes. Asphalt mixture types and work rate impacted on the concentration of asphalt fumes. The findings of this study are expected to help enhance the sustainability of pavement construction industry by improving the health and wellbeing of the workers.

KEYWORDS: asphalt pavement construction, occupational health, asphalt fumes, construction occupational environment hazards

Model of Relationship Between Mechanical Property of Coarse Aggregate and Skid Resistance Attenuation of Asphalt Anti-skid Layer Based on Four-wheel AcceleratedLoading Instrument

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ABSTRACT:

In order to study the quantitative relation between the skid resistance performance attenuation law of asphalt anti-skid layer and mechanical indicators of coarse aggregate, a four-wheel accelerated loading instrument was used to test friction coefficient attenuation law with increasing times of loading based on 12 groups of asphalt mixtures in three gradations and four kinds of coarse aggregate. According to the test, asphalt mixturesgreatly impacted the initial value of asphalt pavement friction coefficient, but impacted less on friction coefficientattenuationlaw (attenuation amplitude, attenuation rate, final value of attenuation);Mechanical indicators (abrasion value, crushing value, polished stone value) of coarse aggregate used in asphalt mixture greatly impacted the skid resistance attenuation law

of asphalt pavement; If the crashing value and the abrasion value were smaller and the polished stone value was bigger, corresponding rate of attenuation for friction coefficient of asphalt mixture was smaller, attenuation amplitude was smaller and final value of attenuation was smaller, or vice versa; A quantitative relation model was established between friction coefficient attenuationlaw and mechanical indicators of the aggregate: $y=-A\ln(x)+C$ (where, y was skid resistance performance indicator, referring to BPN20; A was attenuation rate, its relation with aggregate mechanical indicator was : $A=0.0495 \cdot s+0.0326 \cdot a -0.0197 \cdot b+12.2282$, in which a, b and s referred to abrasion value, polished stone value and crushing value respectively; x referred to times of cumulative axis loading (10K times); C referred to the initial value of skid resistance performance)

KEYWORDS: Road Engineering, Asphalt pavement, Anti-skid surface, Coarse aggregate, Mechanical property, Skid resistance performance, Attenuation model

基于细观结构的沥青混合料车辙程度表征方法研究

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摘　要： 为了从细观结构角度表征车辙形变程度，选取SMA-13和AC-20级配制备双层车辙试件，并对混合料双层结构体系进行了室内车辙剪切破坏过程模拟。利用图像处理技术获取反映车辙形变程度的细观特性指标。结果表明：从细观结构角度寻求沥青混合料车辙程度表证方法是可行的，并且截面空隙率、沥青面积比、4.75mm通过率这三个细观特性指标与车辙形变程度密切相关，皆能很好地表征车辙破坏程度；利用灰关联分析法确定三个细观特性指标在形变贡献率的权值分配，即均值分配。

关键词： 沥青混合料；剪切变形；细观特性；图像处理技术

Research on Rutting Degree Characterization of Asphalt Mixture Based on Meso-structure

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Abstract:

In order to characterize the rut deformation degree from meso-structure angle, SMA-13 and AC-20 gradations were selected to fabricate the double-track rutting specimen, and the rutting shear failure process of the mixture structure was simulated. Then image processing technology was adopted to obtain the microscopic characteristic index which can reflect the rut deformation degree. The results indicate that it is feasible to find out the rutting degree characterization of asphalt mixture based on micro-structure. The cross-sectional porosity,

asphalt area ratio and 4.75mm pass rate are closely related to the rutting deformation degree. All of them can be a good characterization of rut damage. Besides, gray relational analysis method was used to determine the weight distribution of the three mesoscopic characteristic indexes, which is mean distribution.

Keywords: asphalt mixture; shearing deformation; meso-structure properties; image processing technology

Calculation Method of Asphalt Concrete Thermal Stress Based on Interface Mechanics

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Abstract:

The simplified physical model of asphalt mortar and aggregate was established, and the interfacial mechanical theory was used to calculate the thermal stress between asphalt mortar and aggregate. It could be seen from the calculation formula of thermal stress that the maximum stress of asphalt mortar and aggregate occurs on the interface. The circumferential tensile stress on the interface between asphalt mortar and aggregate when cooling was taken as initial thermal stress calculation model. Considering the relaxation effect of asphalt concrete, the integral method and the discrete method were used to calculate the temperature stress of asphalt concrete, and the temperature stress calculation model was verified by TSRST. The results show that the calculated results agree with the results of TSRST before the breaking value.

Keywords:thermal stress, asphalt concrete, asphalt mortar, relaxation modulus, TSRST

一种评价沥青混合料矿料骨架强度的试验方法

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摘　要：本文基于局部加载设计了一种评价不含胶结料的沥青混合料骨架强度的试验方法，并研究了混合料类型、岩性、最大公称粒径对骨架强度的影响。通过建立ABAQUS有限元模型，确定贯入阻力试验的压头直径和贯入速率。压头直径为50mm及贯入速率为2.25mm/min时，具有最优的评价效果。对PAC-13，AC-13，Sup-20及Sup-25进行了贯入阻力试验，采用骨架破坏时的最大贯入压力评价沥青混合料的骨架强度，试验结果表明PAC-13的骨架强度大于AC-13，Sup-25骨架强度大于Sup-20，玄武岩的骨架强度大于石灰岩。含有较多粗集料、最大公称粒径大和集料强度高的混合料具有更高的骨架强度，贯入阻力试验可真实评价沥青混合料的骨架强度。

关键词：沥青混合料；骨架强度；贯入阻力试验；有限元模型

A New Strength Test Method for the Aggregate Skeleton of Asphalt Mixture

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Abstract:

　　The objective of this study is to evaluate the skeleton strength of unbound asphalt mixture.A new skeleton strength test (penetration resistance test) was developed. The influence of mixture type, aggregate type, and nominal maximum aggregate size on skeleton strength was investigated. The diameter of loading head size and penetration rate wasdetermined by ABAQUS finite element method. Results showed that loading head with 50mm in diameter and penetrate rate of 2.25mm/min had the best evaluation results. PAC-13,

AC-13, Sup-20 and Sup-25 was measured itsskeleton strength using this experimental method and we found that PAC-13's skeleton strength is higher than AC-13's as Sup-25's higher than Sup-20's and Basalt's higher than Limestone.The asphalt mixture with more coarse aggregate, larger maximum nominal particle size and stronger aggregate strength prefers to have higher skeleton strength we found that the test can truly evaluate the skeleton strength of asphalt mixture.

Keywords: asphalt mixture;skeleton strength; penetration resistance test; Finite element

直投式SBS改性沥青混合料路用性能试验研究

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摘　要：为了使SBS改性沥青混合料中SBS改性剂的用量透明化，提出采用外掺SBS改性剂的生产工艺，以AC-13C级配作为目标配合比，在最佳油石比下，对不同SBS改性剂掺量的沥青混合料进行了马歇尔稳定度试验、车辙试验和小梁弯曲试验，检验了其水稳定性、高温稳定性和低温抗裂性能，并探究了与成品SBS沥青混合料路用性能之间的差异。试验结果表明：直投式SBS沥青混合料的最佳改性剂掺量为9%；其低温性能劣于成品SBS沥青混合料，但水稳定性和高温稳定性均优于成品SBS沥青混合料。因此，直投式SBS改性沥青混合料的路用性能较为优异，适合于在工程中推广使用。

关键词：外掺改性剂；SBS沥青混合料；马歇尔稳定度试验；车辙试验；小梁弯曲试验

中图分类号：U414

Experimental Study on Pavement Performance of Asphalt Mixture with Direct-Vat-Set SBS Modifier

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Abstract:

In order to make the amount of SBS modifier in the SBS modified asphalt mixture transparent, the production technologyofdirect-vat-set SBS modifier was put forward. The asphalt mixture with different content of SBS modifier was tested by ImmersionMarshall test, rutting test and trabecular bending test under the optimum ratio of AC-13C gradation. The water stability, high temperature stability and low temperature crack resistance were tested, and the difference between the performances offinished SBS asphalt mixture was also

investigated.The results show that the optimum dosage of SBS modifier is 9%, and its low temperature stability is inferior to thefinished SBS asphalt mixture, but thewater stability and high temperature stability are better than SBS asphalt mixture. Therefore, the direct-vat-set SBS modified asphalt mixture has excellent performance and it is suitable for popularization in engineering.

Keywords:direct-vat-set modifier; SBS asphalt mixture; Marshall stability test; rutting test; trabecular bending test

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Study on Cracking-resistance Asphalt Pavement

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ABSTRACT:

The reflective cracking is one of the main diseases of semi-rigid base asphalt pavement. To study the method of alleviating this kind of distress, the graded crushed stone, low dose of cement stabilized graded crushed stone and asphalt macadam were respectively added between the semi-rigid base and asphalt concrete. Based on the fracture mechanics, a three-dimensional finite element model was established with the finite element software. In the model, the singular elements were created at the crack tip. The stress intensity factors of different structures were calculated to analyze their changes with the cracking length. The Generalized Paris Law was adopted to predict the fatigue lives of these pavement structures. The results show that: the graded

crushed stone and low dose of cement stabilized graded crushed stone can efficiently prevent the propagation of reflective cracking in semi-rigid base asphalt pavement, but they will also increase the possibility of flexural-tensile type fatigue cracking of asphalt layer. Asphalt macadam layer has good effects on the reduction of flexural-tensile type cracking and shear type cracking of asphalt layer simultaneously.

KEYWORDS: Asphalt pavement; Reflective cracking; Stress intensity factor; Fatigue life

福建省组合式基层沥青路面性能发展与病害特征分析

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摘　要：组合式基层沥青路面结构在福建省山区高湿热环境条件下取得了较好的应用效果，本文基于厦蓉高速公路（龙岩—长汀段）通车以来的路面技术状况数据，分析了该路面结构的路面性能发展状况，并通过对裂缝、车辙和坑槽病害的调查观测，提出了组合式基层沥青路面的产生模式和规律特征，指出了该路面结构的优势及存在的风险。

关键词：道路工程组合式基层沥青路面结构性能特征病害形式数据分析

Analysis on the Performance and Damage of Compound Base Asphalt Pavement in Fujian

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Abstracts: Base on the practical result of compound base asphalt pavement in the mountainous area and hot humid weather in Fujian, this paper analyze the performance development of compound base asphalt pavement using its technical data got in the past 6 years, propose its damage models and features by analyzing the cracks, ruts and potholes on this pavement, give the advantages and disadvantages of this pavement structure.

Key words: highway engineering, compound base asphalt pavement, performance, damage, data analysis

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Mechanisms of Longitudinal Cracking in Flexible Pavements with Cold Recycled Asphalt Base Layer

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ABSTRACT:

Cold recycling has been widely used in the rehabilitation of the highway system in China, among which 95% were built with asphalt surface on top of cemented treated base. The cold

recycling process consists of milling the existing asphalt surface, mixing them with foamed asphalt or emulsion in-plant or in-place, and then compacting them as a base layer. New hot-mixed asphalt (HMA) mixtures are placed on top of the recycled base layer, resulting a unique pavement structure: HMA + cold recycled asphalt base + semi-rigid base. Severe premature longitudinal cracking was observed on two major highways with this pavement structure in Jiangxi, China. The objective of this study was to understand the mechanism and causes of these longitudinal cracks. Extensive field investigation, laboratory tests, and numerical simulation were conducted. Field cores revealed a special pattern of these cracks: cracks were initiated from both the top and the bottom while the middle layers were intact. Based on this study, the cold recycled base layer is hold accountable for these special longitudinal cracking due to (1) large air voids, (2) structural degradation, and (3) fatigue failure.

KEYWORDS: flexible pavement, asphalt base layer, cold recycled, longitudinal cracking

DTC自调温道路融冰雪相变材料研究及应用

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摘　要：通过对植物临界萃取、冻析分离，再经过碱化、螯合等工艺，利用化学盾构的方式复合而成一种在12至24摄氏度晶体固固相变新型晶体化合物，即DTC相变材料。该材料为晶体固固相变，它可利用太阳能，在不同环境条件下，通过分子链断裂和嫁接，具有相变潜热特性，是公路自身成为能量生产和存储者。该材料在应用中可与沥青形成闭合分子链，从本质上改变沥青的延展性和高温适宜性，主动调控极端环境温度变化下的沥青路面使用温度，提高沥青路面对环境变化的适应能力，从而改变高温车辙、避免低温开裂等病害，从而延长道路寿命54%；DTC道路相变材料在相变过程中，伴随着热量的释放和吸收，避免道路黑冰、冻凝、冰冻现象产生，有效提高了道路安全性和畅通性。

关键词：晶体化合物　晶体固固相变　分子断链放热　分子嫁接吸热　相变融冰雪

Research and Application of DTC Self-adjusting Temperature Road Ice Meltingand Phase Change Material

Abstract:

DCT phase-change material is one new crystal solid-solid phase material, which is a composition of many processes, such as extraction from plants, separation by frozen and alkalinization, chelation at 12 to 24 degrees Celsius.

During the solid-solid phase processing, the DTC molecule chains were cleavage and graft by using solar energy no matter the weather is. This character is called latent heat of phase change, it is worth mentioning that during this process the road can produce and deposit energy by itself.

DTC can fundamentally change the malleability and high thermal resistance of asphalt. Its work is controlling the temperature of road surface in the extreme environment. What's more, in order to extend road of 54% service life, the DTC improved road surface's ability to adapt to environmental changes by resolving the rutting in high temperature, cracking in low temperature and

other diseases.

DTC road phase change material absorbing and desorbing heat is presented in the phase change process, and it play a role in avoiding black ice、frozen and other road phenomenon by effectively improving the safety and accessibility of road .

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资源利用及生态环保技术在长白山生态敏感区高速公路建设中的应用

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摘　要：长白山区具有季冻区的气候特点，同时生态系统敏感，公路建设面临着资源利用和生态保护的技术难题，结合长白山区资源和生态特征，开展了筑路材料利用技术及生态保护技术的系统研究，形成了地产材料火山灰和硅藻土及工程弃渣利用技术，实现了资源节约利用。同时，提出了湿地水系连通保护技术、植物保护技术和低温污水处理工艺，有效保护了生态环境，支撑了寒区生态敏感区高速公路绿色持续发展。

关键词：长白山；生态敏感区；资源利用；生态保护

中图分类号：U416

The Application of Resource Utilization and Ecological Protection Technology in Highway Construction in Changebai Mountain Ecological Sensitive Area

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Abstract:

Changbai Mountains region have seasonal frozen climate characteristic. Highway construction are faced with the technical problem of resource utilization and ecological protection. Combining the resources and ecological characteristics of Changbai Mountains, the systematic research of local materials using and diatomite utilization technology are formed, to realize the economical utilization of resources. At the same time, the wetland water system connecting protection technology, plant protection technology and low temperature sewage treatment technology are proposed. The ecological

environment is effectively protected. The related technologies provide strong support for highway sustainable development in cold and green ecological sensitive area.

key words: Changbai Mountain; ecologically sensitive region; resource utilization; ecological protection

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Rheological Characterization of SBS Modified Asphalt Utilizing Different Modified Parallel Plates

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ABSTRACT:

　　Although the asphalt-aggregate bonding provides contacting strength for hot-mix asphalt, it is ignorant in the dynamic shear test accounting because the only use of metal parallel plate. Aiming at the comprehensive interpretation on bonding's influence, modified parallel plates cored from different types of aggregate were provided to simulate asphalt-aggregate bonding in mixtures. This study began with an experimental design, aggregate plates and joint clamps were processed to be installed into the rheometer; and the type of aggregate and film thickness were set as essential variables. Then, XRF, XRD, SEM and AFM were utilized to obtain chemical components of aggregate, micro morphology of interface, and roughness of plates, respectively. Several rheological tests for SBS modified asphalt were conducted under bonding with modified aggregate plates. Additionally, a contrasting group adopting the metal plate followed the same

experimental procedures. The influence of aggregate type on binder's rheological characteristics is dependent on experimental variables, and the microscopic characteristics can interpret the results comprehensively. This study can provide instructions for the aggregate selection while preparing a mixture design.

KEYWORDS: Rheology; microscopic characteristic; SBS modified asphalt; modified clamp

Analysis on Models of Aggregates Voids in Asphalt Mixture Based on Fractal Theory

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ABSTRACT:

The mechanical performance of asphalt mixes was directly affected by the structure of aggregates voids. Therefore, it was necessary to estimate the distribution and volume of voids space within mix specimens. In this paper, the model of plane circle in Bailey method was used to simulate voids structure in mixes. It could be obtained that the value of voids area was increasing with the growth of the aggregates voids' fractal dimension. Moreover, based on the fractal theory, the fractal model of aggregates voids was proposed. AC-13 was selected in this

study, when the fractal dimension of AC-13 was determined, the volume of asphalt mixture voids can be calculated by the fractal voids model. Meanwhile, the results calculated by the fractal model of aggregates voids were consistent with voids in mineral aggregate (VMA) which were measured by laboratory test.

KEYWORDS: aggregates voids, fractal theory, fractal dimension, Bailey method, model of plane circles, Menger sponge model, model of aggregates voids

Characterization of the Effects of Various Factors on the Accuracy of Electromagnetic Density Gauges in Bituminous Mixture Density Measurement

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ABSTRACT:

This paper presents a laboratory study which evaluated the performance of electromagnetic (EM) density gauges as a non-destructive tool for hot mix asphalt (HMA) density measurement. In total, 36 HMA testing slabs with different compositions were prepared in laboratory. EM density gauge data were collected from these slabs using two commonly used gauges, i.e., PQI 301 and PaveTracker 2701B, and compared with their bulk densities measured by the standard saturated surface dry (SSD) method. It was found that measurement direction, asphalt binder content, mixture air void content, and thickness of the testing slabs did not affect the accuracy of the EM density gauges. However, EM density gauge measurements were affected by the presence of moisture, gradation of asphalt mixture and gauge calibration method. It was also concluded that the accuracy of PaveTracker measurement calibrated with the "mix calibration" method is comparable to that of the conventional SSD method.

KEYWORDS: Asphalt mixture; Density; Electromagnetic density gauge; Evaluation

Friction Characteristics of Traditional Asphalt Pavement Treated by Various Chemicals for Anti-icing or Deicing: A Case Study in Ohio

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ABSTRACT:

This study entailed a literature review, lab and field testing of deicer effect on friction characteristics of asphalt pavement, which led to the possible updates to application guidelines for anti-icing, deicing, and prewetting operations. Five different deicers were tested to evaluate their influence on the friction characteristics. For winter storms with cold pavement (e.g. -9℃) and high humidity, the use of more expensive liquid deicers in place of the salt brine failed to show any benefits. For winter storms with relative warm pavement (e.g. -3℃) and high humidity, the salt brine exhibited very good deicing performance whereas a calcium chloride-based deicer exhibited poor deicing performance (likely due to its hygroscopic nature). For winter storms with warm pavement (e.g. 0℃) and high humidity, the calcium-chloride-prewet salt exhibited very good deicing performance on the warm pavement. The application of these liquid deicers onto the dry asphalt pavement did not significantly change its friction coefficient.

KEYWORDS: Friction, Asphalt Pavement, Deicing, Anti-icing, Prewetting

基于混合效应模型的沥青路面平整度养护干预研究

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摘　要：选择适合于面板数据建模的混合效应模型作为沥青路面平整度预测模型的统计学理论基础，以Logistic模型为基础模型采用SAS中的NLMIXED模块建立新建路面平整的非线性混合效应模型。基于混合效应模型模拟采取养护活动后路面平整度的演化规律，对模型进行了拟合效果分析及验证。分析得出了沥青路面随着养护前平整度（IRI0）增大，平整度的衰减程度增大；路面结构指数（SN）越小，养护活动后路面平整度的衰减速增大。

关键词：道路工程；平整度预测； 非线性混合效应模型； 养护干预

中图分类号：**U416.217**

Research on Maintenance Intervention of Asphalt Pavement Smoothness Based on Hybrid Effect Model

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Abstract:

The mixed effect model suitable for panel data modeling is selected as the statistical theoretical basis of the asphalt pavement flatness prediction model. Based on the Logistic model, the NLMIXED module in SAS is used to establish the nonlinear hybrid effect model of the new pavement flatness. Based on the hybrid effect model, the evolution rule of road surface roughness after simulation is taken, and the fitting effect analysis and verification of the model are carried out. The results show that the asphalt pavement increases with the

increase of the roughness (IRI0), and the degree of decay of the flatness increases. The smaller the pavement structure index (SN) increases, the decay rate of road surface roughness increases.

key words: highway engineering; flatness prediction; nonlinear mixed effect model; conservation intervention

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荧光显微分析技术在SBS改性沥青相态中的研究

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摘　要：为了研究SBS改性剂在改性沥青当中的形态分布，分析SBS改性沥青影响因素。通过荧光显微镜对SBS改性沥青进行形态采集，采用SBS改性剂剂量变化、SBS改性沥青发育时间变化和储存温度变化，来分析改性沥青的形态特征变化。其结果表明，SBS改性剂在沥青中的剂量存在上限，最高掺量不宜超过8.1%，SBS改性沥青的发育时间建议在120-150分钟，同时对SBS改性沥青进行测试时的温度在160-180℃。

关键词：SBS改性沥青；荧光显微测试；剂量

Study on the Application of Fluorescence Microanalysis in SBS Modified Asphalt

Abstract:

In order to study the morphological distribution of SBS modifier in modified asphalt, the influencing factors of SBS modified asphalt were analyzed. The SBS modified asphalt was collected by fluorescence microscope. The change of morphological characteristics of modified asphalt was analyzed by SBS modified dose change, SBS modified asphalt development time and storage temperature change. The results show that SBS modifier in the asphalt dose of the upper limit, the maximum content should not exceed 8.1%, SBS modified asphalt development time is recommended in 120-150 minutes, while the SBS modified asphalt temperature test 160-180 ° C.

Key words:SBS modified asphalt,Fluorescence microscopy,dose

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大型机场机坪管制运行体系建设

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摘　要：随着航空运输的快速发展，机场规模不断扩大，航空器机坪运行环境复杂、塔台指挥存在盲区、空地协同流程不够直接等问题不断出现。本文以首都机场为出发点，通过将互联网思维信息共享交互特点与首都机场机坪实际运行流程相结合，搭建一个机坪管制运行指挥体系，整合运行资源，推进航空公司、空管与机场之间的高效联动与无缝协作，全面掌控航班地面运行情况，实现机坪立体指挥，节省飞机滑行时间及成本，推进绿色机场建设，为促进机坪运行效率提升提供标准化运行模型，为未来大型机场机坪运行管理提供参考模式，以适应机场未来的发展需要。

关键词：机坪管制；机场运行指挥

中图分类号：U238

Build the Apron Operation Control System in the Capital Airport

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Abstract:

With the rapid development of China's civil aviation industry, the improvement of the operating efficiency of the airport is a very important problem for many large international airports. Facing tower control invisible area, complex ramp operational environment andindirect tower command flow, with internet data information sharing, intelligent processing function, to build an intelligent machine apron control operation command system, provides the standardized operation model for improving to promote the large-scale airport operation efficiency. This paper takes the capital airport as the starting

point, and explores the reception and follow-up intelligent operation command system of the airport, and realizes the improvement of the operation efficiency of the airport in the capital airport, in order to meet the development needs of the airport.

keywords:ground control; apron operation efficiency

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旧水泥路面加铺沥青层结构温度场变化规律及数值模拟

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摘 要：本文在实测不同季节（夏季和冬季）的气象参数及路面结构温度场数据基础上，分析旧水泥路面加铺沥青层路面结构温度分布规律，发现沿路面深度方向，温度、变温速率、温度梯度和日较差呈非线性分布并出现变化幅度减小、变化相位滞后的现象。根据传热学原理，考虑太阳辐射、空气对流换热等路表与外界热交换的形式，建立了旧水泥路面加铺沥青层路面结构体系的非线性瞬态3D温度场计算模型。借助路面所处地区的标准气象资料，把气温、太阳辐射等气候条件用较简单的三角函数（或级数）加以表示作为模型边界条件，发现双正弦函数可以很好地模拟近路表气温的日变化规律。采用 ANSYS有限元软件模拟旧水泥路面加铺沥青路面结构温度场，并将模拟结果与路面实测温度场进行对比验证。路面各个时刻不同深度的温度模拟数据与实测数据的偏差在3℃以内，表明该模型具有很高的预测精度。本文研究成果可为旧水泥路面加铺沥青层路面结构设计和材料选择提供可靠的温度依据。

关键词：旧水泥路面加铺沥青层; 实测温度场; 数值模型; 有限元分析; 双正弦函数; 级数

中图分类号：U416.2   文献标志码：A

The Temperature Distribution and its Numerical Simulation in the Asphalt Overlay on the Existing Cement Concrete Pavements

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Abstract:

This paper evaluates the temperature distribution in the asphalt overlay on the existing cement concrete pavements on the basis of measured meteorological parameters and pavement temperature

data during two different time periods of the year (summer and winter). The measured temperature field indicates that the value of temperature, velocity of temperature variation, temperature gradient and daily range of temperature are nonlinear, and their variation amplitude decreases gradually and the variation phases are retarded with the depth of the pavement. Considering heat exchanges between pavement surface and environment, such as solar radiation, air convection heat transfer, a numerical model of nonlinear three-dimensional transient temperature field for the asphalt overlay on the existing cement concrete pavements is established based on the heat conduction theory. And then, the boundary conditions of the temperature field model are obtained by using the series-approximated solar radiation and the sinusoidal-approximated air temperature, in which the diurnal variation of the near-surface airtemperature calculated using ANSYS with the measured temperature at different times of various pavement layers, the result with average absolute error within $3.0\,℃$ shows that the temperature distribution in the asphalt overlay on the existing cement concrete pavements is predicted highly accurately by the proposed numerical model. The findings of this paper provide a thermal basis for the mixture and structure design of asphalt overlay on the existing cement concrete pavements.

Keywords: asphalt overlay on the existing cement concrete pavement; the measured temperature field; numerical model; the finite element analysis; the double sine function; series

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基于混合效应模型的沥青路面平整度预测

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摘　要：本文采用经验分析及机理分析的方法进行研究，并通过统计学聚类分析进行验证，筛选出沥青路面平整度的主要影响因素包括初始平整度、交通荷载、路龄、路面病害以及路面结构。采用SAS中的NLMIXED模块，选择适合于面板数据建模的混合效应模型作为平整度预测模型的统计学理论基础，对比研究了在Logistic基础模型中引入随机变量与引入协变量作为参数的解释变量后的混合效应模型，建立了用于预测新建沥青路面平整度随时间的变化规律的非线性混合效应模型，从而在一定程度上解释了各路段之间的差异，验证了非线性混合效应模型在平整度预测中的适用性，为提高高速公路的服务性能、养护干预研究等提供了理论基础。

关键词：平整度预测；非线性混合效应模型；SAS；沥青路面平整度；聚类分析

中图分类号：**U238**

Asphalt Pavement Evenness Prediction Based on Mixed Effect Model

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Abstract:

In order to establish the asphalt pavement evenness prediction model, the main factors that influence the evenness of asphalt pavement is concluded through empirical analysis and mechanism analysis, and verified by clustering analysis of statistics, screening out the main influencing factors include initial evenness, traffic load, road age, pavement disease, and pavement structure. To choose the more suitable model for the pavement evenness prediction of new roads, and considering the evenness is a kind of panel data, the nonlinear mixed effect model was adopted with the NLMIXED

module of SAS. The time-dependent prediction model is established based on the logistic model, and the random effects and covariate was introduced in as the explanatory variables and compared, which explains the differences between the sections to a certain extent and verifies theapplicabilityofthenonlin earmixedeffectmodelinevennessprediction. Theresearch provides theoretical foundation for improving the service performance of highway and developing theserviceperformanceofhighwayand the following maintenance and intervention research.

keywords: evenness prediction; nonlinear mixed effect model; SAS; asphalt pavement evenness; clustering analysis

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基于DIC方法的硫磺改性沥青混合料疲劳断裂试验研究

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摘　要：采用应力控制模式，对不同硫磺掺量（0%、30%、35%、40%）的马歇尔试件进行间接拉伸疲劳试验，使用CCD相机跟踪采集试验过程中的试件疲劳破坏的全过程，利用数字图像相关技术（DIC）和matlab处理试件变形前后中心区域和局部胶浆区域的位移场和应变场，从而研究硫改性沥青混合料的疲劳断裂性能。结果表明：硫磺掺入对沥青混合料的疲劳断裂性能有一定的提高，其中硫磺掺量为35%对沥青混合料的疲劳断裂性能有显著作用，疲劳性能提高3.61倍，硫磺掺量为40%时，疲劳性能提高2倍，疲劳性能相对35%掺量下降约40%；沥青混合料的疲劳断裂性能取决于沥青胶浆和胶浆与粗集料的界面特性。

关键词：硫磺改性，数字图像相关，沥青混合料，疲劳断裂

中图分类号：TU599　文献标识码：A

Application of DIC Method to Experimental Research on Fatigue Fracture of Sulfur Modified Asphalt Mixture

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Abstract:

The experiment of the indirect tensile fatigue test of Marshall specimen with different sulfur content (0%, 30%, 35%, 30%) was studied by the stress control mode. The CCD was used to track the whole process of fatigue damage in the tested specimen, the digital image correlation (DIC) and Matlab was used to process the displacement field and the strain field of the central zone and the local mucilage area before and after deformation, and fatigue fracture properties of sulfur modified asphalt

mixture were studied. And results show that SEAM was introduced into asphalt can improve the fatigue fracture performance of asphalt mixture. The fatigue fracture properties of asphalt mixture was significantly improved as the sulfur content was 35% and the fatigue life increased by 3.61 times ,when the sulfur content is 40% and fatigue performance increased 2 times,fatigue performance decreased by about 40% compared with the content of 35%;The fatigue fracture properties of the asphalt mixture depends on the asphalt mortar and interfacial characteristics of mortar and coarse aggregate.

Key words: sulfur modified, digital image correlation, asphalt mixture, fatigue fracture

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Research on the Compaction Criterion of Asphalt Mixture for Heavy-traffic Road

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ABSTRACT:Marshall Design Method was commonly used in the design of asphalt mixture in China. Recent years, with the development of heavy traffic, the compaction criterion of Marshall Design Method was not suited to the actual traffic conditions, which resulted in early damage of asphalt pavement. This paper investigated and analyzed the influence of design density of asphalt mixture to the early damage of asphalt pavement under heavy-traffic; the maximum compaction level of construction machinery through field was investigated; the heavy-traffic compaction criterion was proposed based on the heavy traffic, and the proposed criterion was evaluated based on the performance of on-site and laboratory samples. Results show the density of pavement under heavy-traffic was about Marshall density $\times$ 1.006, which indicates the Marshall Density is small and could not meet the development of heavy-traffic; Construction machinery with current mechanical level can improve the field compaction density to Marshall density $\times$ 1.018 at least; Recommended degree of compaction not less than 97%, standard density of asphalt mixture is 1.02 $\times$ Marshall density; Mechanical properties improve 10% and the rutting resistance increased by 34% at least under the new criterion.

KEYWORDS: Road engineering; Asphalt mixture; Degree of compaction; Compaction criterion of heavy-traffic; Mechanical property

Evaluation of Anti-rutting Performance of Asphalt Mixture with

Driving Wheel Pavement Analyzer

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Abstract:

Rutting is one of the common pavement distresses which led to lower riding comfort to the road users and high maintenance costs. One of the widely used tests is the simulation test with wheel tracking devices. A new rutting test system was developed based on the "Driving Wheel Pavement Analyzer" (DWPA) to evaluate the rutting performance of asphalt mixtures. This paper carried out three (3) kinds of rutting tests to validate the feasibility, reliability and accuracy of DWPA test, the results indicated that the DWPA test can provide more ruts information and was suitable to distinguish the performance of materials. The CDWPA index is better to reflect the rutting resistance of the material, which is highly correlated with the APA rutting index and the rutting test index in China according to the Gray relational analysis results.

Key words: rutting evaluation; deformation slope; total deformation; DWPA rutting test method

基于非均布荷载的柔性基层沥青路面纵向开裂分析

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摘　要：纵向裂缝是重载交通沥青路面的主要裂缝类型之一。为研究沥青路面纵向裂缝的产生机理, 借助实测子午线轮胎接地压力和形状, 对柔性基层沥青路面结构进行了非均布荷载三维有限元分析, 并结合加速加载试验路进行了破坏试验验证。结果表明, 路表自顶向下纵向开裂源于轮底轮胎胎纹间隙处, 轮胎胎纹间隙处的路表剪应力是沥青路面自顶向下纵向开裂的主要力学指标, 拉应力对自顶向下纵向开裂基本无影响, 明晰了沥青路面自顶向下纵向开裂破坏的关键源。

关键词：道路工程；沥青路面；纵向开裂；路表剪应力；非均布荷载；轮胎胎纹

中图分类号：U41

Analysis on Longitudinal Cracking of Flexible Base Asphalt Pavement under Non-uniform Distributed Load

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Abstract:

Longitudinal cracks are one of the major types of cracks in heavy traffic asphalt pavement. In order to study the mechanism of longitudinal cracking in asphalt pavement, three-dimensional finite element analysis of non-uniform distributed load of flexible base asphalt pavement was carried out by means of ground pressure and shape of radial tire. The damage test was carried out with the accelerated

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pavement testing. The results show that the longitudinal crack from pavement surface to bottom is derived from the tire tread gap, and the shear stress at the tire tread gap is the main mechanical index of the longitudinal cracks of the asphalt pavement. Longitudinal cracks are not affected by tensile stress; the key damage source of longitudinal cracking from pavement surface to bottom was put forward.

Keywords: road engineering; asphalt pavement; longitudinal cracking; shear stress; non-uniform distributed load; tread pattern

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An Innovative Test Method to Evaluate the Effects of Interface Conditions on Top-down and Reflective Cracking Performance

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ABSTRACT:

Pavement top-down cracking performance not only depends on pavement layer material characteristics, but also on layer interface conditions. Meanwhile, Reflective cracking is a distress mode that is of particular concern for pavements with thin hot-mix asphalt (HMA) overlay as a maintenance and/or rehabilitation method. Interface conditions involve both the shear resistance along the interface and the cracking resistance across the interface provided by the interface bonding agents. A new way to improve pavement top-down cracking and HMA overlay reflective cracking resistance is to use highly polymer modified asphalt emulsion (PMAE) interface. To simulate the crack initiation and propagation process and evaluate the effect of bonded interface conditions on top-down cracking performance, a composite specimen interface cracking (CSIC) test was developed. And this CSIC can be modified by introduction of a teflon spacer in the existing pavement layer to simulate reflective cracking. The developed system involves repeated tensile loading and monitoring of the rate of damage development (reduction in stiffness) on composite specimens specifically designed for these purpose. Number of loading cycles to failure and damage rate results from the proposed test clearly indicate that this test method can be used to optimize bonding agents and application rates for enhanced cracking performance. Test results clearly indicated that the proposed CSIC test and CSIC with teflon spacer was able to simulate top-down cracking and reflective cracking mechanism, respectively.

KEYWORDS: top-down cracking; reflective cracking; PMAE; CSIC

Analysis of Fatigue Cracking Behavior in Asphalt Concrete Based on Coupled XFEM-Continuum Damage Mechanics Method

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ABSTRACT: A coupled XFEM-continuum damage mechanics(CDM) model was developed in this paper to investigate fatigue cracking behavior of asphalt concrete. The model was then implemented in commercial finite element software ABAQUS using user-defined subroutines (UMAT and UDMGINI). Based on this model, fatigue damage accumulation stage and crack propagation stage were sucessfully simulated as a continuous process. Determination of model parameters were discussed and then fatigue crack growth in semi-circular bending(SCB) beam was analyzed. Numerical results of fatigue crack growth in SCB quantitatively match well with experimental records, which indicates that the coupled XFEM-CDM method developed in this paper can serve as an effective tool for predicting fatigue cracking behavior of asphalt concrete. Fatigue cracking behavior and mechanical response of three-point bending beam were also studied. Numerical findings are qualitatively consistent with laboratory results.

KEYWORDS: fatigue cracking, asphalt concrete, extended finite element model(XFEM), continuum damage mechanics(CDM), coupled XFEM-CDM method, ABAQUS

Stochastic Pavement Load Generated by Heavy Vehicle with Nonlinear Suspension

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Abstract:

Stochastic pavement load is influenced by vehicle suspension system, pavement profile and vehicle's speed. This study derived analytical solution of vehicle vibration of Bingham nonlinear quarter-vehicle model using the method of averaging in perturbation theory. This result is validated through numerical simulation in MATLAB and good agreement has been observed. The existence of Coulomb damping force in nonlinear suspension system serves as an effective mechanism to mitigate vehicle vibration. Unsprung transmittance and amplitude of stochastic pavement load of a nonlinear suspension system are both smaller than their counterpart of a nonlinear suspension system. For the particular parameters of heavy vehicle used in this study, dynamic load coefficient (DLC) increases as the vehicle speed increases. Adjusting the Coulomb damping can generate different

cumulative distribution of dynamic loads. Since pavement damage is proportional to the forth power of the magnitude of load, it is possible to design a "road-friendliness" vehicle suspension system by optimizing Coulomb damping to have a shorter tail in the dynamic load distribution that reduces pavement damage to the largest extent.

Keywords: vehicle vibration, pavement load, Bingham nonlinear model, the method of averaging, numerical simulation, road-friendliness

Study on Settlement Characteristics of the Ground Movement Caused by Metro Tunnelling and the Application of the Safety Assessment

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ABSTRACT:

Studies based on practical engineering application on the stratum deformation characteristics are significant and important for the surface safety of subway construction, especially for the subway building under high-speed railways. This paper presents the settlement characteristics form different

crossing angles by the numerical simulation of FLAC3D, in terms of the ground settlement trough, the stratum slip line and the irregularity characteristics of the ballastless track. An effective safety assessment is proposed according to the comparison of the specification,the numerical simulationand site conditions. This assessment deals with the shield engineering undercrossing the high-speed railway and aims at the control standard of the surface, the quality evaluation of the track and the stress standard of the surface. Therefore, some safety measures are put forward to guide the construction according todifferent security level. A case study is presented at the shield section crossing the Wuhan-Guangzhou High-speed Passenger-only Railway between Guang-Zhou North Railway Station and Hua-cheng Road Station, the first subway project undercrossing the high-speed railway in China.The deformation characteristics and the application of the safety assessment are analyzed,afterwards, a series of measures is taken to make sure the safely pass of the shield tunnel and the normal operation of the high-speed railway. This research provides technical support for the safety evaluation of subway under construction.

Keywords: Subway construction; High-speed railway; Deformation characteristics; Safety assessment; Numerical simulation; Case application

高速公路气象观测站点的选址原则及布设要求

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摘　要： 2013年3月，交通运输部与中国气象局联合召开了公路交通气象观测站网建设及信息服务电视电话会议，对公路交通气象观测站网建设及信息服务工作进行了总体部署，为共同推动公路交通气象监测预报预警奠定了基础。但如何科学、合理的规划布设公路气象观测站？公路气象观测站的选址需要综合考虑哪些因素？本文根据交通运输部发布的《公路交通气象观测站网建设暂行技术要求》，以大雾能见度监测为例，进一步细化和明确了公路气象观测站的选址原则及要求，为各省建设公路气象观测站网提供可参考的思路及建议。

关键字： 高速公路；气象观测站；选址；原则；要求

中图分类号：　　　　　　　**文献标识码：A**

The Principle and Requirement of Selecting Location of the Highway Meteorological stations

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Abstract:

　　March 2013, the Ministry of Transport and the China Meteorological Administration jointly held a teleconference meeting about highway meteorological network construction and information services ,had made the overall deployment , laid the foundation for jointly promote highway weather monitoring and warning. But how scientific and rational planning and construction meteorological station? Which factors need to be considered for selecting location meteorological station? In this paper, according to the Department of Transportation released documents—Highway Traffic

meteorological network construction temporary technical requirements. Adopt the fog visibility monitoring as an sample, further refine the principle and requirement of selecting location of the highway meteorological stations ,provide ideas and suggestions for constructing the highway meteorological stations for each province.

Keywords: Highway,Meteorological station,Location,Principle,Requirement

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超粘磨耗层技术在高速公路养护中的应用研究

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摘　要: 超粘磨耗层是一种新型稀浆封层类技术，主要应用于沥青路面养护工程，目前仅在国内部分地区获得试验应用，本文结合超粘磨耗层的技术特点与目前稀浆封层类规范，提出了超粘磨耗层两种改性乳化沥青的技术指标要求，并通过开展超粘磨耗层配合比设计工作，确定了超粘磨耗层适宜的玻璃纤维掺量为0.1%及目标配合比，工程应用效果表明超粘磨耗层能够显著提升高速公路沥青路面的抗滑能力，并提出了超粘磨耗层的适用条件，本文的研究对于探讨超粘磨耗层技术在高速公路养护中的适用性具有重要意义。

关键词:超粘磨耗层；技术指标；配合比设计；工程应用

Study on the Application of Novasurfacing in Highway Maintenance

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Abstract: Novasurfacing is a new type of slurry seal technology, mainly used in asphalt pavement maintenance project, currently there is only test application in parts of the country, combined with the technical characteristics and the current standard of s Novasurfacing, this paper puts forward the requirements of Novasurfacing includes two kinds of modified asphalt emulsion, and through the mix design of Novasurfacing, the glass fiber content is 0.1% and the suitable target mix ratio, the effect of engineering application shows that Novasurfacing can significantly improve the ability of anti sliding of highway, and puts forward the applicable conditions of Novasurfacing. The study of This paper has important significance to the study of Novasurfacing technology in highway maintenance application.

Keywords: Novasurfacing; technical index; mix design; engineering application

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排水沥青路面预防性养护材料的应用性能分析

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摘　要： 排水沥青路面由于具有抗滑性能高、噪声低、抑制雨天行车水雾、防止高速行车"水漂"、减轻夜晚行车眩光等技术优点，已被世界诸多地方广泛应用。但因采用"石－石"嵌挤结构的大孔隙沥青混合料，路面易发生飞散、开裂等病害。针对此问题，本文选用四种不同类型预防性养护材料（还原型材料RJ、聚合反应型材料GL1、粘结增强型材料CEM、乳化沥青EA）开展性能试验，分别对各种材料的表观密度、粘聚力以及粘附性等性能进行观测，然后分别采用四种不同类型预防性养护材料对已使用9年的排水沥青路面进行养护，为评价养护前后路面使用性能状况，本文采用路面使用性能状况指数（PQI）评价了预防性养护材料对路面整体的使用性能的影响，分析了不同预防性养护材料对排水沥青混合料飞散损失下降率，同时采用弯曲劲度模量和弯曲应变能分析了不同预防性养护材料对低温抗裂性能的影响。

关键词： 排水沥青路面；预防性养护材料；路面使用性能状况指数（PQI）；飞散损失；弯曲应变能

中图分类号：U416.217　文献标志码：A

Performance Analysis of the Preventive Maintenance Materialsfor Porous Asphalt

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Abstract:

　　Porous asphalt has been widely used all over the world, based on its good skid resistance, noise reduction ability and reduces significantly splash and spray in wet conditions and other technical advantages. Nevertheless, as porous asphalt is a large-porosity and stone-on-stone interlocked structure,

disasters in porous asphalt are typically presented in the form of raveling, cracking or a combination of them.Aiming to study and solve those problems, properties of four different types of preventive maintenance materials (reduced material RJ, the type of polymerization GL1, CEM bonding enhanced material, emulsified asphalt EA) were analyzed.The apparent density, cohesive force and adhesive properties were tested. And then the four different types of preventive maintenance materials were used on a porous asphalt section which has been built for nine years. The performances of the porous asphalt before and after the curing were evaluated.It is adopted the pavement condition index (PQI) to evaluate the performance of the porous asphaltusing different preventive maintenance materials. Rate ofraveling loss of porous asphalt mixture using different preventive maintenancewas measured; the bending stiffness modulus and curvature strain energy were analyzed to evaluate the low-temperature anti-cracking performanceof porous asphalt mixture treated with different preventive maintenance materials.

Keywords: porous asphalt; preventive maintenance material; pavement quality index(PQI); raveling loss; curvature strain energy

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Research on Temperature Field Distribution of Asphalt Overlay on Existing Cement Pavement

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ABSTRACT:

Asphalt overlay on existing cement pavement structure design and typical diseases (such as low temperature cracking and fatigue cracking temperature, temperature type of reflective crack) have a strong relationship with temperature; At the same time, vehicle load and temperature stress

also produce different effects on asphalt overlay on existing cement pavement. In this paper, through the establishment of three-dimensional finite element model and field test based on the theoretical analysis method, temperature field distribution and influencing factors of asphalt overlay on existing cement pavement were studied. Results showed that different materials and thickness of asphalt overlay on existing cement pavement had weak influence on road surface temperature. The main factor was heat exchange between road surface and the air (namely, solar radiation and air temperature).

Analysis of Loading Stress of Pavement Structure using One-step Forming Cement-stabilized Macadam Base

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ABSTRACT:

Layered construction of large thickness cement-stabilized macadam base makes the base change from designed being forced by whole layer to being forced by two thin layers, the existence

of interfacial friction between two thin layers reduces the pavement performance of the base, which finally cause the reduction of pavement performance of whole pavement structure.To analyze the load responses of large thickness cement-stabilized macadam base asphalt pavement under different working conditions, pavement surface deflection, maximum principal stresses of surface layer bottom and base layer bottom, minimum principal strain of soil base top and maximum shear stress of surface layer bottom under two different working conditions(layered construction and one-step forming) are taken as indexes and are obtained by finite element analysis method in this paper.

KEYWORDS: Large Thickness; Interlayer Contact; Deflection Value; Maximum Principal Stress; Minimum Principal Strain; Maximum Shear Stress

Cooling Mechanism and Sensitivity Analysis of Low Heat Radiation Asphalt Mixture

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ABSTRACT:

Current study focused on the investigation of the cooling mechanism of low heat radiation asphalt mixture. The establishment of equilibrium surface temperature from thermal cooling model radiation conditions was proposed in the current work. Microscopic analysis of the infrared powder was also carried out to examine the heat performance of the pavement made with asphalt mixture. The self-radiating model of the pavement has also been established in the current study. In this paper, thecooling mechanism and sensitivity analysis of low heat radiation asphalt mixture with the modified infrared powder as the filler, was studied by scanning electron microscopy (SEM)

and the self - cooling model of pavement. The influence of low - heat storage type asphalt low heat radiation asphalt mixture on heat island effect was studied by establishing the thermal radiation model. Findings showed that if the radiant energy of atmospheric window increases or the long wave emissivity of the pavement rises, the short-wave absorption rate of solar radiation decreases even if the increase of wind velocity and equilibrium temperature of the pavement surface will be lowered. The atmosphere temperature field model shows that at the higher atmospheric moisture, the equilibrium temperature of the pavement surface is also higher. Results revealed that the pavements made by low heat accumulation asphalt mixture with the thickness of 1-2 meter can reduce the surrounding atmospheric temperature by 3-5 °C.

KEYWORDS: Cooling mechanism; Asphalt mixture; Pavements; Equilibrium temperature; Emissivity.

基于热分析的阻燃沥青阻燃机理研究

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摘 要：为了研究阻燃沥青的阻燃机理，采用综合热分析法对十溴二苯乙烷(DBDPE)、三氧化二锑(Sb2O3)、氢氧化铝(ATH)等三类单体阻燃剂，三类单体阻燃剂以不同掺配方式得到的复合阻燃剂，各类阻燃剂掺入沥青后配制的阻燃沥青，在卤-锑-铝复合阻燃沥青中再掺入温拌剂的温拌阻燃沥青分别进行测试，得到各类材料试样的TG（热重）、DTG（热重微商）、DTA（差热）曲线，分析并给出了在沥青中掺入阻燃剂和温拌剂的阻燃机理。结果表明：DBDPE以气相阻燃机理为主，并兼具凝聚相阻燃作用；Sb2O3主要通过升华吸热的"毯子效应"的阻燃作用，对DBDPE具有良好的协效阻燃效果；ATH主要是吸热阻燃机理，在低掺量条件下的阻燃效果不明显，但能够有效扩大DBDPE-Sb2O3复合体系的阻燃温度范围，且促进沥青的成炭反应，因此DBDPE- Sb2O3-ATH复合阻燃剂具有良好的阻燃效果；Sasobit温拌剂的掺入会抑制沥青的成炭反应，对DBDPE- Sb2O3-ATH复合阻燃剂的阻燃效果具有不利影响。

关键词：阻燃机理；热分析；阻燃剂；十溴二苯乙烷；三氧化二锑；氢氧化铝；Sasobit温拌剂

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Research on Flame Retardant Mechanism of Flame Retardant Asphalt Based on Thermal Analysis

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Abstract:

In order to research the flame retardant mechanism of flame retardant asphalt, thermal analysis method was used to test the TG-DTG-DTA curve of decabromodiphenyl ethane(DBDPE), antimonous oxide(Sb_2O_3), aluminium hydroxide(ATH), DBDPE-Sb_2O_3 flame retardant, DBDPE-Sb_2O_3-ATH flame retardant, and their corresponding flame retardant asphalt. Results indicate that, DBDPE can effectively inhibit the chain reaction of asphalt pyrolysis, and also has condensed phase flame retardancy effect. Sb_2O_3 mainly due to the heat absorption of sublimation, it has a certain endothermic flame retardant effect. ATH can be decomposed to absorb heat in a wide range of temperature. On the other hand, it can generate water vaporis which also has a certain flame retardant effect, and the product Al_2O_3 with condensed phase flame retardant effect. And ATH has a good synergistic effect on flame retardant of DBDPE-Sb_2O_3 flame retardant. Sasobit can inhibit the carbon reaction of composite flame retardant which has adverse effect on composite flame retardant.

Key words: flame retardant mechanism; thermal analysis; flame retardant; decabromodiphenyl ethane; antimonous oxide; aluminium hydroxide; Sasobit warm-mixed agent

Prediction Model of Joints Load-transfer Coefficient for
Cement Concrete Pavement

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ABSTRACT:

The primary goal of the research is predicting the joints load-transfer coefficient of cement concrete pavement wherein dowel-bar position was deviation. A double-layer structure model of pavements that considered interlayer contact status was established and the deviation effect of three-dimensional positions, such as horizontal angle, vertical angle, and embedded depth, on joint load-transfer capacity was analysed. A load-transfer coefficient prediction model that considered dowel bar position deviation was established via ternary nonlinear regression. Load correction factor and its range were also proposed. The modified prediction model can effectively reflect the joint load-transfer capacity of pavement wherein dowel bar position was deviation, which was verified by the field data by Falling Weight Deflectometer.

With the modified model, the conclusion can be summarised that: the horizontal angle of the dowel bar minimally affected joint load-transfer coefficient. By contrast, the joint load-transfer coefficient decreased almost linearly as the vertical angle increased. The coefficient reduced by approximately 12% when the vertical angle deviation was 15°. Meanwhile, the

load-transfer coefficient was maximized when a dowel bar was embedded in the middle of a surface. The coefficient would decline either upward or downward. The coefficient particularly decreased by 10% when the position was 2 cm downward.

KEYWORDS: cement concrete pavement; joint load-transfer coefficient; prediction model; dowel bar deviation

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Faulting Forecast of Concrete Pavement
Considering Erosion and Void

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ABSTRACT：According to the current forecast shortage of concrete pavement faulting, the field investigationof faulting in Guangxi was carried, and the relationship between the erosion height and faulting is good whether setting the dowel bar or not, and it is an effective method of setting dowel bars to reduce the faulting value. The concrete pavement structure was built in the test, the relationship between load and erosion value was analyzed, and it has shown that the erosion value of both lime-flyash stabilized macadam base and cement stabilized macadam base is increased exponentially with the enlargement of axle load, and the erosion value of lime-flyash stabilized macadam base is more 10%~12% than the cement stabilized macadam base. Finally faulting models of two different base types considering erosion and void are established. The faulting model of lime-flyash stabilized macadam base with no dowel bar is verified by Liu-Nan expressway, the result has shown the model has a good applicability.

KEYWORDS: road engineering; cement concrete pavement; faulting; base erosion and void;simulation test

高韧性纤维混凝土弯曲疲劳特性

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摘　要：针对水泥混凝土路面的韧性差和脆性大的缺点，提出混合掺加高模量和高韧性的纤维来解决这一问题。通过制备0.65、0.70、0.75和0.80四种应力水平的弯曲疲劳试件，分析高韧性纤维混凝土小梁试件的疲劳性能，结果表明：在疲劳荷载作用下高韧性纤维混凝土试件的跨中挠度与加载循环次数比仍符合3阶段模式，并且疲劳寿命服从威布尔函数，建立了不同失效概率下的双对数疲劳方程，综合考虑加载间歇、实际受力状况、最不利季节和车辆轮迹横向分布等4因素的影响，推导出纤维混凝土面板的疲劳应力系数计算公式，为高韧性纤维混凝土路面设计提供参考。

关键词：纤维混凝土；弯曲试验；疲劳寿命

中图分类号：TU528

Flexural Fatigue Behavior of High-toughness Reinforced Concrete

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Abstract:

　　Aiming at the shortcomings of poor toughness and brittleness of cement concrete pavement, it is proposed to mix the fiber with high modulus and toughness to solve the problem. The fatigue properties of high toughness fiber reinforced concrete beams were analyzed by bending fatigue specimens with different stress levels of 0.65, 0.70, 0.75 and 0.80. The results have shown that the flexural load and cyclic loading ratio of high-toughness fiber reinforced concrete specimens under fatigue loading are in accordance with the three-stage model, and the fatigue life is obeyed by Weibull

function. The double logarithmic fatigue equation under different failure probabilities is established. Considering the influence of four factors, such as intermittent loading, actual force condition, the most unfavorable season and lateral distribution of vehicle trajectory, the formula of calculating the fatigue stress coefficient of fiber concrete slab is deduced, which can provide a reference for the design of high-toughness fiber concrete pavement.

keywords: fiber reinforced concrete; bending test; fatigue life

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Comparisons of Faulting-based Pavement Performance Prediction Models

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ABSTRACT:

Faulting prediction is the core of concrete pavement maintenance and design. Highway

agencies are always faced with the problem of lower accuracy for the prediction which causes costly maintenance. Although many researchers have developed some performance prediction models, the accuracy of prediction has remained a challenge. This paper reviews performance prediction models and JPCP faulting models that have been used in past research. Then four faulting-based models including Strategic Highway Research Program (SHRP) P-20 faulting model, Mechanistic-empirical Design Guide for New and Rehabilitated Pavement Structures (MEPDG) faulting model, Artificial Neural Network (ANN) model and Markov Chain (MC) model are tested and compared using a set of actual pavement survey data taken on interstate highway with varying design features, traffic, and climate data. It is found that the SHRP P-20 faulting model and MEPDG faulting models need further recalibration, while the ANN model needs more data for training the network. MC model seems a good tool for pavement performance prediction when the data is limited, but it is based on visual inspections and not explicitly related to quantitative physical parameters. This paper then suggests that the further direction for developing the performance prediction model is incorporating the advantage and disadvantage of different models to obtain better accuracy.

Keywords: Faulting; Prediction Models; Comparison; Accuracy

Research on the Concrete Pavement Based on the Durability of Anti-skid Performance

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ABSTRACT:

The objective of the present study is to investigate the anti-skid performance of the concrete pavement, as well as attempting to enhance its durability performance through two different methods: adopting the Longitudinally-Transversely grooved (LT) form self-devised, or curing by the self-developed composite type concrete curing agent involving Na_2SiO_3 and paraffin as the main ingredients. The friction coefficient μ was measured by the dynamic rotating friction coefficient tester self-developed equipment to evaluate the anti-skid performance of the three groups (LT, Longitudinally grooved (L), and transversely grooved (T)) specimens with different groove dimensions. The abrasion tests were then carried out to evaluate the durability of anti-skid performance. Results present that

the LT method can improve the anti-skid performance approximately at 46.2% than L specimens, but hardly in the durability of skid resistance. Nevertheless, aforementioned defect in abrasion resistant can be overcome by the specimens cured by the curing agent. Contrast tests were conducted in two curing ways: cured under the standard condition without curing agent (20℃ ± 1℃, relative humidity > 90%, maintenance water 20℃ ± 1℃), or by spraying the composite curing agent under the identical conditions. The results indicated that compared with the former, the later method greatly improved at 35.4% ~ 47.8%, therefore making it an advisable and promising method to improve the anti-skid durability of concrete pavement.

KEYWORDS: concrete pavement; anti-skid performance; longitudinally-transversely grooved; groove dimensions

辽宁省高速公路水泥混凝土路面病害调查及损伤机理研究

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摘　要：由于冰雪、冻害及除冰盐等环境作用，季冻区水泥混凝土路面容易出现多种病害，耐久性劣化问题十分突出。辽宁省地区位于季冻区，具有夏季多雨，冬季多雪的气候特点，收费广场和服务区的水泥混凝土路面普遍出现了不同程度的耐久性损伤。本文对辽宁省省内高速公路水泥混凝土路面进行普查，调查结果可知：路面病害主要为表层类病害、接缝类病害及断裂类病害，其中接缝填料破损类病害最为严重。此外，本文还对耐久性病害进行了分类，分析了路面病害产生的原因及损伤机理，为季冻区水泥混凝土路面耐久性设计与施工改进提供依据。

关键词：季冻区，水泥混凝土路面，病害调查，损伤机理

Investigation on Damage Mechanism of Cement Concrete Pavement of Expressway in Liaoning Province

Abstract:

In seasonal frozen region, many cement concrete pavements subject to diseases and severe concrete durability problems, due to some bad environmental influences such as ice and snow climate, freeze and thaw cycles, and deicing salts. Liaoning province located in seasonal frozen region of China has a monsoonal climate with most rainfall in summer and most snow in summer, which leads to durability damage of cement concrete pavements in toll plazas and service area. This paper investigated the cement concrete pavement situation of Liaoning province, and the result indicated that there were three main diseases for pavement, including surface type, joint type and fracture type, and the filler damage of joint type was the most serious disease. Besides, the paper analyzed the disease type, reason and damage mechanism, and provided references for durability design and construction technology's improvement for cement concrete pavements in seasonal frozen region.

Key words: seasonal frozen region, cement concrete pavement, disease investigation, damage mechanism

A Micromechanical Model for Life-cycle Assessment of Concrete Pavements

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ABSTRACT: Combined mechanical and environmental loads on concrete pavement slabs could cause fast degradation of the concrete material and the slab structure. Changes in temperature and moisture can induce curling and warping of concrete slabs, which may cause concrete cracking under the self-weight and/or wheel loads. Also, pavement slabs on highways are often subject to ingress of chemical species such as chlorides from marine environment, deicing and anti-icing activities. If not well attended, such chemical ingress can cause rebar corrosion, materials loss, concrete cracking, and eventually the loss of serviceability and failure of pavement. In order to assess the accelerated degradation of concrete and the service life of pavement slabs, the mechanical loads, temperature field, and the ingress of detrimental chemical species into variably saturated concrete matrix need to be accurately determined. A multiphysics and microstructure model was recently developed by the authors to determine concrete degradation under the typical highway conditions. The modeling work was based on the reconstructed 3D microstructure of concrete matrix and thecoupled multi-physics fields including the mechanical field, temperature field, moisture field, solute transport, and electrical field. The developed model was successfully used for evaluating the temperature and moisture effects on a concrete slab and evaluatingthe alkali–silica reactionproblem of concrete.

Keyword: Concrete Slab, FEM Modeling, Life-cycle Assessment

Research on Pavement Performance of Iron Tailings Cement Concrete

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ABSTRACT:

Iron tailings is a kind of industry wastegenerated during the ironmaking. More and more iron tailings caused many environmental problems. The test used iron tailingssand to replacenatural sand to make concrete and compared the iron tailings concrete (ITC) with natural sand concrete (NSC) in the workability. In order to meet the workability requirementsit needs to add naphthalene-based superplasticizer. Then study tested workability and mechanical performance in compressive strength, flexural strength, flexural modulus of resilience, dry shrinkage, abrasion resistance, frost resistance and considered economic benefit.

The experiment results shows the good workability of ITC. Physical index and mechanical properties are close to the NSC. So it can meet the requirements of road materials and completely replace the natural sand in some low grade road.Besides, it has better economic benefits and social benefits. The research provides a feasible way for saving cost and solving environment issues.

KEYWORDS: Iron tailings; road; fine aggregate; workability; mechanical performance; economic benefit

A380轮载作用下刚性机场跑道临界响应研究

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摘　要：为研究A380轮载作用下，刚性机场跑道临界响应，采用高精度单元建立三维有限元模型，对刚性机场跑道的典型加载工况进行数值模拟。结果表明：(1) A380轮载之间的应力叠加效应较小，最大主应力峰值突出；（2）两个主起落架在板两侧加载时，造成中部向上拱起，在正温差和荷载联合作用下，板中部会产生由顶部向下部扩展的纵向裂缝；(3)相邻起落架形成的弯沉盆发生较大程度叠加；(4)板角加载时基层竖向峰值压力最大，而其它加载工况时，水平方向最大峰值压力大于竖向峰值压力。

关键词：刚性机场跑道；A380；接缝；临界响应；Top-Down裂缝

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Study on Critical Response of Rigid Airport Pavement under Loading of A380

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Abstract:

To study the critical response of rigid airport pavement under typical loading situation of A380, high precision element was utilized to establish three dimensional finite element model, typical loading case of rigid airport pavement were simulated. Results show that: (1) Stress superposition effect between the A380 wheel load is small and the maximum principal stress peak is prominent. (2)When the two main landing gear are located on the opposite side of a slab, upward arching occurs at central slab, which results in great tensile stress at center of slab top surface, and in the combined effect of temperature and stress, longitudinal crack extending from the top to the bottom of the slab will be produced. (3)The deflection

basin induced by adjacent landing gears are superimposed to a great extent. (4)Peak vertical pressure in base is greater than peak horizontal pressure in case of corner loading condition, while in case of other loading conditions, the larger one of peak horizontal pressure is greater than peak vertical pressure.

Keyword: Rigid airport runway; A380; joint; critical response; Top-Down cracks

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软弱围岩隧道爆破开挖围岩应力分布及变形控制研究

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摘　要：软弱围岩隧道爆破开挖最大的问题就是复杂的地质环境以及自然介质脆弱的物理力学特性，施工过程中极易因不可预测的围岩应力和位移变化造成施工事故。为了研究软弱围岩隧道爆破施工过程中掌子面周边围岩应力和位移的变化情况，本文依托寻全高速松虎坑3号隧道爆破施工实例，利用有限元软件MIDAS/NX对软弱围岩隧道爆破过程中掌子面周边围岩的位移-时间变化及其应力分布情况进行了分析，并且总结了软弱围岩隧道开挖过程中围岩的变形机理及相应的控制变形工程对策。模拟结果表明：爆破过程中爆破荷载的主应力对已开挖洞室周边围岩的影响范围较小，掌子面周边围岩的位移沿开挖轮廓线向四周扩散，其位移量也逐渐减小。因此，为了控制围岩变形，在爆破完成后应该对围岩进行加固，且及时施作初期支护，以免已开挖轮廓线上部围岩松动坍塌。

关键词：软弱围岩隧道；爆破施工；爆破荷载；应力和变形

Study on the Stress Distribution and Deformation Control of Blasting Excavation in Soft Rock Tunnel

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Abstract:

Applied finite element model analysis method, study the rock displacement and stress distribution in the blasting process in the mountains tunnel, based on the tunnel projects of freeway Shaanxi Province. It is pointed that the rock displacement changed significantly in the blasting process, and principal stresses generated by blasting load mainly in the working face and the front. The surrounding rock displacement and blasting load stress distribution can be

determined more accurately, using blasting process finite element analysis method, and providing a theoretical basis to improve the utilization of blast loads. The results indicate that the principal stress of blasting loads occurred mainly in the working face, during blasting. The impact of cavern contour lines that have been excavation is negative and smaller range. The rock displacement is ranging from excavation contour to spread around, and the displacement is from large to small, in process of blasting.

Keywords:soft rock tunnel; blasting construction; blasting load; stress and deformation.

连续式碳纤维自发热机场道面融雪化冰数值模拟

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摘　要: 利用有限元分析软件Ansys建立连续式碳纤维自发热机场道面板温升及融雪化冰的瞬态传热模型，主要模拟道面板的温升及化冰过程，分析不同发热线布置方式对板面温度均匀性的影响以及XPS板隔热层对除冰效果的影响，为连续式碳纤维发热线在机场道面融雪化冰中的应用提供一定的理论依据。

关键词: 机场道面；碳纤维发热线；融雪化冰；数值模拟

Numerical Simulation of Continuous Carbon Fiber Self-heating Airport Pavement

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Abstract:

Using the finite element analysis software Ansys to establish the transient heat transfer model of continuous carbon fiber self-heating airport pavement snow melting and deicing.Mainly simulating the process of temperature rising and ice melting, analysising the effects of different arrangement modes on the surface temperature uniformity and the effects of XPS heat insulation on deicing. Providing the theoretical basis for the application of continuous carbon fiber heating line in the snow melting and deicing of airport pavement.

Key words: Airport pavement;Carbon fiber heat line; Deicing and snow melting; Numerical simulation

水泥混凝土路面防渗水设计新探

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摘　要：水泥混凝土路面接缝常规设计为平头缝，在养护实践中发现水泥混凝土路面平头缝不能有效防止地表水渗入，导致路基基层强度降低，直接影响公路的使用寿命。文章结合养护实践，介绍了"V"型缝防止地表水渗入路基，阻水墙防止长距离板底水损坏养护方法，探索了延长水泥混凝土路面使用寿命的有效途径。

关键词："V"型缝；滤水槽；隔水层；阻水墙

Innovative Research on the Design of Seepage Control for Cement Concrete Pavement

Abstract:

the design for cement concrete pavement joint conventional flat seam, found in the maintenance practice flat seam of concrete pavement can not effectively prevent the infiltration of surface water, results in the decrease of strength of subgrade at the grass-roots level, directly affects the service life of highway. Combining with maintenance practice, this paper introduces the "V" type seam to prevent surface water infiltration of roadbed, block water wall to prevent damage of long-distance plate bottom water curing method, explores the effective way to prolong the service life of concrete pavement.

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浅谈水泥混凝土路面预防性养护及修复措施

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摘　要：水泥混凝土路面具有强度高、稳定性好、使用寿命长、易施工等优点。目前交通运输车辆超载现象十分突出，超载车辆给水泥混凝土路面造成了十分严重的破坏，道路板块由压断到压碎，路面失去防水性能，雨水沿裂缝进入路面基层，使基层泡软，失去部分原本支撑抗压强度，再经过车辆碾压则路面完全被破坏，造成很大的社会影响和给国家带来极大的经济损失。预防养护可以（是）对轻度、中度病害进行养护和修复，采取简单的方法也可达到对水泥路面的破损进行预防，还能延长路面的使用寿命。

关键词：水泥混凝土路面，预防性养护；修复措施及方法

Discussion on Preventive Maintenance and Rehabilitation Treatment of Cement Concrete Pavement

Abstract:

the cement concrete pavement has high strength, good stability, long service life, easy construction, etc. Transport vehicle overload phenomenon is very outstaon, losing some originally support compressive strength, by car, the road was completely destroyed, caused great social impact and bring huge econommding, the overload vehicles caused serious destruction to the cement concrete pavement, road plate by broken to crush, pavement waterproof properties lost, the rain into the pavement base along the fissures, the grassroots maceratiic losses to the country. Preventive maintenance (is) for maintenance and repair, mild, moderate disease take simple method can also be reached on the cement road surface damage prevention, can also extend the service life of pavement.

作者简介：王新华（1967-），男，正高级工程师，云南省玉溪公路局局长，主要从事道路管理（养护）工作，研究沥青路面、水泥混凝土路面破损养护及病害处治25年之久，取得了许多成果及荣誉。获得国家实用新型专利及发明专利7项。电话：13908777908，传真：0877-2024001。

中川机场高铁站客流分析及优化

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摘　要:以提高中川机场高铁站各项服务设施的能力，提升其运营能力为目标，优化车站的客流流线，为车站的发展提供必要的帮助。以Anylogic 仿真软件为仿真平台，建立中川机场高铁站客流仿真模型，分别对中川机场高铁站平峰时期、高峰时期的客流进行仿真模拟，并对高峰时期进行重点研究，找出其在高峰时期的不足之处。最终提出改进方案，并运用Anylogic仿真软件对优化后的车站再次仿真并与优化前进行对比，结果表明优化后进入售票大厅购票的旅客的走行距离虽然有所增加，却达到了客流分离的效果，优化后的高铁站流线清晰，交叉干扰减少，设施设备通行能力明显增加，车站疏散能力明显提高，进而提升中川机场高铁站的运营效率。

关键词：中川机场；旅客流线优化；Anylogic；动态仿真

中图分类号：U238

Analysis and Optimization of Passenger Flow at Zhongchuan Airport High -speed Railway Station

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Abstract:

In order to improve the services ability and operation ability of high-speed rail station in Zhongchuan airport, optimize the station passenger flow and provide necessary help for the development of the station, the simulation model of station passenger flow for high-speed rail in Zhongchuan airport was established based on the simulation software of Anylogic, the passenger flow of mean period and peak period was simulated. This paper focused on the peak period and found out the deficiencies, put forward the improvement scheme and compared

the passenger flow before and after optimization use the Anylogic simulation software. The results show that the walking distance of passengers who entering the ticket hall buy ticket was increased but the flow separation effect was achieved after optimization, the cross line was clear after optimization, and the cross interference was reduced, the traffic capacity of facilities was increased, the evacuation capacity of the station was improved, so the efficiency of railway operation was enhanced.

Key words: Zhongchuan airport ; passenger flow optimization; Anylogic ; Dynamic simulation

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砂砾土地基道面结构不均匀冻胀防治

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摘　要：为了有效地解决砂砾土地基道面结构不均匀冻胀问题，分析了道面结构防冻现状的问题及其原因，对果洛机场现场试验段的砂砾土进行了颗粒分析，现场取点并实测了土基的含泥量和含水率，设计并评价了五种道面结构方案，优选出了跑道与道肩一体化方案并进行了抗冻性验算和成本费用分析，结果表明该方案不仅能够有效避免不均匀冻胀现象，而且满足抗冻性要求，且具有一定的经济适用性。最后根据本文分析、实测和验算等研究成果和工程实际情况，提出了工程措施建议，并对实际应用效果进行了评价。

关键词：不均匀冻胀；砂砾土；道面结构；方案评价；抗冻性验算

中图分类号：TU475+.2

Prevention and Control of Anisotropy Frost Heave of Pavement Structure on Gravel Soil Foundation

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Abstract:

In order to prevent the uneven frost heave deformation of pavement structure of gravel soil subgrade, this paper analyzes the problem and reason of present situation Prevention and control of anisotropy frost heave of pavement structure, according to the grain size analysis test and the measured value of silt content and moisture, we designed five scheme of pavement structure and compared them, then put forward a new anti-freezing design measurement. Based on checking computation of frost resistance and the cost analysis, the optimization program of integration of runway and the shoulder not

only solve the damage of anisotropy frost heave, but also satisfies the requirement of frost resistance, have a certain economic applicability. According to the results of analysis, actual measurement, checking computation and engineering practice, engineering measures are put forward and evaluate the efficacy of the practical application.

Keywords: anisotropy frost heave,gravel soil,pavement structure,project evaluation,checking computation of frost resistance

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现代混凝土结构强度检测方法的比对与分析

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摘　要：通过比对试验分析回弹法、超声回弹法、钻芯法检测相同混凝土强度的差别，加深了对于规范的合理应用，能够更科学的用无损检测判定结构混凝土强度。

关键词：混凝土强度；无损检测；回弹法；超声回弹法；钻芯法

Modern Concrete Structure Strength Testing Method of Comparative Analysis

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Abstract:

Through comparing and analyzing different results with Rebound method,Ultrasonic -rebound Method and Core-drilling Method which tested the concrete strength of same sample,itdeepend the norm of the rationale application,and scientifically detect and determine the structure concrete without damage.

Keywords: Concretestrength;Nondestructivetesting;Reboundmethod;Ultrasonic rebound method; Core –deillingmethod

振动搅拌技术在高温多雨典型性地区的应用探讨

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摘　要：2015年8月1日，交通运输部发布了行业推荐性标准《公路路面基层施工技术细则》，细则对于公路基层混合料的拌合时间和搅拌工艺提出了新的要求，目的是延长拌合时间，提高混合料均匀性。为此，江西省高速公路开始使用振动搅拌技术，以期改善由拌合不均匀引起的各类问题。本文选取四条已建成的高速公路进行介绍，通过对路面基层进行检测，发现振动搅拌技术能够提升抗压强度、控制变异系数、减少水泥用量，改善路面基层的各项性能。

关键词：振动搅拌；路面基层；高温多雨地区应用

Discussion on Application of Vibration Mixing Technology in High Temperature and Moisture Typical Region

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Abstract:

August 1, 2015, the Ministry of Transport issued the industry recommended standard Technical Guidelines for Construction of Highway Roadbases, The new guideline put forward new requirement for the mixing time and process of the roadbed mix, which purpose to extend mixing time and improve mixture uniformity. The highway of Jiangxi Province decided to use vibration mixing technology to solve the problem caused by uneven mixing. This paper chooses four completed highways to introduce vibration mixing technology. Through the detection of pavement, the vibration mixing technology can enhance the compressive strength, control the coefficient of variation, reduce the amount of cement,

and improve the performance of pavement grassroots.

Keywords: Vibration Mixing Technology; Pavement base; application on High Temperature and Moisture Region

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小变形条件下轮胎-错台动力特性的试验分析

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摘　要：为了分析轮胎经过错台时轮胎-路面的动力效应，提出一种考虑轮胎变形的冲击荷载计算方法，运用基于ADAMS有限元的汽车行驶模型，对轮胎在低速条件下冲击错台过程产生的竖向荷载进行定量分析，讨论了行驶速度、错台高度对冲击荷载的影响，并结合汽车经过错台过程产生冲击力的现场试验，对仿真模型进行验证。结果表明：随着速度、错台高度增加，产生的冲击力就越大；考虑轮胎变形的冲击荷载仿真模型计算得到的冲击荷载与试验值之间有较好的一致性；轮胎-错台作用过程中，轮胎初始能量越小，仿真模型效果越好，反之误差就变大。

关键词：小变形；错台；冲击荷载；速度；ADAMS；

Aircrafts Dynamic Load Analysis on Passing Pavement Faulting Considering Tire Transformation Character

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Abstract: In order to analyze the tire-pavement dynamic effect when cars pass pavement faulting,a dynamic load calculation method considering tire transformation is put forward. Using sliding model based on finite element,combining atress influence from angle of attack change ,doing quantitative analysis to vertical load during up and down the faulting under the condition of low velocity,and influence on dynamic load from go through velocity and faulting height is discussed.Simulation results show,

Keywords:faulting;dynamic load;tire transformation;impact coefficient;angle of attack

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冲击荷载作用下混凝土本构关系对路面力学响应的影响

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摘　要：为了解决混凝土路面结构在冲击荷载作用下的设计计算难题，基于对路面载荷动态化与材料计算塑性参数的考虑，探讨水泥混凝土路面在重载冲击载荷作用下的响应规律。以水泥混凝土损伤模型和三维有限元数值分析方法为手段，在冲击荷载作用下，以足尺寸三维试槽试验为依托，对典型水泥混凝土路面结构不同计算参数下进行计算分析，研究混凝土本构关系对混凝土路面面层弯沉、板底应变分布与塑性损伤开裂在动态冲击荷载作用下的影响。提出线弹性模量计算参数在应用中的不足。研究结果表明：采用混凝土塑性本构模型的计算结果与实际工况更为相近，也可以很好的预测裂缝的发展。由于采用塑性损伤作为计算参数后，混凝土路面结构变形相对较大，导致荷载效应集中于路面中心位置，各结构层层底应力应变均较大。

关键词：道路工程；动力响应；冲击载荷；有限元模型

Influence of Constitutive Relation of Concrete on Pavement Mechanical Response under Impact

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Abstract：

To address the challenges of the impact of structural concrete pavement load design computing, based on the calculated parameters and dynamic load Plastic surface material considerations discussed in cement concrete pavement response under heavy loads. Cement concrete damage model and three-dimensional finite element numerical analysis method was

calculated and analyzed, curved surface constitutive relation study of heavy concrete pavement is a shock load of cement concrete pavement structure is under the full-size three-dimensional test unit test different calculation parameters basis, the impact of bottom damage plastic strain distribution and dynamic impact load in the cleavage. Modulus of elasticity is less than the recommendation line calculation parameters of the application. The results show that: the relationship between concrete plasticity constitutive model and the actual working conditions more similar, and can predict the development of cracks. Since plasticity after injury calculation parameters, the deformation of the concrete pavement structure is relatively large, the resulting load effects concentrated in the center of the road position, the larger structural stress and strain of each layer at the bottom.

Keyword：road engineering，dynamic response, impact load, the finite element model

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Analysis for Dynamic Mechanical Properties of Slab Staggering under Vehicle Load

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ABSTRACT:

In view of the phenomenon of dislocation occurred on the runway, this paper finds the causes and harms of dislocation, and then conducts the dynamic mechanical properties study on

slab staggering under vehicle load. Firstly, this paper studies the measurement methods of the dynamic mechanical properties of slab staggering under vehicle load, and establishes the type-dislocation interaction models which lay a solid foundation for the subsequent tests. Secondly, this paper draws up different impact force curves by use of velocity and wheel load as variables, the quantitative analysis of the relationship between the impact force and all variables shows that at the height of 5 cm, the larger the velocity is and the heavier the wheel load is , the more obvious the impact effect. The impact effect is in exponential relation with the velocity and in parabolic relation with the wheel load. At the arrival of 70km/h, the impact force approaches the stable value, accompanied with the "Jump car". Finally, this paper designs the multi-factor orthogonal experiment of the impact effect on five-centimeter-tall dislocation, and the numerical model of solving the impact force.

KEYWORDS: dislocation; wheel load; velocity; the impact force

Evaluation of Concrete Pavement Using Infrared Thermography

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ABSTRACT:

Infrared Thermography (IRT) is an effective non-destructive testing method in the field of concrete pavement inspection. IRT is used in this research in order to have an initial evaluation of the surface and near surface of concrete pavement in a time effective manner. The method can be widely used for concrete pavement particularly bridge decks inspection. In this paper, the effect of the depth of delamination inside concrete pavement on infrared thermography technique is studied. To be able to mimic the delamination in subsurface, two Styrofoam cubes have been inserted in different depth near the surface of the concrete cylinder. After heating up the specimen, thermal images were taken from the surface using an infrared thermal camera to evaluate the effect of subsurface defects on detection sensitivity and accuracy. We also investigated the precision to which the shape and the size of the subsurface anomalies can be perceived using an uncooled thermal camera. To achieve this goal, we used image processing technique to accurately compute the size of delamination in order to compare it with

the actual size. Also, distance/thermal graph is used to detect the presence of the defect underneath the concrete surface. Furthermore, thermal transfer modelling was adopted in this paper to assist the setup of this experiment and the results are compared with laboratory findings.

KEYWORDS: IR thermography, Non-destructive testing, Pavement inspection, Image processing

快干型水性标线涂料的研制与应用

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摘　要：本文通过几种方式优化了水性标线涂料的配方。其中包括：采用合理的快干胶乳用量达到不粘胎时间与涂料稳定性的平衡，采用水性蜡乳液提高耐污性，选择适量的有机膨润土改善了体系的稳定性。本文还讨论了涂料反光效果与玻璃微珠的的关系，并根据实际施工情况，选择了合适规格的玻璃微珠及适当的撒播量，对快干型水性标线涂料的性能特点及性能指标进行了总结。在此基础上，结合S102试验段的施工，对水性标线涂料的施工设备、施工工艺进行了分析总结，为后续施工推广提供了基础。

关键词：水性标线；快干；不粘胎；施工工艺

中图分类号：U416

Development and Application of "Quick Set" Waterborne Road Marking Paint

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Abstract:

In this paper, waterborne road marking paint formulation was optimized by various methods. With reasonable amount of 'quick set' waterborne latex, equilibrium of 'no track' time and paint stability was achieved. In addition, appropriate amount of organic bentonite thickener further improved paint's shelf life. Water-based wax emulsion was adopted to improve stain resistance. Furthermore, the relationship between reflective propertyof waterborne road marking and glass micro-beads was discussed, as well as the selection and application of glass micro-beadsin the field. The performance

characteristics and performance indicators of quick set waterborne road marking paint were summarized. The optimized pavement markings were applied on S102 state road. Configurations of construction equipment and application results of the paint were analyzed and summarized.

Keywords: waterborne road marking paint; quick set; no track; construction technology

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基于Gibss自由能的温拌沥青混合料四相体系粘附模型的推导研究

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摘　要：表面能理论可以反映出沥青混合料发生水损害前后沥青–集料及沥青–水–集料粘附能量的变化，因此广泛应用于沥青混合料水损害的研究。由于现有文献中无相关的四相粘附模型，无法揭示表面活性剂型的温拌沥青混合料发生水损害后沥青–温拌剂–水–集料四相粘附能量的变化。本文以Gibbs自由能概念为基础，推导出了沥青、水与集料三相体系的粘附模型，该模型与文献中的模型表达式完全相同，验证了应用Gibss自由能推导沥青、水与矿料三相体系粘附模型的可行性。以此为基础，应用为Gibbs自由能推导了温拌沥青混合料中沥青–温拌剂–水–集料四相粘附模型，为温拌沥青混合料水损害研究提供了理论支撑。

关键词：温拌沥青混合料；Gibss自由能；水损害；四相粘附模型

中图分类号：U414　　　　　　**文献标志码：A**

Study on the Deduction of Four Phase System Adhesion Model for Warm Mix Asphalt Based on Gibss Free Energy

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Abstract：

　　It could be relfected that the energy changes of asphalt mixture water damage from asphalt-aggregate to asphalt- water-ggregate by surface energy theory. Therefore, it was widely used in the study of water damage of asphalt mixture. The energy changes of asphalt-

warm mix agent-water-ggregate could not be revealed when the warm mix asphalt mixture appears water damage for therewas no relevant four phase adhesion model.From the Gibbs free energy concept to derive asphalt-water-aggregate adhesion model. It was reasonable from the Gibbs free energy concept establishment of asphalt-water-aggregate adhesion model for the adhesion model expression and the existing are given by literature was the same way. Based on that,the asphalt- warm mix agent-water-ggregate adhesion model was deduced by used Gibbs free energy,which provided theoretical support for the study of water damage of warm mix asphalt mixture.

Keywords： Gibbs free energy; asphalt mixture; Water Stability; adhesion model

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掺高分子裂解物的复合改性沥青流变特性研究

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摘　要：采用废塑料废橡胶等裂解物为主要原料的复合改性剂制备了低能耗改性沥青，通过沥青三大指标测试、布氏旋转粘度仪及动态剪切流变仪（DSR）对旋转薄膜烘箱老化（RTFOT）前、后的改性沥青进行基本性能分析、PG分级、温度扫描和粘温曲线。比较掺高分子裂解物改性沥青旋转薄膜烘箱老化前后的流变特性，并分析其与沥青三大指标、布氏旋转粘度的相关性。分析结果得出，掺高分子裂解物的复合改性沥青老化前后的流变特性均比基质沥青优异，结合粘度、延度、软化点和针入度的结果可得沥青施工温度降低至少50℃。研究结合高分子裂解物改性沥青的改性特性证明掺高分子裂解物复合改性剂的沥青不仅能够实现低温施工，同时还能够提高沥青的高低温性能和抗老化性能。

关键词：高分子裂解物；复合改性沥青；低能耗；流变特性

中图分类号：U416.26

Rheological Properties of Composite Modified Asphalt with Polymer Lysates

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Abstract:

The low-energy modified asphalt was prepared by using compound modified agent such as waste plastic and rubber that polymer lysates as the main raw materials. Through the three indexes-

softening point, penetration, degree of extension of asphalt test, Brookfield rotational viscometer and dynamic shear rheometer (DSR) Membrane oven aging (RTFOT) before and after the modified asphalt for basic performance analysis, PG classification, temperature scanning and viscosity curve. The rheological properties of the modified asphalt spinning film were compared before and after aging, and the correlation between the three indexes and the rotational viscosity of the asphalt was analyzed. The results show that the rheological properties of the composite modified asphalt were better than that of the control asphalt. The asphalt construction temperature was reduced by at least 50 ° C as a result of the combination of viscosity, ductility, softening point and penetration.The modification characteristics of modified asphalt with polymer lysate is proved that the asphalt with polymer modifier composite modifier can not only realize low temperature construction, but also improve the high and low temperature performance and anti - aging properties of asphalt.

keywords: polymer lysates; composite modified asphalt; low energy consumption; rheological properties

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Analysis on Warm Mix Flame Retardant Asphalt Mixture Properties

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ABSTRACT：Warm Mix retardant asphalt mixture is a new kind of pavement material, particularly suitable for highway tunnels and other closed environment, yet lacks the technical standards. Warm mix asphalt mixture primarily improves the work performance at room temperature by reducing the viscosity of asphalt. Flame retardant performance works out by covering isolated, endothermic cooling or inhibition reaction. The paper compared and analyzed the retardant effect of warm mix retardant asphalt mixture and hot-mix asphalt by Marshall combustion experiments, The rut specimen combustion experiment and Tectonic depth experiment. Warm Mix retardant asphalt mixture specimen flame is small but the other burns vigorously. Tectonic depth of the former increase by 3.5% , 4.2% and the latter 8.2%. The former mix temperature is lower 30℃ than the latter and saves much fuel in production, CO_2 emissions can be reduced by 20% and the dust and smoke emissions can be reduced by 40%. Warm mix retardant asphalt mixture has greater economic benefits and environmental benefits, and make a useful exploration to promote the technological progress of the warm mix flame-retardant asphalt mixture.

KEYWORDS: Road engineering, Pavement engineering, Warm mix, Flame retardant, Asphalt mixture, Flaming

High Temperature Property Evaluation for High Modulus Asphalt Mixture Modified With Interfacial Method

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ABSTRACT：High temperature rutting test and dynamic creep test are carried out to high modulus asphalt mixture produced by several selected high modulus additives. The results are compared and analyzed with SBS modified asphalt mixture. The results show that the high temperature property of high modulus asphalt mixture modified with interfacial method is excellent having obvious anti- rut affect and can effectively solve the rutting on asphalt pavement.

KEYWORDS: Interfacial method; High modulus asphalt; Asphalt mixture; Dynamic creep; Property evaluation

Study on Viscoelastic Characteristic of Asphalt-aggregate Interface

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ABSTRACT

Interface bonding condition between asphalt and aggregate plays an important role in determining the overall mechanical properties of asphalt mixture. To investigate the influence of asphalt–aggregate interface creep behavior, an interface creep constitutive model under the coupled compression and shear loading was established based on the viscoelasticity theory. The model parameters were calibrated by the oblique interface shear creep tests with the nonlinear multiple variables fitting method. The results show that there was a good agreement between the theory model and the experimental results, which reflect the three stages creep deformation characteristic of the asphalt–aggregate interface. The research would hopefully give some insights into the meso-scale analysis of asphalt-aggregate interface viscoelastic behavior.

KEYWORDS:asphalt-aggregate interface; constitutive model; interface viscoelastic behavior; adhesion

三维随机分布纤维加筋沥青砂浆弯拉流变模拟

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摘　要：　本文基于所建的三维随机分布纤维模型，研究了纤维加筋沥青砂浆梁的弯拉流变性能。首先，以Burgers模型作为粘弹本构，通过弯曲流变试验获取纯沥青砂浆的弯拉粘弹参数。其次，基于一个纤维随机生成算法，建立三维随机分布纤维与砂浆基体组成的两相复合模型，对其弯拉流变在ABAQUS有限元中进行数值模拟，结果表明纤维砂浆梁流变值与试验值具有较好的一致性。最后，进一步考虑纤维含量及其长径比的影响，模拟结果表明在恒定的纤维直径下纤维含量的提高和纤维长度的增加都能有效降低砂浆弯拉流变，纤维具有显著的加筋效果。

关键词：沥青砂浆；玄武岩纤维；三维模型；弯拉流变

Numerical Simulation of Flexure-tensile Rheological Behavior Based on 3D Random Distribution Fiber-reinforced Asphalt Mortar

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Abstract:

Based on a new three-dimensional (3D) random fiber distribution model, this study investigates the flexural-tensile rheological behaviors of fiber-reinforced asphalt mortar. Firstly, the viscoelastic parameters of the Burgers model for the pure asphalt mortar were obtained by the beam bending creep test. Secondly, a numerical model consisting of the homogeneous asphalt mortar and the basalt fibers was built based on a 3D fiber algorithm to study the flexural-tensile rheological behavior using ABAQUS software, and results indicated that the rheological behaviors of the numerical model were in good agreement with the test results. Finally, further numerical simulations were carried out to analyze

the effect of fiber content and aspect ratios. Simulated results showed that the decrease of fiber content and aspect ratios had a positive effect on the rheological behaviors under a constant fiber diameter.

key words: asphalt mortar; basalt fiber; 3D model; bending rheology

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沥青混合料抗剪强度参数研究与预测

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摘 要：本文主要研究了两种密级配沥青混合料的高温抗剪强度参数及其影响因数。首先，选定AC13和AC20级配沥青混合料，通过不同温度下的三轴压缩试验，获得了级配、温度对沥青混合料抗剪强度参数的影响；其次，对加入抗车辙剂和纤维的沥青混合料在代表性温度下进行三轴压缩试验，分析了不同添加剂对抗剪强度参数的影响；最后，通过分析抗剪强度参数的变化规律，利用本文提出的多参数非线性模型，拟合试验结果获得了两种级配沥青混合料粘聚力和内摩擦角与温度相关的四参数预测模型，基于此，进一步推导得到了材料破坏面上剪应力值与围压、温度相关的预测模型。本研究所获得的两种沥青混合料全温度范围内的抗剪参数预测结果与实验结果具有较好的一致性，所提出的预测模型和方法对实现实际温度场下路面抗剪性能的研究具有重要意义。

关键词：沥青混合料；抗剪强度；预测模型；三轴压缩试验

Research and Prediction of Shear Strength Parameters of Asphalt Mixture

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Abstract:

This paper mainly investigated shear strength parameters at high temperature and their influence factors of two kinds of dense-graded asphalt mixtures. First, asphalt mixtures for AC13 and AC20 gradation were selected, and then the effect of gradation and temperature on the shear strength parameters of asphalt mixture was obtained through the triaxial compression test at the different temperatures. Second, the triaxial compression tests of asphalt mixtures including anti-rutting agent and fiber were performed under the representative temperature, and the influence

of different additives on the shear strength parameters was got. Finally, the four-parameter prediction models of cohesive force and internal friction angle for two gradation asphalt mixtures, which were just related to the temperature, were acquired by analyzing the change law of the shear strength parameters, using the proposed nonlinear multi-parameter model, and fitting the test results. Based on this method, the prediction model of the shear stress on the damage surface, which was associated with confining pressure and temperature, was further derived. The prediction results of the shear parameters of two-type asphalt mixtures have good consistency with the experimental results for the high temperature range. The proposed prediction models and the method of getting them are of great significance to researching the pavement shear properties in the actual temperature field.

key words: asphalt mixture; shear strength; prediction model; triaxial compression test

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Characterization of the Rheological Characteristics of Gussasphalt Concrete Using the Huet-Sayegh Model

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ABSTRACT:

The rheological characteristics of Gussasphalt concrete was characterized using the Huet-Sayegh model. Laboratory tests of complex modulus were conducted at temperatures of 10, 20, 30, 45, and 60°C and frequencies of 0.1, 0.5, 1, 5, 10, and 25Hz for each temperature. Measured data obtained from the complex modulus tests were employed in the construction of the Huet-Sayegh rheological model for Gussasphalt concrete. Master curves of the dynamic modulus and phase angle were developed by the Huet-Sayegh model, respectively. Results show that Gussasphalt concrete exhibits

typical rheological behavior at low strain level. There is good agreement between the measured complex modulus values and results of analytical calculations obtained from the Huet-Sayegh model. Hence, the Huet-Sayegh model can be successfully used in describing the rheological characteristics of Gussasphalt concrete over a wide range of frequencies with few parameters.

KEYWORDS: Gussasphalt concrete; rheological characteristics; complex modulus test; Huet-Sayegh model

基质沥青与SBS改性沥青老化性能差异研究

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摘　要：选择基质沥青和SBS改性沥青两种原料，通过TFOT和PAV实验分别模拟沥青在拌和温度下和路面长期使用条件下的老化过程，分析了两种原料性能随老化温度和老化时间的变化规律，并对比老化性能的差异。实验结果表明，改性沥青粘温性能对拌和温度的敏感性高于基质沥青，提高拌合温度对SBS改性沥青性能影响较大，因此要避免采用过高的拌合温度，且拌和时间不宜过长；基质沥青和改性沥青对PAV试验温度的敏感性差别不大，两者的老化性能相当，说明SBS改性工艺并未对基质沥青的长期老化性能造成明显的影响，两者在路面长期使用过程中的老化性能差异可以忽略。

关键词：沥青；改性沥青；老化性能；TFOT；PAV

中图分类号：TE 626.28

Study on the Difference of Aging Performance between Asphalt and SBS Modified Asphalt

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Abstract:

　　Two kinds of material, asphalt and SBS modified asphalt, were chosen in this experiment, and their aging process with the condition of mixing temperature and long-term Pavement Service have been simulated by TFOT and PAV test. The aging performance changed with temperature and aging time has being compared between the two kinds of asphalt. The results show that the viscosity-temperature property of SBS modified asphalt is more sensitivity to the mixing temperature than

asphalt. If the mix temperature is higher, It wll have significant effects on the performance of SBS modified asphalt. So it should be avoided to take high mix temperature for SBS modified asphalt, and the mix time should not be too long. In PAV test, the temperature sensitivity of asphalt and SBS modified asphalt are almost the same. It showed that the SBS modified process does not have a significant impact on the aging performance of asphalt. In practical use, the difference of the aging performance between the two asphalt used in long-term Pavement can be ignored.

key words: Asphalt; Modified asphalt; Aging performance; TFOT; PAV

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拜耳法赤泥路用基本工程特性研究

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摘　要：基于对拜耳法赤泥矿物化学特性、基本物理力学性能、环保特性的试验研究表明，赤泥是对人体以及周围环境不会造成危害的一般废渣。从岩土工程角度考虑，赤泥具有高液限、低重度、高PH值的特性。其主要成分和性质因铝土矿的来源以及氧化铝生产工艺的不同而存在差异。为了更好的改善赤泥工程性能以及保证环境安全，还需要通过掺加适量的固化改性材料等措施进一步提高基础承载力、降低赤泥的污染性，以达到良好的工程特性，才可以应用于公路路基、地基基础、回填堤坝等工程建设中。

关键词：工程特性；赤泥；污染性；力学特性；工程应用

Study on General Engineering Properties of Bayer Red Mud

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Abstract:

Judging from the research on various characteristics of Bayer red mud including environmental aspects, basic mechanical properties as well as mineral chemical features, red mud will cause no harm to human body and environment. As to geotechnical engineering field, red mud material possessed several advantages that no other general factory wastes have, including high liquid limit, low density and high pH value. The main compositions and properties of red mud could vary based on the different sources of bauxite or different alumina production process. The applications of red mud on highway subgrade and foundation or backfill embankment engineering should follow behind several improvements and modifications of red mud materials, including strengthen engineering performance

and environmental protection ability. Adding an appropriate amount of curing modified agents into red mud is one way to achieve a better foundation bearing capacity as well as a lower pollution indicator for the red mud, and more detailed information will discussed in the following paper.

Key words: Engineering properties; red mud; pollution; mechanic properties; engineering applications

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Design and Performance of Anti-cracking Asphalt Stabilized Macadam

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ABSTRACT:

In order to enhance the crack resistance of asphalt stabilized macadam, a new type of anti-cracking mixture, GSOG-25, was optimally designed according to the volume design method. The gradation of GSOG-25 is gap and semi-opened, and the binder is rubber powder and SBS composite modified asphalt. Then, Rutting tests at 60 degree Celsius, Immersion Marshall tests, and Four Point Bending Fatigue tests were conducted on GSOG-25 and ordinary ATB-25. The results demonstrate that the performance of GSOG-25 is much better than that of ordinary ATB-25, especially with excellent anti-cracking performance.

KEYWORDS: asphalt stabilized macadam, crack resistance, volume design method, gap gradation, semi-opened gradation, composite modified asphalt

Application of Finite Layer Method in Pavement Structural Analysis

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ABSTRACT:

The finite element (FE) method has been widely used in predicting the structural responses of asphalt pavements. However, the three-dimensional modeling in general-purpose FE software systems such as ABAQUS is relatively time-consuming. To address this issue, a specific computational code was developed based on finite layer method for asphalt pavement structural responses under a static load. Basically, it is a three-dimensional FE program that requires only a one-dimensional mesh by incorporating analytical method using Fourier series in the othertwo dimensions. The parallel computing technology can be applied easily in this code, which can significantly reduce the computation time. The accuracy of the program is verified by comparing it with results from ABAQUS for a typical asphalt pavement structure and a standard single axle load. The results show that the predicted responses from both programs are in good agreement.

KEYWORDS: finite layer method; asphalt pavement structural analysis; Fourier series; EasyFEM; ABAQUS

有限层法在道路结构分析中的应用

摘　　要：有限单元法已经被广泛地应用在沥青路面结构力学响应的预测中，但是使用传统有限元软件（如

ABAQUS）在对路面结构进行三维模拟时，往往耗时太长，影响分析效率。为了解决这个问题，本文基于有限层法开发了适用于沥青路面受静态力作用下的特殊程序。该程序在对路面结构进行三维分析时，只需进行一维网格化，对其余两个维度通过傅里叶级数的解析方法进行处理。结合并行算法，可以大幅缩短分析时间。通过与传统有限元软件ABAQUS对同一沥青路面结构受单轴标准荷载作用下的对比，该程序表现出了非常高的准确性。

关键词：有限层法，沥青路面结构分析，傅里叶级数，EasyFEM，ABAQUS

Comparison of the Anti-UV Aging Effects of Different Ultra Violet Blocking Materials on Asphalt

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ABSTRACT:

Ultra Violet (UV) radiation would cause serious aging of asphalt on the pavement surface. And in recent years, different UV blocking materials were investigated to prevent asphalt aging during the service period of the pavement. In this paper, Layered Double Hydroxides (LDHs), organo-montmorillonite (OMMT) and Carbon black (CB) were introduced as UV blocking materials into base asphalt with 80/100 pen grade. Then UV aging was applied to simulate the aging process. Finally, softening point, penetration, ductility and Fourier Transform Infrared

Spectroscopy (FTIR) tests were conducted to evaluate anti-UV aging effects of three UV blocking materials. The results indicate that the anti-aging effects of LDHs is the best. And CB is the worst UV blocking material.

KEYWORDS: LDHs, OMMT, CB, UV ageing, Asphalt

生物重油对70#老化沥青物理性能影响

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摘　要：为研究生物重油对70#老化沥青再生的可行性，选取三种生物重油进行试验。对三种生物重油进行比重、粘度、水分含量、元素分析、红外光谱等理化性能测试，将三种生物重油按照2%、4%、6%、8%的比例掺配至经室内模拟老化后的70#沥青中，通过针入度、延度、软化点、粘度试验，对比分析三种生物重油对70#老化沥青再生效果的差异性，参照沥青混合料最佳沥青用量的方法确定生物重油的最佳掺量。结果表明，随生物重油掺量的增加，老化沥青软化点和粘度呈下降趋势，针入度和延度呈上升趋势；生物重油再生性能存在一定的差异性，生物重油A和B再生性能较好，生物重油C再生性能稍差；生物重油A、B、C最佳掺量分别为3.9%、4.6%、6.4%。

关键词：生物重油，再生，老化，物理性能

Effect of Heavy Bio-oil on Physical Properties of 70# Aging Asphalt

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Abstract:

In order to study feasibility regeneration of 70# aging asphalt using biological heavy oil, three kinds of heavy bio-oil were selected to carry out the experiment. Physical and chemical properties such as specific gravity, viscosity, and moisture content were tested as well as elemental analysis and infrared spectrum analysis were undertaken. #70 asphalt under indoor aging simulation experiment was blended with these three heavy bio-oil in the proportion of 2%, 4%, 6% and 8%, respectively. the penetration, ductility, softening point and viscosity tests were undertaken to analyze differences of regeneration effect of three kinds of bio heavy oil on 70# aging asphalt. Besides, the optimal

dosage of bio heavy oil was determined according to the method for optimum asphalt usage of asphalt mixtures. The results showed that, (1) with the increase of bio-oil content, there was a downward trend for softening point and viscosity of aging asphalt while there was a upward trend for penetration and docility of aging asphalt ; (2) There were differences among different types of heavy bio-oil in regeneration performance, the regeneration effects of bio heavy oil A and B were better while regeneration performance of heavy bio-oil C was slightly worse; (3)The optimum contents of heavy bio-oil A, B and C were 3.9%, 4.6% and6.4% respectively.

Keywords: biological heavy oil, regeneration, aging, physical properties

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废轮胎热解再生炭黑改性沥青制备及技术性能试验研究

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摘　要：针对大量的废轮胎热解再生炭黑产品过剩问题，开展了废轮胎热解再生炭黑改性沥青的试验研究。采用4因素3水平正交试验，检测各制备参数下废轮胎热解再生炭黑改性沥青三大指标，确定其制备参数。并制备再生炭黑/SBS复合改性沥青，探究再生炭黑对SBS改性沥青性能影响的问题。研究结果表明：制备参数为剪切时间30min，再生炭黑掺量15%，剪切温度140℃，剪切速率4000r/min；废轮胎热解再生炭黑可以提高基质沥青的高温性能，改善温度敏感性，降低低温抗裂性能；15%废轮胎热解再生炭黑/SBS复合改性沥青的技术性能满足原SBS改性沥青的技术要求。

关键词：道路工程；技术性能；制备工艺；再生炭黑；改性沥青；试验研究

Research on the Technology Performance and Preparation Method of Asphalt Mixed With Reclaimed Carbon Black From Pyrolysising of Disused Tire

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Abstract：

By using 4 factors 3 orthogonal experiments, testing the three indexes of asphalt mixed with reclaimed carbon black come from pyrolysising of disused tire under the different prepared parameters to identify preparation parameters of it.Preparing reclaimed carbon black+SBS modified asphalt to explore its effect on the performance of SBS modified asphalt.Research results show that preparation parameters are cutting time 30min,reclaimed carbon black dosage 15% and cutting

temperature of 140 degrees, the shear rate 4000r/min;reclaimed carbon black come from pyrolysising of disused tire can improve high temperature performance and sensitivity to temperature,reduce low temperature performance of original asphalt;technical performance of 15% waste tire reclaimed carbon biack/SBS composite modified asphalt can meet the technical requirements of the original SBS modified asphalt.

Keywords:road engineering;technical performance;preparation process; reclaimed carbon black; modified asphalt; experimental study

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P0.075组分对坍落筒法测量细集料密度及吸水率的影响分析

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摘　要： 针对细集料中存在的P0.075（集料中粒径小于 0.075mm的部分）组分的不同，采用JTG E42-2005《公路工程集料试验规程》中T 0330-2005细集料密度及吸水率试验方法，分别探究了P0.075组分不含粘土和含粘土的细集料对密度及吸水率测量值的影响。试验结果的SPSS Tukey分组表明，当P0.075组分不含粘土时，对细集料密度及吸水率的测量值影响十分微小；当P0.075组分含有粘土时，显著影响细集料密度及吸水率的测量值；为了精确测量细集料的密度和吸水率，建议当细集料的砂当量值低于75%时，分别对细集料中0.075mm筛余和P0.075组分进行密度和吸水率试验。

关键词： 道路工程；细集料；密度及吸水率；坍落筒法；P0.075组分；粘土

Effect of P0.075 Materials on Density and Water Absorption of Fine Aggregate Test Results Using Slump-tube Test Method

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Abstract:

Due to the existence of P0.075 (minus 0.075mm materials in aggregate) materials in fine aggregate ,this report explores the effect of P0.075 materials without clay, P0.075 materials with clay on density and water absorption of fine aggregate test results by T 0330-2005 density and water absorption test of fine aggregate in JTG E42-2005 test methods of aggregate for highway engineering. Tukey's groupings of test results show that, P0.075 materials have little effect on test results under the condition of P0.075 materials without clay and significant effect on test results under the condition

of P0.075 materials with clay. Due to the potential error caused by the presence of clays in P0.075 materials, it is proposed that plus 0.075mm materials and P0.075 materials of a fine aggregate be tested separately when the sand equivalent of the fine aggregate is lower than 75 percent.

Keywords: road engineering;fine aggregate;density and water absorption; slump-tube test ; P0.075 materials; clay

高模量沥青混凝土技术应用的探索

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摘　要：高模量沥青混凝土是一种新型沥青混合料，针对其独特的材料组成、配合比设计及施工生产环节要点，详细说明高模量沥青混凝土的特点，施工工艺，质量要求等重点，以保证工程质量。

关键词：高模量；沥青混合料；配合比设计；施工工艺

Exploration on Application of High Modulus Asphalt Concrete Technology

Abstract:

the high-modulus of asphalt concrete is a new kind of asphalt mixture, for its unique material composition Mixture ratio design and construction key points of production, elaborate the characteristics of high modulus-asphalt concrete construction technology, quality requirements such as key, to ensure the engineering quality。

Keywords: High-modulus; Asphalt mixture; Mixture ratio design; The construction technology

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高模量沥青混凝土力学性能研究

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摘　要：随着高模量沥青混凝土应用范围的不断扩大，作为沥青混凝土路面结构设计时的重要参数，高模量沥青混凝土各项力学性能指标与材料组成有着密切关系，本文结合阿尔及利亚东西高速公路359公里路段高模量沥青混凝土使用经验，通过分析沥青混凝土模量，针对高模量沥青混凝土配合比设计过程中各项力学性能指标与材料组成变化的关系，研究高模量沥青混合料的特性，探寻提高沥青混凝土的力学性能的途径。

关键词：高模量　沥青混合料　配合比设计　力学性能　试验研究

Study on Mechanical Properties of High Modulus Asphalt Concrete

Abstract:

Along with the enlarging of application range of high-modulus asphalt concrete, as the important parameters of asphalt concrete pavement structure design, the mechanical property indexes of high-modulus asphalt concrete closely relate to material composing, Combining with the experience of using high-modulus asphalt concrete in East-West Expressway in Algeria, through analyzing the modulus of asphalt concrete, aiming at the relation between mechanical property indexes and various material composing during the design process of high-modulus asphalt concrete mix proportion design,the characteristics of high-modulus asphalt mixture are studied,the approach to enhance the mechanical property of asphalt mixture is discussed.

Keywords: high modulus;asphalt pavement;mix proportion design;mechanical property;experimental study.

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Laboratory Evaluation of SBS Modified Asphalt Aging Behaviour

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ABSTRACT:

To study the effect of aging SBS modified asphalt on asphalt pavement, various aging time and temperature tests were conducted with thin film oven, then penetration softening point, ductility, viscosity, toughness and fluorescence microscope were tested on the different aging degree modified asphalt. The results show that: with the increasing aging time, penetration and ductility decrease, softening point and viscosity increase, and the trend of toughness and tenacity are related to the aging temperature; the aging dynamic model established by Brookfield viscosity is able to better describe the aging process of modified asphalt; at micro level, the SBS particles size are decreased and particles size uniformity is better. Macroscopic properties and

microscopic characteristics, as well as the significance analysis, show that the SBS particles area ratio has a significant correlation with tenacity as the aging temperature increases. When the aging temperature is 163℃, the SBS particles area ratio still has a significant correlation with tenacity as the aging time increases.

KEYWORDS: Road engineering; SBS modified asphalt; aging; Phase structure; Significance

沥青混合料不同模量同步测试方法对比

摘　要：为了更方便快捷地得到沥青混合料的模量参数，提出了两种同步测试沥青混合料模量的新方法。结合弹性力学中的平面假设和平衡条件，推导了试件在四点弯曲加载模式下的拉伸模量与压缩模量的计算公式；依据二维应力状态下的胡克定律，推导了试件在劈裂加载模式下的拉伸模量与压缩模量的计算公式。并开展了四点弯曲、劈裂、直接拉伸和无侧限压缩四种模量试验，比较了两种新方法测得的拉压模量与直接拉伸、无侧限压缩试验测得的拉压模量，分析了它们的相关性。研究结果表明：沥青混合料是一种各向异性材料，呈现出明显的拉、压模量不同的特性；采用两种方法均可同步得到沥青混合料的拉压模量，且所得的拉压模量与直接拉伸试验和无侧限压缩试验的结果具有较好的一致性。

关键词：道路工程；沥青混合料；弯拉试验；劈裂试验；拉伸模量；压缩模量；各向异性

中图分类号：U416.217 文献标识码：A

Comparison of Synchronous Measurement Method of Different Modulus for Asphalt Mixture

Abstract:

In order to determine the modulus of asphalt mixture more conveniently, the two new test methods to measure the modulus of asphalt mixture simultaneously were proposed based on the four point bending test and splitting test. The new calculating formulas were derived of tensile and compressive modulus for asphalt mixture under four-point bending loading model, which combining the equilibrium condition and the plane hypothesis in elastic mechanics. And on the basis of the test principle of splitting modulus and Hooke's law in two dimensional stress states, the other new calculating formulas were derived in splitting loading model. The modulus tests of four point bending, splitting, direct tension and unconfined compression were carried out separately. The results of tensile and compressive modulus gained by the two new methods were compared with the direct tension modulus tests and unconfined compression modulus tests.

And the correlations among them were analyzed. The result indicates that asphalt mixture is a kind of anisotropic material. The tensile and compression modulus show a significant difference obviously. The tensile and compressive modulus of asphalt mixture can be obtained by two methods simultaneously, which has a good agreement with direct tensile test and unconfined compression test.

Keywords: road engineering, asphalt mixture,bending test, splitting test, tensile modulus,compressive modulus,anisotropy

基于缓解城市热岛的新型路面材料研究

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摘 要： 市区与郊区温度的差异引起了人们对城市热岛效应的广泛关注。根据国内外学者在相关领域的研究进展，结合路面工程专业知识，通过理论分析、室内试验等手段，研发了一种能缓解城市热岛效应的新型光反射保水阻热多孔水泥路面材料。从保水、阻热和光反射三方面着手，以强度、工作性和空隙率为设计指标，通过在保水材料中掺加6%的硅灰、控制0.28～0.30的水灰比及18%～22%的目标空隙率，采用高铝质耐火碎石作为骨料成型阻热式多孔水泥混凝土，将水泥、硅灰和粉煤灰作为保水材料灌注于多孔水泥混凝土中，形成具有光反射降温、保水降温与阻热降温于一体的复合式降温水泥混凝土路面材料。它在满足路用性能的基础上具有优良的保水阻热作用，对于缓解城市热岛效应和最大程度上降低路面温度有着较好的效果。

关键词： 道路工程 新型路面材料 多孔水泥混凝土 城市热岛

Based on the New Pavement Materials Research to Slow the Progress of the Urban Heat Island

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Abstract:

Urban and rural differences in temperature has attracted people's attention to the urban heat island effect. According to the research progress of domestic and foreign scholars in related fields combined with the pavement engineering professional knowledge by theoretical analysis, laboratory tests and other means to develop light reflectance water retaining and thermal resistant cement concrete which can alleviate urban heat island effect. Based on water retention, heat resistance and light reflection technology integration, three aspects to strength workability and void ratio as the design index by adding 6% of silica fume in the water-retaining material control of 0.28 ~ 0.30 water cement ratio 18% ~ 22% of the target void fraction water-retaining materials including cement, silicon fume and fly ash were poured into thermal resistant porous cement concrete, which adopted high aluminum refractory gravel as aggregate with its high reflectance. It has excellent water-retaining and heat resistance effect on the basis of the road meet and has a good effect to ease the urban heat island effect as well as reduce the pavement temperature to the maximum extent.

Key words: Road engineering,New pavement materials,Porous cement concrete,Urban heat island

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Research on Time-temperature Characteristics of Strength and Fatigue Equation of Asphalt Mixture Based on Semi-circular Bending Test

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ABSTRACT:

The superpave gyratory compactor (SGC) was utilized to fabricate all asphalt mixture specimens. The semi-circular bending strength test and fatigue test were used in this paper. Then the semi-circular bending strength test was carried out at 8 loading rates and 3 temperatures, followed by

the semi-circular bending fatigue test at 5 load levels, the time-temperature characteristics of asphalt mixture strength were studied and the traditional fatigue equation and the fatigue equation based on nominal stress ratio were established, and the fatigue test results were analyzed from two aspects of displacement and energy. And according to the dynamic strength, the fatigue equation based on real stress ratio was obtained as well. The results showed that (1) asphalt mixture strength was affected by loading rate and temperature significantly, the relation between strength and loading rate could be approximately expressed as a power function; (2) the relation between fatigue life and stress level(or nominal stress ratio) could be also approximately expressed as a power function, the lower the stress level, the longer the fatigue life was, and the fatigue life and the cumulative energy consumption showed a good linear relationship in the double logarithmic coordinates; (3) the fatigue equation based on real stress ratio revealed the link between fatigue failure and strength failure.

KEYWORDS: road engineering, asphalt mixture, semi-circular bending test, time-temperature characteristics, fatigue equation, stress ratio

摘　要:本文采用superpave旋转压实仪成型沥青混合料试件，利用切割后的半圆试件进行半圆弯曲强度试验及疲劳试验。在8种加载速率和3种温度下开展半圆弯曲强度试验，并在5种荷载水平下进行半圆弯曲疲劳试验，研究了沥青混合料强度的时温特性并建立了传统的以及基于名义应力比的疲劳方程，从位移和能量两方面分析了疲劳试验。根据动载强度，建立了基于真实应力比的疲劳方程。研究结果表明：加载速率和温度对沥青混合料的强度影响显著，强度与加载速率之间可近似表示成幂函数形式；疲劳寿命与应力水平（或名义应力比）可近似表示成幂函数形式，应力水平越低，疲劳寿命越长，疲劳寿命与累积能耗在双对数坐标中表现出较好的线性关系；基于真实应力比的疲劳方程揭示了疲劳破坏和强度破坏之间的联系。

排水性沥青稳定碎石级配优化设计

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摘　要： 针对沥青路面排水性基层采用的排水性沥青稳定碎石（ATPB）耐久性差的问题，提出通过降低混合料的控制空隙率为10%¯14%、选用粗集料间断级配、增加细集料用量等措施，并通过路用性能的综合评估确定沥青用量的级配优化方法。以体积设计法为基础，对初拟的5组级配通过干捣试验测定了粗集料间隙率VCA，计算理论空隙率，利用旋转压实仪成型试件，采用真空密封水中重法实测其空隙率，再将空隙率满足要求的级配成型试件进行各项路用性能试验，并与AC-25的路用性能进行对比。最后选择满足排水要求，且各项路用性能最优的级配作为优选级配。结果表明按本文方法优化的ATPB-25满足排水要求，且各项路用性能均优于AC-25。

关键词： 排水性沥青稳定碎石；优化设计；间断级配；路用性能

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Gradation Optimization of Asphalt Stabilized Permeable Macadam

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Abstract:

The gradation optimization of asphalt stabilized permeable macadam was studied to improve its performance. The optimization object is set to control its void ratio at 10%~15%, using coarse aggregate gap gradation and more fine aggregates and asphalt binder, and its asphalt content can be designed according to its performance tests. Based on the volumetric method, 5

gradations were proposed with coarse aggregate gapped, and their void of coarse aggregate (VCA) were obtained through dry insertion tests, then the voids of every gradation were calculated, the samples were fabricated with SuperPAVE Gyratory Compactor to test their voids through the vacuum sealing and weight in water methods. The specimens were fabricated for the gradations whose air voids meet the objective to conducted performance tests, and the optimal gradation was chosen according to the performance results. The performance of optimized ATPB-25 was better than that of AC-25.

Keywords: asphalt stabilized permeable macadam; optimization design; gap gradation; pavement performance

大型钢桥高黏沥青桥面铺装体系疲劳性能研究

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摘　要： 为研究大型钢桥桥面高黏沥青混合料铺装体系的疲劳特性，开展了铺装层体系疲劳寿命预测研究。依托济南黄河三桥高黏沥青桥面铺装养护工程，测试了高黏沥青混合料的疲劳寿命，基于损伤-断裂力学理论和等效抗弯刚度原则获得铺装体系的疲劳寿命预估方程，以实测数据预估了实际工程中桥面铺装体系的疲劳寿命。结果表明：高黏沥青混合料在高应变水平下表现出良好的抗疲劳性能；在铺装层与桥面板保持良好粘接的条件下，桥面铺装体系具有远高于铺装层材料自身的疲劳寿命。

关键词： 大型钢桥，高黏沥青，桥面铺装，疲劳性能预估

Fatigue Performance Research of High Viscosity Asphalt Deck Pavement on Long-span Steel Bridge

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Abstract:

This paper focus on the fatigue life prediction of high viscosity asphalt deck pavement of the long-span steel bridge. Combined with the deck-paving rehabilitation project of Jinan Yellow River No.3 Bridge, fatigue performance of high viscosity asphalt mixtures was tested, and predicting equation of fatigue life of bridge deck-asphalt pavement system was derived based on damage-fracture mechanics and rule of equivalent bending rigidity. Furthermore, the fatigue life of practical bridge deck-asphalt pavement system was calculated using the fatigue test results. Results show that, high viscosity asphalt mixture has better anti-fatigue characteristics at high strain level, and bridge deck-asphalt pavement system can process outclass fatigue life under the terms of full bond between steel

bridge deck and asphalt deck pavement.

Keywords: Long-span Steel Bridge, High viscosity asphalt, Deck pavement, Fatigue performance prediction

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辽宁省道路石油沥青分级体系的研究

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摘　要： 本文依托辽宁省公路科技项目"辽宁省道路石油沥青地方标准的研究"（项目编号201501）科研成果，基于对辽宁省气候、交通条件的调查、分析与计算，提出了适合于辽宁省的按2℃分级的沥青PG分级体系，以及基于气候、交通等级、重载车辆比例选取沥青等级的方法。

关键词： 道路石油沥青；PG分级；交通等级

Study on Performance-graded System of Asphalt Binder in Liaoning Province

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Abstract:

Relying on scientific achievements of highway science and technology project of Liaoning province "Study on Local standards of asphalt binder in Liaoning province" (project number 201501),This paper covers asphalt binders graded by performance. Grading designations are related to the pavement design temperature, traffic loading and proportion of overloading vehicles in Liaoning province, and 2℃ grading standard is used in this new performance-Graded system.

Keywords： Standards of Asphalt Binder，Performance-Graded Asphalt Binder，Traffic Levels

Experimental Study on Road Performance of Basalt Fiber Reinforced Asphalt Binders

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ABSTRACT：This paper examines the physical and machanical properties of asphalt binder containing basalt fiber and other kinds of fibers as comparison by using different macroscopic and microscopic experimental methods. Experimental comparisons were made, in terms of adsorption performance, shear performance, crack resistance property and high temperature rheological property, between the innovative asphalt binder made with basalt fiber and asphalt binders made with two commonly used fibers. Then, the reinforcing mechanisms was explored by using SEM.Different types of samples with varying dosages and dimensions of the additives were studied, namely asphalt binder with 3%, 5%,7% and 10% of basalt fiber and that with 6mm and 9mm of basalt fiber. Laboratory test results indicate that basalt fiber have great effect on the ultimate tension and rheological properties of asphalt binders, which derived from that basalt fibers make them forming a network structure to disperse stress and made a contribution to the stability of asphalt mixture.

KEYWORDS: Basalt fiber; Asphalt binder; Rheological property; Ultimate tension;Reinforcing mechanism

The Initial-stage Performanceof Unbound Gravel Materials under the Single-stage and Multi-stage Loading Modes

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ABSTRACT:

To investigate the initial-stage permanent deformation and resilient modulus of theunbound gravel material (UGM) during the initial several hundred loading cycles, the triaxial tests were

conducted via the precision unbound material analyzer (PUMA). Three single-size gravels were used to carry out the single-stage loading model (SSLM) and multi-stage loading mode (MSLM) tests. The results of the first 400 loading cycles were analyzed and discussedemphatically.The growth of the permanent deformation was rapid when the loading level was smaller than 340kPa approximately for the MSLM. The permanent deformation of the initial stage accounted for the main parts within the 4000 loading cycles for the SSLM and the proportion became greater as the loading increasing. In addition, the permanent deformation curve would be better divided into three stages, and the 1000th loading cyclewould be the first demarcation point. The results indicated that the MSLM can improve the bearing capacity of the structure, which related to the importance of three-stage compaction during ¬pavement construction. The resilient modulus was calculated by the four models derived from the previous repeated CBR and triaxial tests. The equivalent modulus can be described better with the full-friction model. And the modulus value was lower than the results in the literatures, but they presented the same trends and lows. Compared with Constant Confining Pressure (CCP)model, the resilient modulus of Variable Confining Pressure (VCP) model showed a significantly increasing trend with the growth of the loading level. It proved that the effect of confining pressure was more significant with higher loading level.These findingscould be also used for the foundation to explore effect of the single-size gravels to the integral UGM.

KEYWORDS:unbound gravel materials; precision unbound material analyzer; permanent deformation; resilient modulus;single-stage loading model;multi-stage loading mode

基于摩擦学的表面活性剂类温拌沥青作用机理研究

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摘　要： 对温拌沥青的温拌作用机理研究是应用温拌沥青技术的本源性问题，但是，现有的沥青粘度理论无法准确地阐明温拌沥青温拌作用机理。为此，从沥青在沥青混合料中的实际薄膜状态为研究依据，引入润滑特性作为研究沥青的一个新属性，采用摩擦学理论及相应试验方法，研究沥青在沥青混合料中实际状态下的流变特性。采用球-三板和球-板摩擦试验方法，研究90℃¯135℃温度区间下沥青和沥青胶浆的摩擦特征。研究结果表明：球-三板摩擦试验和球-板摩擦试验可以通过摩擦系数的差异，区分温拌沥青和基质沥青特征；温拌沥青和基质沥青摩擦曲线均呈现摩擦系数快速上升、达到峰值、缓慢衰减和快速失稳四个阶段，但是，温拌沥青具有显著的平台期；温度对摩擦试验有一定影响，随着温度增加，摩擦系数逐渐增大；沥青胶浆摩擦系数比沥青摩擦系数偏大50%以上，温拌沥青胶浆与基质沥青胶浆摩擦性能差异10%左右，胶浆差异性比纯沥青差异性低。与传统沥青的粘度一个参数评定沥青混合料压实机理不同，表面活性剂类温拌沥青作用机理由高温时裹附性和低温时摩擦性两个参数组成，而温拌剂的润滑效应随着作用时间更为显著。

关键词： 道路工程；温拌沥青；润滑特性；球-三板摩擦试验；摩擦系数

Study on Mechanism of Surfactant Warm Mix Asphalt Based on Tribology

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Abstract:

The interpretation for mechanism is important issue of warm-mix asphalt (WMA), however, the sole use of viscosity is insufficient to characterize the role of the asphalt in mixture compaction. Given

that a thin film of asphalt coats the aggregate, the concept of using lubrication to evaluate asphalt has been implemented, and tribology theory and test are utilized to study rheology of asphalt in the thin film. Tribology of asphalt and asphalt mastic is measured by ball-on-three-plates test and ball-on-plate test at the temperature ranging from 90□to 135□. Results indicated that coefficient of friction was significantly different between asphalt and WMA, which was measured by the ball-on-three-plates test and ball-on-plate test; The Tribology Curve describes three regions: sharp increase, peak value, decay and destabilizing suddenly, and the Tribology Curve of WMA shows slower decay; It was also found that the coefficient of friction is sensitive to testing temperature, and coefficient of friction increases with the increase of temperature; the coefficient of friction of asphalt mastic is larger 50% than asphalt, and coefficient of friction WMA mastic is lower 10% than asphalt mastic, and asphalt mastic is less sensitive to coefficient of friction than asphalt. It is estimated compaction temperature only on the basis of viscosity traditionally, instead of that surfactant warm-mix asphalt can be estimated compaction temperature in according to coating at high temperature and tribological property at low temperature, and lubrication of warm additive play an important part with time.

Keywords： Road Engineering; Warm Mix asphalt; lubrication; ball-on-three-plates; Coefficient of friction

The Optimization Technique of Nano-TiO$_2$ Coating for Automobile Exhaust Degradation

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Abstract:

In order to optimize nano-TiO$_2$ coating for the degradation of automobile exhaust, anevaluation method was established, and the effect of carrier adhesive, dispersing method, content of nano-TiO$_2$ and abrasion of traffic was studied on the degradation efficiency of NO. It is founded that using reasonable shear rate, shear time and the content of nano-TiO$_2$ can improve the degradation effect of NO; The base composition of carrier adhesive has an adverse effect on the degradationefficiency of NO; nano-TiO$_2$ coating has adverse effect on the anti-slide performance of asphalt pavement, but adding emery in coating can improve the situation, and has little effect on the degradation efficiency; nano-TiO$_2$ coating has better durability on the degradation efficiencyof NO, however its durability on anti-slide performance is poor.

Keywords: asphalt pavement; nano-TiO$_2$; coating; automobile exhaust

Study on Fatigue Damage Characteristics of Asphalt Mixture under Different Loading Conditions

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ABSTRACT:

Based on the strain-controlled four-point bending fatigue test, the effects of temperature, frequency, and strain value on the fatigue damage properties of asphalt mixture were studied, meanwhile, variable amplitude fatigue test was carried out to verify the adaptability of Miner's rule to the damage accumulation of asphalt mixture. The results show that: under strain-controlled mode, the lower the temperature, the shorter the fatigue life and the greater the cumulative dissipated energy; the higher the frequency, the greater the fatigue life and the greater the cumulative dissipated energy; the

greater the strain, the shorter the fatigue life, and the smaller the cumulative dissipated energy. With the increasing of load cycles, the phase angel becomes greater, the increasing rate under high frequency or high strain level is greater than that under low one. The damage under high-low load sequence is greater than that under low-high load sequence, while the difference between load level is greater or the temperature is lower, the phenomenon is more obvious.

KEYWORDS: asphalt mixture; temperature; frequency; strain value; load sequence

新型填充式桥梁伸缩缝改性沥青混合料路用性能试验

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摘　要： 桥梁伸缩缝受桥梁整体结构挤压、车辆荷载及温度荷载的反复综合作用，易产生局部沉陷、拥包及界面开裂等病害，属于桥梁构造的薄弱部位。为提高桥梁伸缩缝的路用性能，本研究选用一种新型改性沥青桥梁伸缩缝专用沥青混合料，测试并分析其高温稳定性、水稳定性、低温抗裂性、疲劳性能、拉伸性能、粘结性能等路用性能，对比分析了不同试验温度条件下性能的变化规律。结果表明：该新型桥梁伸缩缝专用沥青混合料具有良好的路用性能，尤其其抗拉强度、粘结强度及线收缩系数等性能优异，能够满足桥梁伸缩缝反复伸缩的变形要求。研究成果为改性沥青桥梁伸缩缝材料的设计和施工提供了的试验支撑。

关键词： 改性沥青混合料；填充式桥梁伸缩缝；路用性能；伸缩变形

Experiment on Performance of A New Modified Asphalt Mixture for Stuffed Bridge Expansion Joint

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Abstract:

Under the comprehensive influences of the overall deformation of the whole bridge structure, the repeated moving vehicle and temperature loading, the bridge expansion joint was the weak part of bridge structure. Therefore, asphalt expansion joints should have excellent pavement performance. The paper chose a new type of modified asphalt mixture as the asphalt bridge expansion joint. The pavement performance of modified asphalt mixture was evaluated with high temperature stability, moisture susceptibility, low temperature anti-cracking, fatigue properties,

tensile properties and bonding properties. Meanwhile comparative analysis the change rule of road performance under different test temperatures and conducted its regression prediction models. The test results indicated that: this new type of bridge expansion joint has good road performance. And the tensile strength, bonding strength, linear contraction coefficient have some advantages to meet the requirements of the bridge expansion joints repeated expansion deformation. The research results provide basis for improving the design and construction technology of modified asphalt stuffed bridge expansion joint.

Keywords: modified asphalt mixture; stuffed bridge expansion joint; pavement performance; telescopic deformation

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Study on the Performance and Action Mechanism
of New Priming Oil

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ABSTRACT:

Because of a large amounts of volatile organic solvents (VOC) in common primers, the poor function of primers between asphalt layers and base layers has became one of the main reasons for early damage of asphalt pavement, meanwhile effective methods to evaluate the performance of primers is few in the existing domestic specification. In order to solve these problems, an eco-friendly material and some designed indoor test methods has been developed to compare the properties and action mechanism with other three kinds of common material. The results showed that the performances of the material were effectively distinguished by the

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self-designed test methods and the performances affect factors were explained from the action mechanism. The comprehensive performance of the new primers was better than the other three kinds of materials, the inter-laminar adhesion and consolidation effects of new primers on the base surface were significantly enhanced by the curing agent. Therefore, if this material could be widely used in construction, the layers' functionality could be enhanced and pavement early damages could be effectively reduced. Hoping practical projects and new test methods could be implemented to verify the performance of new primers.

KEYWORDS: asphalt pavement, prime coat, emulsified asphalt, permeability, interlayer bonding performance, anti-scouring performance

车轮荷载作用下沥青路面细观力学响应

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摘　要： 通过FISH语言编程建立包含上面层、中面层和下面层的沥青面层三维细观结构离散元模型，模拟了沥青路面在标准轴载下的细观力学响应，研究了沥青面层各层内法向接触力和切向接触力的分布情况、沥青砂浆之间、粗集料和沥青砂浆之间以及粗集料之间接触力个数和接触力之和的比例以及接触力的均值。研究结果表明：在荷载作用下沥青面层内接触力数值分布在很大的区间内，沥青混合料内部受力具有高度的不均匀性；沥青面层内粗集料之间的接触力个数仅占10%左右，但粗集料之间的接触力之和占接触力总和的比例超过了50%，是车轮荷载的主要承担者；沥青面层各层内粗集料之间的法向接触力的均值在5 N左右，切向接触力的均值在2 N左右。

关键词： 车轮荷载；沥青路面；离散元；细观力学响应；接触力

Meso-mechanical Response of Asphalt Pavement under Vehicle Load

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Abstract:

A three-dimensional meso-structure discrete element model of asphalt layer including top layer, middle layer and bottom layer was generated with the FISH programming language and the meso-mechanical response of asphalt pavement under vehicle load was analyzed. Firstly, the contact force distribution in asphalt layer was studied. The results show that the contact forces distribute in a large range and so that the load distribution within asphalt mixture is highly uneven. Secondly, the

percentages of the number and sum of the contact forces in asphalt mastic, in coarse aggregates and between asphalt mastic and coarse aggregates were analyzed. The results shows that the percentage of contact force number in coarse aggregates is only about 10% while the percentage of the sum of contact forces in coarse aggregates is over 50%, which demonstrates that the coarse aggregates bear most of the vehicle load. Finally, the means of the contact forces in asphalt mastic, in coarse aggregates and between asphalt mastic and coarse aggregates were computed. The results indicates that the mean of the normal contact forces in coarse aggregates is about 5 N and the mean of the shear contact forces in coarse aggregates is about 2 N.

Keywords: Vehicle load; Asphalt pavement; Discrete element method; Meso-mechanical response; Contact force

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沥青路面用水性环氧热反射涂料性能研究

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摘　要： 采用相反转法合成一种水性环氧乳液，考察了乳液合成工艺对乳液性能的影响。以该乳液为基料制备路用热反射涂料，研究了热反射涂料的室内外及实际路面的降温效果，并测试了涂层试件的耐磨性能、抗滑性能等路用性能。结果表明，当乳化剂用量23%，乳化温度60℃，剪切速度3500n/min，滴水速度2mL/min时所得乳液性能较优；铁红颜料的较佳掺量为2%，在AC沥青路面上，热反射涂料的用量宜为1.0kg/m2，此时该涂层的室内降温值为11.5℃，室外降温值为7.6℃，实际路面降温值为8.2℃；热反射涂层具有良好的耐磨性能、抗渗水性能等，但涂料会降低路面的抗滑性能，添加石英砂以满足行车安全性要求。

关键词： 相反转法；水性环氧乳液；路用热反射涂料；降温效果；路用性能

Performance of Waterborne Epoxy Heat-reflective Coating for Asphalt Pavement

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Abstract:

Waterborne epoxy emulsion was prepared by phase inversion, and the factors of synthesis

technics on the emulsion performance was investigated. The emulsion was selected as film-forming material to prepare heat-reflective coating. The indoor and outdoor cooling effect of heat-reflective coating were evaluated, and the pavementcooling effect and performance of the coating were also studied. Optimum synthesis technics were as follows: emulsifier dosage was 23%, emulsifying temperature was 60℃, shearing speed was 3500n/min and dripping speed was 2mL/min. The better content of iron oxide red was 2%, and when the coating dosage was 1.0kg/m2, the indoor and outdoor and pavement cooling value were 11.5℃, 7.6℃ and 8.2℃, respectively. The pavement coating had good wear-resisting and anti-permeability performance. However, the anti-sliding performance partly declined, and anti-sliding aggregates were added to meet the security requirements.

Keywords: phase inversion; waterborneepoxy emulsion; heat-reflective coating; cooling effect; pavement performance

Mix Design and Performance Evaluation of Buton Rock Asphalt Modified Superpave-25 Mixture

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ABSTRACT:

The main objectives of this study are to conduct mix design and evaluate of performance of buton rock asphalt (BRA) modified Superpave-25 mixture through wheel tracking test, freeze-thaw indirect tensile test, beam bending test, dynamic modulus test, and the flow number (FN) test.The results showed that the high temperature performance and moisture susceptibility of BRA modified Superpave-25 mixture were improved, but the low temperature performance was slightly declined

compared to the control mixture (Superpave-25 mixture without BRA). The values of E*/sinφ of Superpave-25 mixture were larger than those of the control mixture at various test temperatures and loading frequencies. The FNvalues of BRA modified Superpave-25 mixtures were also bigger than those of the control mixture. In conclusion, BRA modified Superpave-25 mixture has the excellent high temperature performance ofresistance torutting.

KEYWORDS: Buton rock asphalt (BRA);Superpave mixture; Mix design; Performance;Dynamic modulus;Flow number (FN)

Rheological Properties and Microstructure of Cement Modified Emulsified Asphalt Mortar

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ABSTRACT:

Cement Modified Emulsified Asphalt Mortar (CMEA) is widely applied in semi-flexible base to alleviate pavement cracking disease. In this study, dynamic shear amplitude scanning, frequency scanning, temperature scanning test, Scanning Electron Micrographs (SEM) and Energy Dispersive Spectrometer (EDS) analysis were adopted to investigate the mechanical performance, rheological properties and modification mechanism of CMEA with 10, 55 and 110% cement by mass of emulsified

asphalt after seven days standard curing. Amplitude scanning results illustrated that 0.5% strain percentage was found to be the optimum strain value in the range of 0.01~1000% ensuring all CMEA samples remain in the linear viscoelastic range when samples were tested at loading frequency of 1, 10, 50, 100 rad/s and under temperature varying from 50 to 80°C. Frequency and temperature scanning test results indicated that the mechanical performance and plastic deformation resistance of CMEA was enhanced, while the anti-fatigue property was reduced, as the cement content increased. SEM observation and EDS analysis exploring the modification mechanism of CMEA demonstrated that CMEA with 55% cement presented desirable mixture dispersed network. The uniformly distributed hydration products and non-hydrated cement particles in the stable mixture system contributed greatly to the excellent comprehensive performance of cement modified emulsified asphalt.

KEYWORDS: Semi flexible base, Cement modified emulsified asphalt, Dynamic shear rheological tests, Modification mechanism.

Analysis of Preparation and Properties on Shape Memory Hydrogenated Epoxy Resin Used for Asphalt Mixtures

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ABSTRACT:

Shape memory epoxy resin has been widely used in the biomedicine, aerospace and textile fields for its excellent process-ability, low recovery temperature and good shape memory performance.

However, there are little research results at present about applying the shape memory epoxy resin to highway engineering, especially the asphalt mixture. The objective of this investigation is to prepare the shape memory hydrogenated epoxy resin used for asphalt mixtures (SM-HEP-AM) and study its properties. The shape memory hydrogenated epoxy resin (SM-HEP) is prepared using the hydrogenated bisphenol A epoxy resin(AL-3040), polypropylene glycol diglycidylether diacrylate (JH-230) and isophorone diamine(IPDA). The formulations of the SM-HEP-AM are obtained by the linearly fitted method. The thermo-mechanical property, molecular structure and shape-memory performance of the SM-HEP-AM were studied. The glass-transition temperature (Tg) is determined using the differential scanning calorimeter (DSC). It proved that the Tg increased when the JH-230 content decreased. The thermo-mechanical property of the SM-HEP-AM is measured by the dynamical mechanical analysis (DMA). The storage modulus of the SM-HEP-AM decreased with the increase in JH-230 content. The above phenomena are attributed to the change in the JH-230 content. The shape memory performance results of the SM-HEP-AM indicate that the dumbbell-shaped specimen deformation can completely recover after only several minutes at Tg+10ºC and Tg+20 ºC. The shape recovery time of the SM-HEP-AM increases with increased JH-230 content, and the change between the shape recovery time and JH-230 content gradually decreased as the temperature increased.

KEYWORDS: road engineering; asphalt mixture; shape-memory hydrogenated epoxy resin; glass-transition temperature; shape-memory performance.

氧抗滑封层路用性能试验研究

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摘　要： 鉴于传统的预防性养护技术往存在加铺层使用寿命短、粘结力不足等诸多问题　鉴于传统的预防性养护技术往存在加铺层使用寿命短、粘结力不足等诸多问题，研究新型路面养护方式，以此来提高沥青混凝土路面表面层的抗老化能力，　增强路表服务功能。本研究采用自主研发的封层车和铣琢等一体化施工设备进　层车和铣琢等一体化施工设备进　层车和铣琢等一体化施工设备进　层车和铣琢等一体化施工设备进行试验路的铺筑，通过抗滑性能试验（铺砂法、摆式仪实验）、平整度试验和渗水性能试验，证明了环氧抗滑封层能显著提高路面的抗滑性能，并能有效防止路表水下渗，从而保护了路面结构层。试验路的施工和检测结果表明，环氧抗滑封层是在公路养护维修时很有推广前景的道路预防性养护材料。

关键词： 水性环氧；　抗滑性能；乳化沥青 ；预防性养护

中图分类号：U418

The Study on Epoxy-based Sliding Sealing Technology of Asphalt Pavement

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Abstract:

In view of the problems existing in the traditional preventive maintenance technology, such as short service life, poor bonding between the layers of the road, from the consideration of improving the aging ability and road performance, a new type of pavement seal coating called Epoxy-based Sliding Sealing Technology has been developed in this study. Self-developed sealing and milling vehicles and some other integrated equipment were used on the construction of the test road.From the MTD,

roughness test and permeability test which were conducted on the test road, it is proved the Epoxy-based Sliding Sealing can significantly improve the anti-slide performance of original pavement. In addition, the water could be prevented by the sealing, so the pavement structure layer will be protected. The field data indicate that the Epoxy-based Sliding Sealing Technology is an efficient style in highway preventive maintenance.

Keywords: Epoxy-based /anti-Sliding/modified asphalt/ preventive maintenance

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Investigation of the Aging Properties of Multi-dimensional Nanomaterials Modified Different Bitumens

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ABSTRACT:

Multi-dimensional nanomaterials consisting of nano-zinc oxide (nano-ZnO) and organic expanded vermiculite (OEVMT) was utilized to improve aging resistance of different types of bitumen. The distinction of three types of bitumen in chemical composition and the influence of multi-dimensional nanomaterials on bitumens were evaluated by Fourier transform infrared (FTIR) spectroscopy. Carbonyl index (IC=O) and viscosity aging index (VAI) were defined to evaluate aging degree of binders in chemical property and physical property, respectively. These binders were aged by thin film oven test (TFOT), pressure aging vessel (PAV) and ultraviolet radiation (UV) aging. Results show that there are some differences in chemical composition among 70#, 90# and 110# bitumensaccording to FTIR analysis. Additionally, with the interfusion of multi-dimension nanomaterials, the deterioration in physical properties and the carbonyl formation areprevented significantly when bitumens undergo TFOT, PAV or UV aging. However, for TFOT, PAV and UV aging, the improvements of the multi-dimension nanomaterialsin aging resistance of the binders depend on the evaluation methods and the nature of the base bitumen.

KEYWORDS: Bitumen; Multi-dimensional nanomaterials; Aging; Viscosity; Fourier transform infrared spectroscopy.

两种改性沥青混合料的疲劳特性试验研究

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摘　要：湖沥青作为天然沥青改性剂在高温稳定性、耐久性、抗老化性能、抗剥落性以及沥青路面再生利用方面有着诸多聚合物改性剂不可比拟的优点而越来越受到关注。通过应用BFA气动四点弯曲小梁疲劳试验机对湖沥青改性沥青混合料、SBS改性沥青混合料以及基质沥青混合料AC-20进行疲劳寿命试验研究，并在此基础上对不同混合料进行疲劳极限预估研究。通过研究混合料的疲劳特性对沥青混合料的耐疲劳性能有一定改善作用　，也对延长沥青路面的使用寿命大有裨益，最终可以起到节约公路建设维护费用，对提高高等级公路的社会效益和经济效益有着至关重要的作用。

关键词：道路工程; 湖沥青改性沥青; SBS改性沥青; 沥青混合料; 疲劳特性; C值; m值; 疲劳极限

The Experimental Study on Fatigue Properties of Two kinds of Modified Asphalt Mixture

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Abstract:

TLA modified asphalt has advantages in high temperature stability,durability,anti-aging properties, spolling resistance and the recycled use of asphalt pavement,which polymer modified bitumen unparalleled.In this paper,the fatigue life of the lake asphalt modified asphalt, SBS modified asphalt and asphalt mixture were tested under two common grading AC-13, AC-20 By applying BFA pneumatic four-point bending beam fatigue testing machine for next to the lake,and the limits of fatigue were estimated upon the fatigue life.The studying of fatigue life can improve the characteristics of

asphalt mixture,also can extend the life of asphalt pavement .The study has a great benefit to save the road construction and maintenance cost savings, also can improve the social and economic efficiency of highway.

Keywords:road engineering; TLA modified asphalt; SBS modified asphalt; Asphalt mixture; fatigue properties; the value of c; the value of m; estimated fatigue limit

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Application Technology of Construction Waste in Subgrade

of Jingxin Highway

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ABSTRACT:

Based on the analysis of the construction waste near the Jingxin project, according to different requirements on different parts of the fill subgrade, different disposal methods for the construction waste are put forward in the paper. In the subgrade non-work area, on-site crushing for the construction waste was carried out, and filled to the bottom of the subgrade directly; the quality control requirements were achieved through the impact of rolling, vibration rolling and compaction on subgrade. In the subgrade work area, the construction waste was sorted, crushed, sieved and blended with lime-ash soil, and the compressibility, permeability and CBR value of the improved soil were experimentally studied, its feasibility was verified.

KEYWORDS: fill subgrade; construction waste; lime - fly ash improvement; indoor experiment; field compaction

一种生态混凝土——透水混凝土性能及应用综述

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摘 要： 简要介绍了透水混凝土的性能及应用。总结分析了透水混凝土在材料组成、配合比设计、力学性能、孔隙特性等方面的研究成果，以及其作为一种生态混凝土的应用现状。针对透水混凝土在当前应用中存在的问题提出了建议，并对其进一步发展进行了展望。

关键词： 透水混凝土；生态混凝土；力学性能；透水性

中图分类号：TU 528.37

Performance and Application of Pervious Concrete as a kind of Ecological Concrete: a review

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Abstract:

The performance and application of pervious concrete are reviewed in this paper. The study results of pervious concrete onmaterial composition, mix design, mechanical properties and pore characteristicsare summarized and analyzed, as well as the application of the pervious concrete asa kind of ecological concrete.This review proposes suggestions towards theproblems of the pervious concrete existing in thecurrentapplication, and discussesits further development.

key words: pervious concrete; ecological concrete; mechanical properties; permeability

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Portland Cement Hydration at Low Temperatures: Views from the Calculation and Experimental Study

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Abstract:

Portland cement must be hydrated in cold climates in some particular conditions. Therefore,a better understanding of cement hydration under low temperatures would benefit the cement-based composite application. In this study, Portland cement was therefore kinetically and thermodynamically simulated based on a simple kinetics model and minimization of Gibbs free energy. The results of an evaluation indicate that Portland cement hydration impact factors include the water–cement ratio (w/c), temperature,and specific surface area, with the latter being an especially remarkable factor. Therefore, increasing the specific surface area to an appropriate level may be a solution to speed the delayed hydration due to low temperatures. Meanwhile, the w/c ratio is believed to be controlled under cold climates with consideration of durability. The thermodynamic calculation results suggest that low-temperature influences can be divided into three levels: irrevocable effects (<0°C), recoverable effects (0~10°C), and insignificant effects (10~20°C). Portland cement was additionally measured via X-ray diffraction, thermal gravity analysis, and low-temperature nitrogen adsorption (Brunauer–Emmett–Tellemethod)ina laboratory and comparisons were drawnthat validate the simulation result.

Keywords: Portland cement; Cold climates; Low temperature; Calculation; Hydration

废弃碳粉改性沥青的PG性能试验

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摘　要： 针对目前各种添加剂的应用现状，提出了利用打印机废弃碳粉作为改性剂对沥青进行改性。采用4因素3水平正交试验，检测各制备参数下碳粉改性沥青的三大指标，确定其制备参数，得出最佳室内制备工艺参数。在此条件下将不同掺量的改性沥青进行PG性能试验。并采用DSR、BBR及PAV等方法对碳粉改性沥青进行了高温性能、低温性能、疲劳性能和旋转粘度进行研究。研究表明：改性沥青的最佳剪切温度为155℃，剪切时间为30min，剪切速率为4000r/min；在此的条件下制备的改性沥青，添加碳粉后其PG高温等级比基质沥青要高，在添加量为10%时达到76℃等级；添加碳粉后其低温性能有所降低，但添加量不超过10%时，对其低温性能影响不大，且对沥青路面的施工工艺的影响较小。

关键词： 道路工程；废弃碳粉；改性沥青；PG性能试验

中图分类号：U416

PG Performance Test of Waste Carbon Powder Modified Asphalt

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Abstract:

Aiming at the current status of application of various additives, proposed the use of the printer waste carbon powder that is used as a modifier for asphalt modification. By using 4 factors 3 orthogonal experiments, testing the three indexes of carbon powder modified asphalt under the different prepared parameters to identify preparation parameters of it and it is concluded that the

best indoor preparation process parameters. At this condition, use the different dosage of modified asphalt to carry out PG performance test. And study the high temperature stability, low temperature crack resistance and rotational viscosity for asphalt by adopting the method of DSR, BBR and PAV. The results show that modified asphalt's best shearing temperature is from 150℃ to 160℃, shearing time is 30 minutes, shearing rate is 3500-4500r/min;The modified asphalt which product under this condition, after adding the carbon powder, the PG high temperature grade is higher than base asphalt, and reach 76 degrees grade in adding 10%; At the same time, after adding the carbon powder, the low temperature performance reduce, but when adding less than 10%, it has little effect on low temperature performance; it also has no influence to the construction of asphalt pavement after adding the carbon powder.

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李闯民，男，湖南宁乡人，博士，长沙理工大学公路工程学院教授，硕士研究生导师。现主要从事沥青和沥青混合料设计与施工，公路工程检测技术、道路专业英语，路基路面工程等方面的教学和科研工作。主攻领域：路面结构与材料，公路工程检测技术。电话：13875908009，邮箱：13875908009@126.com。

多孔沥青混合料压实特性研究

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摘　要：Superpave设计方法中利用空隙率指标确定混合料设计压实次数的方法不适用于多孔沥青混合料。本文研究典型多孔沥青混合料在旋转压实过程中压实特性的变化过程，并确定合理的设计压实次数。根据空隙率、VCA比及飞散损失随压实次数的变化过程，研究多孔沥青混合料功能特性、骨架结构、耐久性与压实特性的关系。试验结果表明，满足空隙率不大于22%的最小设计压实次数为31次，形成稳定骨架结构所对应的最小设计压实次数为45次。过多的压实次数将导致集料的破碎，骨架结构稳定性降低，由飞散损失曲线确定的最大设计压实次数为77次。基于功能特性、强度与耐久性的平衡，多孔沥青混合料合理的压实次数应在45-77次之间，设计压实次数的具体取值应依据设计交通量的大小确定。

关键词：多孔沥青混合料；旋转压实；空隙率；压实特性；设计压实次数

Gyratory Compaction Characteristics of Porous Asphalt Concrete

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Abstract:

In the Superpave design method, using the porosity indexof asphalt concrete to determine the number of compaction times,however,it's not suitable for the porousasphaltconcrete. In this paper, usingthecompaction characteristicofporousasphalt mixture todeterminethe reasonable designcompactiontimes. According to the data of porosity,VCA ratio and Cantabroloss test, to research the relationship between functional characteristics, skeleton structure, durability and compaction characteristics of porous asphalt concrete. The results show that the minimum number of compaction

times for 22% porisity is 31 times, and the minimum number of compaction times for forming the stable skeleton structure is 45 times. Too much compaction will reduce the stability of the skeleton structure, and the maximum number of design compaction times determined by the Cantabro loss curve is 77 times. Based on the functional characteristics, strength and durability, the reasonable compaction times between 45-77 times, and the accurate value of the design compaction times should be determined by the size of the traffic volume.

Keywords:porous asphalt mixtures,gyratory compaction,porosity,compactioncharacteristic,designcom pactiontimes

基于半正弦荷载的沥青混合料力链量化分析

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摘　要：为了研究沥青混合料内部颗粒间力链的演化及分布规律，以AC-13沥青混合料作为研究对象，利用离散元方法重构沥青混合料数字试件，模拟简单性能试验，提取试件内部颗粒间的力链信息进行力链演化、概率分布和角度分布分析。结果表明：通过比较预测结果和实测结果，基于离散元方法重构的AC-13沥青混合料细观模型用于模拟其细观力学特性是可行的；试件内部力链空间分布具有各向异性，以垂直方向的压力力链为主，承受大部分的半正弦荷载；法向力链概率分布随加载时间的变化规律基本一致，接触力与平均接触力比值f最小时，概率分布出现最大值，f=1.75时，概率分布再次达到峰值，然后逐渐减小并趋于稳定；力链角度分布主要位于90o和270o附近，强力链比例大于50%，但最大仅为51.12%。

关键词：沥青混合料；力链演化；力链概率分布；力链角度分布；离散元方法

中图分类号：**U416.217**

Quantitative Analysis on Force Chain of Asphalt Mixture Under Haversine Loading

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Abstract:

AC-13 asphalt mixture was taken as the research object to investigate the evolution and distribution laws of force chains inside the asphalt mixture. A digital specimen of AC-13 asphalt mixture was reconstructed using the discrete element method (DEM) to simulate the simple performance test (SPT). Next, the force chain information among aggregate particles was extracted

to analyze the evolution, probability distribution and angle distribution of force chains. The results indicate that the AC-13 mesoscopic model reconstructed using the discrete element method is feasible to simulate the mesoscopic mechanical properties of asphalt mixture by comparing the predicted results and laboratory test results. The spatial distributions of force chains are anisotropic, which are mainly the compressed force chains in vertical direction and sustain most of the Haversine loading. The probability distributions of normal force chains vary with loading time are consistent. The probability distribution has the maximum value at the minimum f (the ratio of contact force and mean contact force), at f = 1.75, it appears the peak value again, then gradually decreases and tends to be stable. In addition, the angle distributions of force chains mainly locate near 90º and 270º, the proportions of strong force chains are greater than 50%, but the maximum proportion is only 51.12%.

Keywords: asphalt mixture; evolution of force chain; probability distribution of force chain; angle distribution of force chain; discrete element method

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Investigation on the Properties of Machine-crushed Mountain Sand

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ABSTRACT:

It is an inevitable trend that the manufactured sand (MS) or machine-crushed mountain sand (MMS) will be used in major construction projects. The high-quality MMS was prepared with an impact crusher. This system utilize rotor with a high rotation speed to break the materials. The broken particles are washed with water which simulates the scouring and milling process of water to natural river sand (NRS). The water that has been used in washing can be used again and the soil precipitates at the bottom of the tank is shipped to the farmland nearby. The results show that the mineral composition of MMS was same as NRS. The main mineral components of the MMS are quartz, feldspar and mica. However, compared to the NRS, the surface of MMS is rougher. The water absorption capacity of the MMS was 1.37%, much higher than that of the NRS (0.73%). Furthermore, the quassation value of MMS is 22%, which is higher than that of the NRS (12%). The variance between MMS and NRS led to the different techniques and methods in preparation of concrete. Hence, it can be concluded that the MMS can be utilized to produce the concrete with high workability, high performance and high durability.

KEYWORDS:machine-crushed mountain sand(MMS), natural river sand(NRS), preparation, property.

The Effects of Nano Hydrated Lime Particles on Water-foamed Asphalt

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Abstract:

Water-foamed Warm Mix Asphaltbased on foaming technology is generally considered one of the eco-friendly technologiesfor producing asphalt mixture. This study was conducted to investigate the physical properties of water-foamed asphalt mixed with nano hydrated lime and to evaluate the dispersed situation of nano hydrated limeparticles in water-foamed asphalt using the scanning electron microscopy test (SEM). The nano hydrated lime was added to the water to make suspensions, and the suspensions were mixed with the original binder to form nano hydrated limemodified water-foamed asphalt. The dynamic shear rheometer (DSR) was used to investigate the rutting and fatigue cracking properties of the asphalt binder while the asphalt binder cracking device (ABCD) was carried out to evaluate the thermal cracking temperatures of asphalt binders.The SEMimage shows that the nano hydrated lime particles were well dispersed in the water-foamed asphalt. Nano hydrated limemodified water-foamed asphalts exhibited a lower rutting and fatigue cracking potential compared to the original asphalt.However, the addition of nano hydrated lime to the foamed asphalt increased the possibility oflow temperature cracking compared to the original binder, and the different proportions of nano hydrated lime used did not violate the SuperpaveTM low temperature cracking specifications. Therefore, the nano hydrated lime particles could be well dispersed in the asphaltbased onwater foaming technology, and nano hydrated limemodified water-foamed asphalt creates possibilities to reduce the rutting and fatigue crackingof asphalt binder.

Keyword: Water-foamed warm mix asphalt; nano hydrated lime; dynamic shear rheometer (DSR); asphalt binder cracking device (ABCD) test; energy demand

基于三类沥青温拌改性技术的机理分析与性能研究

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摘　要：利用XRD、差热分析、红外光谱等测试手段，对基于沸石类矿物、石蜡类和乳化平台的三类温拌沥青改性技术进行机理分析，为温拌改性剂材料的研究与应用提供一定的理论支撑与技术指导。同时，选取AC-13C和SMA-13，对温拌沥青混合料的路用性能进行试验研究。结果表明，温拌改性剂可有效降低击实温度10¯35℃，路用性能指标良好，但在极端高温和寒冷气候下，温拌沥青混合料的部分性能受到一定程度的不利影响，在实际应用中应予以关注和避免。

关键词：沥青 温拌 机理 路用性能

Mechanism Analysis and Performance Study of WMA Technology

Abstract:

　　Using XRD, Differential Thermal Analysis(DTA), Infrared Spectrum and other testing methods, the mechanism of three kinds of Warm Mix Asphalt(WMA) based on Zeolite Mineral, Fisher-Tropsh Paraffin and Dispersion Asphalt Technology(DAT) was analyzed. At the same time, the experimental study on the Pavement performance of WMA mixture was carried out by AC-13C and SMA-13. The results show that the temperature and the modified agent can effectively reduce the impact of 10~35℃, but the performance is good, but in the extreme high temperature and cold climate, the performance of WMA mixture is a certain degree of adverse effect, which should be paid attention and avoided in the practical application.

Keywords：Asphalt; Warm Mix; Mechanism; Pavement performance

Mafilon在我国南方潮湿山区公路的适用性研究

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摘　要：通过采集南方潮湿山区的气候条件，结合Bayes判别理论确定其路面凝冰形式和凝冰风险。再通过试验确定Mafilon对沥青混合料的影响，并评价Mafilon在该气候条件下的抗凝冰性能。对Mafilon在南方潮湿山区公路的适用性进行辩证分析，得出Mafilon在南方潮湿山区公路的适用性建议。

关键词：南方潮湿山区公路；凝冰形式；凝冰风险；Mafilon

The Applicability Study on the Mafilon for Wet Mountain Road in the Aouth of China

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Abstract:

By collecting the climatic conditions of the wet mountainous areas in the south and combining the Bayes discriminant theory, to determinethe icing mode and icing risk. Then some experiments have been carried out to confirm the effect of Mafilon on the asphalt mixture ,and make an evaluation onthe freezing inhibiting performance of Mafilon onthis climatic conditions .At last,analysis the applicability of Mafilon for wet mountain road in the south of China dialectically, and get applicability advice of Mafilon.

key words: wet mountain road in the south of China;icing mode; icing risk; Mafilon

Effect of Short-term Aging on Rheological Properties of Crumb Rubber and SBS Modified Asphalt Binders

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ABSTRACT:

The effect of short-term aging on crumb rubber (CR) modified asphalt and styrene–butadiene–styrene (SBS) modified asphalt is investigated. The short-term aging was conducted using a rotating thin film oven (RTFOT). The dynamic shear rheological (DSR) test and repeated creep recovery test (RCRT) were performed to measure the pertinent rheological parameters while scanning electron microscopy (SEM) was employed to observe the change of internal structure in asphalt from

mesoscopic view due to short-term aging. The rheological properties of the asphalt binders in terms of their complex modulus(G*), overall resistance to deformation, storage modulus(G'), binder elasticity, loss modulus(G"), viscous behavior and phase angle(δ), viscoelastic behavior were measured by DSR; accumulative strain($\sum\varepsilon$), deformation recovery capacity (εP /εL) and the viscous part of creep stiffness Gv were measured by RCRT. To evaluate the effect of different modifiers on the viscoelastic response of asphalt, the temperature (20℃-80℃) and frequency (0.1rad/s-100rad/s) dependence of the dynamic viscoelastic properties are compared. The result indicate that crumb rubber (CR) modified asphalt has better rheological properties in all temperature and frequency whether asphalt aging or not.

KEYWORDS: Aging; Rheological properties; Viscoelastic; Resist deformation capacity; Deformation recovery capacity

老化SBS改性沥青二次改性再生工艺研究

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摘　要：为研究老化SBS改性沥青的二次改性再生效果，比较不同工艺对再生效果的影响，本文首先通过常规试验、SHRP试验选择恰当的SBS改性沥青老化模拟方式；然后对添加SBS改性剂、新沥青进行再生的3种工艺展开研究，并借助红外光谱试验分析不同掺加顺序对老化SBS改性沥青再生效果的影响，确定了改性剂及新、旧沥青的最佳比例和最佳工艺。试验结果表明：采用RTFOT试验进行老化模拟更加方便、科学，RTFOT试验5h获得的改性沥青指标与服务年龄为7年的SBS改性沥青一致；SBS改性剂、新沥青添加顺序与老化沥青再生效果关系密切，先将SBS改性剂和新沥青混合制备改性沥青，再将改性沥青与老化沥青混合的工艺可使再生沥青性能最佳，其中SBS最佳掺量为4%，新、旧沥青比值为2。

关键词：道路工程；SBS改性沥青；二次改性再生；最佳工艺；最佳掺量

中图分类号：U416　　　　**文献标识码**：A

Research on Re-modified Recycling Process of Aging SBS Modified Asphalt

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Abstract:

To study the re-modified recycling effect of SBS modified asphalt and compare the influence

on different recycling process, the SBS modified asphalt aging simulation method was selected by the routine test and the SHRP test firstly in this paper. Then three kinds of processes were researched about recycling method that adding SBS modifier and new asphalt. On the basis of infrared spectrum test, the influence of different processes to recycling effect of aging SBS modified asphalt were analyzed. Finally, the optimal ratio and best process were determined, which including the content of SBS modifier, the ratio of new to old asphalt. The results show that using RTFOT experiment in aging simulation is more convenient and scientific. The indicators of SBS modified asphalt after five hours RTFOT experiment accords with already was applied for seven years. And the addition order between the SBS modifier and the new asphalt is closely related to the recycling effect of aging asphalt. The process that preparing modified asphalt with SBS modifier and new asphalt firstly, then mixing the modified asphalt and aging asphalt is the best, which needing the content of SBS modifier and the ratio of new to old asphalt is 4%, 2 respectively.

Keywords: road engineering; SBS modified asphalt; re-modified recycling; best process; optimal content

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路面径流污染渗滤介质组合优化及净化机理分析

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摘　要：为确定适用于不同污染状况道路的渗滤介质组合形式，室内配置与扬州市次降雨径流污染物平均浓度（EMC）等浓度的污水水样，利用自制的过水模拟装置对6种典型渗滤介质的净化能力进行了测试和评价，并通过环境扫描电子显微镜（ESEM）、场发射扫描电镜对渗滤介质的微观进行了测试，分析其净化机理。结果表明：渗滤介质主要通过介质内部孔隙吸附、介质间空隙截留两种方式降低径流雨水中污染物浓度，且不同渗滤介质对污染物的吸附/截留效果差异显著；采用模糊综合评价法能够量化不同净化材料组合对污染物的去除效果，最后给出不同污染状况道路径流雨水的推荐渗滤介质组合形式。

关键词：径流污染；渗滤介质；材料组合；净化机理

The Permutation Form and Purification Mechanism Analysis of Diafiltration Media used in Pavement Runoff Pollution

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Abstract:

In order to determine the permutation form of diafiltration media applicable to different pollution condition, configuring the sewage water samples whose concentration is the same as the EMC of Yangzhou. Testing and evaluating the purification capacity of six kinds of typical diafiltration medium by self-made simulating device, and testing the microcosmic of the diafiltration medium by means of Environmental Scanning Electron Microscope(ESEM) and Field Emission Scanning Electron Microscopy so as to analyze its purification mechanism. The results show that the diafiltration medium reduces concentration of the runoff pollutant in two ways of its porosity adsorption and surface

interception, moreover, The effect of different diafiltration media on the adsorption / interception of contaminants is quiet different;The fuzzy comprehensive evaluation method can be used to quantify the effect of different purification materials combination on the removal of pollutants, in order to recommend the permutation form of diafiltration media used in purifying pavement runoff with with different pollution conditions.

keywords: runoff pollution, diafiltration media, material combination, purification mechanism

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树脂基光催化尾气降解路面技术研究

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摘　要： 目前国内空气污染严重，30%的PM2.5粒子产生于机动车尾气，尤其是高速公路收费站，机动车集中频繁制动，汽车尾气排放严重超标，使收费站成为集中污染区，严重影响人类身体健康。因此本文针对收费站高交通量、高尾气排放量等特殊使用条件，基于纳米二氧化钛光催化尾气降解性能，研发了光催化复合材料；并选取冷拌环氧树脂作为基体材料，开发了树脂基光催化磨耗层方案，打造尾气降解路面。同时，提出了实验室尾气降解试验方法，并对尾气降解效果进行了分析。最后，依托收费站尾气降解路面试验段实施，对树脂基光催化磨耗层技术方案实施效果进行了评价。研究结果表明：光催化尾气降解路面对汽车尾气中的CO、CH及NO均具有明显的降解效果，综合降解率达到50%左右，且基本前10min即可使尾气得到充分降解；且树脂粘结强度高，不易起皮剥落，保证磨耗层持久的尾气降解效能。此外，树脂基光催化磨耗层还可以提高路面抗滑及抗磨耗性能，并可封闭原路面裂缝，恢复路面结构强度。本文提出的光催化树脂基路面尾气降解技术可为同类工程项目提供有力的技术支撑。

关键词： 高速公路收费站、尾气降解、树脂基光催化磨耗层、性能评价

中图分类号：U416.216

Study on the Technology of Epoxy Resin Based Photocatalytic Exhaust Gas Degradation Pavement

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Abstract:

Air pollution has been a serious problem in China, with 30% of the PM2.5 particles produced by automobile exhaust gas. Especially, in the highway toll station, motor vehicles are mostly in a

condition of frequent braking, resulting in a serious exceeding of vehicle exhaust. So that, toll stations are becoming a centralized pollution area, seriously affecting human health. Therefore, for the special conditions of high traffic volume and high exhaust emissions, a kind of photocatalytic composite material was developed, based on the photocatalytic degradation performance of nanometer titanium dioxide in this paper. And cold epoxy resin was selected as the matrix material to design a scheme of resin-based photocatalytic wearing course. Meanwhile, a kind of lab test method was put forward to analyze the exhaust gas degradation effect. And also the mechanical performance of this program was tested. Finally, relying on the test section of exhaust degradation pavement, the implementation effect of the technical scheme of resin-based photocatalytic wearing course was evaluated. The results show that the photocatalytic pavement has obvious degradation effect on CO, CH and NO about 50%, within 10 min. Thanks for high bonding strength, the resin is not easy to peel off from the original pavement under repeated vehicle load to ensure long exhaust gas degradation efficiency. Additionally, the road anti-skid and anti-wear performance can be improved by the wearing course. Due to the permeability of epoxy resin, cracks can be cured to restore the strength of pavement structure. The resin-based photocatalytic wearing course turned out to effectively reduce the exhaust gas level and recover pavement performance, and was strongly recommended for similar projects.

key words: highway toll station, automobile exhaust, vehicle exhaust gas degradation, resin-based photocatalytic wearing course, performance evaluation

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Strength Damage and Fatigue Life Prediction Model of Pavement Cement Concreteunder Loading-High Temperature- Wetting-Drying Cycle Condition

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ABSTRACT:

Research on the residual flexural strength and fatigue life of pavement cement concrete in Guang Xi region under loading-high temperature-wetting-drying cycle condition to obtain the pavement concrete fatigue strength damage and the residual life prediction model. Based on defining fatigue strength damage variable and constructing residual flexural strength model, the nonlinear mathematical equation between residual flexural strength and such parameters as number of load, placing time in high temperature and wetting-drying environment is established. Results showed that it can better reflect the decreasing process of pavement cement concrete strength after fatigue damage. The S-N curvilinear equation and failure probability were introduced to analyze the fatigue life of pavement cement concrete, results indicated that

the single logarithmic equation can be used to predict the fatigue life accurately with different probability, and it accord with the Weibull distribution. the specific double parameters in Weibull distribution function was given for pavement concrete fatigue life in this multi-field environment.

改性聚丙烯纤维增强水泥基稳定土路用性能研究

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摘　要：为了研究分析改性聚丙烯纤维增强水泥基稳定土的路用性能，采用物理加筋和化学固化的综合加固技术制备纤维增强水泥基稳定土复合材料，分别在室内制作各种规格试样，开展了无侧限抗压强度及水稳定性试验、耐磨耗性能试验、抗冲刷性能试验以及抗松散性能试验，并进行了对比研究分析。研究结果表明：（1）试样无侧限抗压强度和水稳定性系数，基本随着水泥掺量的增加以及养护龄期的延长而提高，且早期强度较高，3d龄期强度即可达2.36¯4.42 MPa，随着纤维掺量的增加而呈现先增强后减小的趋势，最佳纤维掺量范围为0.3¯0.45%；（2）试样耐磨耗性能与纤维和水泥的掺量有密切关系，纤维的"锚固加筋"和"桥梁纽带"连接作用可明显地提高试样的耐磨耗性能；（3）试样冲刷总量和冲刷速率随着水泥和纤维掺量的增加而不断减小，表明抗冲刷性能得到不断增强，添加纤维之后稳定土的抗冲刷性能提高26¯75%；（4）试样的抗松散性能对水泥掺量较为敏感，试样剩余质量随转数的变化关系曲线，大致可划分为初始阶段、急剧松散阶段及稳定阶段。由此可见，改性聚丙烯纤维加筋增强作用可显著改善水泥基稳定土的各项路用性能，研究成果对其在应急道路工程和简易道面工程中的推广应用具有一定的参考价值。

关键词：道路工程；水泥稳定土；纤维加筋土；路用性能；改性聚丙烯纤维

Research on Road Performance of Modified Polypropylene Fiber Reinforced Cement Stabilized Soil

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Abstract:

In order to analyze reasonable pavement structure form and study the fatigue deformation

characteristic of emergency airfield pavement structure. In order to research and analysis the road performance of modified polypropylene fiber reinforced cement stabilized soil, the comprehensive reinforcement technology which was composed of physical reinforcement and chemical curing, were used to prepare the fiber reinforced cement stabilized soil composite materials. Unconfined compressive strength test, water stability test, wear resistance test, anti-erosion test and scattering test were carried out, and comparative analysis was carried out too. The results show that: (1) The unconfined compressive strength and water stability coefficient of the sample increase with the increase of cement content and the curing age, and the early strength is higher, the strength of 3d age can be up to 2.36~4.42 MPa. With the increase of fiber content, the strength of the sample showed a trend of decrease after the first increased, and the best fiber content ranged from 0.3 to 0.45%. (2) The wear resistance performance of the samples increased with the increase of fiber content and fiber content, and the function of "anchoring reinforcement" and "bridge linking" of the fiber can significantly improve the wear resistance performance of the samples. (3) The erosion amount and erosion rate of samples decreased with the increase of cement and fiber content, which indicated that the anti-erosion performance was enhanced, and the anti-erosion performance of the stabilized soil was increased by 26~75% after addition of fiber. (4) The anti-loose performance of samples are sensitive to the cement content, and the residual mass of the sample varies with the number of revolutions, which can be roughly divided into the initial stage, rapid loose stage and stable stage. It can be seen that the reinforcement effect of modified polypropylene fiber can significantly improve the road performance of cement stabilized soil. The research results have certain reference value for its promotion and application in emergency road engineering and rough pavement engineering.

Keywords: road engineering; cement stabilized soil; fiber reinforced soil; road performance; modified polypropylene fiber

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阻燃型多功能路面超薄层研发及其在隧道路面铺装中的应用

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摘　要：以聚磷酸铵（APP）、三聚氰胺氰尿酸盐(MCA)为阻燃剂对多功能路面超薄层（MRS）用环氧树脂(EP)粘接剂进行了阻燃改性，并将其用于隧道路面铺装。结果表明APP/MCA对改性环氧树脂胶有良好的阻燃效果。阻燃型多功能路面超薄层具有优良的耐水性，并可显著提高隧道路面的抗滑性能。当APP用量为10.5wt%、MCA用量为10.5wt%时，阻燃EP的极限氧指数（LOI）为31.5%、通过垂直燃烧实验（UL-94）V-0级。同时，阻燃MEP的烟释放速率峰值和总生烟量得到明显下降。阻燃型MRS铺装层在80℃热水中煮168h后，粘接强度仍达到2.1MPa。铺装阻燃型MRS（fl-MRS）后，隧道路面潮湿状态下的BPN摆值由46提高到71，横向力系数（SFC）在67以上。本文为隧道路面抗滑养护提供可行的解决方案。

关键词：隧道铺装，阻燃，抗滑性能，耐水性。

中图分类号：U238

Study on Flame Retardancy of Epoxy Binder of MRS and Its Application on Tunnel Paving

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Abstract:

The epoxy binder of multi-function road surface (MRS) was flame-retarded with ammonium polyphosphate (APP) and melamine cyanurate (MCA), and it was used in expressway tunnel paving. The results revealed that APP/MCA could effectively improve the flame retardancy of EP. The flame-retarded MRS (fl-MRS) pavement exhibited good skid resistance. When the content of APP was 10.5wt% and MCA was 10.5wt%, the limiting oxygen index value (LOI) of the EP/APP/MCA

composite was 31.5%, and the vertical burning (UL-94) test classed a v-0 rating. Meanwhile, the peak smoke production rate,total smoke production of the composite were also decreased significantly. After paving with fl-MRS, the british pendulumnumber of the tunnel at wet state was increased from 46 to 71, and the sideway force coefficient was higher than 67. Moreover, the MRS pavement showed a good water resistance. After soaking in 80℃ water for 168h, the bond strength of fl-MRS overlay could still reach 2.1MPa.

keywords: tunnel pavement, flame retardance, skid resistance, water resistance.

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沥青混合料两种疲劳试验方法的定量比较

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摘　要：沥青混合料的疲劳性能受荷载作用模式和试验方法的影响，现存的试验方法众多，关于疲劳已开展了大量的研究，却没有统一标准。但是各试验方法之间依然缺少关联，致使方程外延性不佳。本文开展了四点弯曲疲劳试验与梯形悬臂梁两点弯曲试验之间的关系研究。建立了疲劳寿命方程，耗散能与疲劳寿命关系及损伤之间的关系，发现四点弯曲试验得到的对数疲劳寿命为梯形悬臂梁试验的1.3倍，累积耗散能随疲劳寿命增加的速率相同，差异存在于初始能耗。两种试验模式的疲劳损伤规律一致，累积损伤的增长率四点弯曲试验是梯形悬臂梁试验的两倍。

关键词：沥青混合料；四点弯曲；梯形悬臂梁；相关性

Quantitative Comparison of 2pt Test and 4pb Test to Characterize Fatigue in Asphalt Materials

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Abstract:

Different experiment methods have been developed to assess fatigue of asphalt mixtures. Most of these methods have been motivated by the need to develop a unified fatigue criterion that is independent of the mode of experiment tests. This paper offers quantitative comparison of the four-point bending fatigue test and trapezoidal cantilever two point bending fatigue test based on S-N

curve,energy methods anddamage . The Logarithmic fatigue life of four-point bending test was 1.3 times of cantilever beam test. After conversion with coefficients 1.3, the coincidence of the two test mode is high.The rate of cumulative dissipated energy increases with the fatigue life in two test modes are same. Differences exist in the initial dissipated energy.With the same fatigue damage developped process, the cumulative damage growth rate of the four-point bending test is the trapezoidal's twice.

keywords: asphalt mixture, four-point bending test, trapezoidal cantilever, correlation

高性能纤维加筋水泥基复合材料的工程力学特性

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摘　要：为了改善工程土体的力学性能，采用纤维的物理加筋和水泥的化学加固相结合的方式，制备高性能纤维加筋水泥基稳定土复合材料试样，并通过开展无侧限抗压强度试验、劈裂抗拉强度试验、直接剪切试验和抗压回弹模量试验，对其工程力学特性进行试验研究和探讨分析。试验结果表明：（1）试样的无侧限抗压强度、水稳定性系数和抗压回弹模量，基本随着水泥掺量的增加及养护龄期的延长而提高，且早期强度较高，3d龄期强度达2.36ˉ4.42MPa，已具备一定的承受荷载能力；（2）水泥的掺入使得试样的应力-应变曲线在峰后迅速下降，并呈现脆性破坏特征，而纤维的掺入改善了试样的脆性破坏模式，试样破坏特征呈现由脆性破坏向延性、塑性破坏过渡的趋势；（3）纤维加筋稳定土的纤维最佳掺量范围为0.3ˉ0.45%，此时纤维对土体的加筋增强效果最好；（4）随着水泥和纤维掺量的增加，试样的凝聚力和内摩擦角不断增大，并且大致呈线性增长趋势，表明增强了土体的抗剪强度。相关研究工作可为纤维加筋稳定土技术进一步的深入研究和工程应用提供一定的参考。

关键词：道路工程；水泥基稳定土；纤维加筋技术；工程力学特性；室内试验

中图分类号：U416.212

Engineering Mechanical Properties of High Performance Fiber Reinforced Cement - based Composites

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Abstract:

In order to improve the mechanical properties of engineering soils, high-performance fiber reinforced cement-based stabilized soil composites were prepared by means of the combination of physical reinforcement of fibers and chemical strengthening of cement. By carrying out unconfined compressive strength test, splitting tensile strength test, direct shear test and compression resilience modulus test, the engineering mechanical properties of samples had been studied and analysis. The results show that: (1) the unconfined compressive strength, water stability coefficient and compressive resilience modulus of the specimen increase with the increase of the cement content and the curing age basically, and the early strength is higher, the strength of 3d age can be up to 2.36~4.42 MPa.(2) The incorporation of cement makes the stress-strain curve of the sample decrease rapidly after the peak, and presents brittle failure characteristics. The brittle failure mode of the specimen was improved by fiber, and the failure characteristics of the sample showed a transition from brittle fracture to ductile fracture.(3) The optimum fiber content of the fiber reinforced stabilized soil is 0.3-0.45%, which the reinforcing effect of the fiber on the soil is the best.(4) The cohesion force and the internal friction angle are increasing with the increase of cement and fiber content, and the increase trend is linear, which indicates that the shear strength of the soil is enhanced.The relevant research work can provide a certain reference for the further research and engineering application of fiber reinforced stabilized soil technology.

Keywords: road engineering; cement-based stabilized soil; fiber reinforcement technology; engineering mechanical properties; laboratory test

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Pavement Performance of Aged Asphalt Mixture Incorporating Waste Cooking Oil

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ABSTRACT:

The application of waste cooking oil (WCO) as the rejuvenator for aged asphalt mixture has been regarded as an economical and sustainable method. The objective of this paper is to investigate

the rejuvenation effect of WCO on pavement performance of aged asphalt mixture. WCO was prepared with frying oil in the laboratory. The composition and properties of WCO were analyzed by Gas Chromatograph-Mass Spectrometer-computer (GC-MS) and Fourier Transforms Infrared Spectroscopy (FTIR). The initial content of WCO was determined by the viscosity to rejuvenate aged asphalt to its virgin level. Reclaimed asphalt pavement (RAP) was prepared from virgin asphalt mixture with a laboratory ageing method and rejuvenated with 6wt% ~15wt% WCO by mass of aged asphalt binder. Pavement performances include moisture resistance, low-temperature cracking resistance, rutting resistance and fatigue life. The experimental results indicate that WCO is a complex material with smaller molecules, but the WCO has both oleophilic and hydrophilic properties, which are detrimental to the adhesion with asphalt. WCO could improve the moisture resistance, low-temperature property and fatigue life of aged asphalt mixture. In addition, the aged asphalt mixture attains good resistance to rutting deformation and the dynamic stability of the aged asphalt mixture decreases. It can be concluded that WCO can reduce the stiffness of aged asphalt mixture. However, the characteristics of WCO need to be investigated further. Although the application of WCO is full of challenges, it can be one of the most potential regeneration agents for aged asphalt mixture.

KEYWORDS: asphalt mixture; waste cooking oil; rejuvenation; pavement performance

考虑沥青路面可变形特征的轮胎——沥青路面摩擦接触仿真研究

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摘　要：路面抗滑性能的好坏是影响交通安全的关键因素，现有研究多从路表宏观及微观纹理探究路面抗滑行为，因此在道路服役期内，由于路表构造衰减造成抗滑性能显著降低的问题也难以避免。本研究从轮胎——路面系统动力学出发，分析胎路耦合摩擦机理，通过改变沥青路面弹性模量，即增大胎路实际接触面积的方式探究其对路面抗滑性能的影响。论文建立轮胎——柔性路面摩擦接触动态模型，分别研究了轮胎制动工况中，三种不同弹性沥青面层在各级荷载作用下与轮胎接触过程中与轮胎的接地压强、路面剪应力、胎路实际接触面积、接触面摩擦力以及路面对轮胎制动力等接触行为的变化规律。结果表明，当路面弹性得到较大改善时，轮胎与路面之间实际接触面积增大，能有效提高轮胎——路面之间摩擦附着，增强路面对轮胎的减速抗滑作用，路面弹性增强对抗滑性能的贡献不容忽视。论文研究思路为沥青路面抗滑研究提供了新的理论支撑和设计依据。

关键词：轮胎；沥青路面；实际接触面积；摩擦行为；制动力系数

中图分类号：U238

Investigation of the Tire-Pavement Friction Contact Simulation by Considering the Deformation

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Abstract:

The skid-resistance performance of pavement has been key factor affecting traffic safety. Recent research mainly concentrates on the road anti-skid behavior by means of macro or micro texture of the pavement. Thus, it's inevitable that the skid-resistance performance deteriorate because of the pavement texture decline in its service life. Based on the tire-pavement system dynamics, tire-road coupled friction mechanism is analyzed, and the effect of enlarging the tire-road real contact area in road skid resistance is also investigated by changing the elastic modulus of asphalt pavement. Firstly, this paper constructed the dynamically contacted model of tire-asphalt pavement friction; Secondly, during tire braking condition, the contact behaviors such as tire-pavement (three different types of elastic modulus are included) contact pressure, pavement shear stress, the exact contact area between tire and pavement surface course, brake force supported by the pavement to the tire are investigated respectively. It was observed that with distinct improvement of pavement elasticity, the actual tire-pvement contact area increases, which can effectively highlight the tire frictional adhesion to the pavement. Therefore, it should not be ignored that the improvement of pavement elastic property will contribute to its skid resistance ability. This research approach provides theoretical basis and design reference for anti-skid research of asphalt pavement.

keywords: tire, asphalt pavement, actual contact area, friction behavior, tire brake coefficient

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New Perspective on Surface Treatment of Recycled Concrete Aggregate Utilizing a Novel Nanomaterial

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ABSTRACT:

Existing studies on concrete made with recycled concrete aggregates (RCA) have shown a number of deleterious characteristics which make recycled aggregate concrete (RAC) unfit for high-strength (>50 MPa) applications. Such characteristics mostly derive from the presence of old cement mortar adhering to the RCA. Two specific qualities of old mortar cause many of these degradations. The first, is a much higher water absorptivity caused by the porous nature of old cement mortar. This greater absorption alters workability and curing time of the resultant concrete. The second, is a loss of modulus of elasticity caused by a substantially weaker interfacial zone as new cement mortar adheres to old mortar rather than the aggregate itself, as is the case with virgin aggregate concrete (VAC). Our previous work has demonstrated the viability of a novel nanomaterial as a treatment for the deleterious characteristics of recycled concrete aggregate (RCA) via the production of high-strength concrete (>50 MPa). In that study, commercially produced RCA was soaked in nitric acid, washed,

dried, and immersed in a suspension made from a novel nanomaterial in a volume of water equal to the determined absorptivity of the RCA. The amount of the novel nanomaterials required to achieve high-strength status was far below that required for the two most common methods of treating RCA, silica fume (SF) and colloidal silica (CS) demonstrating an inherently more economical treatment.

This study will analyse the effects of eliminating the acid soaking step, as this would further enhance cost savings to RCA producers. Specifically, non-commercially processed RCA was acquired by manual crushing of concrete debris from building demolition. As a consequence, there remains a substantially greater amount of adhering old cement mortar, thereby replicating the product a RCA producer might expect should the number or duration of crushing steps be reduced.

Four groups of non-commercially RCA are analysed: an untreated control, a group that has only undergone acid soaking, a group that only receives treatment by the novel nanomaterials, and a group that receives both acid soaking and treatment by the novel nanomaterials. RCA is first divided into two groups, those to be soaked in acid, and those not. The group to be soaked in acid is immersed in a 0.5M nitric acid for 24 h, before being washed with water and dried. Absorptivity of the two groups is then determined. Following determination of absorptivity, the RCA is immersed in a suspension made from a novel nanomaterial in a volume of water equal to the determined absorptivity of the for 24 h to one half of the acid soaked group and one half of the non-acid soaked group. The other halves are immersed in water only, equal to absorptivity, in order to bring them to saturated surface dry condition. Each of the four samples is then added to concrete mix and filled in the necessary moulds for testing. The strength development and the influence of the treated RCA on interfacial zone of RAC as well as its durability properties such as water absorptivity, dry shrinkage, alkali-aggregate reactivity, and chloride permeability are investigated and discussed to validate the goal of this study. The results of this study helps improve the treatment process of RCA and decrease its cost and environmental footprint, thereby facilitating RCA's use in place of virgin aggregate. As concrete debris is presently sent to landfills in large amounts, such an outcome will reduce both demand for finite landfill space and demand for limited virgin aggregate resources.

KEYWORDS: Recycled concrete aggregates; Acid treatment; Nanomaterials; Structural concrete; Strength development; Durability

渖东南龙马溪组黑色页岩特性及其用作高速公路路基填料的适应性研究

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摘　要： 渖东南作为我国龙马溪组地层发育的典型区域，成为国内页岩气界众多科技人员研究的热点。本文对区内龙马溪组黑色页岩的地质背景、矿物组成、结构特征、工程特性和用作公路路基填料的适应性进行了研究。结果表明：渖东南龙马溪组黑色页岩由黏土矿物和石英等脆性矿物构成，强度受控于石英的含量，其矿物组成中蒙脱石等水敏感性矿物成分极少，不具有膨胀性；岩样耐崩解性试验表明该种岩石崩解性差；不同层理方向页岩的抗压强度差异较大，强度受制于层理发育的方向；干湿交替环境对页岩的强度和完整性影响较大，不能用作季节性过湿土路基的基底换填材料，用其填筑的路堤应及时封闭坡面；应重视因裂隙内部形成动水压力对岩体强度影响而造成的路基变形；岩块碾压后不易固（板）结成形，用作路基填料整体性差，承受路面荷载后，岩块碎屑颗粒间易发生错动，潮湿环境将加剧其粒间错动，故此类岩石不能直接用作路床填料。

关键词： 龙马溪组；黑色页岩；矿物组成；工程特性；路基填料

中图分类号：U414

Research on the Adaptability of Highway Road Filling and the Characteristics of Longmaxi Black Shale Southeast Chongqing

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Abstract:

As the developmental typical area of Longmaxi formation in Southeast Chongqing, it is becoming the focus of numerous scientific and technical personnel work at the shale gas industry.

This paper discussed the geological background, mineral composition, structure characteristics, engineering properties and adaptability of roadbed filling material of Longmaxi black shale in Southeast Chongqing. Results show that the black shale is made of clay minerals and quartz brittle mineral, the rock strength is controlled by quartz content, the mineral composition has very little water sensitive mineral such as smectitic, does not have expansion. Test showed the black shale was of poor disintegration. The compressive strength depends on the direction of stratification. The alternation of dry and wet environment has great influence on the strength and integrity of shale, can't be used as the base material for the seasonally wet soil subgrade, embankment should be closed in time. Attention should be paid to the deformation of subgrade caused by dynamic water pressure. It isn't easy to be formed after compaction and has the poor integrity of roadbed filler, under the pavement load, rock debris particles can slip easily, especially in humid environment, so this kind of rock can't be used as roadbed filler directly.

Keywords: Longmaxi formation; black shale; mineral composition; engineering characteristics; road filling

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Effect of Materials Composition on Cohesion Characteristics of SBS Modified Asphalt Using Surface Free Energy

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ABSTRACT

The SBS modified asphalts were prepared by mixing different base asphalt, SBS modifier, extracting oil and stabilizing agent. The contact angles between SBS modified asphalt and distilled water, glycerol and formamide were detected by the sessile drop method. Based on the surface energy theory, surface free energy and the cohesive power of SBS modified asphalt were calculated. The influence of the raw materials composition such as virgin asphalt, SBS modifier types and extracting oil and stabilizing agent content on cohesive characteristics were discussed for SBS modified asphalt. The results show that the virgin asphalt has a good compatibility with a SBS modifier that is suitable to make better cohesiveness SBS modified asphalt. The cohesive power of branched SBS modified asphalt is larger than that of liner SBS modified asphalt. The cohesion of SBS modified asphalt will be improved as the SBS modifier and stabilizer content increased. And the cohesion of SBS modified asphalt will decrease when extraction oil content exceed a certain amount. It is helpful to cohesive characteristics of SBS modified asphalt that stable three-dimensional network structure were formed because cross-linking, winding and grafting by different raw materials.

KEYWORDS: pavement materials; SBS modified asphalt; materials composition; cohesion characteristics; contact angle; surface free theory

工厂化橡胶粉改性沥青混合料矿料级配优化分析与性能评价

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摘　要：由于工厂化橡胶粉改性沥青优良的高低温性能和储存稳定性，其应用于沥青路面得到愈来愈多的重视。但由于其较高的粘度，直接作为粘结料将大幅度提高混合料矿料间隙，增大沥青用量和工程造价，这也限制了其更大面积的推广应用。本文针对这一问题，研究了混合料的矿料级配优化方法，并对该方法进行了验证分析。研究结果显示，优化后的级配设计方法可以有效减少沥青用量，混合料中沥青膜厚度满足要求，矿料形成的骨架结构也更加稳定，且其路用性能也得到了相应的改善。对比分析表明，级配优化后的橡胶粉改性沥青混合料更能满足工程需求。

关键词：道路工程；工厂化橡胶粉改性沥青混合料；矿料级配优化方法；路用性能；汉堡车辙试验；冻断试验

Aggregate Gradation Optimization and Performance Evaluation on Industrialized Rubber Modified Asphalt Xixture

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Abstract:

　　Due to the excellent performance at high and low temperature and the good sto-rage stability, the industrialized rubber modified asphalt has been paid more and more at-tention to its application in asphalt pavement. However, because of the high viscosity, the industrialized rubber modified

asphalt can greatly increase the voids of mineral aggregate when used directly as the binder in the mixture, and the amount of asphalt and the cost of the project are increased as a result, which limit its wider application. To solve this problem, the paper studied and verified the method of aggregate gradation optimization of the mixture. According to the results, the optimized design method can effectively reduce the amount of asphalt, and the thickness of the asphalt film meets the requirements. The structure of the mixture is more stable and the pavement performance is also improved af-ter the optimized design. Comprehensive comparison shows that the industrialized rubber modified asphalt mixture with optimized gradation can meet the engineering needs better.

Keywords: road engineering; industrialized rubber modified asphalt mixture; aggregate gradation optimization; service performance; Hamburg wheel tracking test; thermal stress restrained specimen test (TSRST)

Low Temperature Performance Characteristics of RAP Mortars with Virgin and Aged Soft Binders

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Abstract:

Reclaimed asphalt pavement (RAP) has many advantages and is utilized to improve the high temperature properties of asphalt mixtures. Low temperature cracking is a predominant distress in asphalt pavements containing RAP materials. Thus, the evaluation of fracture resistance for asphalt mixtures containing RAP is of interest. The objective of this research is to explore the low temperature performance characteristics of RAP mortars containing sieved RAP and soft binders at three aged states. The stiffness values and m-values from bending beam rheometer (BBR) tests at three test temperatures of -18°C, -12°C and -6°C were obtained to conduct the minimum low temperature grades. The results indicated that RAP mortars containing virgin binder, rolling thin film oven (RTFO) binder and pressure aged vessel (PAV) binder could simulate RAP mixture during the construction, after the construction and after a long term performance, respectively. In addition, RAP mortars with virgin soft binder had the best low temperature resistance followed by the RAP mortars with RTFO and PAV binders.

Keywords: Reclaimed asphalt pavement; Mortar; Stiffness; m-value; Low temperature determination

Numerical Evaluation of Particle Shape on Aggregate Mixture's Performance UsingDiscrete Element Method

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ABSTRACT:

In order to studythe effects of aggregate shape on the strength of mixtures, theglue-spheredellipsoid particleswereused to create cylinder samples, and triaxial tests were simulated usingDiscrete Element Method (DEM).This paper discussesa) how to create ellipsoid aggregates by glued spheres and control its size; b)how to simulate the triaxial performance of HMA skeleton; and c) how to choose coarse aggregates for HMA according to shape factors.Through computation, anephogramof triaxial strengthvarying with shape factor Flatness and Elongation was finally given. The results show that cubical and part of rod aggregate work much better in strength than others, which was proved to be consistent with that of indoor tests.

KEYWORDS: Asphalt mixture; Shape factors; DEM; Ellipsoid particle; Triaxial test

砂堤拦阻效果现场试验分析

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摘　要：根据Bekker承压模型和Janosi剪切理论，分析飞机在砂土中通行时轮胎的力学模型，建立端保险道阻机砂堤设计方法，并以汽车代替飞机开展砂堤拦阻效果的试验，定量分析拦阻效果。试验表明：轮胎在砂堤中通行时，产生的轮辙深度大于理论分析值，其修正系数接近1.1；砂堤尺寸越大、设置高度越高，砂堤的拦停效果越好。

关键字：阻机砂堤；轮辙深度；拦停效果；试验；力学模型

Field Test Analysis on the Arresting Effects of the Sand Embankment

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Abstract:

Based on the Bekker pressure model and the Janosi shear theory, analysis the mechanics model of tire when aircraft passing the arresting embankment of sand, establish design method of the arresting embankment of sand at the airport overrun, and carry out the experiment of sand embankment on the arresting effects based on the car instead of aircraft, and makes a quantitative analysis of the arresting effects. Test results showed that the wheel rut depths greater than the theoretical value when tire in the sand embankment, and the correction coefficient close to 1.1; The bigger size and higher altitude setting of the sand embankment, the better arresting effect is.

Keywords: the arresting embankment of sand; wheel rut depths; arresting effec;embankment; mechanics model

Evaluation on the SBS-modified Asphalt's High-temperature Performance Using Rheological Indexes

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ABSTRACT:

In the present study, five different modified asphalts with different addition amounts of SBS were first prepared. Two rheological indexes, the rutting factor (G*/sinδ) and the unrecoverable creep compliance (Jnr), were then tested using a dynamic shear rheometer for evaluating the high-temperature performances of these SBS-modified asphalts, and meanwhile, their softening points were tested. Then, the SBS-modified asphalt mixtures were prepared and underwent Hamburg wheel tracking tests for investigating these mixtures' high-temperature rutting resistance performances. The correlations among the rheological indexes, the softening point and the mixture's Hamburg wheel tracking test results were finally analyzed for investigating the applicability in the evaluation of SBS-modified asphalt's high-temperature performance using the rheological indexes.

Results show that, for the SBS-modified asphalts, the softening point is well correlated with G*/sinδ and Jnr; the high-temperature PG result of the SBS-modified asphalt cannot reflect the asphalt mixture's actual high-temperature performance, i.e., these two indexes show a poor correlation; the MSCR test results can provide more accurate evaluation results on the high-temperature performances of SBS-modified asphalts and asphalt mixtures than the PG results, with a stronger applicability.

Keywords: rutting factor (G*/sinδ), unrecoverable creep compliance (Jnr), Hamburg wheel tracking test, softening point, correlation analysis

Influence of Releasing Graphene Oxide into a Clayey Soil and a Silty Soil：Strength and Mechanical Properties

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ABSTRACT:

Graphene oxide (GO) is highly soluble in water, and upon releasing into environment, its interaction with soil might have significant effects on the strength and other mechanical properties of soil. By mixing GO with a clayey soil and a silty soil, we systematically studied the mechanical properties of the modified soil and GO-soil interaction mechanisms. The experimental results indicate that the unconfined compressive stress (UCS), failure strain and elastic modulus of the soils were significantly changed by the addition of minute quantity of GO. The UCS of the soils was greatly enhanced by the addition of GO, and reached its maximum at 0.08% GO for clay, 0.06% GO for silt, respectively. Such remarkable modification of soil by GO is likely resulted from the extremely high surface area and dispersion quality of GO in water, which induce the alternation of the soil microstructure. In light of the X-ray diffraction (XRD) and scanning electron microscopy (SEM) results, it is concluded that the intercalation of GO nanosheets between soil particles effectively enhances the water binding capability of soil particle.

KEYWORDS: Graphene oxide; Soil; Stabilization; Unconfined compressive stress; Releasing

Research on the Volumetric Parameters for Dense-graded Asphalt Mixture

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ABSTRACT

Volumetric parameters of asphalt mixture are essential for a better understanding of the properties of an asphalt mixture. This is even more applicable for a dense-graded asphalt mixture, where volumetric parameters have a significant correlation with its pavement performance, especially against rutting and moisture. This paper deals with the choice of the representative volumetric parameter for dense-graded asphalt mixture. A total of 6 volumetric parameters were studied. Volumetric analysis showed that linear correlation existed between any two of volumetric parameters. The change of volumetric parameters was mainly caused by the variation of gradation. The test result indicated that volumetric parameters were sensitive to the variation of gradation. The finding also indicated with the variation of gradation, the change rate of   is the largest. Based on the research above, was selected as the representative volumetric parameter for dense-graded asphalt mixture.

KEYWORDS: asphalt mixture; aggregate gradation; volumetric parameter

Recycling Behaviour of Rejuvenating Agent on Aged SBS Modified Asphalt

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ABSTRACT:

To evaluate the effect of rejuvenating agent on the properties of aged SBS modified asphalt and the recycling mechanism, different types and blending proportions of rejuvenating agents were added to the aged modified asphalt. Depending on the experimental results of penetration softening point, ductility, Brookfield viscosity, toughness and tenacity, the improvement effect of rejuvenating agent on the aged modified asphalt was analysed, and the relationships between the blending proportion of rejuvenating agent and each index of modified asphalt blends were summarized. In addition, the role of rejuvenating agent on the aged modified asphalt was analysed by fluorescence microscope, and the relationship between the microscopic phase characteristic and the macroscopic property was established. The results indicate that rejuvenating agent can recycle the properties of aged modified effectively, including its rheological property, but the low-temperature property of modified asphalt blends is poor after thin film oven test (TFOT); the sensitivity of penetration and viscosity of modified asphalt blends for the blending proportion of rejuvenating agent is different; and the recovery degree of viscosity and ductility of modified asphalt blends is poorly synchronized. At microscopic level, the initial phase of the aged modified asphalt is not changed by the addition of rejuvenating agent; after significant analysis, SBS particles area ratio of modified asphalt blends is significantly correlated with tenacity as the proportion of rejuvenating agent increases. Based on this, a new idea to determine the blending proportion of rejuvenating agent in aged modified asphalt is proposed.

KEYWORDS: Road engineering; SBS Modified asphalt recycling; Rejuvenating agent; Rheological property; Phase characteristic

Performance Evaluation of Stable Crumb Rubber Asphalt and Mixture

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ABSTRACT:

Crumb rubber asphalt with good stability, thus named as stable crumb rubber asphalt, was produced in plant based on wet process. Both conventional performance test and Superpave performance test were conducted to evaluate the performance characteristics of the stable crumb rubber asphalt. Based on Marshall mix design, SMA mixtures with stable crumb rubber asphalt and SBS modified asphalt were designed for performance evaluation. The results show that, SMA with stable crumb rubber asphalt has better high-temperature performance and similar low-temperature performance and moisture stability as compared to SMA with SBS modified asphalt. The SMA with stable crumb rubber asphalt shows better fatigue life at low strain condi-tion and similar fatigue life

at high stain condition as compared to SMA with SBS modified as-phalt. The findings in this study indicate that the stable crumb rubber asphalt provides a promis-ing replacement for SBS modified asphalt used for SMA.

KEYWORDS: Stable crumb rubber asphalt; performance; SMA; SBS

Laboratory Evaluation of Asphalt Binders Containing Titanium Dioxide Nanoparticles

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ABSTRACT:

The objective of this study is to evaluate the physical and rheological properties of various warm-mix asphalt (WMA) binders blended with nano-titanium dioxide (TiO_2). In this study, four percentages of nano-TiO_2 (0%, 1%, 3% and 5% by the weight of warm asphalt binders) were added

to Sasobit-modified asphalt binder (NTOWA), Sasobit/styrene-butadiene-styrene (SBS) polymers compound asphalt binder (NTOWS), respectively. The experimental group including NTOWS binders and NTOWS binders were artificially aged through rolling thin-film oven (RTFO) and pressure-aging vessel (PAV) prior to evaluation. The conventional test, rotational viscosity (RV), dynamic shear rheometer (DSR), bending beam rhometer (BBR) were used to analyze the physical and rheological properties of the nano-TiO_2 warm-mix asphalt (WMA) binders. Based on the result, it was found that the physical properties and rotational viscosity of warm-mix asphalt (WMA) binders are marginally influenced by the addition of nano-TiO_2. In addition, the results of high and moderate temperature rheological tests showed that the high temperature performance of NTOWS binders was better. However, the fatigue performance was worse in comparison to NTOWA binders. This study also revealed that the incorporation of nano-TiO_2 significantly reduced low temperature performance of warm mix asphalt.

KEYWORDS: nano-titanium dioxide (TiO_2); rheological property; high temperature performance; fatigue performance

复合道面板抗冲击性能试验与数值模拟

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摘　要： 本文采用大型落锤冲击仪对一种新型复合道面板进行了抗冲击动态响应试验，该新型复合道面板自上而下依次为：土工格栅加固的沥青混凝土(AC)层、高强度混凝土(HSC)层及复合水泥基(ECC)层。通过落锤冲击试验获得道面层板构件的损伤形式及变形特征。随后采用显式有限元软件LSDYNA建立该新型复合板在冲击荷载下的数值计算模型。采用混凝土损伤材料模型模拟复合道面板中混凝土类材料，同时考虑复合道面板中界面特性和各层材料的动力增长因数。根据复合道面板冲击落锤的结果，通过比较其破坏形式，损坏直径及位移值对该数值模型进行了校核和验证。结果表明：文章建立的考虑界面性能和动力增长因数的三维数值模型能够较准确地模拟复合道面体系在冲击荷载作用下的真实特性，且验证后的模型可进一步应用于研究不同因素（材料强度、断裂能及层间界面）对新型复合道面体系在不同冲击荷载作用下抗冲击性能的影响。

关键词： 落锤冲击；本构模型；界面模型；复合道面

中图分类号：U238

Experimental and Numerical Study on the Dynamic Response of Composite Pavement Slab Under Large Scale Drop Weight Impact

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Abstract:

In this paper, the experimental and numerical study is employed to investigate the dynamic

behavior of the composite pavement slab subjected to large scale drop weight impact. This composite pavement structure consists of Asphalt Concrete (AC) layer reinforced with Geogrid, followed by High Strength Concrete (HSC) layer and then Engineered Cementitious Composites (ECC) layer, taking into account their relative advantages in terms of strength and relative ductility. A large scale drop weight impact test is firstly conducted to investigate the dynamic behavior of the composite pavement structure. After that, a 3D finite element numerical modelling is developed to simulate the dynamic response of the composite pavement structure subject to impact load. For this modelling, an advanced concrete damaged model is used to represent the dynamic property of concrete-like materials under severe dynamic loading. Furthermore, some key parameters such as the strain rate effect of concrete-like materials and the interface properties are also considered in the numerical model. Actual measurements from the drop weight impact test are used as a validation for the developed numerical model. It is shown that the numerical simulation agrees closely with the experimental data in terms of damage pattern, crater diameter, and potentiometer readings. This calibrated numerical model can then be further used to investigate the factors that might enhance the impact resistance of the composite pavement structure subject to various levels of impact loads.

Three Dimensional Digital Sieving of Asphalt Mixture Based on X-ray Computed Tomography

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ABSTRACT:

In order to perform three dimensional digital sieving based on X-ray CT images, the definition of critical sieve size was proposed first. In this research, whether an aggregate was able to pass through certain sieve opening was depend on the value of critical sieve size of the aggregate. The corresponding program was developed using MatlabTM to reconstruct aggregate structure and to obtain critical sieve size. Laboratory experiments consisting of cement-filled aggregate specimens were conducted to validate the calculation. A comparison between critical sieve size and equivalent diameter was also performed. Moreover, the digital sieving technique was used to estimate the gradation of a dense graded asphalt mixture. The results revealed that it is feasible to conduct aggregate digital sieving for asphalt mixture.

KEYWORDS: asphalt mixture, aggregate gradation, digital sieving, x-ray computed tomography

南方多雨地区沥青路面防水抗裂层配合比设计

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摘 要： 为了改善沥青路面层间结构，增强其防水抗裂能力，在上面层和中面层间铺筑一层空隙率小于2%的沥青混合料薄层。考虑江西省气候特点和交通状况，采用适当的防水抗裂层原材料。在原材料各项技术指标试验的基础上，依据设计空隙率不大于2%，参照AC-5密级配沥青混合料的规范，通过试验调整级配和配合比，确定最佳合成级配。通过马歇尔试验确定防水抗裂层所需的最佳沥青用量及最佳纤维掺量。最终通过高温车辙试验、低温抗裂试验以及水稳定性试验等来验证防水抗裂层的路用性能。

关键词： 防水抗裂层;纤维沥青混合料； 马歇尔试验； 车辙试验； 最佳纤维掺量。

Mix Proportion Design of Waterproof and Anti-crack Layer of Asphalt Pavement in South Rainy Area of South China

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Abstract:

In order to improve the asphalt pavement structure, enhance its waterproof and anti-crack ability, in the upper layer and the middle of the surface layer of a layer of gap ratio of less than 2% of the asphalt mixture. According to the climate characteristics and traffic conditions in Jiangxi Province, the suitable waterproof and anti-crack layer of raw materials. In the raw materials of the technical indicators test based, according to the design space rate is no more than 2%. Refer to specification of AC-5 dense gradation asphalt mixture, by adjusting and optimizing with ratio, determine the

optimum synthetic gradation.Through the Marshall test the optimum asphalt content and optimum fiber content of the asphalt mixture were determined.Finally through the high temperature rutting test, low temperature crack resistance test and water stability test to verify the waterproof and anti crack layer of the road performance.

Keywords: Waterproof and anti-crack layer; fiber asphalt mixture; Marshall test; rutting test; optimum fiber content.

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溶剂型DS冷补料研制及其路用性能研究

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摘　要： 为实现沥青路面坑槽快速修补，解决溶剂型冷补料初期强度不高、强度增长缓慢的难题，研究开发了一种溶剂型冷拌冷铺沥青混合料。首先采用正交试验设计法，研究不同组成比例冷补液的粘度及储存稳定性，确定溶剂型DS沥青冷补液的最优组成比例。针对宁波地区的气候特点，分析三种级配类型沥青冷补料体积指标、力学性能及路用性能的优缺点，选择合适的级配并制备沥青冷补料。最后对DS沥青冷补料的力学性能及路用性能进行了研究。试验结果表明：溶剂型DS沥青冷补料具有早期强度高、强度增长快，粘聚性能、高温性能、水稳定性能好，易于施工等优点。

关键词： 道路工程，沥青冷补液，沥青冷补料，级配设计，路用性能

中图分类号：U418

Development and Pavement Performance Analysis of DS Solvent-based Cold Patch Asphalt Mixture

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Abstract:

In order to rapidly repair asphalt pavement pits and solve the problems of low initial strength and slow strength increase of solvent-based cold patching asphalt mixture, a kind of solvent-based cold mix asphalt mixture was developed. First of all, the orthogonal experiment design method was used to study the viscosity and storage stability of cold patching asphalt liquid with different compositions, and to determine the optimal proportion of solvent-based DS asphalt cold asphalt. According to the climate characteristics of Ningbo district, the advantages and disadvantages of volume index, mechanical properties and road performance of the three kinds of gradation asphalt cold patching asphalt mixture

were analyzed, then the proper gradation was selected, and the asphalt cold patching material was prepared. Finally the mechanical properties and pavement performance of DS asphalt cold patching asphalt mixture were studied. The experimental results show that the solvent-based DS asphalt cold patching asphalt mixture has the advantages of early high strength, high strength growth, good adhesion, high temperature performance, good water stability and easy construction.

keywords:road engineering, cold patching asphalt liquid, cold patching asphalt mixture, gradation design, road performance

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The Analysis of Cold Recycling Technology of the Road Base Based on Patent Map

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Abstract:

There are many cases that used the cold recycling technology in road base in China and abroad. However the present development status, technological difficulties and the development tendency of this technology are not clear. Based on the search results of cold recycling technology from CNKI, patent map, technology of life cycle and K-means, literatures are analyzed and discussed. The results show that this technology can be divided into six groups including: subgrade pavement, construction quality, cold in-place recycling, cold recycling technology, asphalts and mixtures, and road. Compared with the traditional pavement study, the development of cold recycling technology in road base is mature. But the study of quality control and management for cold recycling technology is promising.

Keyword: Patent map, Cold recycling technology, Road base

预制路面研究现状综述

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摘　要： 对国内外预制式路面的研究现状、材料选择及施工工艺进行综述。综合对比国外技术，板块式预制路面技术成熟，主要用于道路重建以及整块替换；卷曲式预制路面目前仍处于试验阶段，但发展前景巨大。

关键词： 预制式路面；板块式路面；卷曲式路面；快速修补；综述

A Review of Prefabricated Pavement Technology

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Abstract:

This paper made a detailed introduction to the research status,material selection and construction technology of prefabricated pavement at home and abroad. Comprehensive comparison of domestic and foreign technology, plate prefabricated pavement technology is mature and has been put into use whilerollable prefabricated pavement is still in the experimental stage, but the development prospectis broad.

Keywords: refabricated pavement;plate precast concrete pavement; rollable road; rapid repair; review

纳米材料–聚合物复合改性沥青低温性能研究

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摘　要：为了提高基质沥青的低温性能，采用纳米层状硅酸盐和聚合物A制备复合改性沥青。通过5℃延度、当量脆点和BBR试验评价了其低温改善效果，同时对其高温性能、温度敏感性和抗老化性能等进行了评价；采用低温弯曲试验对基质沥青、5%B聚合物改性沥青和纳米材料–聚合物复合改性沥青混合料的低温抗裂性进行比较分析，并通过车辙试验和浸水马歇尔试验对其混合料高温抗车辙性能和水稳定性进行评价。试验结果表明：纳米材料–聚合物复合改性沥青及其混合料明显改善了基质沥青的低温性能，且具有良好的高温抗车辙性能，但其在实际施工和抗水损害性能方面有待进一步研究。纳米材料–聚合物复合改性沥青具有良好的低温抗裂性，适用于寒冷地区路面铺装材料。

关键词：道路工程，复合改性沥青，纳米材料，低温抗裂性

中图分类号：U416.217; TU535文献标识码：A

Nanomaterial-polymer Composite Modified Asphalt for Improved Performance at Low-temperature

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Abstract:

In order to improve the low-temperature property of matrix asphalt, Nano-layered silicate and polymer A were used as modifiers to prepare composite modified asphalt. The paper evaluated the

performance of low-temperature through the 5℃ductility, equivalent brittle point and BBRtest, at the same time, the paper also evaluated the other properties including high-temperature, temperature sensitivity and aging resistance,etc. The paper made a comparison analysis of low-temperature crack resistance to matrix asphalt mixture, 5% polymer B-modified asphaltmixture and nano/ polymer composite modified asphalt mixture by the low-temperature bending test,and evaluating the high-temperaturerutting resistanceandwater stabilityevaluation throughrutting testandimmersion Marshalltest. The results show that nano/ polymer composite modified asphalt and asphalt mixturenot onlysignificantly improvedlow-temperature propertiesof matrix asphalt, and it hadgood high-temperaturerutting resistance. But the actual construction and resistance towater damage needed further studying. Nano/polymer composite modified asphalthas a good performance on low-temperature crack resistance, and it can beapplied topavementmaterialsin cold area.

Keywords: Road Engineering, Composite modified asphalt, Nano-materials,Low-temperature crack resistance

Permeability and Stiffness Assessment of Paved and Unpaved Roads with Geocomposite Drainage Layers

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ABSTRACT:

Poor subsurface drainage is frequently identified as a factor leading to accelerated damage of both paved and unpaved roadway systems. Geocomposite drainage layers offer an alternative to traditional methods but have not been widely evaluated, especially in terms of the impact of changes in both drainage capacity and pavement foundation stiffness. In this study, lab, field, and numerical analyses were conducted to evaluate influences of geocomposite drainage layers on both paved (concrete and asphalt) and unpaved roadway systems. Laboratory large-scale Horizontal Permeameter Test (HPT) was conducted to compare the horizontal permeability of the systems with and without an

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embedded geocomposite layer. Falling weight deflectometer (FWD), core-hole permeameter (CHP), and air permeameter test (APT) devices were used to evaluate the in situ stiffness and drainage conditions of test sections. A two-dimensional water infiltration model was also developed to evaluate how effective the geocomposite drainage layer can drain water out of unpaved road systems after a simulated heavy rain event. The test and numerical analysis results show that the geocomposite layers increased the permeability of the roadway systems by more than one order of magnitude and also can effectively prevent the unpaved road surface materials from being saturated during a heavy rain event. For the stiffness of the test sections, the composite modulus values of the paved test sections with a geocomposite layer were similar to the corresponding sections without the geocomposite. However, the unpaved road test section with a geocomposite layer yielded lower elastic modulus than the control section, but resulted in overall better road surface conditions after a rain event due to the improved subsurface drainage condition. (267 words)

KEYWORDS:

Pavement, Unpaved Road, Geocomposite, Permeability, Stiffness, Elastic Modulus, Water Infiltration Model

基于原子力显微技术的SBS改性沥青纳观粘附性研究

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摘　要： 为了探究原材料组成对SBS改性的纳观粘附性的影响，采用原子力显微镜对不同的基质沥青、SBS改性剂、抽出油和稳定剂混溶制备得到的SBS改性沥青进行力谱试验，基于表面自由能理论对SBS改性沥青的纳观粘附力结果进行了验证。在此基础上，探讨了基质沥青、SBS改性剂类型和SBS改性剂、抽出油与稳定剂的掺量等SBS改性沥青原材料组成对其纳观粘附性的影响。结果表明：采用原子力显微镜中的力谱技术可以直观地得到SBS改性沥青的纳观粘附力，其实验结果与表面自由能结果具有较好的线性相关性；与改性剂配伍性好的基质沥青制备的SBS改性沥青的纳观粘附力较大；星型SBS改性沥青较线型SBS改性沥青的纳观粘附力大；SBS改性沥青的纳观粘附力随SBS改性剂和稳定剂掺量的增加而增加，随抽出油掺量的增加而减小。

关键词： 路面材料；SBS改性沥青；材料组成；纳观粘附性；原子力显微镜；表面能

中国分类号：U414　　　　**文献标识码：A**

Nano-adhesive Characteristics of SBS Modified Asphalt using Atomic Force Microscope Technology

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Abstract:

In order to investigate the effect of the raw materials composition on the nano-adhesive characteristics for SBS modified asphalt, force spectrum experiments were conducted to test the nano-

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adhesive force of SBS modified bitumen prepared by different virgin asphalt, SBS modifier, extraction oil and stabilizer using the atomic force microscope (AFM). The nano-adhesive force result of SBS modified asphalt containing warm mix additive were verified based on surface free energy theory. Based on this, the influence of the raw materials composition such as virgin asphalt, SBS modifier types and extracting oil and stabilizing agent content on cohesive characteristics were discussed for SBS modified asphalt. The results show that force spectrum experiments in atomic force microscope is helpful to collected intuitively nano-adhesive force of SBS modified asphalt. And the experimental results using the atomic force microscope are in good linear correlation with the results of surface free energy. The virgin asphalt has a good compatibility with a SBS modifier that is suitable to make SBS modified asphalt with nano-adhesive force. The nano-adhesive force of star-shaped SBS modified asphalt is larger than that of line-shaped SBS modified asphalt. The nano-adhesive force of SBS modified asphalt will be improved as the SBS modifier and stabilizer content increased. And the nano-adhesive force of SBS modified asphalt will decrease when extraction oil content increased.

Keywords: pavement materials; SBS modified asphalt; materials composition; nano-adhesive characteristics; atomic force microscope; surface free theory

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冻融循环对泡沫沥青冷再生混合料微观结构影响

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摘　要：针对泡沫沥青冷再生混合料抗水损害能力相对较差的特点，选取6种不同级配泡沫沥青冷再生混合料，系统研究了不同冻融循环次数下混合料强度衰减特性、空隙级配及最可几孔径的变化规律。结果表明，随着冻融循环的增加，冷再生混合料的强度明显减小，微空隙显著减小，大空隙显著增加，空隙数目的变化直接影响到混合料的强度大小。CT试验及劈裂试验结果表明：在总空隙率相同条件下，微空隙越多混合料强度越高；大空隙越多混合料强度越低。以此为基础提出再生混合料内部空隙的三种分类：无害孔、少害孔及有害孔。前两次冻融循环对冷再生混合料最可几孔径影响最大。在相同的冻融次数下初始空隙率越大泡沫沥青冷再生混合料的最可几孔径越大。

关键词：泡沫沥青冷再生混合料；冻融循环；劈裂强度；空隙级配；最可几孔径

Study on Impacts of Freeze-thaw Cycles on Microscopic Characteristics of Cold Recycled Mixture Using Foamed Asphalt

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Abstract：

　　As cold recycled mixture using foamed asphalt has a poor ability to resist water damage. 6 kinds of gradation cold recycled mixture using foamed asphalt was selected to study strength characteristics, air voids gradation and the most probable air voids diameter under different freeze-

thaw cycles. As the freeze-thaw cycle increased, strength of the recycled mixture prominently reduced, micro-void significantly decreases, comparing to larger gap increased significantly. The CT and ITS test results show that the more micro-void is, the higher strength is when they have the same total air voids; The more amounts of larger volume voids is, the lower strength of specimens. Division method of air voids which is in cold recycled mixture using foamed asphalt was put forward. The first two freeze-thaw cycles of cold recycled mixture had significant influence. The larger the initial void volume is, the larger the most probable air void is.

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Coupled Thermo-Hydro-Mechanical Simulation of Concrete Interfacial Transition Zone

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ABSTRACT:

Concrete pavement is under accelerated deterioration due to environment loads and rapidly increasing heavy traffic. This article presents a numerical study for the analysis of the thermo-hydro-mechanical behaviour of concrete with Interfacial Transition Zone (ITZ) around individual aggregate. Attention was given to the simulation of concrete having different phases such as, cement paste, aggregate and particularly the ITZ surrounding the aggregates. All the boundary loads and temperatures were static to keep the simulation as simple as possible. A parametric study was conducted to observe the variation of strains

depending on the variation of the porosity of ITZ. It was found that strain depends on the variation of the porosity of ITZ. Two different failure functions were utilized to evaluate the potential failure location. Both of the failure functions agree with the identified failure locations.

KEYWORDS: Concrete, Transition zone, Microstructure, Porosity, THM simulation

Dynamic Management of Accelerated Pavement Tests due to Pavement Response and Behavior

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ABSTRACT:

Accelerated Pavement Testing (APT) is conducted to determine the response of pavement structures to applied simulated traffic loads in a shortened time period to enable an improved understanding of the expected response of the pavement structure to expected traffic loads. During a typical APT project, the applied loads and the environmental conditions under which the test is conducted are defined and managed to ensure a certain type of response from the pavement. Planning, management and analysis of APT should allow for dynamic changes in pavement behavior that occur due to pavement balance changes caused by pavement material and layer responses to the applied loads and environmental conditions. This paper evaluates some of these aspects and set some guidelines for the dynamic management of APT, based on the experience of the authors.

KEYWORDS: Accelerated Pavement Testing, pavement balance, traffic molding

单轴压缩下泡沫混凝土的强度特性研究

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摘　要：以水泥、粉煤灰、矿渣为胶凝材料，水胶比0.43，按照质量比16∶3∶1制备出不同气泡含量泡沫混凝土。通过室内试验，对不同气泡率下（0～74.23%）泡沫混凝土进行单轴压缩破坏试验，得到其不同龄期下（7d、14d、28d）的抗压强度和破坏形态，研究了泡沫混凝土的应力-应变曲线，探讨了抗压强度与龄期和气泡率之间的关系。结果表明：泡沫混凝土在单轴压缩下经过密实、弹性、屈服、破坏四个阶段；其抗压强度随泡沫含量增大而减小，在一定范围内随着龄期增大而增大；通过拟合，得到泡沫混凝土抗压强度与气泡率之间成指数关系，且拟合曲线与试验数据具有很好的一致性；对于气泡含量高的试样，其破坏形态表现出低强度脆性破坏特征，在中部形成较宽裂缝，而对于气泡含量低的试样，其破坏形态与普通混凝土基本一致。

关键词：泡沫混凝土；单轴压缩；强度特性；应力-应变曲线；破坏形态

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Strength Characteristics of Foam Concrete to Uniaxial Compression

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Abstract:

Foam concrete with different content of foam was prepared with cement, fly ash and blast furnace slag as binding materials and according to the mass ratio 16:3:1, water-binder ratio 0.43. Through laboratory tests, the uniaxial compression tests for foam concrete under different rate of foam (0～74.23%) at different curing age (7d, 14d, 28d) were conducted to study compression strength and failure mode, the stress-strain curve of foam concrete and the relationships between compressive

strength and curing age, rate of foam were studied. The research results indicate that there are four stages in foam concrete to uniaxial compression process, namely densification stage, elastic stage, yield stage and failure stage; the higher content of foam, the lower the compressive in a certain range increases with curing age. The relationships between compressive strength and the rate of foam were studied by fitting and show an exponential relationship between each other. Also the fitting curve has a good consistency with test data. For samples with high content of foam, the failure pattern shows low strength and brittle failure characteristics, and forming a wide crack in the middle of sample, while the sample with low content of foam, the failure pattern of foam concrete is similar to ordinary concrete.

Key words: foam concrete; uniaxial compression; strength characteristics; stress-strain curve; failure mode

New MA Class Cast Asphalt Concrete Experimental Study of Flow Characteristics

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ABSTRACT:

GMA is a kind of brand-new MA class cast asphalt mixture mixing technology, and it will be used to solve the problem that steel deck plate paving of the HongKong-Zhuhai-Macao bridge project is giant and the time limit for a project is tight. Using the El fluidity test, evaluate its workability that is cast asphalt concrete of British system that simulated small cooker equipment and large cooker car to produce. Results show that small cooker equipment within 120min of mixing time and large cooker car within 270min of mixing time to produce GMA mixture fluidity are all less than 20s. This shows that large cooker car can extend the duration of mixing, and be advantageous to the organization construction. At the same time it also shows that simulated small cooker equipment can also produce considerable liquidity of cast asphalt mixture as large cooker car, and can reduce material consumption on the phase of the experimental study.

KEYWORDS: Cast Asphalt Mixture MA/GMA; Flow Characteristics; El Fluidity Test

Aging of Asphalt Binders from Weathered Asphalt Mixtures Compared by SHRP Processes

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Abstract:

Aging of asphalt binders is very critical to the long-term performance of asphalt pavements. In this study, aging of asphalt binders from weathered asphalt mixtures were quantitatively evaluated in micro-level properties by Atom Force Microscope (AFM) and macro properties in terms of their rheological behaviors by Dynamical Shear Rheometer (DSR). The binders tested were recovered from

weathered asphalt mixtures at different times, in addition to those aged by SHRP binder processes, i.e., Rolling Thin Film Oven test (RTFO) and Pressure Aged Vessel (RTFO+PAV) as controls. The results are as follows: 1) aging from both weathered mixtures and by SHRP processes can be characterized qualitatively by AFM; 2) "Bee structures" appeared commonly in morphology imagines did not present in the imagines of adhesion and modulus of elasticity measured; 3) the asphalt aging by SHRP processes can be reproduced from weathered asphalt mixtures in terms of the roughness of morphology, adhesion and modulus of elasticity; 4) Aging by weathering duration of 0, 2,400hrs was roughly equivalent to those by RTFO, RTFO+PAV residuals, respectively, which was true for both micro- and macro-level properties.

Keywords: weathering aging, asphalt mixtures, Atom Force Microscope, nano, morphology, Dynamical Shear Rheometer

Research on the Performance of Dense Graded Ultra-thin Wearing Course Mixture

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ABSTRACT:

This paper adopted the compound modification method by using multi-chain polyolefin and SBS to improve the workability and extend the construction temperature range of ultra-thin wearing course materials. Therefore the dense graded Ultra-thin Pavement (U-PAVE) mixture was designed with the nominal maximum aggregate size 10mm. Based on laboratory results of volumetric properties, high temperature performance, low temperature cracking resistance and moisture stability, design parameters and evaluation indexes of U-PAVE10 were proposed. Meanwhile, the attenuation law of texture depth was comparatively studied with traditional ultra-thin wearing course materials via modified wheel tracking test. Besides, the Computed Tomography (CT) scanning method was employed to investigate the void distribution law inside U-PAVE10 samples cored from test roads,

and bonding strength with the lower layer was measured by pull out test. The U-PAVE10 exhibited excellent pavement performance during laboratory and field tests. Compared with traditional ultra-thin wearing course materials, the attenuation speed of texture depth for U-PAVE10 was much slower and its bonding effect was better.

KEYWORDS: U-PAVE, Ultra-thin wearing course, CT scanning, anti-sliding, dense graded

Gray Relational Entropy Analysis of High Temperature Performance of Bio-asphalt Binder and its Mixture

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ABSTRACT:

To analyze the gray relational entropy of high temperature performance of bio-asphalt binder and its mixture, the performance indexes of bio-asphalt binder were determined through the

conventional performance test and Superpave test of asphalt. The correlation between the performance indexes of the asphalt and the dynamic stability of the mixture was studied by the gray relational entropy method. The results showed that: the creep compliance of bio-asphalt with low content(1%) SBS modifier was weakly correlated with the dynamic stability of the mixture. The difference of the entropy correlation between the same performance indexes of the bio-asphalt determined before and after RTFO and the dynamic stability of the mixture was big. The dynamic viscosity of bio-asphalt and the dynamic stability of the mixture have the highest gray entropy correlation, which can be used as the key index of high-temperature performance evaluation of bio-asphalt.

KEYWORDS: road engineering; high temperature; gray relational entropy; bio-asphalt

Aging Characteristics of Rubber modified Asphalts in Different Environmental Factors Combinations

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ABSTRACT:

Two kinds of rubber modified asphalts were investigated and compared with virgin asphalt. In order to making the aging simulate more close to engineering practice, different combinations of four

environmental factors were merged into the laboratory aging simulation. Subsequently, conventional property tests, including softening point, viscosity, creep stiffness, creep rate and fatigue cracking were conducted on asphalt samples. Performance difference of asphalt before and after aging was selected as an evaluation index for asphalt aging degree. Results indicate that two kinds of rubber modified asphalts show stronger resistant ability to temperature deformation and fatigue cracking than virgin asphalt in all kinds of environmental factors combinations. Tests on chemical analyses were conducted to investigate the asphalt aging characteristics. The apparent morphology of rubber modified asphalts are described in detail under Environment Scanning Electron Microscope (ESEM).The damage condition reflected in images reveals the aging degree caused by multiple environmental factors. Moreover, the Thermogravimetric analysis (TG) confirms that three kinds of asphalts can maintain thermal stability in various environments. Besides, new characteristic functional groups were not detected in the infrared(IR) spectra of rubber modified asphalts, which means they have stable antioxidant properties given that their oxidation degrees change slightly throughout aging processes.

KEYWORDS：Rubber modified asphalts; Environmental factors; Aging characteristics; Evaluation index; Chemical analyses

条带界面约束阻尼结构的模态实验研究

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摘　要：设计了七种约束阻尼结构，采用单点锤击自由振动法，通过分析结构的复合损耗因子、振动加速度级及时域波形，研究了阻尼层厚度及条带凸起宽度对约束阻尼结构阻尼性能的影响。损耗因子分析结果表明：随着阻尼层厚度的增加损耗因子逐渐增加，分别增加为0.026、0.019、0.013，但增加的幅度逐渐减小；随着条带凸起宽度的减小损耗因子呈增大趋势，分别为0.278、0.308、0.337、0.363，依次同比增加了10.8%、21.2%、30.6%。振动加速度级值研究结果表明：在25Hz～2500Hz范围内，随着阻尼层厚度的增加，四种平板型结构的振动加速度级值逐渐减小，其中，最大振动级值依次为139dB、135dB、132dB、131dB；整体趋势对比看出条带凸起结构的加速度级在各个频率段内均小于平板型结构，最大值上分别下降了2dB、5dB、6dB。时域波形研究结果表明：阻尼层厚度为1mm平板型结构的衰减时间为0.13s，随厚度的增加衰减时间逐渐减小，幅度也逐渐减小，相比1mm平板结构，最大相差0.11s左右；条带凸起结构相比平板型结构衰减时间明显减小，但三个条带凸起结构的衰减时间差距却不大，都在0.02s～0.03s之间。由研究结果可知，阻尼层厚度的增加可以提高结构的阻尼性能，但增加的趋势会越来越平缓；当阻尼层厚度相同时，采用条带界面时阻尼效果要优于平板型界面。

关键词：条带界面；约束阻尼；复合损耗因子；加速度级值；时域波形

中图分类号：O328; TB123

The Study on the Modal Experimental of the Strip Interface Constrained Damping Structure

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Abstract :

Seven kinds of constraint damping structures are designed, using single point of hammer free

vibration method, through the analysis of the compound loss factor, vibration acceleration level and the time domain waveform of the structure, studied the damping layer thickness and strip width on the damping property of constrained damping structure. Results of the loss factor research show that with the increase of damping layer thickness, the loss factor increases gradually, which increases to 0.026, 0.019, 0.013, but the magnitude of the increase gradually decrease; With the decrease of the width of the strip, the loss factor increases, which is 0.278, 0.308, 0.337, 0.363, which increased respectively by 10.8%, 21.2%, 30.6%.Results of vibration acceleration level value research show that In the range of 25Hz to 2500Hz, with the increase of damping layer thickness, the vibration acceleration level of the four kinds of flat structure decreases gradually, and the maximum vibration level is 139dB, 135dB, 132dB, 131dB; The comparison of the overall trend shows that the acceleration level of the strip bulge structure is less than that of the flat structure in each frequency range, and the maximum value is decreased by 2dB, 5dB, 6dB. Results of the time domain waveform research show that the damping time of the flat structure with damping layer thickness of 1mm is 0.13s, and the decay time decreases with the increase of thickness, and the amplitude decreases gradually, compared with the 1mm flat structure, the maximum difference is about 0.11s; Compared with the flat structure, the attenuation time of the strip bulge structure is significantly reduced, but the attenuation time difference between the three strips is not large, which is between 0.02s and 0.03s. The results show that the damping property of the structure can be improved by increasing the damping layer thickness, but the increasing trend will be more and more gentle. When the damping layer thickness is the same, the damping effect of strip interface is better than that of the flat interface.

Keywords: The strip interface; Constrained damping; Compound loss factor; Level acceleration value; The time domain waveform

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Synthesis and Structure-activity Relationships Study of Double Quaternary Ammonium Salt as Emulsifier

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ABSTRACT： A cascade reaction to synthesis emulsifiers of fatty amine, epichlorohydrin and amine could be performed with catalyst free in organic media and the structure-activity relationships of those emulsifiers were studied. Some control experiments had been designed to obtain the excellent reaction conditions and a series of double quaternary ammonium salt emulsifiers were prepared. Besides, the emulsifying property and penetration performance were investigated via laser particle size analyzer and permeability test. The results showed that with increasing of hydrophilic, the emulsifying property and penetration performance increased sharply. However, the emulsifying property was improved as hydrophobic increased. The penetration performance had closely associated with the concentration of emulsifiers. With the structure-activity relationship in hand, the structures of asphalt emulsifier can be designed according to the performances.

KEYWORDS: Structure-activity Relationship, Double Quaternary Ammonium Salt, Emulsifying Property, Penetration Performance.

Chemical Characteristics and Rheological Properties of CR/SBS Composite Modified Bio-asphalt

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ABSTRACT:

The non-renewable characteristics and growing demand for crude oil has contributed to the development of alternative materials, such as bio-asphalt in the field of pavement engineering. In this

paper, the chemical compositions of SHB bio-asphalt extracted from castor oil residue were analysed by elemental analysis, infrared spectroscopy and molecular weight distribution, which proves that the chemical compositions of SHB bio-asphalt are similar to those of petroleum asphalt, but could not be utilized in the pavement directly. Therefore, CR and SBS additives were incorporated into petroleum asphalt blended with bio-asphalt to prepare modified asphalt. According to the ultimate high- and low-temperature performance of modified asphalt, the percentages of raw materials were determined as 15% for SHB, 18% for CR, and 2% for SBS. Eventually, from rheological properties results evaluated by small strain oscillation test, it shows that the addition of SHB increases the high- and low-temperature performance of the CR/SBS composite modified asphalt, whose application will lead to vast environmental and economic benefits.

KEYWORDS: composite modified bio-asphalt; chemical characteristic; rheological property

再生炭黑改性沥青混合料室内性能试验研究

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摘　要：本文为评价再生炭黑改性沥青混合料的路用性能，采用室内试验的方法对再生炭黑掺量为15%的改性沥青混合料与70#沥青混合料进行对比分析。试验结果表明：在AC-20级配中，再生炭黑改性沥青混合料相较于基质沥青混合料的油石比增大0.1%即可符合马歇尔指标要求；基于车辙试验再生炭黑改性沥青混合料较基质沥青混合料的高温稳定性，以及基于低温弯曲试验中的低温抗开裂性能皆有所提高；通过汉堡车辙试验得出改性沥青混合料的水稳定性能有所提高。

关键词：道路工程；沥青混合料；再生炭黑；室内试验；路用性能

Laboratory Experimental Research on Properties of Recycle Carbon Asphalt Mixture

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Abstract: In order to evaluate road performance of recycle carbon asphalt mixture, contrast experiments of 15% recycle carbon asphalt mixture and 70# asphalt mixture were taken by laboratory experiment. Some main conclusions are drawn as follows. In AC-20 grade,recycle carbon modified asphalt mixture compared to the original asphalt mixture must increase 0.1% asphalt-aggregate ratio; Based on rutting test and low temperature bending test,the ability of high-temperature rutting and low-temperature cracking can be greatly improved;By Hamburg wheel tracking test again to verify that the modification increased water stability of asphalt mixture.

Keywords: road engineering; asphalt mixture; laboratory test; recycled carbon black; road performance

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Effect of Coarse Aggregate Shapes on Graded Stone Mixtures Performances through Discrete Element Simulation

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ABSTRACT:

Aggregate shapes pose significant influences on mechanical performances of the graded macadam. In this paper, performances, including workability in compaction stages and bearing capacity

in loading stages, are discussed by virtual laboratory tests based on discrete element method (DEM). In the first, six shapes, including four standard shapes and two realistic shapes, were selected to generate the graded macadam specimens. After generation, compaction tests were performed to analyze the workability of the specimens with different shapes. During the compaction test, the aggregates inside the macadam specimens were gradually packed closely and contacted well. Then a virtual triaxial test was performed to reveal the relation between the shapes and bearing capacity. According to the test results, following conclusions can be drawn: Firstly, while making a high performance specimen both in strength and in workability, ellipsoid particles with a slenderness ratio of two are recommended. Secondly, while making a high performance specimen in strength, modulus and workability, cube particles are recommended. Thirdly, shapes with obvious edges and corners have a poor performance in workability, however, this workability does not constantly deteriorate with the increase of edges and corners. Fourthly, shapes with more edges and corners have a better strength, ellipsoid shapes with a slenderness ratio of 2.5 also provide a high strength. Lastly, shapes with apparent edges have a high modulus; however, the modulus does not increase with the increase of the corners and edges.

KEYWORDS: Graded macadam, Particle shape, Road performance, Triaxial test, Discrete element method

复合浇注式沥青钢桥面铺装结构与材料试验研究

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摘　要：钢桥面铺装是大跨径桥梁建设的重点和难点，特别是大跨径悬索桥。南京四桥是主跨1418m的三跨连续钢箱梁悬索桥，主要承担南京绕城高速过境交通，交通量大，交通荷载重。基于钢桥面铺装的高温性能和变形性能综合平衡，南京四桥钢桥面铺装采用了复合浇注式沥青钢桥面铺装方案，该方案由"下层4cm直馏硬质沥青浇注式沥青混凝土（压入大粒径碎石）+上层3.5cm高弹改性沥青AC"组成。本文开展了直馏硬质沥青浇注式沥青混凝土、高弹改性沥青AC混合料设计及性能研究，开展了铺装复合结构高低温性能和疲劳性能研究，试验结果表明复合浇注式铺装具备优异的变形协调性能和疲劳性能，组合结构动稳定度近3000次/mm，疲劳寿命超过1200万次。南京四桥通车运营4年，桥面铺装性能优良，车辙深度3-5mm，表明在大跨径悬索桥中采用复合浇注式沥青钢桥面铺装是可行的，也为国内类似工程项目提供了有益借鉴。

关键词：悬索桥、钢桥面铺装，复合浇注式沥青铺装、直馏硬质沥青，高弹改性沥青，路用性能

Research on Structure and Material Test of the Steel Deck Composite Gussasphalt Concrete Pavement

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Abstract:

　　Steel bridge deck pavement is a key issue in the construction of long-span bridges, especially of long-span suspension bridge. Nanjing 4th Yangtze River Bridge is a three-span continuous steel box girder suspension bridge with the main span of 1418m. It undertakes the heavy traffic from Nanjing Outer Circular Expressway. Based on the balance of high temperature performance and deformation performance of steel bridge deck pavement, the deck pavement structure of Nanjing 4th Yangtze River

Bridge was designed as composite gussasphalt concrete structure, which consists of "4cm gussasphalt (GA) with straight-run hard bitumen as lower layer (with spreading of crushed stones) and 3.5cm high elastic modified asphalt concrete (AC) as upper layer". This paper presents the design and performance of GA with straight-run hard bitumen and of high elastic modified AC, as well as the high and low temperature performance and fatigue performance of composite pavement structure. Laboratory test results show that the composite gussasphalt concrete pavement has excellent deformation coordination and fatigue performance. Dynamic stability of the composite structure is nearly 3000 times /mm, and the fatigue life is more than 12 million times. After 4 years in service, the pavement of Nanjing 4th Yangtze River Bridge performs well, showing that the composite gussasphalt concrete pavement is feasible for long-span suspension bridges, and provides beneficial reference for similar projects in China.

Keywords: Suspension bridge,Steel bridge deck pavement, Composite gussasphalt concretepavement, Straight-run hard bitumen,High elastic modified asphalt concrete, Pavement performance

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快固冷拌冷铺RPF树脂透水混合料路用性能研究

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摘　要：透水沥青路面由于其空隙率大的特点，耐久性差，容易发生剥落飞散，形成坑槽病害，相对于常规密集配沥青路面，更迫切面临着快速养护与修复的需求。本文选用了快固冷拌冷铺RPF树脂作为修复材料的胶结料，并通过室内试验研究了RPF树脂透水混合料的路用性能。试验结果显示，RPF树脂常温（20℃）粘度为5539m Pa.s，能够实现常温拌合、压实，60℃动稳定度超30000次/mm，高温性能极佳，低温弯曲应变达到3800με，低温抗裂性能良好，残留稳定度和TSR都能达到75%以上，满足规范要求。综合来看，RPF树脂透水混合料能够作为透水沥青路面的快速修复和具备透水需求的重载交通路段材料。

关键词：透水路面，快固冷拌，RPF树脂透水混合料，路用性能

Research on the road usage performance of rapid-curing, cold-mixing and cold-paving RPF resin permeable mixture

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Abstract:

Due to the characteristic of large air voids, the permeable asphalt pavement with pore durability is prone to peeling off to pot hole. Comparing to the conventional dense gradation asphalt pavement, it faces the demand of the rapid maintenance and repair more urgently. This paper selected the RPF resin,which could cure rapidly, and mix and pave at normal temperature, as the binder of the repaired material. The performance of the RPF resin permeable mixture was studied through laboratory test. Results indicated that viscosity at 20℃ was 5539mPa.s which meant it could be mixed and compacted at normal temperature. Dynamic stability of the RPF resin mixture at 60℃ was higher than 30000cycle/

mm, which meant it had extremely good high-temperature stability. Low temperature bending strain reached 3800με, which showed the RPF mixture's good anti-cracking at low temperature. Remaining marshall stability and TSR both came up to 75%, meeting the standard requirements. In conclusion, the RPF resin permeable mixture could be used as the rapidly-fixing material to the permeable asphalt pavement and the pavement material of the heavy trafficroad section which need water permeable.

Keywords:permeable asphalt pavement,rapid-curing, cold-mixing,RPF resin permeable mixture,road usage performance

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FLAC3D and PFC3D Coupled to Analyse Drilling Core Backfill Compaction on Pavement

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ABSTRACT:

Drilling core examinations on pavement is an important method to analyse the service performance of the road and reveal internal pavement structure condition. Backfill is a common method to repair drilling core. During the process of backfillin order to achieve target compaction degree, compaction stress is too large that can cause material damage at the bottom and deformation at the lateral of drilling core.However, national construction specifications ignoreits influenceafter drilling core examination. Under this background, this research herein presents a FLAC3D and PFC3D

coupled model to analyse stress and deformationdistributionof the backfill compaction. In terms of the geometrical model, both subgrade and pavement are simulated with layered structures, backfill materials are replaced by a relatively large assemblyballs from the PFC3D model.Subgrade model consists of two layers which are the roadbed soils and original ground soils, while the pavement consists of three layers according to the pavement types. In terms of mechanical models, balls are generatedfrom different radius byuniform distribution, andthese are simulated with linear model where normal and shear stiffness ,frictioncoefficient are given, subgrade is simulated with Mohr-coulomb model where Young's Modulus, Poisson ratio, angle of internal friction, cohesion coefficient are various based on the layer material properties.Pavement layers are simulated with the linear elastic model where Young's Modulus and Poisson ratio are various based on the layer material properties. In terms of loading condition, differentstressesare assigned to the hammer above drilling core. The FLAC3D and PFC3D coupled simulation outputs are stress and displacement around drilling core region during the corresponding history. According to the resultof the history. With punching hammer pressure increasing, thestressat the bottom of the drilling core and Maximum lateral displacement increase, moreover, the arching action occur in this process.Shear stressand displacement at the top of the drilling core are almost linear relationship with pressure of hammer

KEYWORDS: Drilling Core Examination, Pavement Structure, FLAC3D, PFC3D

高性能合成纤维道面混凝土冻蚀耦合试验及损伤模型研究

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摘　要：对纤维掺量为0、1.0、1.2kg/m3的机场道面混凝土，在清水溶液中及质量分数为5%的Na2SO4溶液中的抗冻性能进行了对比试验研究，并分别探讨了混凝土在这两种溶液中的冻融损伤及纤维增强机理。由试验结果可知，无论是在清水溶液中还是质量分数为5%的Na2SO4溶液中纤维道面混凝土的抗冻性能均较基准组要好。在清水中冻融循环时，混凝土损伤度值的下降规律及相互之间的差距均与Na2SO4溶液中冻融循环表现不尽相同。机场道面混凝土在Na2SO4溶液中的损伤劣化效果并不完全符合1+1>1的模式，在冻融初期产生了1+1<1的耦合损伤负效应模式，在冻融中后期产生了1+1>1的耦合损伤正效应模式。

关键词：机场道面混凝土；高性能合成纤维；冻融腐蚀；损伤模型

Experimental Study of Freeze-erosion and Damage Model of High-performance Synthetic Fiber Reinforced Pavement Concrete

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Abstract:

With the fiber content of 0 kg/m3, 1.0 kg/m3, 1.2 kg/m3, the freezing resistance of in clear water and the Mass fraction of 5% sodium sulfate solution of airport pavement concrete, were studied. The freeze-thaw damage of concrete in these two solutions and the mechanism of fiber reinforcement are also discussed. From test results know that, whatever in clear water or the Mass fraction of 5% sodium sulfate solution, the frost resistance of fiber airport pavement concrete is both better than the reference group. The freeze-thaw cycle of concrete in clear water is different from in sodium sulfate solution, whatever the damage degree and the difference between each other of concrete. The freeze-

thaw damage of the pavement concrete in sodium sulfate solution is not completely consistent with the 1+1>1 model, in the early of freeze-thaw that produced 1+1<1 coupling damage model of negative effect, in the late of freeze-thaw that produced 1+1>1 coupling damage model of positive effect model

Keywords: Airport pavement concrete; High-performance synthetic fibre, Freeze-thaw erosion, Damage model

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高模量沥青混凝土在半刚性基层长寿命沥青路面中应用的合理性研究

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摘　要：为了修筑更具耐久性的半刚性基层长寿命沥青路面，本文结合国内外长寿命沥青路面的不同技术特点，分析了层间结合状态和下面层模量对半刚性基层长寿命沥青路面典型结构力学状态的影响，探讨了沥青面层存在的疲劳问题以及面层抗车辙和抗疲劳的协调问题；进而通过不同温度、不同控制模式的四点弯曲疲劳试验，评价了高模量沥青混凝土的抗疲劳特性，采用累积耗散能指标将其与表面层材料进行了比较。分析表明：在半刚性基层长寿命沥青路面中，下面层使用高模量沥青混凝土可以改善路面的抗车辙和抗疲劳性能，具有一定的合理性。

关键词：道路工程；高模量沥青混凝土；长寿命沥青路面；层间结合状态；四点弯曲疲劳试验；累积耗散能

中图分类号：U416.217

Rationality Research on Application of High Modulus Asphalt Concrete in Long-life Asphalt Pavementwith Semi-rigid Base

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Abstract:

　　To construct a more durable semi-rigid base long-life asphalt pavement, this paper combined with different technical characteristics of long-life asphalt pavements at home and abroad. Different interlayerbonding conditions and moduli of bottomsublayer were considered to analyze mechanical state differencesof semi-rigid base long-life asphalt pavement.Two issues were discussed: fatigue failure in the surface layer and coordination between unti-rutting and unti-fatigue characteristics. Then four-point bending fatigue tests were used in various temperatures and loading modes to evaluate the

unti-fatigue characteristics of high modulus asphalt concretes. The index of accumulative dissipated energy was adopted to make a comparison with materials in the uppersublayer. The analysis indicates that the application of high modulus asphalt concrete in semi-rigid base long-life asphalt pavement can improve the anti-rutting and anti-fatigue characteristics and has some rationality.

keywords: road engineering; high modulus asphalt concrete; long-life asphalt pavement; interlayer bonding condition; four-point bending fatigue test; accumulative dissipated energy

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沉管隧道管节接头耐火试验

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摘　要：管节接头的防火性能受制于耐温极限仅为100℃的Ω橡胶止水带；管节接头的防火效果取决于防火隔断的设计。因此，本文主要通过自行研制的1：1全比例尺的大型构件试验进行，研究在RABT升温曲线下，测试采用不同耐火保护方案时，沉管接头复合构造处OMEGA止水条温度变化情况。模拟管节接头部位的高温受热状况，比较各种不同防火措施条件下的隔热效果。试验结果表明：管节接头的耐火保护部分，采用防火隔断（龙骨+3cm玻镁防火板+2cm硅酸铝耐火棉+1cm玻镁防火板）+底层防火板（2cm玻镁防火板）的耐火保护方案可以满足RABT升温曲线下，外部火灾温度1200℃，而接头处止水带温度保持在70～100℃的正常工作温度，并建议沉管隧道防火隔断处务必做好锚固连接，推荐采用龙骨加固方案。

关键词：沉管隧道；管节接头；防火试验；双层防护；橡胶止水带

Immersed Tube Tunnel Fire Test Socket Joint Were Reviewed

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Abstract:

Socket joint fire performance subject to heat resistance limit is 100 ℃ only Ω rubber water-stop;Socket joint fire effect depends on the design of fire partition.Therefore, this article mainly through the self-developed 1:1 full scale test of large components, research under RABT temperature curve, the test using different fire protection scheme, immersed tube joint compound structure of OMEGA water stop temperature changes.Simulate the socket connector parts of high temperature heat condition, compare different under the condition of fire prevention measures of heat insulation effect.Fireproof protect part of the test results show that the socket joint, using fire partition (keel + 3 cm bo magnesium

fire board + 2 cm aluminum silicate refractory cotton + 1 cm glass magnesium fire prevention board) + fire prevention board (2 cm glass magnesium fire board) at the bottom of the fire protection scheme can satisfy RABT under temperature curve, external fire temperature 1200℃, and water-stop temperature joint in the normal work temperature of 70 ~ 100 ℃, and suggests that immersed tube tunnel fire partition area for the anchor connection, keel is recommended for the reinforcement scheme.

Keywords: immersed tube tunnel;Socket joint;Fire prevention trials;Double protection;Rubber water-stop

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基于显微镜图像分析的振动作用下混凝土孔结构研究

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摘　要：为探究振动对混凝土凝结过程中孔结构变化的影响，采用室内模拟车桥振动，通过设置不同振动试验参数，研究在混凝土不同凝结时间段振动对混凝土力学性能的影响程度，并与未振动组进行对比，利用显微镜图像分析技术对振动后混凝土孔结构的变化进行分析。研究表明：在混凝土初凝前施加较小频率（5Hz）、小振幅（4mm）振动能在一定程度减少孔面积比例与孔数，对混凝土后期强度有所提高；而较大振动频率和振幅（9Hz，8mm）作用对混凝土结构有所影响，特别是初凝至终凝期间，较大振动作用会对混凝土结构产生破坏，产生一定裂隙，孔数有所增加，强度有一程度降低；混凝土强度与孔数和孔面积比例之间有较好的相关性，可通过孔数与孔面积比例反映混凝土强度。

关键词：车桥振动；混凝土；图像分析；孔结构

中图分类号：**TU528.1**

Study on the Pore Structure of Concrete under the Action of Vibration Based on Microscope Image Analysis

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Abstract:

In order to investigate the influence of vibration on the change of pore structure in the process of concrete condensation,the simulation of vehicle bridge vibration and by image analysis methods to analyze the change of pore structure of concrete interior vibration.By using simulation of vehicle bridge vibration indoor, setting different parameters of vibration test,to research the influence of vibration

on the mechanical properties of concrete in different setting time, and compared with non vibration group, then analysed the change of pore structure of concrete after vibration using microscope image analysis technique.The results show that the pore area ratio and the number of holes decrease to some extent before applying the small vibration frequency and amplitude (5Hz,4mm)during concrete initial setting period.and the later strength of concrete is improved much,but the larger vibration frequency and amplitude(9Hz,8mm)have bad effect on concrete structure,Especially during the initial setting and final setting period,Larger vibration will cause damage to concrete structure,produce certain cracks and number of holes increased,the intensity is reduced to a certain extent as well.There is a good correlation between the strength of concrete and the ratio of pore size and pore area,the strength of concrete can be reflected by the ratio of hole number and hole area.

keywords: bridge vibration; concrete; image analysis; pore structure

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Effects of Nano-silica and Rock Asphalt on Rheological Properties of Modified Bitumen

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ABSTRACT:

In this research study, rheological properties of binders modified by nano-silica and Qingchuan rock asphalt at different contents were investigated by univariate and variance analysis. The experimental tests performed were rotational viscosity (RV), dynamic shear rheometer (DSR) and bending beam rheometer (BBR). Results of RV test showed that the two modifiers had significantly influence on rotary viscometer. And the compound modified asphalt had a better ability to resist shear deformation. Analysis of DSR test results revealed that Qingchuan (QC) rock asphalt had a remarkable

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impact on the complex shear modulus G* and phase angle δ, while the effects of Nano-silica was relatively small, which mainly improved G* and barely had any influence on δ. It is indicated that nano-silica modified asphalt is not cost effective in improving anti-rutting performance. From the results of BBR test, the low-temperature performance subjected to degradation on account of the two materials addition, while the adverse effect of nano-silica was comparatively small. Given the similar high temperature characteristics, the compound modified asphalt had smaller decline in low temperature performance compared with QC rock asphalt modified bitumen. Moreover, based on rheological properties of modified asphalt, the optimal content, which consisted of 6% QC rock asphalt and 1% nano-silica, was determined.

KEYWORDS: Nano-silica; QC rock asphalt; compound modification; rheological property.

基于松弛时间谱确定沥青混合料粘弹性参数

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摘　要： 为了准确研究沥青混合料线性粘弹性质，提出了一种利用连续松弛时间谱求解沥青混合料时间域内粘弹性方程参数的方法。根据2种沥青混合料在5个温度下的单轴压缩蠕变试验的结果，基于线性粘弹性原理得到松弛模量数据；采用改善的幂函数对松弛模量数据进行平滑预处理；通过松弛时间谱在时间域的定义推导出连续的松弛时间谱函数；利用松弛时间谱求解得到松弛模量Prony级数模型中的参数。结果表明：改善的幂函数对试验数据的预处理可以剔除噪点，有效减小试验误差对函数参数值的影响；利用连续松弛时间谱求解Prony级数模型中的粘弹参数，所得计算结果均为正值，且具有一致的变化趋势。

关键词： 路面工程；沥青混合料；松弛模量；Prony级数；连续松弛时间谱

中图分类号：U414.1

Determination of Viscoelastic Parameters of Asphalt Mixtures Using the Relaxation Spectrum

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Abstract:

In order to investigate the linear viscoelastic properties of asphalt mixtures accurately, a continuous relaxation spectrum method was applied to model the time-domain viscoelastic function of asphalt mixtures. According to the uniaxial compressive creep test results of two kinds of asphalt mixtures at five temperatures, the relaxation modulus data were obtained based on the linear

viscoelastic theory. Experimental data were pre-smoothed with the modified power law. The definition of continuous relaxation spectrum was employed to solve the continuous relaxation spectrum function in time domain, which was then used to compute the viscoelastic parameters of Prony series model. Conclusions can be drawn that: pre-smoothing experimental data using the modified power law is efficient in removing the scattered data and therefore reduces the adverse effect of experimental error; the continuous relaxation spectrum function can be used to determine the viscoelastic parameters of asphalt mixtures, which can overcome the problem of negative coefficients and oscillating curves.

Keywords：road engineering; asphalt mixtures; relaxation modulus; Prony series; continuous relaxation spectrum

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基于X-ray CT技术的沥青混合料三维数值模型

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摘　要：运用MATLAB软件获取CT图像的数字信息，利用MATLAB语言构造出一系列M函数，用于显示、处理获取到的CT图像的图像数据。将得到的图像信息导入有限元软件ANSYS，建立沥青混合料三维细观结构有限元模型，具体包括集料、空隙和沥青胶浆的模型，建立生成的模型与真实的模型更加接近，对模型进行有关的数值模拟。通过对比分析真实沥青混合料试件与数值模型内部结构中各组分在体积含量方面的差异，验证了该三维数值模型的正确性。沥青混合料三维数值模型的重构研究为进一步实现沥青混合料三维数值虚拟试验奠定了重要基础。

关键词：CT图像；三维微观结构；有限元软件；沥青混合料；数值模拟

中图分类号：U414

Asphalt Three-dimensional Numerical Model Based on X-CT Technology

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Abstract: Using MATLAB software to obtain the digital information that from CT images,and using MATLAB language constructs a series of image data for display and processing of M functions. While the reconstruction of the image information can import large finite element software ANSYS,and build a asphalt three-dimensional finite element model of the microstructure that includ aggregate, voids and asphalt mortar. The numerical simulation of the model is carried out, and the useful information is obtained.

keywords: CT image,three dimensional microstructure ,finite element software,asphalt mixture,numerical simulation

Test Evaluation of Rutting Performance Indicators of Asphalt Mixtures

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ABSTRACT:

Rutting performance indicators were evaluated based on the wheel tracking testing data of AC-20 limestone and AC-13 basalt asphalt mixtures. A/C rutting index which was determined using the modified Tseng-Lytton model, had the highest ranking potential compared to: rutting at 2 cycles (R-2 index), densification index, dynamic stability index, complex stability index and shear index. All the proposed indicators were highly correlated to rutting development (R2>0.80). However, secondary deformation based indicators were more correlated to rutting development than primary deformation based indicators. The high rutting correlation coefficients of R-2 index and densification index, implied that primary deformation based indicators could be used for quick rutting prediction. Basing on the rutting significance of R-2 index, it was hypothesised that one wheel tracking cycle could be adequate for mixture design optimisation. The threshold values of the proposed indicators were determined and validated to be used for mixture design. However, they were not applicable to recycled hot mix asphalt mixtures.

Keywords: Asphalt mixture; Wheel tracking test; Rutting; Rutting indicator

化学-物理综合抑制和破碎沥青路面暗冰的技术研究

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摘　要:将物理破冰路面与化学融冰雪路面各自的优点有机结合，可提高沥青路面的融雪除冰效率从而提高冬季行车安全，并可减少融雪剂用量和消耗一定的废旧轮胎胶粉。因此，该除冰雪技术具有重要的环保意义和应用价值。

本研究以SMA-13作为基准级配，分别用橡胶颗粒（简称RP）和冻结抑制剂（简称IB）等体积替代0mm-3mm粒级的部分集料和部分矿粉，最终形成抑制和破碎路面暗冰的沥青混合料（简称PCAM-13），经试验得到其最佳油石比为6.2%。当RP掺量为2%～4%及IB掺量为4%～6%时，PCAM-13的高温稳定性、低温抗裂性及水稳定性均满足JTG F40-2004的相关要求。与普通SMA-13相比，PCAM-13的抑制冻结效果明显，并得到其抑制结冰效果较好的温度范围为-12℃～0℃。

PCAM-13板式试件浸于水温25℃下并经车轮往返碾压，用其浸泡水的电导率变化来表征试件中溶析出盐化物量的变化。对RP掺量3%、不同掺量IB的PCAM-13板式试件进行测试表明，融雪剂中盐化物在荷载作用下能加快析出，在相同碾压时间内溶析出的抗冻剂有效融冰盐分与IB掺量成正相关。温度低于-15℃或者冰层厚度超过10mm时，PCAM-13的化学-物理作用综合破冰效果就十分微弱。

关键词：沥青路面，橡胶颗粒，冻结抑制剂，化学-物理作用，融雪破冰，PCAM-13

Study on the Physical and Chemical Ice Removal Effects of Asphalt Pavement

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Abstract:

The icy asphalt pavement is a safety issue and big concern for drivers and highway agencies,

especially during winter period for mountainous areas in the rainy climate zones. This study aimed at developing a new snow-melting asphalt mixtures based on their physical and chemical interactions. This asphalt mixture has high efficiencies of physical-based ice-breaking and chemical-based ice-melting, therefore, it increases the speed of ice removing of the pavement and improves the driving safety in the winter. In addition, the consumption of waste tires is an economic and sustainable idea, which is also helpful to protect the environment.

The chemical anti-freezing agent named IceBane (IB) and rubber particles (RP) were used to replace the some fine aggregates between 0 mm to 3 mm and some mineral powder for size smaller than 0.0074 mm, respectively. The two replacement materials have the same volume as the previous materials. The determinations of the weight percentage for the two additives are discussed later. Using these material combinations, a new type of asphalt mixtures was developed and named as PCAM-13. The ratio of optimum binder content was determined as 6.2%. When the weights of RP and IB are between 2% to 4% and 4% to 6%, the high temperature rutting resistance, low temperature cracking resistance, and water stability are sufficient to meet the construction requirement. Compared to the unmodified SMA-13 mixtures, the ice removing effect of PCAM-13 is significant and the most efficient temperature range is between -12°C and 0 °C.

The electrical conductivity was measured using the repeated load (rutting) test on the asphalt mixture slab in the 25°C water bath, which is used to determine the change of the salt dissolve rate. The salt dissolve rate is used to indicate the efficiency of the anti-freezing agent. It has been found that for the same repeated loading period, the more anti-freezing agent used, the more dissolved salt observed. However, if the temperature of the slabs is below -15°C or the thickness of the cube is larger than 10 mm, the ice-dissolve effect of PCAM is relatively weak.

The use of PCAM-13 has been found to be affected by the temperature, thickness of ice and the magnitude of loading. From the measurement of the repeated load test, under the same environmental condition and magnitude of loading, the ice on the PCAM-13 mixtures is more prone to break and become separated from the asphalt slabs compared with the SMA-13 mixtures. Meanwhile, no significant ice cube melting on the control SMA-13 was observed, which means the advantage of

PCAM-13 mixtures is remarkable.

Keywords: asphalt mixtures, rubber particles, anti-freezing agent, chemical-physical effect, ice-dissolve.

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不粘轮乳化沥青的制备及其作用机理研究

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摘　要： 路面层间材料的优劣直接影响到道路的使用寿命，由于施工车辆带走粘层油，导致层间粘结不良，后期出现层间脱空、滑移、拥包等现象。为此，本文制备一种不粘轮乳化沥青，避免施工车辆带走粘层材料，确保路面层间粘结效果，实验和工程应用效果表明，不粘轮乳化沥青具有优异的低温延展性、粘结性能和不粘轮特性。

关键词： 沥青路面; 粘层材料; 粘结性能; 不粘轮; 延度

Development of the Trackless Tack Coat And Analysis
The Trackless Mechanism

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Abstract: The tack coat is usually applied on existing clean asphalt or concrete pavement surfaces, a good bond between bond layers can ensure the work time of the road. The tack coat oil was easily taken away by wheels, which due to abscission, entresol and slippage. A special tack coat material, trackless tack coat, which does not track or pick up on paving equipment has been developed, ensure the pavement layer system act as a uniform composite layer and more effectively transfer the external load into the subgrade. Results indicated that trackless tack coat had superior low temperature ductility, bond strength and trackless.

keywords: asphalt road ; tack coat material; bond strength; trackless; ductility

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多年冻土区路线工程困难度评价模型

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摘　要： 传统的路线方案比选是决策者对路线方案进行技术经济论证和效益分析，未考虑像多年冻土区等特殊环境带来的工程困难。为了科学合理地确定一条安全、经济、环保、美观的多年冻土区公路，摆脱决策者的主观性，以工程困难度的视角运用数学方法进行路线方案的评价。从影响工程困难度的评价指标入手，定性与定量分析相结合提出并量化了海拔高度、地面坡度、年平均地温、冻土分布、融区构造和既有工程等6个主要指标，采用物元可拓理论中的优度评价法对量化的指标进行分析评价，考虑信息熵客观地确定评价指标权重，提出了多年冻土区路线工程困难度的熵可拓学评价模型。本文以青藏高原多年冻土区秀水河至雅玛尔河段为例，以传统评价方法为参考，对熵可拓学评价模型进行验证。结果表明：同传统方法评价结果一致，N1线工程困难度最小，优度值为0.92；其他方案的比选结果与传统评价方法的结论也一致。熵可拓学评价模型将路线方案比选的过程数字化，更具有直观性与科学性，尤其进行相近路线方案比选时，避开了决策者的主观性，为线路方案比选提供一种新的评价思路与方法。

关键词： 道路工程；多年冻土区；方案比选；工程困难度；熵可拓学评价模型；评价指标；

中图分类号：U412

The Entropy Extension Evaluation Model of Engineering Difficulty Degree in Permafrost Engineering

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Abstract: In traditional highway comparison, the technical, economic and benefits of highway is

demonstrated and analyzed by decision makers. However the engineering difficulty caused by special environmental like permafrost is ignored. To scientifically and reasonably determine a safe, economic, environmental, beautiful permafrost highway, getting rid of the subjectivity of decision makers, the mathematical method is used to evaluate the highway from the perspective of engineering difficulty. Firstly 6 main evaluation indexes including altitude, slope, annual average temperature, permafrost distribution, melt region structure and existing engineering are proposed and quantified by macro-micro analysis. The superiority evaluation method of matter-element extension theory is used to analyze and evaluate the quantitative indexes. The weight of evaluation indexes is objectively determined by considering the entropy of information. The entropy extension evaluation model of engineering difficulty in permafrost route planning was proposed. In this paper, taking the Xiushui River to Yamaer River in the permafrost region of the Qinghai-Tibet Plateau as an example, the traditional evaluation method is used as a reference to validate the entropy extension evaluation model. The results show that, consistent with the traditional evaluation methods, highway plan N1 has the least difficulty and the superiority value is 0.92. And the comparison results of the other schemes are also the same as the traditional evaluation methods. Because of entropy extension evaluation model, the process of highway plan comparison is digitized with more intuitionistic and scientific. In particular, when the similar highway scheme is selected and compared, the subjectivity of the decision maker is successfully avoided and a new evaluation method is provided for the highway plan selection.

k**ey words**：road engineering; permafrost region; scheme comparison; engineeriong difficulty degree; entropy extension evaluation model; evaluation index

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高速公路超高渐变段纵坡对路表径流特性的影响研究

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摘　要：为探究高速公路超高渐变段纵坡对路表径流的影响，基于水动力学理论中的二维浅水方程，建立考虑紊流阻力和地形因素影响的路表径流仿真模型。结合沪宁连接线实际工程，在S型超高段工况条件下，从路表径流的集流时间和稳态下最大水深两方面率定模型。分全超高—正常路拱和正常路拱—全超高两类过渡段，对纵坡的敏感性分析结果表明：①纵坡从0%增大到6%的过程中，最大水深分布区域由近零横坡外侧车道逐渐过渡到下游内侧车道。②综合考虑减小最大积水深度和积水面积的要求，提出超高段的"最优纵坡"为1.5%的近零缓和坡。

关键词：道路工程；抗滑；数值模拟；超高渐变段；路表径流

文献标识码：A

Study on Influence of Longitudinal Gradient of Super Elevation on Expressway Runoff

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Abstract：In order to study the effect of longitudinal gradient of super elevation on the runoff on road surface, the numerical model considering the turbulence resistance and topography was established on the base of the two-dimensional shallow water equation in hydrodynamics. Based on the S - shaped super elevation of Shanghai - Nanjing connecting line, the model is established by using the empirical model from both the time of flow and the maximum water depth at steady state. The results show that: (1) In the process of longitudinal slope increasing from 0% to 6%, the distribution area of maximum water depth transfers from nearing the zero cross-lateral lane to the downstream inner lane. (2) Considering the requirement of reducing the maximum water depth and water area, the 'optimal longitudinal slope' of the super elevation is a longitudinal slope of 1.5%.

key words: road engineering; skid resistance; numerical simulation ; super elevation transitions; expressway runoff

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Longitudinal Design Methodology of Expressway Based on Safety Assessment in Mountain Area

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ABSTRACT

The ability to identify any potential crash problems at the planning and designing stage of a roadway is critical for ensuring the long-term safety operation and proactively improving roadway

infrastructure safety. This paper introduces the methodologies and tools for evaluating and improving safety of expressway longitudinal design, which are more and more widely accepted in China.

This paper focuses on both uphill and downhill longitudinal section design, and also proposes a series of methodologies and the process of evaluation respectively. Setting an extra climbing lane or escape ramps are optimization methods besides adjusting the grade and length of the slope. Efficiency and economic analysis should be done to choose recommended proposal. This paper gives an engineering example to explain the methodologies and the effects of optimization design better.

The practicality of the evaluation methodologies and tools have been successfully popularized in China, which will contribute greatly in roadway safety. Proactively improving roadway infrastructure safety by elimination safety hazard at planning and design stage works well in roadway development.

KEYWORDS：Thru-mountain Expressways, long-steep slope, safety assessment, optimization design

基于"海绵城市"理念的干线公路交汇处LID设计研究 [1]

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摘　要：基于干线公路交汇处的交通特征，着重从源头径流总量控制、中途径流峰值削减、末端径流污染处理构建干线公路交汇处LID设计策略。立足于该策略，以G312国道与长山中路交汇处的海绵化建设为例，通过设置源头环岛雨水花园、中途设施碎石盲沟以及末端沉泥井，结合横断面、纵断面的设计，实现了雨水的有效利用和排放，对缓解干线公路交汇处内涝以及降低径流污染具有重要的意义。

关键词：海绵城市；干线公路交汇处；低影响开发设施；径流总量控制；径流污染处理

中图分类号：U412

Low-impact Development Design Research in Arterial Highway Intersection based on Sponge City

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Abstract: The LID design strategy for arterial highway intersection was proposed based on the traffic characteristics of the arterial highway intersection, whichi focused on runoff decrease at source、peak runoff reduction on the way and runoff pollution treatment at the end.The Intersection between G312 State Road and Changshan Road was chosen as a case to apply the strategy.Through setting the rain garden at source、the blind ditch on the way、the mud well at the end and combining cross section and longitudinal section design, not only did it achieve the effective use of rainwater,but was of great significance to alleviate waterlogging and reduce runoff pollution in the arterial highway intersection.

key words: Sponge city;Arterial highway intersection; Low-impact development; Total runoff control; Runoff pollution treatment

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沥青路面水膜敏感性分析[1]

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摘　要：为探求不同因素变化对沥青路面水膜演进过程的影响，分析沥青路面水膜变化过程敏感性。本文基于沥青路面二维浅水方程建立沥青路面水膜仿真模型，利用正交试验法设计试验方案，分析降雨强度、路幅宽度、路面横坡、路面纵坡对沥青路面（内、外侧车道和路肩）水膜变化的影响作用，并进行影响因素的灵敏度分析。结合沈山高速改扩建工程，通过对多车道沥青路面水膜敏感性进行分析，得到如下结论：降雨强度对水膜厚度变化最为灵敏，路表粗糙系数对水膜厚度最大值出现时间影响最为灵敏，路面宽度对路面水膜退水过程表现最为灵敏，较之于纵坡，横坡对水膜变化过程更为灵敏。沥青路面水膜变化呈现出较强的二维特征。水膜厚度由内侧车道向路肩依次增大，在模拟方案中，在路面粗糙系数影响下，路面行车道水膜厚度最值出现时间推迟最长达1min以上。通过路面水膜敏感性分析，可为沥青路面水膜变化分析中不同影响因素的确定与灵敏度分析提供理论支持。

关键词：路面工程；路面水膜；灵敏度；正交试验

中图分类号：U416

Sensitive Analysis of Asphalt Pavement Water Film

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Abstract：In order to analyze the sensitivity of water film change on asphalt pavement surface. The simulation model based on two-dimensional shallow water equations of asphalt pavement is established to formulate different programs with the method of the orthogonal experiment. Rainfall intensity, pavement width, cross slope, longitudinal slope, pavement roughness coefficient are selected to analyze the influence on the process of water film change, which included the location of inner lane, outer lane and shoulder. Combining the preliminary design scheme of Shen-shan expressway reconstruction and extension projects, results showed that rainfall intensity is the most sensitive to the maximum depth of

water film, pavement roughness coefficient is the most sensitive to the emergence time of maximum water film depth and pavement width is the most sensitive to the retreating time of water film. Compared to longitudinal slope, cross slope is more sensitive to the water film change, the water film thickness increase from the inside lane to shoulder. The emergence time of maximum water film depth is delayed up to more than 1min under the influence of pavement roughness coefficient according to the simulation. Through the analysis on the sensitivity of the water film on asphalt pavement, this paper can provide reference for the sensitivity analysis of water film on asphalt pavement.

key words:　Pavement engineering; pavement water film; sensitivity; orthogonal test

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Research on Horizontal Alignment Design
Theory of Superhighway

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ABSTRACT

The road top design speed of 120 km/h in China have been greatly improved after more than 60 years, in order to adapt to the development demand of highway design speed above 120 km/h in the future, the paper studied the superhighway alignment design theory and calculated the length limit of straight line according to driver characteristics, calculated the minimum radius of circle curve on the basis of stress analysis when vehicle is running. Finally, calculated the minimum length of transition curve according to the centrifugal acceleration of vehicle when it is running, the travel time and the passengers visual characteristics. The calculation and analysis results show that superhighway linear feature is in conformity with the vehicle running characteristic, and superhighway technically feasible.

KEYWORDS: Superhighway; Horizontal alignment; Circle curve; Transition curve; Design speed

Modelling Transit Assignment Problem with Sharing BRT Lanes

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ABSTRACT

More and more cities have bus rapid transit (BRT) and its independent lanes for the rights-of-way. However, the actual volume of BRT lines is far less than the capacity of BRT lanes. The spare of the BRT lanes causes the waste of the road resources. Sharing BRT lanes to the conventional buses is a popular strategy to integrate the road traffic resources. In this paper, we create a network with sharing BRT lanes to illustrate the effect of conventional buses on BRT under user equilibrium (UE). Different levels of demand are loaded on the network to account for the effect of congestion. As the stop-to-stop distances of BRT service and regular bus service is different, not every BRT stop is shared to buses. Therefore, the walking time is supposed to have a great impact on the route choices of passengers whose destinations are between the BRT-only stops and the bus-only stops. So, walking time should be taken into consideration in route choice analysis. A typical transit assignment algorithm is employed to solve the model. Conclusions are presented through the comparison of numerical examples.

KEYWORDS: Sharing BRT lanes; transit assignment model; route section; walking time

弯坡组合路段可靠性设计方法研究

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摘　要：为了提高弯坡组合路段的交通安全水平，提出了基于货车交通安全的弯坡组合路段可靠性设计方法。先以现行公路工程结构可靠度设计统一标准为依据，对弯坡组合路段可靠度进行了定义，以货车转弯和下坡过程中制动器制动效能下降的临界安全温度、货车侧滑和侧翻失稳现象为约束条件，建立弯坡组合路段的功能函数，推导了其可靠性模型，提出了弯坡组合路段可靠性计算模型的求解方法。结合实际案例分析，示范了弯坡组合路段可靠性设计方法的应用，并验证了其合理性。研究结果表明：（1）货车在某些设计参数条件下的弯坡组合路段上行驶时，往往也会发生侧翻先于侧滑的现象；（2）现行的弯坡组合路段设计即使能满足现行有关规范和指南的验算要求，但不一定能满足可靠性设计的要求。提出的弯坡组合路段可靠性设计方法能够减少危险弯坡组合路段的出现，提高道路运营安全性。

关键词：弯坡组合路段；温升模型；侧滑模型；侧翻模型；可靠性设计

中图分类号：**U412.3**

Research on Reliability Design Method for Combination of Vertical and Horizontal Curves

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Abstract: In order to improve the traffic safety level of combination of vertical and horizontal curves, the reliability design method of combination of vertical and horizontal curves based on the traffic safety of trucks is put forward. Based on Unified Standard for Reliability Design of Highway Engineering Structures, the reliability of combination of vertical and horizontal curves was defined. Then, with the critical safety temperature of braking efficiency drop, sideslip and rollover of trucks as constraints during turning and downhill, the performance function of combination of vertical

and horizontal curves was established. Model for calculating combination of vertical and horizontal curves' reliability was deduced and method for solving the model was put forward. With case study, application of the combination of vertical and horizontal curves reliability design method was illustrated, and its reasonability was verified. The results show that（1）When trucks are driving on combination of vertical and horizontal curves with some design parameters, the phenomenon of rollover before sideslip also occurs; （2）even if the current design results satisfy requirement of the specification, they may not reach the requirement of reliability design method. The proposed reliability design method for combination of vertical and horizontal curves can effectively reduce the occurrence of dangerous combination of vertical and horizontal curves and improve the safety of road operation.

key words：combination of vertical and horizontal curves；temperature rising model；sideslip model；rollover model；reliability design

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公路路线指标安全评价体系研究

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内容摘要：本文从公路路线平面、视距、纵断面、横断面和合成坡度五个方面进行了路线指标的安全评价体系研究，通过对公路路线指标的分析研究得出影响公路安全的路线因素，通过工程实例对各指标进行了安全限值分析，并对不满足安全需要的指标采取了相应的优化措施，为设计部门在公路设计中提供了参考。

关键词：道路交通事故　公路路线指标　公路安全评价

Study on Safety Evaluation System of Highway Route Index

Abstract:　In this paper,the safety evaluation system of highway route is studied from five aspects of highway route plane, sight distance,vertical section,cross section and synthetic slope,through the analysis and research of highway route index,the influence factors of highway safety are obtained,the safety limits index are analyzed by engineering examples,and the corresponding measures are taken to meet the safety requirements,it provides reference for design department in highway design.

key words:　road traffic accident; highway route index; highway safety evaluation

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浅谈几种公路常见病害预防性养护及适用处治方法

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摘　要：近年来，本人对如何搞好预防性养护，在全面提升路况质量的同时，有效降低养护成本，提高养护资金使用效益的方法和途径进行了不辍研究，找到了一些处治公路常见病害的简单易行的措施和方法，通过实践，收效良好。下面，笔者就公路常见病害的预防和处治方法谈一些体会。

关键词：覆盖式封缝、人工刮油、机械喷洒沥青、横向开槽、止水线、热拌冷补

Discussion about Preventive Maintenance in terms of Several Common Road Diseases and Corresponding Applicable Solution

Abstract: In recent years, oneself how to do well the preventive maintenance, at the same time of comprehensively improving the quality of road conditions, effectively reduce the maintenance cost, and the ways and methods to improve the efficient use of maintenance funds for the ceaseless research, found some treatment highway simple measures and methods of the common diseases, through practice, good results. Here, the author road common diseases prevention and treatment method is to talk about some experiences.

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"福银高速"武当山互通立交改建方案设计分析与研究

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摘　要：互通式立交是高速公路的关键节点工程之一，它对充分发挥高速公路交通功能起着重要的作用，现有互通的改建正是为了适应高速公路日益增长的交通需要。以福（州）¯银（川）高速公路武当山互通立交改建方案设计工程项目为依托，系统分析研究"改建互通立交"的主要技术问题，梳理设计理论、总结设计经验，为类似项目方案设计提供技术借鉴。首先，分析本项目的研究背景，结合本项目立项目的，确定本文分析研究技术路线；然后，分析研究福银高速武当山互通改建项目方案设计背景及要求，充分阐述、论证本互通立交改建项目实施的必要性和可行性；其次，通过实地现状交通调查，运用交通量预测"四阶段"法，预测武当山互通立交远景交通量，预测年限为20年。最后，综合考虑福银高速武当山互通相关的服务区设置、地形地貌、预测远景交通量等因素，结合当地旅游区总体规划等3个地方规划（根据武当山总体规划的要求，在互通改建的同时同步在连接线两侧实施新建集散中心工程），拟定设计了"原地改建互通（方案一）"和"异地新建互通（方案二）"两个可行方案，经过详细分析研究比较，推荐的"异地新建互通（方案二）"。为武当山互通改建项目优化、合理、经济地实施，提供了重要参考依据。

关键词：高速公路，互通立交，改建项目，交通量预测，设计分析，方案研究

The Design Analysis and Research on Rebuilding Project of Wudangshan Interchange in Fuzhou and Yinchuan Expressway

Abstract: Interchange is one of the key node of the highway project, and it plays an important role in traffic functions of highway. The current interchange reconstruction is to adapt to the increasing traffic demand of highway. Based on the design project of Fu(zhou)-Yin(chuan) highway Wudangshan interchange reconstruction scheme, we systematically analyzed the main technical problems of "interchange reconstruction", combed design theory, summarized design experience, and provided technical reference for similar project scheme design.

First, we analyzed the research background of this project and the research status of highway interchange at home and abroad, and established the technical routes of analysis and research in this paper by combining the purpose of this project. Then, we analyzed the design background and requirements of Fu-Yin highway Wudangshan interchange reconstruction project scheme, fully illustrated and demonstrated the necessity and feasibility of implementing the interchange reconstruction project. Besides, through field investigation, we utilized traffic volume "four stages" prediction method to predict the future traffic volume of Wudangshan interchange for a period of 20 years. Finally, we took service area setting, topography and predicted future traffic volume of Fu-Yin highway Wudangshan interchange into comprehensive consideration, combined the overall planning of 3 areas including local tourism zone, and proposed two feasible schemes, "interchange reconstruction on the original place" (scheme 1) and "interchange reconstruction on a different place" (scheme 2). We recommended scheme 2 after elaborate analysis and comparison.

The route of recommended "interchange reconstruction on a different place" (scheme 2) starts near Yaogou on the west of north-south main road, via Xiaogou, Xiaobeigou and Daijiawa, and ends at the original Wudangshan interchange. The main control points are starting point near Yaogou on the west of north-south main road, Xiaogou, Xiaobeigou and Daijiawa and ending point at the original Wudangshan interchange. Which provides an important reference for optimizing, rationally and economically implementing Wudang Mountain interchange project.

Keywords: highway, interchange, Renovation project , traffic volume estimate, design analysis, project research

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重庆山区高速公路路线方案研究探讨

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摘　要：本文从平纵面线形指标、工程地质情况、工程规模、公路用地及拆迁情况、营运里程和社会效益、与场镇协调性和干扰性、环境影响评价、造价比选等多方面，以实例详细阐述了山区高速公路选线理念和方法。

关键字：山区高速公路，地质选线，方案比选

A Research on Route Plan for Mountainous Expressway in Chongqing

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Abstract: this article carefully illustrates concepts and methods for route selection of expressway in mountainous region through examples from the perspective of horizontal and vertical alignment indicator, engineering geological condition, engineering scale, highway land and demolition condition, operation mileage and social effects, coordination and interference with cities and towns，environmental impact assessment，cost comparison etc.

key words: expressway in mountainous region, geology route selection, plan comparison

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Evaluation of Highway Horizontal Curve Data Measurement Methods

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ABSTRACT

This paper documented an evaluation and comparison of two horizontal curve data extraction methods. The first method used the MicroStation software accompany with the Google Earth Satellite images, named the MicroStation method; the second method was to apply the automatic curve extraction tool, named as CATER-CURVE method, developed by the Center for Advanced

Transportation Education and Research (CATER) at the University of Nevada, Reno (UNR). The detailed procedures of the MicroStation method and the CATER-CURVE method were introduced in this paper. Accuracy and reliability of the two methods were evaluated based on the case studies for different highways in Nevada. Recommendations were provided based on the comparison of the two methods. Results show that the MicroStation method generates radius data with lower errors, but requires much longer operation time. The CATER-CURVE method is able to scan a state wide road network in the Geographic Information System (GIS) format, identify and extract curve data automatically. The extracted curve information is stored in a new GIS layer that is ready for data application or further processing. The CATER-CURVE method is more appropriate for generating the curve dataset of a large road network, while the Microstation procedure is better for project level curve data identification. The tool evaluation in this paper can be used as a reference for traffic agencies to select curve data generation tools.

KEYWORDS: MicroStation method; CATER-CURVE method; Geographic Information System; Curve Identification

低路堤重载交通下钢波纹管涵与路基变形协同性研究

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摘　要： 依托泗许高速安徽淮北段2标K15+031处直径3米钢波纹管涵洞，采用有限元分析了荷载作用下钢波纹管涵洞的应力值，并与实测结果对比分析，得出有限元模拟计算结果与实测结果具有较强的一致性，验证了利用有限元软件进行数值模拟分析的可行性；同时采用有限元软件模拟分析了钢波纹管涵洞结构的位移、挠度及应力的变化规律，分析了采用不同土体弹性模量与钢波纹管涵波峰、波谷和波测的相互关系。

关键词： 低路堤；重载交通；钢波纹管涵洞；路基；变形协同性

Research on Deformation Cooperativity between Steel Corrugated Pipe Culvert and Subgrade under Heavy Traffic in Low Embankment

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Abstract: Through the field test of the single corrugated steel pipe culverts' stress, strain and deflection in heavy traffic in low embankment, The stress values of steel corrugated pipe culverts under load are analyzed by finite element method, and the results are compared with the measured results, The results of finite element simulation are in good agreement with the measured results. The feasibility of numerical simulation analysis using finite element software is verified; And the variation law of displacement, deflection and stress of steel corrugated pipe culverts were simulated and analyzed by using finite element software. The relationship between the elastic modulus of different soils and the crests, troughs and wave measurements of steel corrugated pipe culverts was analyzed.

key words: low embankment; heavy traffic; steel corrugated pipe culvert; subgrade;deformation synergy

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Sediment Transport Mechanics in Coastal Plain Shallow-Grade Storm Drain Systems

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ABSTRACT

Sedimentation of fine muddy material in coastal plain shallow-grade storm drain system has been recognized for many years and self-cleansing minimum critical velocity or critical shear stress was specified in the local design manual. However, this approach may not be possible to maintain at all

points in time. It leads to sedimentation and a reduction of inflow capacity with time, and an associated high cost of cleaning. Recent studies showed that the sediment characteristics and concentration, and hydraulic behaviour of the drain system play an important role to properly represent the ability of drain flows to transport sediments. It is necessity to incorporate the sediment and drain system characteristics into the design criteria. The objective of the study is to evaluate the sediment concentration under different hydraulic conditions to better understand the sediment transport mechanics in shallow-grade storm drain system and implement design guidance for self-clean drain system. A suite of empirical equations for calculating sediment concentration in the storm drain under different sediment transport mechanics have been synthesised. A case study in the Southeast Texas has been conducted to incorporate the sediment grain distribution, pipe size, roughness water depth in the pipe, and flow velocity to design the self-cleansing drain system. The minimum flow velocity of 1.2m/s (4ft/s) and minimum shear stress of 3.6N/m2 is recommended for self-cleaning drain system in the coastal plain shallow-grade region.

KEYWORDS: shallow–grade storm drain, sediment transport mechanics, self-cleansing design criteria, sediment grain size distribution, sediment concentration, hydraulic behaviour

基于灰色理论的洛栾高速线形连续性评价研究

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摘　要：线形连续性是高速公路线形设计不可忽视的重点之一，本文针对现有评价方法的不足，将相邻路段运行速度差$|\Delta V\_85|$、单位速度相对差$|RV|$及车辆加速度$|a|$等作为评价线形连续性的主要指标，运用灰色理论的相关知识并结合洛栾高速公路的实际情况，建立了线形连续性灰色综合评价模型，对洛栾高速公路上行段的线形连续性进行了评价。并与洛栾高速部分事故数据进行对比分析，验证了该方法的可行性。

关键词：高速公路；线形连续性；灰色理论；评价模型

Research on Evaluation of Luoyang-Luanchuan Highway Alignment Consistency Based on Grey Theory

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Abstract: Alignment consistency is one of the most important key points of highway alignment design. For the shortage of current assessment method, this paper selected adjacent road's running speed difference $|\Delta V\_85|$, unit speed relative difference $|RV|$ and vehicle acceleration $|a|$ as indexes, and used the grey theory related knowledge and combined the actual situation of the Luoyang-Luanchuan highway, and established a comprehensive gray evaluation model of the alignment consistency, and then evaluated the alignment consistency of the upward road of the Luoyang-Luanchuan highway. And then and the results were compared with part of the accidents occurred on this highway, verifying the feasibility of the method.

key words: Highway, Alignment consistency, The grey theory, Evaluation model

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"二十四道拐"盘山公路修筑背景及线形参数研究

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摘　要：本文以享誉世界的"二十四道拐"盘山公路为研究对象，通过阐明其修筑过程及现场勘测所获得的线形参数，为之后从工程技术角度评价"二十四道拐"的公路技术参数及其线形设计精妙之处提供背景支撑。

关键词："二十四道拐"盘山公路；修筑背景；线形参数；工程技术

Study on the Building Background and Linear Parameters of "24-zigs" Mountain Road

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Abstract: This paper takes the famous "24-zigs" mountain road as the research object. By clarifying the construction process and the linear parameters which obtained from the road survey, the paper is going to provide background support for the future analysis of the technical parameters and project highlights of "24-zigs" mountain road in the perspective of engineering technology.

key words: "24-zigs" mountain road; building background; linear parameters; engineering technology

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公路视距检测技术研究

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摘　要：行车视距是影响到公路行车安全的重要因素，在公路几何设计中必须考虑满足一定的视距要求。本文综述了国内外对公路视距检测技术的研究概况，分别介绍了传统公路二维视距及三维空间视距检测理论与方法。同时也提出了现有视距检测技术研究存在的不足以及未来视距检测技术的展望。

关键词：行车视距；检测技术；二维视距；三维空间视距

中图分类号：U238

Research on the Sight Distance for Highway

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Abstract: Driving sight distance is one of the important factors affecting highway safety which must be considered in the highway geometric design satisfies the requirement of a certain sight distance. We review the general situation of the research of highway Inspection Technology of sight distance at home and abroad. Then, introduce the traditional highway 2D and 3D space inspection technology of sight distance. Finally, we put forward the existing weakness of sight distance inspection technology and future outlook.

key words: driving sight distance; inspection technology; 2D sight distance; 3D space sight distance

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An Improved Analytical "Soil Arching" Model for the Design of Piled Embankments

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ABSTRACT

The understanding of the inherent load-transfer mechanism of the "soil aching" is far behind the application of piled embankments. In this study, a series of numerical simulations is conducted firstly with the particle flow code PFC2D to investigate the development of the "soil aching" in a piled embankment with the pile-subsoil relative displacement. Then, based on the understanding of the "soil aching", an improved design method for piled embankments has been proposed with the limit equilibrium equation. The main refinements of this method are considering the effect of the "soil aching" height on the load-transfer of a piled embankment and determining the introduced load-uniformity coefficient α based on DEM models. Results indicate that the "soil aching" height varies with the variation of pile-subsoil relative displacement and the maximum "soil aching" height is about 0.8 times of pile clear spacing. Meanwhile, the load-uniformity coefficient α decreases in power

with the increase of the "soil aching" height and friction coefficient of embankment fill, and increases linearly with the embankment height. Additionally, ultimate bearing capacity, "soil aching" height as well as the corresponding load-transfer efficacy of piled embankments can be estimated via the present method. The calculated results using the present method are compared with results using several existing design methods and experimental data reported in literature. It is found that a good agreement has been obtained between results from the present method and measured data from the experiment by Low, B.K., Tang, S.K., Choa, V. [1994. Arching in piled embankments. Journal of Geotechnical Engineering 120 (11), 1917-1938].

KEYWORDS: piled embankment; "soil aching"; analytical method; "soil aching" height; load-uniformity coefficient

不同降雨工况对粗粒土高路堤边坡稳定性影响的数值分析

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摘　要： 降雨是诱发粗粒土高路堤边坡失稳的主要因素之一。为了深入研究不同降雨工况下两类粗粒土高路堤边坡失稳破坏的机制，本文首先提出一种能同时考虑高路堤边坡内部饱和度、孔隙水压力及软化效应的高路堤边坡稳定性分析方法，并设定小雨、中雨、大雨、暴雨四种降雨工况，利用Geo-studio中seep模块分析最佳填筑边坡在不同降雨工况下水位线、基质吸力的变化规律；然后采用修正的饱和-非饱和抗剪强度理论，通过fish语言对降雨边坡岩土体重度及抗剪强度进行修正，将渗流的计算结果导入FLAC3D软件平台中，分析不同降雨工况下边坡安全系数及边坡塑性区的分布情况。研究结果表明：路堤边坡最佳填筑方案为A类；降雨0-12h内边坡安全系数下降较快，随着降雨持时的增加，安全系数下降趋势减缓；相同降雨持时下，降雨强度越大，安全系数下降越快，当降雨强度超出一定范围后，其安全系数下降趋势相差不大；降雨初期，水位线上升较快，但存在一定的滞后性，随后降雨持时的增加导致水位线上升速率减慢并呈规律性上升；小雨对边坡塑性区分布影响较大，但随着降雨强度增加，降雨强度不再是影响边坡塑性区分布的主要原因。

关键词： 降雨入渗；饱和-非饱和；边坡稳定性；粗粒土高路堤；基质吸力

Stability Analysis of Coarse Grained Soil High Embankment Slope under Different Rainfall Conditions

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Abstract: Rainfall is one of the main factors of slope instability of high coarse grained soil embankment. To study the failure mechanism of two kinds of coarse grained soil high embankment slope in different rainfall conditions, an analysis method is firstly proposed considering the saturation, pore water pressure and the softening effect of high embankment slope. Light rain, moderate rain, heavy rain and rainstorm are considered when analyzing the change rule of groundwater, matric suction of embankment slope under different rainfall conditions by Seep/W. Then base on the modified unsaturated shear strength theory, using the FISH language to modify the shear strength of slope. Importing the calculation results of seepage analysis into FLAC3D. The slope safety factor under the condition of different rainfall and plastic zone distribution of slope are analyzed. The results shows: Scheme A is the optimal scheme for embankment filling, the safety factor of slope during 0-12h rainfall decreased rapidly. With the increase of the rainfall duration, the downward trend of safety factor slowed down. During the same rainfall time, the greater intensity of rainfall, the safety factor decreased more quickly. When the rainfall intensity reaches a certain range, the safety factor decreased a little. In the initial stage, the water level raise rapidly but has hysteresis, then the water level rise rate slowed down regularly due to the rainfall duration increase. Rainfall has obvious effect on the plastic zone distribution of slope, with the increase of rainfall intensity, it is no longer the main reason affecting the distribution of slope plastic area.

key words: rainfall infiltration; saturated unsaturated soil; slope stability; coarse-grained soil high embankment; matric suction

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Mechanical Behavior of Vetiver Vegetated Soil and Application in Stabilization of Riverbank and Silt Soil Embankment

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ABSTRACT

There have been many vegetated soil slopes which were stabilized by grass generally with short roots to resist rainfall scouring erosion, to dissipate water pressure in soil slope under rainfall infiltration. In contrast to general grasses, vetiver root is strong, thin and long so as to penetrate and bound the soil to a depth of up to 1 to 3 meters and thus withstand the effects of cracking in soil slope. Although many laboratory or in-situ tests had been studied to approximate the contribution of tree roots to slope stability, there are still less similar systematic researches for vetiver root reinforcement and demonstration, and even until now there have no reports for vetiver root reinforcement on expansive soil slope. Therefore in this paper, vetiver root reinforcement was demonstrated on an expansive soil riverbank and a silt soil railway embankment. General planting, growing and observing of vetiver grass in the riverbank and embankment were recorded and analyzed.

Firstly, laboratory oedometer expansion and direct shear test were conducted on expansive soil samples derived from the river bank. The samples were made at different initial water content, with and without vetiver fiber root. It was investigated how the shear strength parameters, expansive pressure and initial shear stiffness of expansive soil changed with initial water content and vetiver root reinforcement in the vetiver root-soil composite. Secondly, laboratory triaxial compression test was

conducted on silt soil samples derived from the embankment. Cohesion and internal frictional angle were derived from the tests on silt soil samples and the man-made vetiver root-soil composite. In-situ direct shear tests were also conducted at the embankment on silt soil sample and vetiver root-soil composite. Conclusions are drawn from the tests that vetiver grass roots helped in strengthening soil slope and avoiding failure of slope soil.

KEYWORDS: Vegetated stabilization, root-soil composite, vetiver grass, expansive soil, shear strength, expansive pressure, railway embankment, riverbank.

Engineering Challenges in an Underground Transit Project in Singapore

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ABSTRACT

Going underground will not only have economic benefits, but will also lead to environmental benefits to the community. At the same time, there are always challenges during both the design and underground construction, especially in built-up urban area. Circle Line Stage 3 (CCL3) is the 3rd stage of underground railway project built in Singapore to link existing three railway lines. CCL3 comprises 5 stations and 5.6 km twin tunnels. The construction of tunnels and stations has posed enormous challenges to the designer and contractor due to their close proximity to urban area where many buildings are within the zone of influence of bored tunnels and stations. The difficult soil conditions encountered at the station areas and tunnel route have even created more challenges to the successful delivery of the project. This paper will discuss the challenges at CCL3 project and explain how the challenges are dealt with using developed innovative solutions to make the project complete on schedule and with good quality.

KEYWORDS: underground, risk, tunnel, station

Mechanical Properties of Laterite Soil under Dry-wet Cycles

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ABSTRACT

The basic reason of instability of roadbed is the change of filler mechanical index, the effect of long-term dry-wet cycles cause mechanical properties attenuating. The triaxial test, resilient modulus test and consolidation test are done to study the change law of mechanical properties of laterite soil under dry-wet cycles. Besides these tests, the mechanism of attenuation of mechanical properties of laterite soil is explained from the point of view of microstructure. How to determine calculating parameters in pavement design is also discussed. The results show: the effect of dry-wet cycle significantly reduced the strength index of laterite soil, increased the deformation index, after a certain number of dry-wet cycles, the strength and deformation indicators tend to be stable. The microstructure of laterite in initial state is flocculated structure, after first dry-wet cycle, the structure turn into stacked grain structure, the pore in soil increases, the structure is loose, soil softening after water absorption, bearing capacity sharply decay. After 3-5 times dry-wet cycles, the fissures in soil have stabilized, the structure has been gradually rebalanced and soil mechanical properties tend to be stable. The calculation parameters of roadbed slope stability under dry-wet cycles are recommended as follow: the stable value of cohesion is 47%~57% of the value which without dry-wet cycles, the stable value of

internal friction angle is 45% ~ 65% of the value which without dry-wet cycles. In pavement thickness calculation, the stable value of resilient modulus is 10% ~ 46% of the value which without dry-wet cycles. In roadbed settlement calculation, the stable value of compressibility is 1.4~10.5 times of the value which without dry-wet cycles. The research results provide scientific basis for the long-term stability evaluation of roadbed and pavement and have certain reference significance for improving the design method of highway roadbed and pavement in our country.

KEYWORDS: dry-wet cycles; laterite soil; mechanical properties; microstructure

Oedometer Expansion and Direct Shear Test on Vetiver Root Reinforced Expansive Soil with Different Water Content

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ABSTRACT

Oedometer expansion test and direct shear test were conducted on expansive soil with various initial water contents. Expansive force and shear strength of the samples with/without vetiver roots at different initial water content were measured. Expensive force and shear strength with respect to vetiver root reinforcement were investigated. It is illustrated that vetiver root can increase shear strength and be used as flexible reinforcement to control expansive deformation and release expensive force of expansive soil with a degree of saturation under rainfall.

KEYWORDS: Root-soil composite, vetiver grass, expansive soil, shear strength, expansive pressure

Numerical Analysis of Expansive Subgrade Subjected to Rainfall Infiltration

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ABSTRACT

Rain-induced distresses of expansive subgrade are frequently described in the literature. These distresses are primarily attributed to the deduction of matric suction and shear strength, with the significant volume expansion during the rainfall infiltration. The processes of unsaturated seepage and wetting-induced swelling, however, were not fully considered in conventional numerical simulation. In order to improve the existing computation theory, a numerical simulation approach for analysis of unsaturated expansive soil subjected to rainfall infiltration was proposed in this paper. The variation of matric suction, unsaturated permeability coefficient and shear strength parameters with volume water content was taken into account by programing the in-built FISH language of finite difference software FLAC3D and the wetting-induced swelling behavior was simulated using the thermal module. The global stability of expansive soil slope was evaluated using a user-defined strength reduction method appropriate for unsaturated soil concerning the effect of matric suction. Then a finite difference analysis was conducted to explore the behavior of an expansive subgrade under rainfall condition. Results indicate that the failure mechanism of expansive subgrade exhibits typical shallow slide tendency initiating from the toe of the slope with the decreasing of matric suction and shear strength in the surficial slope.

KEYWORDS:Expansive subgrade; Rainfall infiltration; Unsaturated seepage; Wetting-induced swelling; Numerical analysis

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公路边坡综合预警判别方法研究

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摘　要：公路边坡的预警预报十分重要，本文通过地质定性判别法和累计时序位移法确定预警分级标准；根据资料调研、工程类比和数值模拟分析提出了基于现场巡查判据、降雨信息判据和变形速率判据的综合预警方法，通过依托工程的验证，确定预警判别方法正确可靠，为今后公路边坡预警预报提供了重要的技术支持。

关键词：边坡工程；边坡变形影响因子；预警判据；变形速率；降雨信息。

Study on the Comprehensive Pre-warning Synthetic Judging Methods on Slope of Highway

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Abstract：It was very important to give the pre-warning and prediction of slope of highway. This thesis identified the warning grading standards via geological qualitative discriminate methods and cumulative timing displacement methods. With the literature study, engineering analogy and data simulation analysis, the writer put forward the comprehensive pre-warning methods based on site inspections, rainfall information, and deformation rate. As verified in construction project, the suggested warning methods were proved to be reliable to provide important technical supports for pre-warning and forecast of slope of highway.

key words：slope engineering, factors influencing slope deformation, warning criterion, deformation rate, rainfall information.

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基于物联网的高边坡变形和稳定性实时监测技术研究

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摘　要：本文基于物联网技术，提出并建立了一套远程实时自动化高边坡监测预警预测系统。该系统依托公路高边坡实际情况，提出一套施工期系统建设方案和安全预警方法。并使用逐步回归分析法对高边坡监测数据进行预测分析，为高效、快捷的预警预测公路高边坡提供了有效的方法和手段。

关键词：边坡工程；边坡变形影响因子；预警判据；回归分析。

Study on the Real-time Deformation and Stability Monitoring Technology of High Slope of Highway Based on the Internet of Things

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Abstract: Based on the Internet of Things, a set of pre-warning and forecasting system is established to monitor high slope automatically in real time from long distance. According to the practical conditions of high slope of highway, this system provided systematical construction scheme and security alarming method during construction period. The established system could also analyze and predict the monitor data of high slope by stepwise regression analysis so as to predict and pre-warn the high slope of highway efficiently and conveniently.

key words: slope engineering; influencing factors of slope deformation; warning criterion; regression analysis.

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基于自动化监测系统的公路高边坡变形预测方法研究

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摘　要：基于逐步回归分析法，建立了考虑时效、降雨等因素的边坡变形预测模型。提出了拟合曲线和预测曲线的双精度判别标准，对依托工程开展了预测分析，结果表明本文提出的预测方法和精度判别标准具有良好的适用性，为快捷、高效地预测公路高边坡变形发展趋势提供了有效的分析方法和手段。

关键词：公路高边坡；边坡变形预测；逐步回归分析法；模型精度。

Study on the Forecasting Methods of High Slope of Highway Based on the Automatic Monitoring System

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Abstract: Based on the stepwise regression analysis, the forecasting model of slope deformation was established including factors such as ageing and rainfalls. The thesis put forward double precision judging criteria including fitting curve and prediction curve, and analyzed and predicted the construction project. The results showed that the suggested forecasting methods and precision judging criteria were well applicative to offer analytical methods to predict the developing trend of high slope of highway efficiently.

key words: High slope of highway, Prediction of slope deformation, Stepwise regression analysis,Model precision.

Study on Mechanical Characteristics of Micropiles in Step-shaped Slope

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ABSTRACT

Based on a large scale step-shaped model test which was carried out in loess slope and numerical studies on the location of slip surface influenced by different factors, a numerical model with presupposed slip surface was established by using finite difference method, in which the same scale and physical mechanics parameters of loess soil as in-situ slope test were used, and the x-displacements of the toe below the step with different loads were monitored. Soil pressures in front of and behind the micropile with step loading were monitored. Meanwhile, micropile deflection and the moment and shear values of micropile were obtained. The mechanism of micropile-soil interaction was analysed.

KEYWORDS: Slope; Micropile; Presupposed slip surface;Micropile-soil interaction; FLAC

基于BP神经网络的CPTU土分类研究

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摘　要： 根据孔压静力触探（CPTU）测试数据进行土工程分类时，所采用的分类标准多为具有地域性的经验理论，并且需要对直接测量参数进行后处理。为提高CPTU测试场地的土工程分类效率，本文采用基于误差反向传播算法（BP）神经网络方法，在3处CPTU测试场地的基础上，建立CPTU测试参数与土分类国际标准之间的非线性模型，通过输入CPTU相关实测参数，即可快速、准确地模拟土的工程分类结果。研究表明：（1）当BP网络模型的隐含层包含15个神经元、迭代级数为14时，模拟性能最优；（2）建立偏最小二乘回归模型并对土分类进行预测，对比分析以BP神经网络模型的模拟精度较高；（3）建立BP网络模型对孔压参数比Bq、土类指数Ic值展开分析，为Ic(BJ)的计算结果提供补充。

关键词： 土分类，BP神经网络，CPTU，偏最小二乘回归

中图分类号：TU413

Soil Classification Using CPTU Data Based on BP Neural Network Method

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Abstract: Based on the piezocone penetration test (CPTU) for soil engineering classification, the classification criteria is empirically regional and always needs to be post-processioned. In order to improve the classification efficiency of soil by CPTU data, this paper, based on three different sites, uses the back-propagation (BP) artificial neural network to establish one nonlinear model between CPTU test parameters and the criterion of soil classification. By inputting the CPTU testing data, this

paper can simulate the engineering classification of soil quickly and accurately. It is concluded that: (1) Inversion performance of BP neural network model is best when the hidden layer contains 15 neurons and the iterative series are 14; (2) Established partial least squares regression model to predict soil classification respectively, compared with the BP neural network model which has the highest accuracy; (3) Build neural network to simulate the output value of pore pressure parameter Bq and the soil index Ic, and improve the accuracy of Ic(BJ) results.

key words: soil classification; BP neural network; CPTU; PLSR

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A Nonlinear Double Reduction Method for Stability Analysis of Loess Slopes

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ABSTRACT

The classical limit equilibrium method(LEM), traditional strength reduction method(SRM) and double reduction method(DRM) can't reflect a significant characteristic of loess that c and $\tan\varphi$ reduces at different ratio. Based on experimental data, a new reduction method applying to loess slope

(LDRM) is proposed. In the expression of LDRM, reduction factors of c and tanφ keeps to a nonlinear relationship controlled by a parameter k, which is determined by dry density ρd of loess specimens. Its reliability is also demonstrated by numerical calculations and results of triaxial compression tests on undisturbed unsaturated loess. Safety factor of loess slopes with different angles is carried out.

KEYWORDS: double reduction method; Safety factor; loess slopes; strength parameters

Study on Softening Constitutive Model of Geomaterials
Based on Strain Place

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ABSTRACT

Most of the available constitutional equations indicating strain softening effect are based on stress space, but it is found that the elastic-plastic theory based on strain space is superior to stress space on solving the problem associate with large strain and softening. In this paper, expansive mudstone and its constitutive model are studied. A series of triaxial tests have been carried out on this soft rock. The constitutive equation of consolidated undrained triaxial stress state expressed in strain space is derived to simulate the stress-strain relationship of the results. It indicates that the elastic-plastic model based on strain space is applicable to express the strain softening effect of soft rock.

KEYWORDS: Strain softening, Strain space, Triaxial tests, Soft rock

Soil-cement: Properties and Design Considerations
for Reinforced Excavation

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ABSTRACT

Soil-cement is a man-made material produced by grouting or mixing cement with soils. This paper reviews and discusses the general classifications of grouting technique and the suitability of the applications. Properties of the soil-cement and influence of the admixes on the strength properties are reviewed, compared and discussed. Design considerations for deep soil-mixing-method for excavation support and vault arch for tunnelling stabilization are presented, parameters for the advanced analysis for the area of soil-cement are evaluated and recommended.

KEYWORDS: Grouting; soil-cement mixture; strength properties; deep soil-mixing wall; vault arch.

Large-scale Triaxial Test of Municipal Solid Waste Incineration Bottom Ash

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ABSTRACT

Bottom ash (BA) as a product of municipal solid waste incineration (MSWI) has similar characteristics to sandy soils, which can be used as a subgrade aggregate. In order to study its strength and deformation characteristics, we performed both consolidated drained (CD) and consolidated undrained (CU) triaxial shear tests on bottom ash specimens of two different degrees of compaction (DOCs), and obtained their stress-train curves. By analyzing the relationships between the axial strains, deviatoric stresses, volumetric strains, and pore water pressures, and the mechanism that stress and strain are affected by dilatancy and granular grinding, some conclusions can be obtained that bottom ash has similar strength and deformation characteristics to sandy soils, and displays significant strain softening under high DOC and low confining pressure conditions. With the data from the CU tests, the Duncan-Chang model parameters can be determined for bottom ashes with the two initial DOCs.

KEYWORDS:MSWI BA;triaxialshear test;strength and deformation characteristic;Duncan-Chang model;

Compression Deformation Behavior of Compacted Laterite Soil in Highway Engineering

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ABSTRACT

To discuss the compression deformation behavior of compacted laterite soil, used one-dimensional indoor consolidation tests, introduced the compression consolidation coefficient, the relationship between compression deformation behavior of compacted laterite soil and degree of compaction, moisture content is analysed, the loading constitutive model of compacted laterite soil is analysed. Besides these, the relationship between compression deformation behavior of compacted laterite soil and number of dry-wet cycles is also analysed. The results show that: the consolidation coefficient increase when moisture content increase, decrease when degree of compaction increase, the strain-stress relation of compacted laterite can be expressed with power function. Under dry-wet cycles, the void ratio under certain load level of compacted laterite soil decrease when number of dry-wet cycles increase, the consolidation coefficient increase when the number increase.

KEYWORDS: highway engineering; compacted laterite soil; consolidation coefficient; dry-wet cycles; degree of compaction;moisture content; constitutive model

Landslide Damage along Araniko Highway and Pasang Lhamu Highway Related to the April 25, 2015 Gorkha, Nepal Earthquake

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ABSTRACT

The Gorkha, Nepal Mw 7.8 earthquake of 25 April 2015 triggered a large number of coseismic landslides in a broad area. Two highways, Araniko Highway and Pasang Lhamu Highway, that connect Tibet of China and Nepal, were affected seriously by these landslides. We examined the coseismic landslides of the 2015 Gorkha earthquake that blocked or damaged the Araniko Highway (117.3 km) and Pasang Lhamu Highway (139.3 km) in Nepal. Results show 35 coseismic landslides damaged the Araniko Highway along a total length 1,415 m. The total volume of them was estimated to be 0.37 million m^3. We delineated 89 coseismic landslides that damaged the Pasang Lhamu Highway, where the total length of the damaged or buried roads is about 2,842 m and the total volume of the 89 landslides is about 1.47 million m^3.

KEYWORDS: Gorkha earthquake, coseismic landslides, field investigation, visual interpretation

冻结黄土三轴蠕变特性

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摘 要：通过不同温度作用下冻结黄土的蠕变试验，得到了轴向应变、体应变随时间的变化关系。结果表明：当应力水平较低时，发生衰减型蠕变，轴向应变速率随时间逐渐降低。体积表现为体缩，体应变与时间大致呈线性关系。径向应变速率在零附近波动，最终趋近零；当应力水平较高时，发生非衰减型蠕变，轴向应变速率随时间曲线呈U型，各个蠕变阶段轴向应变速率的大小和所占时间的长短与应力水平相关。体积表现为体胀，在蠕变非稳定和稳定阶段，体积随时间线性膨胀，进入加速阶段后，体积随时间加速膨胀，体应变随轴向应变线性增加；径向应变速率在蠕变前两个阶段数值较小，数值在负值处动态波动；进入加速蠕变阶段后，径向应变速率加速增大，试样鼓曲破坏。最后，从蠕变速率的角度，提出蠕变速率法确定长期强度。

关键词：冻结黄土；蠕变试验；体应变；蠕变速率法；长期强度

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Triaxial Creep Characteristics of Frozen Loess

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Abstract: Through the creep tests of frozen loess under different temperatures, the creep curves of the axial strain-time and volumetric strain-time were analyzed. The results show that when at low stress levels, the sample exhibits an attenuation creep, the axial strain rate decreases gradually with time. Volume shrinks and volumetric strain with time is roughly linearly dependent. The radial strain rate

fluctuations approach zero, eventually reaching zero; when at high stress levels, the sample exhibits a non-attenuation creep, the axial strain rate with time curve is U-shaped, the axial strain rate and the length of time of each the stage of the creep stage are associated with stress level. Volume expands, and linearly expands with time in unstable stage and stable stage of creep; volume expansion rate accelerates over time during the acceleration stage, volumetric strain increased with axial strain linearly; the radial strain rate is lower and numerical dynamic fluctuations stay negative at the first two stages; after the creep enters the accelerated creep stage, the radial strain rate increases, and the sample buckles and fails. Finally, from the perspective of creep rate, the creep rate method to determine the long-term strength is put forward.

key words: frozen loess; creep test; volumetric strain; the creep rate method; the long-term strength

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Experimental Study on the Influence of Granulometric and Material Compositions on Soil Rheological Properties

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ABSTRACT

With an improved direct shear creep apparatus, sandy soil samples with different granulometric compositions and water contents were tested. Manually mixed soft soil samples with different organic matter contents were evaluated as well. The effects of granulometric and material compositions on the rheological properties of soft soil were investigated. Creep curves were obtained under different shear loading values. The average viscosity coefficients were determined from experimental data, and the curves of the relation between the creep stress threshold and organic matter content were obtained. Experimental analysis showed that the rheology of sandy soil was influenced by particle size, water content and shear stress level, among which the last factor exerted the most significant effect. Organic matter content was the main material factor that affected the rheological characteristics of soft soil. As the organic matter content increased, the soft soil rheology significantly increased, and the creep stress threshold significantly decreased. This experimental study offers insights into the microscopic mechanisms of soil rheology. Such information is beneficial for the calculation and engineering design of ground deformation.

KEYWORDS: soil rheological properties, granulometric composition, organic matter, plasticity rheology, fluid rheology

Experimental Analysis of The Influence of Soil Composition On Strength Characteristics

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ABSTRACT

Soil composition is a key factor affecting soil strength. This study investigates the influence of soil composition on soil strength by performing direct shear test on various samples, including artificial soil with different components, artificial mixed soil with different amounts, natural soil with different moisture contents and sandy soil with different sizes. The test results show that soil strength is determined by the joint effect of inter-particle friction and cohesion. Mineral composition and water content are the main factors affecting clay strength. Changes in the mineral composition and water content of clay alter the contact state and connection of its particles, thereby significantly affecting the macroscopic properties of the soil. Grain composition is the primary factor affecting the strength of sandy soil. Different grain compositions modified the shear deformation characteristics by altering the arrangement and intergranular engagement of the particles, consequently affecting the strength. The results of this study provide further insight into the micro and fine mechanism of the soil shear strength characteristics of different components. This study also offers guiding significance in engineering practice.

KEYWORDS: strength characteristic of soil, mineral composition, grain composition, connection mode of inter-grain

压实度和水分对青藏高原季冻区砂砾土冻胀特性的影响

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摘　要：为得到压实度和水分对青藏高原季冻区砂砾土冻胀特性的影响规律，为机场工程冻胀防治提供依据，利用改进后的冻胀率试验装置进行一系列室内试验，系统地研究了压实度、初始含水率及补水状况对冻胀率的影响规律。研究结果表明：在封闭条件下，若控制初始含水率不变，则冻胀率随压实度的增大呈先增大后减小的趋势，在压实度为95%左右时达到最大值；若控制压实度不变，则冻胀率随初始含水率的增大而线性增大。压实度和初始含水率均与冻胀率之间存在高度相关的函数关系，这些关系式在某些情况下可用作相关指标的相互预测。在开放条件下，砂砾土的冻胀率较封闭条件下显著增大，通常达数倍以上。为有效防治土体冻胀，不仅要严格控制压实度和初始含水率，更要采用降低地下水位、设置隔水垫层等措施阻止外界水源补充。

关键词：砂砾土；冻胀；初始含水率；压实度；补水

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Influence of Compaction Degree and Moisture on Frost Heaving Properties of Gravel Soil in Seasonally Frozen Region of Qinghai- Tibetan Plateau

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Abstract: In order to obtain the influence of compaction degree and moisture on frost heaving properties of gravel soil in seasonally frozen region of Qinghai-Tibetan Plateau, and provide the foundation for the prevention and control of soil frost heaving, a series of frost-heaving ratio indoor tests were conducted to study the influence of compaction degree, initial moisture content and water replenishing on frost-heaving ratio by the improved test device. The research results show that, frost-

heaving ratio of gravel soil decreased after the first increase with compaction degree, and approached its maximum at the compaction degree of 95% under the condition of closed and the same initial moisture content, and increased linearly with the increase of initial moisture content under the condition of closed and the same compaction degree. There are highly relevant functional relationship between compaction degree, initial moisture content and frost-heaving ratio, which can be used to forecast related indicators in some case. Frost-heaving ratio increased over several times under the condition of open than that under the condition of closed. It is necessary to reduce the underground water level and set the water-resisting layer not only strictly control compaction degree and initial moisture content for effective prevention and control of soil frost heaving.

key words: gravel soil; frost heaving; initial moisture content; compaction degree, water replenishing

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落石冲击荷载下柱式棚洞结构对比研究

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摘　要:借助ANSYS/LS-DYNA有限元软件模拟柱式棚洞结构在落石冲击荷载下的动力响应，通过对比分析4种棚洞结构的应力、位移特征，研究不同结构类型的抗冲击性能。研究表明：在落石竖向冲击棚洞洞顶时，柱式棚洞结构产生的最大等效应力均在柱处；半拱斜柱式棚洞结构产生的最大等效应力最小、顶板垂向位移最小，为最优结构形式；落石冲击力大小受棚洞的结构形式影响较大。

关键词：棚洞；落石；冲击力；数值模拟

Contrastive Research on Column Shed-tunnel under the Impact of Load of Rockfall

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Abstract： The dynamic response of column shed-tunnel for rockfall impact were simulated with the finite element software ANSYS/LS-DYNA. Stress and displacement characteristics of 4 kinds of shed-tunnel structure was analyzed comparatively, impact resistance of different structure types was studied. Research results show that in the vertical impact of rockfall，the maximum equivalent stress of column shed tunnel structure is in the column. The maximum equivalent stress and vertical displacement of roof of inclined column and semi-arch shed-tunnel structure stress is minimum, it is the optimal structure. Rockfall impact force is greatly influenced by the structure form of shed-tunnel structure.

key words： shed-tunnel； rockfall； impact force； numerical simulation

Model Test Research on Coefficient of Rockfall Rolling Friction

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ABSTRACT

Coefficient of rolling friction is one of critical sensitive parameter for rockfall rolling calculation and passive control design. To determine the coefficient of rolling friction, a series of model experiments are developed to simulate rolling process of the round rock in different slope pavements, slopes, and rock masses. In the test, the high-speed camera and the motion analysis software are used to shoot the rolling process and determine the motion parameters in the rolling section, respectively. The test result figure out the following regularities: (1) The slope pavement and the gradient of the rolling slope are the major parameters influencing the coefficient of rolling friction. With the slope pavement changing from hard to soft surface, the coefficient of rolling friction gradually increases; with increase of the gradient, the coefficient of rolling friction also increases significantly; rock mass has little effect

on the coefficient of rolling friction. (2) The coefficient values of rolling friction are all more than 0.2 and less than 0.9; the values less than 0.8 account for 89%, those less than 0.6 account for 70%, and those within 0.4 and 0.5 for 20%. (3) Suggestions on coefficient values of rolling friction are given in the aspects of the slope pavement and rolling slope section. The softer the slope, the sharper the gradient of the rolling section, high values are selected; the harder the slope, the gentler the gradient of the rolling section, low values are selected.

KEYWORDS: Rockfall; Coefficient of rolling friction; Model test

An Analytical Modelling on the Soil Arching Effect in a Column Supported Embankment

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ABSTRACT

Soil arching effect is a common phenomenon in a column supported embankment system. It results from the non-uniform stiffness of a foundation which has seldom been considered in the literature, especially for analytical models. In this study, a generalized mathematical model is proposed to study soil arching effect within a column supported embankment considering the modulus ratio between the column and the surrounding soil. For simplification, a cylindrical unit cell is drawn to study the deformation compatibility among the included column, the surrounding soil, and the overlying embankment fill. A deformed shape function is adopted to satisfy the continuity of stress and volume deformation between the embankment fill and the column reinforced foundation. A

finite element analysis is carried out to verify the present model and a case study is performed to demonstrate the application of this model. In the parametric study, some influencing factors, such as the column modulus, the spacing between columns, and the embankment height, are taken into account to investigate the stress ratio between the column and the surrounding soil. It highlights that a larger modulus ratio between the column and the surrounding soil would increase the stress ratio between them. The modulus ratio would have slight effects on the height of equal settlement plane which is close to the net spacing between columns.

Effect of Roughness on Shear Strength of the Soil-steel Interface Shearing

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ABSTRACT

In effort to investigate the influence of surface roughness on the shear behaviour between soil and steel, a series of monotonic direct shear tests of the interface are conducted with different surface roughness of steel. Some mechanical responses from the system, such as the shear stress, strength, and vertical deformation were measured. It was found that the soil strength was influenced by the surface roughness, as the shear strength increasing with increased surface roughness level before a critical surface roughness value, and the volume of the soils is dilated in the shearing process as well. Sliding occurs along the smooth sand-steel surface, and no shear dilation observed. Compared with the initial shear test, the interface could decrease the shear strength of soil more than the initial test. The soil resistance against shearing would be better mobilized when the surface roughness increases but less dilatancy would occur under the interface shearing.

KEYWORDS: surface roughness, interface, direct shear test, shear behaviour

Numerical Simulations for Large Deformation of Geomaterials Using Molecular Dynamics

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ABSTRACT

Soil large deformation flow disasters have many forms, such as slope instability, deformation damage of the foundation pit, and ground settlement, with a serious threat to human life and property safety. Thus, studying soil granular flow has a significant geotechnical disasters prevention application value. Currently, some researchers study soil granular flow by means of many different kinds of numerical methods. However, most studies have been started from a macro perspective. From the micro perspective, this thesis presents a model based on a new type of non-continuous theoretical mechanical method, molecular dynamics (MD) to simulate the typical soil granular flow. The Hertzian friction formula and viscous damping force are introduced in the MD governing equations to model the granular flow. To show the validity of the proposed approach, a benchmark problem of 2D viscous material flow is simulated. The calculated final flow runout distance of the viscous material agrees well with the result of constrained interpolated profile (CIP) method as reported in the literature. Numerical modeling of the propagation of the collapse of three-dimensional axisymmetric sand columns is performed by the application of MD models. The whole processes of collapse are represented. Time-history curve of the runout distance was obtained to analyze the movement characteristics of granular flow. Comparison of the MD computational runout distance and the obtained distance by experiment shows a high degree of similarity. This indicates that the proposed MD model can accurately represent the evolution of the granular flow. The model developed may thus find applications in various problems involving dense granular flow and large deformations, such as landslides and debris flow. It provides a means for predicting fluidization characteristics of soil large deformation flow disasters, and for identification and design of appropriate protective measures.

KEYWORDS: Geomaterials; Molecular dynamics; Large deformation; Numerical simulation

陕西高速公路工程处治滑坡稳定性预警模型研究

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摘　要：针对工程治理后的滑坡再次发生滑动现象，本文开展了治理后滑坡的稳定性预警预报模型研究。结合天然滑坡预警预报模型的研究成果，分析确定了支护后滑坡预警判据，主要包括抗滑桩桩身应力、锚索锚固力、抗滑桩桩顶位移、挡土墙位移、地表位移、深层土体位移以及降雨量判据和宏观变形迹象；选取在天然滑坡中应用效果较好的数理统计模型作为位移预测模型；基于支护结构设计验算方法，提出抗滑桩桩顶位移预警模型、锚索锚固力预警模型以及格构位移预警模型；最后结合预警模型和预警判据划分滑坡预警等级，并成功对渭玉高速公路滑坡稳定性进行了预警预报。

关键词：高速公路，滑坡，支护结构，预警判据，预警模型，预警等级

Research on Early-warning Model of the Stability on the Treatment of Expressway Landslides In Shaan Xi Province

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Abstract: This paper studied the early-warning and forecasting model of the landslide stability after treatment on the sliding phenomenon of the treated-landslide. Determining the landslide's early-warning criterion combined with the research's results of natural landslide's early-warning and forecasting model which includes anti-slide pile's stress, anchoring force, anti-slide pile's top displacement, displacement of retaining wall, surface displacement, deep soil displacement, rainfall and macro deformation signs; the statistics model whose application was good in the natural landslide was selected as the displacement forecasting model; based on the supporting structure's design and checking

method, the early-warning model of displacement on the top of anti-slide pile, cable anchorage force and lattice structure's displacement were proposed; at last, the landslide's early-warning level was divided combining with early-warning model and criterion, and successful prediction on the stability of Wei Yu Expressway landslide.

key words: highway; landslide; supporting structure; early-warning criterion; early-warning model; early-warning level

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工程物探技术在线性交通工程建设中的应用

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摘　要：物探技术在公路铁路等线性工程建设中有着广泛用途。针对工程建设中的具体问题，选择合理的物探方法能在建设起到重要作用。介绍了物探技术在公路地质选线、工点不良地质勘察（岩溶、采空区、断层、滑坡、地下管线等）、施工、工程质量检测中的应用效果。物探技术在公路铁路建设中有良好的应用前景。

关键词：线性交通工程、建设；物探；应用

Application of Engineering Geophysical Prospecting Technology in Linear Traffic Engineering Construction

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Abstract: Geophysical prospecting technology is widely used in the construction of railway and other linear projects. In view of the specific problems in engineering construction, choosing reasonable geophysical methods can play an important role in the construction. The application effect of geophysical prospecting technology in highway geological survey, bad geological survey (karst, goaf, fault, landslide, underground pipeline, etc.), road construction and pavement quality inspection is introduced. Geophysical prospecting technology has a good application prospect in highway or railway construction.

key words: Linear traffic engineering, construction; geophysical exploration

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Research on BP Neural Network Model for Stability Assessment of Loess Slopes Based on Particle Swarm Optimization and Partial Least-squares Regression

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ABSTRACT

The assessment of loess slope stability is a highly complex nonlinear problem. There are many factors that influence the stability of loess slopes. Some of them have the characteristic of uncertainty. Meanwhile, the relationship between different factors may be complicated. The existence of multiple correlation will affect the objectivity of stability analysis and prevent the model to make correct judgments. In this paper, the main factors affecting the stability of loess slopes are analysed

by means of the partial least-squares regression (PLSR). After that, two new synthesis variables with better interpretation to the dependent variables are extracted. By this way, the multicollinearity among variables is overcome preferably. Moreover, the BP neural network is further used to determine the nonlinear relationship between the new components and the slope safety factor. Then, a new BP model based on the particle swarm optimization and partial least-squares regression, which is initialized by the particle swarm optimization algorithm is developed. The network with global convergence capability is simpler and more efficient. The test results of the model show very good precision, which indicates that the model is feasible and effective for stability evaluation of loess slopes.

KEYWORDS: slope engineering; stability assessment; BP neural network; particle swarm optimization; partial least-squares regression;

Performance of Geogrid Encased Stone Columns Under Axial Loading:
Theoretical and Field Investigations

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ABSTRACT

This paper presents the theoretical and field investigations of bearing behavior of geogrid encased stone column under axial loading. The failure modes of the vertically loaded geogrid encased stone column are investigated. A theoretical method is developed to estimate the bearing capacity of

the geogrid encased stone column for gravel bulging failure under the tubular geogrid. To verify the validity of the proposed method in this study, the derived solution is compared with field test results. The comparison shows that the calculated results agree well with the field tests. The test results also reveal that the ultimate bearing capacity of the geogrid encased stone column is much greater than that of the unreinforced column. Parametric studies are carried out to investigate the effects of length of tubular geogrid, internal friction angle, undrained shear strength and pile diameter on the bearing behavior of the geogrid encased stone column.

KEYWORDS:geogrid encased stone column; tubular geogrid; bearing behavior; static loading test; soft ground

Influencing Parameters on the Peak Pullout Resistance of Soil Nails under Different Testing Conditions

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ABSTRACT

This paper presents a comprehensive analysis of the correlation between influencing parameters and peak pullout resistance (PPR) of soil nails installed in typical completely decomposed granite (CDG) or sand. A total of 8 soil nail pullout tests were conducted in a field to examine the influence of overburden pressure (OP) and grouting pressure (GP) on the PPR of soil nails. Comparative analysis indicates PPR values of soil nails pulled out in soils with relatively high degree of compaction are almost twice of that in loose soils when degree of saturation is constant. ACF increases linearly as the increase of GP, but decreases linearly as the increase of OP when GP is constant in both laboratory and field tests. Extensive studies also show that the magnitude of normalized ACF is more sensitive to OP compared with GP and degree of saturation (Sr). Diameter increase in percentage of soil nails pulled out from field are almost twice of the soil nail diameters in laboratory tests, indicating that due to complex geological condition in field (such as possible high void ratio of field soils), failure surface of soil nails presents substantial shift into surrounding soils.

KEYWORDS: Soil nails, Influencing parameters, Apparent coefficient of friction, Peak pullout resistance, Laboratory and field pullout tests.

中巴公路奥布段泥石流危险性评价与防治分析

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摘　要：中巴公路国内段泥石流灾害暴发频繁且危害严重，严重制约中巴经济走廊带建设和互联互通安全，当前缺少对区域泥石流危险性评价和防治分析。本文以中巴公路奥布段为研究区，基于野外调查和遥感解译等手段，结合泥石流孕灾环境和控制要素分析，通过GIS 与信息量模型相结合分析公路沿线泥石流危险性，并提出公路泥石流防治原则与对策。研究发现，公路沿线域大部分区域处于中度危险以上，中度、高度和极高度危险区三者面积占研究区总面积的74.34%，泥石流数量达到66个，主要分布在盖孜河的深切峡谷区段；评价结果与实际灾情较为吻合，近年来频发的泥石流灾害较好验证了评价结果的精度；结合泥石流危险度和泥石流活动特点，提出不同危险度下公路泥石流应采取不同防治原则和对策。研究成果可为中巴公路选址布线和制定泥石流防治方案提供参考和科学依据。

关键词：中巴公路；奥布段；泥石流；危险性评价；信息量法；防治对策

Hazard Assessment and Prevention Analysis of Debris Flows along Aoyitage-blulunkou Section of Sino-pakistan Highway

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Abstract: Debris flow disasters with frequent occurrence were extremely serious along Aoyitage-Blulunkou section of Sino-Pakistan highway, and significantly restricted China-Pakistan economic corridor construction and interconnectivity security. At present the hazard assessment and prevention analysis of debris flows are lack. In this paper Aoyitake-Bulunkou section of Sino-Pakistan highway is selected as a study area. Based on the field investigation and remote sensing interpretation，the key inducing factors of debris flows are analyzed. Through adopting information acquisition analysis method, the hazard degree of debris flow is evaluated with support of GIS technique, and further the

control principle and countermeasures of debris flows along this highway are presented. Assessment results show that the high hazardous areas along Aoyitake-Bulunkou highway are mainly located in the medium，high，very high levels，which account for 74.34% of the whole study area with 66 debris flows, and they are located in the canyon area of Gaizi River. The evaluated results above are consistent with results from the actual debris flows situation along Aoyitake-Bulunkou highway, and recently frequent occurrence of debris flows preferably verify the accuracy of assessment results. Further based on hazard degree and movement characteristics of debris flows, the control principle and countermeasures are presented in different hazardous levels. The hazard evaluation results will provide scientific basis and reference for debris flow project management and road line selection and design.

key words：Sino-Pakistan highway；Aoyitage-Blulunkou section；debris flow；hazard assessment；information acquisition analysis ；control countermeasures

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Durability Analysis of the Modified Salty Soil-cement Based on Early Mechanical Behaviors

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ABSTRACTS

The soil-cement mixed piles are frequently used to reinforce the soft ground in the coastal area, however, salty environment have erosion effect on these piles. Because the erosion effect is a long term process and insufficient information has been collected, at present few design specifications have considered the salty erosion effect on soil-cement. The early deterioration of soil-cement exposed to salty groundwater in the Yellow River Delta of China within 180 days was studied through a series of strength tests. To improve the corrosion resistance of salty soil-cement, fly-ash and GGBS (Ground Granulated Blast Furnace Slag) were chosen as additives. Results indicated that with the additive of fly-ash, the initial strength of salty soil-cement decreased slightly, while the long-term strength increased potentially. GGBS could significantly increase the early and long-term strength and enhance the resistance to deterioration of salty soil-cement.

KEYWORDS: Salty soil-cement mixed pile; Deterioration; Additives

Experimental Study on Seismic Behavior and Deformation Modes of Gravity Retaining Wall

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ABSTRACT

The paper focused on the influence factors of seismic response and deformation mode of retaining wall using large-scale model shaking table tests. Experimental results showed that the distribution of peak seismic earth pressure along the height of wall is a single peak value curve. The seismic earth pressure of gravel soil retaining wall is larger than weathered granite and quartz retaining wall, and the peak seismic earth pressure increases with increasing of PGA and wall height. The measured seismic earth pressure for rock foundation retaining wall is larger than calculated values, and the resultant seismic earth pressure application location is higher than 0.33H. For soil foundation retaining wall, the measured seismic earth pressures are much smaller than calculated values, while the application location is slightly higher than 0.33H. The soil foundation retaining wall suffered base sliding and overturning under earthquake, while overturning is the main deformation mode for rock foundation retaining wall.

KEYWORDS:gravity retaining wall; earthquake action; seismic behavior; deformation mode; shaking table test

富水红层路基碎石改良填料的力学特性试验研究[12]

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摘　要：为解决富水区红层黏土路基含水率高、无法压实等问题，通过向原状土中掺入一定粒径配比的弱风化红层泥岩碎石，制成不同级配和含水率的改良填料，进行重型击实试验、大型直接剪切试验及无侧限抗压强度试验，获得满足铁路路基填筑要求的填料。研究结果表明：红层原状土属级配良好的细角砾土，通过掺入弱风化泥岩碎石可有效降低原状土含水率，改良填料的最优含水率为10.26%，最大干密度为2.22 g/cm3；最优含水率时改良填料的黏聚力（c）为29.336 kPa，内摩擦角（φ）为32.86°，相较于红层天然原状土抗剪强度有明显的提高；改良填料的无侧限抗压强度在含水率为8.85%时最大，达到518.8 kPa，随着含水率的增加逐渐降低。通过混合弱风化红层泥岩碎石与红层黏土的改良填料，不仅没有改变红层黏土特性、施工便捷，而且能有效降低原状土填料含水率，增加抗剪强度和抗变形能力，改良后填料的含水率和压实性能满足铁路路基设计规范要求。

关键词：红层黏土；铁路路基；填料改良；重型击实试验；大型直接剪切试验；无侧限抗压强度试验

中图分类号：TU411

Experimental Study on Mechanical Properties of Improved Red Soil Subgrade in Rich Water Area

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Abstract: To solve the high-water content and uncompacted problems for red clay subgrade in rich water area, improved subgrade material with different water content were made by mixing original soil with weakly weathered red-mudstone gravel, which was sorted by a certain ratio of the particle size. Heavy compaction test, large direct shear test and unconfined compression test were conducted to get the filling material that meet the requirement of the railway subgrade construction. The results show

that the original red soil is fine breccia with good gradation, and the water content of original red soil can be reduced effectively through adding weakly weathered mudstone gravel. The optimum water content of the improved material is 10.26%, and the maximum dry density is 2.22 g/cm3. The cohesion c of shear strength is 29.336 kPa and the friction angle is 32.86°, when the improved material is at optimum water content. Compared to the natural soil of red layer, the shear strength of the improved material has significantly improved. Unconfined compressive strength of the improved material reaches 518.8 kPa when water content is about 8.85%, and decreases gradually with the increased water content. Through mixing the weakly weathered red mudstone gravel with red clay, the characteristics of red clay did not change, and the water content of original soil can be reduced effectively as well, and the shear strength and deformation capacity also be increased. Besides, water content and compaction performance of the improved material can meet the requirements of railway subgrade design criterion.

key words: red clay; railway subgrade; mixed improvement; heavy compaction test; large direct shear test; unconfined compression test

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基于电阻率CPTU的状态参数确定及液化评价应用

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摘　要：状态参数ψ能够获取砂土应力−应变−强度之间的关系，是表征砂土体积变化的一个重要指数。由于室内试验原状试样获取困难，而且成本高昂，采用现场原位测试技术进行相应的评价指标估算受到了广泛的应用。目前国际上常利用状态参数来代替相对密实度表征砂土的状态特性。以宿迁−新沂高速公路工程建设为背景，通过电阻率孔压静力触探原位测试，发现土体电阻率和状态都与密实度相关；以已有文献中Plewes等人和Robertson公开发表原位测试状态参数计算法的均值作为参考值，联合电阻率与土类指数，建立状态参数计算模型。并与上述文献已有的两种方法进行对比分析，验证了本文提出方法的有效性。对状态参数在液化评估方面的应用进行了探讨，建立了状态参数与相对密实度的关系，并研究与验证了基于状态参数进行液化判别的正确性。

关键词：电阻率；孔压静力触探；状态参数；液化

中图分类号：U413

Research on the Method of Determining the State Parameters Based on the Resistivity CPTU and the Application about Evaluation of Liquefaction

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Abstract: The state parameter ψ can obtain the relationship among stress-strain- strength of sand, which is an important index to represent the change of sand volume. Due to the difficulty and high cost of acquisition of undisturbed sample for the laboratory test, so the in situ test technology has been widely used to estimate the corresponding evaluation index. At present, the state parameter is often used to describe the state characteristics of sand by replacing the relative density. In this study, the resistivity piezocone penetration test was conducted in the field of Suqian-Xinyi expressway project; it was found

that the soil resistivity and state of the soil were related to the density. The mean value based on the state parameters calculation method of in situ test which was from the literatures published by Plewes et al. and Robertson was used as the reference value, combining resistivity and the soil type index, the calculation models of state parameters were established. Compared with the two methods already in the above literatures, the validity of the proposed method in paper is verified. The application of state parameter in liquefaction evaluation is also discussed, and the relationship between state parameter and relative density is established. The correctness of liquefaction discrimination based on state parameter is studied and verified.

key words: resistivity; piezocone penetration test; state parameter; liquefaction

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Probabilistic Analysis of Slope Stability Based on Alternating Conditional Expectations Algorithm

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ABSTRACT

Prevention and control of slope instability or landslide has been paid much attention in prevention and mitigation of mountain hazards. The main purpose of this is to reduce the probability of slope instability or landslide. However, the factor of safety for a slope is not a constant value because of the uncertainties in distribution of soil properties, moisture contents and loads. Therefore, it is necessary to develop a reasonable probabilistic analysis method for slope stability. In this analysis process, there are many uncertain factors, such as soil properties, boundary conditions, loads and support systems, etc. Among them, the variability of soil properties, which is one of the main sources of uncertainties in slope engineering, is often considered. In this paper, a numerical procedure about

probabilistic analysis of slope stability based on Alternating Conditional Expectations (ACE) algorithm is presented. A commercial finite difference method (FDM) software was used to analyze the slope stability. Given that the limit state function cannot be expressed in an explicit form, the ACE algorithm, which does not need to assume functional forms and determine model parameters for multivariate regression, was adopted to establish the response surface that can approximate the limit state function in order to reduce the amount of stability analysis calculations. On the basis of the response surface, the First-Order Reliability Method (FORM) and the Monte Carlo method were used to calculate the probability of failure, respectively. Application of the proposed procedure was illustrated by the probabilistic stability analysis of a hypothetical two-layer slope case and the Cannon Dam case. The results verified that the ACE algorithm can be applied well to probabilistic analysis of slope stability.

KEYWORDS: slope stability; probabilistic analysis; alternating conditional expectations; response surface; failure probability

Experimental Investigations of Embankments with Different Reinforcement Materials

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ABSTRACT

A series of experimental tests were conducted to compare the performance of embankment reinforced with geocell and waste tires. Several design factors of a reinforced embankment were studied in laboratory; these design factors include embedment depth of reinforcement, number

of reinforcement layers, vertical spacing between reinforcement layers, and soil relative density. Experimental results suggested that, when compared with an unreinforced embankment, a reinforced embankment possesses improved bearing capacity, reduced the vertical and lateral displacement, and more uniformly distributed additional stress. These characteristics indicate that the reinforcements can effectively enhance the stability of an embankment. This study also observed an optimal embedment depth and spacing for the reinforcement layers. The bearing capacity of geocell-reinforced embankment increases with the number of reinforcement layers increase, albeit at a slow rate; meanwhile the vertical and lateral displacements decrease. A waste tires-reinforced embankment was found to have superior performance over a geocell-reinforced embankment. The reinforcement effects offered by geocell and waste tires were observed to be more advantageously mobilized in an embankment consisting of soils with a lower relative density.

KEYWORDS:geocell; waste tires; reinforced embankment; bearing capacity; load-displacement response

Analytical Study of Compaction Grouting

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ABSTRACT

The proposed research focuses on the theoretical study of the compaction grouting in clay. The analytical simulation method used in this study is based on the most existing closed-form solutions for displacement-controlled cavity expansion problems in an infinite, homogeneous and isotropic continuum under undrained conditions. The responses of the clay with different overconsolidation ratio

in this analysis were studied by using the modified Cam-clay model. The distribution of total stress, effective stress and excess pore pressure over radial direction can be obtained base on the analytical method. The results of analytical simulation will compare with the experimentally measured results with an objection to have a better understanding of the soil behaviour during compaction grout process.

KEYWORDS: Cavity expansion, Compaction grouting, Modified Cam-clay model, OCR

基于修正Mohr-Coulomb屈服准则的冻结砂土损伤本构模型

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摘　要： 低围压作用下，冻结砂土侧向刚度较小，荷载作用使内部微裂隙逐步贯通形成宏观破碎带，随着围压的增加，冰产生塑性流动和冰晶的重新定向作用，增加了砂土的塑性能力，使变形从应变软化逐渐过渡到应变硬化。由于冻结砂土内部微缺陷、微孔洞的离散性和随机分布，假设微元强度服从Weibull随机分布，通过引入修正Mohr-Coulomb屈服准则来描述冻土微元强度破坏机理和破坏准则，利用统计理论和连续损伤力学理论建立反映冻土破裂全过程的损伤演化本构方程，以此来探讨冻结砂土在荷载作用下损伤变形机理。根据低温三轴试验结果确定了模型参数，对Weibull分布参数n和F0进行了修正，获得了损伤变量的演化规律和冻结砂土的粘聚力、内摩擦角随围压的变化规律，最后将理论与试验结果进行对比表明该模型能够较好地模拟应力应变全过程曲线，并能反映随围压的增大，冻结砂土应力应变曲线从应变软化向应变硬化过渡的现象。

关键词： 冻结砂土；修正Mohr-Coulomb屈服准则；损伤本构模型；Weibull随机分布；微元强度

中图分类号：TU445

Damage Constitutive Model for Frozen Sand Soils Based on Modified Mohr-Coulomb Yield Criterion

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Abstract: Under the low confining pressure, the macroscopic fracture bands are formed from the internal micro cracks gradually due to the small lateral stiffness for frozen sand soils. With the

increasing confining pressure, the bonding ice will flow with the plastic deformation and the ice crystals will be re-orientated, leading to a kind of transition from strain softening to strain hardening gradually. On the basis of an assumption that the micro-unit strength obeys Weibull random distribution due to discreteness and randomness of the internal micro-defects and micro-holes for frozen sand soils, a modified Mohr-Coulomb yield criterion is introduced to describe the micro-unit strength failure mechanism and criteria. With the propose of pursuing the deformation mechanism under external loading for frozen sand soils, the statistical theory and the continuum damage mechanics are used to establish a damage constitutive equation to reflect the whole fracture process. Through the determined model parameters according to triaxial tests at a low temperature and the corrected Weibull distribution parameters n and F0, the evolution of damage variable, cohesive force and internal friction angle are obtained under the condition of different confining pressures. Finally, the comparisons between theoretical and experimental results demonstrated that the proposed model can well simulate the whole stress-strain curves, and reflect the transition phenomenon from strain softening to strain hardening along with the increasing confining pressure for frozen sand soils.

key words: frozen sand soils; modified Mohr-Coulomb yield criterion; damage constitutive model; Weibull random distribution; micro-unit strength

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The Analytical Method for Determining Flexural Toppling Failure Plane Based on the Limit Equilibrium Theory

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ABSTRACT

The limit equilibrium method is the most common, successful, effective approach in the studies of flexural toppling failure. But before using the limit equilibrium method for mechanics analysis, we must obtain the position and shape of the failure plane of a slope. According to the results of physical model tests, the failure plane of a countertendency layered rock slope was a linear type plane. However, various experts obtained different failure angles (the angle between the basal failure plane and the plane normal to the discontinuities), and none of them had developed a reasonable & effective method to determine the failure angle. This paper was initiated on the purpose for solving the above problem. Based on the limit equilibrium theory, we considered that the failure angle was the angle which

resulted in the stress state of a slope reaching the limit equilibrium state, namely, the residual sliding force at the toe of a slope equaling to zero. With cantilever beam model and step by step analytical method, the corresponding computational process was given in this paper. A slate slope in South Anhui of China was taken as engineering example to prove the effectiveness of the method developed in this study. Furthermore, the sensitivity analyses of parameters used in the calculation process of the slope failure angle were conducted as well.

KEYWORDS: Flexural toppling failure; Failure plane; Limit equilibrium theory; Failure angle; Residual sliding force

公路路堤稳定分析的简便方法

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摘　要：高填方路堤的稳定性是设计和施工中的重要控制因素，基于电子表格的简化毕肖普法为路堤稳定性分析提供了新的、便捷实用的计算工具。利用Lisp或ActiveX函数从AutoCAD中自动获取边坡几何信息以及相关数据极大地简化了计算的前处理过程。通过电子表格的计算以及少量VBA函数可以实现路堤边坡计算的自动化。Excel自带的"规划求解"功能项用于安全系数的优化求解，避免了最为困难和复杂的优化程序编写。整个方法具有简单易用、自说明、可扩展等特点。计算过程呈现在电子表格中，完全透明、可校核。

关键词：极限平衡；路堤稳定；毕肖普法；电子表格；优化

中图分类号：U238

Handy Tool for Stability Analysis of Highway Embankment

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Abstract：The stability of embankment is vital to the safety of highway. Spreadsheet based method can provide a new perspective and handy solution for the stability analysis of embankment. The preprocess of embankment and foundation by program coded with Lisp language or ActiveX function can extract the numerical information of geometry. The calculation function and some VBA programs make whole procedure of analysis automatic. The "Solver" add-in was employed to optimize the calculation and obtain the factor of safety, which avoid the most difficult part of coding. The method proposed in this paper has the advantages of simple, self explanation, extensible, etc. the whole calculation procedures were presented in the spreadsheet and all the data were checkable.

key words：Limit equilibrium; Stability of embankment; Bishop method; The spreadsheet; Optimization

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刚/柔性组合墙面加筋土挡墙筋材拉力计算方法[1]

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摘 要： 刚/柔性组合墙面加筋土挡墙是一种能适应地基变形的新型加筋土结构，但目前还缺少对其筋材拉力的设计计算方法。本文基于现场原型挡墙和离心模型试验实测筋材拉力分布，以及三维数值模型计算结果，探讨工作应力下刚/柔性组合墙面加筋土挡墙筋材拉力设计计算方法。筋材拉力可看作为挡墙自重作用下筋材拉力和上覆荷载引起的筋材拉力增量两者之和。挡墙自重作用下筋材拉力计算考虑了地基变形和连接件"张力膜"效应的影响，通过修正"K-刚度法"获得；上覆荷载引起的筋材拉力增量沿墙高呈均匀分布，可通过朗肯主动土压力及筋材荷载分担比计算获得。采用本文方法计算的刚/柔性组合墙面加筋土挡墙筋材拉力与数值模拟及离心模型试验实测结果吻合较好。

关键词： 加筋土挡墙；刚/柔性组合墙面；筋材拉力；工作应力状态

中图分类号：U238

Calculation Method of Reinforcement Loads of Reinforced Soil Walls with Flexible/Rigid facings

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Abstract: Reinforced soil retaining walls (RSWs) with flexible/rigid facings are a new type reinforced structure that can tolerate large ground deformation. There is lack of calculation method for the reinforcement loads. This paper investigated the load distributions in the reinforcements of a number of full-scale field walls, centrifugal test walls and three dimensional numerical models. Based on the results obtained from field and laboratory measurements, and numerical modelling, a simple method

is proposed to calculate the reinforcement load in the RSWs with flexible/rigid facings under working stress conditions. In the method, the reinforcement loads induced by soil weight and external load are calculated separately. The reinforcement loads under self-weight of the wall can be calculated using a modified "K-stiffness" method considering the effect of foundation deformation and the contribution of the anchors. The load in the reinforcement induced by the surcharge is found to be distributed uniformly along the wall height and can be calculated using Rankine's active earth pressure theory. The reinforcement loads of the RSWs with flexible/rigid facings calculated using the proposed method are in good agreement with those obtained using numerical and centrifugal modelling.

key words: Reinforced soil wall, Flexible/Rigid facing, reinforcement load, working condition

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An Improved Theoretical Method for Analysis of Geogrid-reinforced Pilesupported Embankments

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ABSTRACT

Geogrid-reinforced pile-supported (GRPS) embankments are increasingly used in the construction of highways and railways on soft soils due to its inherent advantages of short construction time, low costs and efficiency in reducing both vertical and horizontal displacements. As the main mechanisms of load transfer for GRPS embankments, soil arching effect and tensioned membrane effect have remarkable influences on the behavior of load transfer and embankment displacement. This paper focuses on presenting an improved theoretical method for analysis of GRPS embankments. This method is based on the theory proposed by Hewlett and Randolph (1988). The elastoplastic state parameter of arching crown or pile top soil pressure (α) and the cohesion of embankment fill are introduced in this method. Meanwhile, a coefficient of equivalent uniform pressure on the surrounding soil (β) is also introduced to consider the nonuniformity of vertical stress acting on the ground surface. The pile efficacy obtained from the improved method is compared with experimental results to verify its validity. The results show that this theoretical solution is in good agreement with the field data. Finally, parametric studies are performed to investigate the effect of embankment height, pile spacing, geosynthetic stiffness, ground reaction modulus, and internal friction angle of embankment fill on the pile efficacy, tension in geosynthetic, and maximum settlement at the ground surface.

KEYWORDS: Geogrid-reinforced pile-supported (GRPS) embankment; Load transfer mechanism; Theoretical method; Pile efficacy

Mechanical Properties and Binary-medium Constitutive Model for Artificially Structured Soils with Initially Stress-induced Anisotropy

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ABSTRACT

Triaxial compression tests were carried out on artificially structured soil samples with initially stress-induced anisotropy at confining pressures of 25 kPa, 37.5 kPa, 50 kPa, 100 kPa, 200 kPa and 400 kPa, respectively. Based on the analysis on these test results, a binary medium constitutive model for initially stress-induced structured soils was formulated here by regarding the structured soils as a binary medium consisting of bonded blocks and weakened bands. In the model, the bonded blocks are named bonded elements described by elastic-brittle materials and the weakened bands are named frictional elements described by Lade-Duncan model, respectively. Based on homogenization theory

of heterogeneous materials, the non-uniformly distribution of stress and strain within a representative volume element (RVE) can be given by introducing structural parameters consisting of breakage ratio and local strain coefficient. Finally, the determination methods of model parameters were given on the basis of experimental results and verified with experimental data, which demonstrates that the new model provides satisfactory qualitative and quantitative modelling of many important features of artificially structured soils with initially stress-induced anisotropy.

KEYWORDS: artificially structured soils; binary medium constitutive model; breakage ratio; local strain coefficient; initially stress-induced anisotropy

Slope Stability Analysis of an Ore Transportation Road Induced by Rainfall Infiltration

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ABSTRACT

Due to the influence of rainfall infiltration, the slope of an ore transportation road of the Yongping Copper Mine appeared a high probability of losing stability, posing a great threat to mineral transportation roads and mining safety. In this study, we simulated the hydraulic response of the slope under rainfall conditions, discussed the response of the slope state under different rainfall intensities, and analysed failure probability of the slope during or after rainfall infiltration. Results indicate that the rainfall infiltration has a hysteresis effect on the slope instability. The failure of the slope is more likely to occur in three days later after rainfalls. The distribution of activity of the slope is prone to be an advancing landslide.

KEYWORDS: Slope stability; Safety factor; Failure probability; Rainfall infiltration; Ore transportation road

团聚效应对改性红粘土路基填料强度的影响研究[1]

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摘　要：为了探究团聚效应对改性红粘土路基填料强度的影响，特以红粘土为原材料，以碳酸钙石粉为改性材料，以三种不同的方法制备试验样品，开展抗剪强度和无侧限抗压强度等试验。结果表明：团聚效应对改性红粘土路基填料强度的影响较大，将天然红粘土风干后再掺料改性的方法比直接掺料改性或烘干后再掺料改性的效果更好，前者抗剪强度和无侧限抗压强度值明显比后两者强，前者最大粘聚力为148.3kPa，后两者的最大粘聚力依次为116.1kPa和101.1kPa；前者的无侧限抗压强度最大值为0.8MPa，后两者均随掺料比的增加而减少；碳酸钙石粉含量达到10%时，风干红粘土改性后的抗剪强度和无侧限抗压强度值最大。相比之下，天然红粘土风干后掺料改性的做法更符合实际，虽然占用一定的时间和空间，但其能在一定程度上克服团聚效应的影响，同时能够有效提升红粘土的抗剪与抗压强度。

关键词：改性红粘土；路基填料；团粒化；抗剪强度；无侧限抗压强度

中图分类号：**TU411**

Experimental Study on Clustering Effect on Strength of Roadbed Filling of Modified Lateritic Clay

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Abstract: To find the effect of clustering effect on strength of roadbed filling of modified lateritic clay. Using lateritic clay as the raw material and CaCO3 powder as the modified material to make three different test samples carried out the direct shear and unconfined compression strength index test. The results show that there is a great influence of clustering effect on strength of modified lateritic clay, the method which admix modified nature lateritic clay after it was air-dried has batter effects than the methods which just admix modified lateritic clay or admix modified lateritic clay after drying it, the shear strength and unconfined compressive strength of the former one is apparently better than the

latter two. The former has a maximum cohesion of 148.3 kPa, but the latter two are in the order of 116.1 kPa and 101.1 kPa, respectively. The maximum unconfined compressive strength of the former is 0.8MPa, and the latter two decrease with the increase of the admixture content. When the content of calcium carbonatestone powder reaches 10%, the shear strength and unconfined compressive strength of air-dried lateritic clay are the largest. In contrast, the way which adimix modified nature lateritic clay after it is air-dried is more factual, although it takes a certain amount of time and space, to some extent, it can overcome the clustering effect,it also can effectively improve the strength of the lateritic clay, it is a more efficient way.

key words: modified red clay;roadbed filling;aggregation;shear strength;unconfined compressive strength

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暗涵墙体混凝土温度场与应力场仿真分析

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摘　要：为了研究暗涵墙体在施工运行前期混凝土的开裂情况，从混凝土温度变形出发，对暗涵中墙裂缝成因进行分析。根据稳态温度场理论，采用ANSYS有限元分析软件，混凝土热单元类型选用solid70，建立三维实体模型求解中墙温度场，论述不同工况组合下的暗涵墙体温度场分布规律。根据暗涵墙体混凝土的温度场进行温度应力的仿真分析，研究暗涵中墙混凝土温度应力的分布及变化规律。结果表明：暗涵中墙内外表面的压应力近似相等，与温度变化呈线性关系，中墙内外表面不存在拉应力；暗涵中墙中间截面的压应力与温度差成反比，而拉应力与温差近似成正比；最大拉应力为1.92 MPa，出现在中墙中间截面，其值在混凝土的抗拉强度范围内，故中墙几乎不产生裂缝。通过设置合理的边界条件与环境条件，以指导温度监测点的布设，研究成果为相关混凝土施工温度裂缝控制提供参考依据。

关键词：结构温度应力；温度场；应力场；仿真分析；暗涵混凝土墙体；ANSYS

中图分类号：TV315　　　　　**文献标识码：A**

Culvert Concrete Wall of Temperature Field and Stress Field Based on Simulation Analysis with ANSYS

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Abstract: In order to study the cracking of the concrete wall in the early stage of the construction, the causes of cracks in the middle of the culvert wall are analyzed from the concrete temperature deformation. According to the steady-state temperature field theory, ANSYS finite element analysis software was used to analyze the culvert wall concrete. And different working conditions under the culvert wall of the temperature field distribution law with establishing the 3D solid model were discussed using concrete thermal unit type selected solid70. The simulation analysis of the temperature stress on the basis of the temperature field of the concrete wall, the distribution and variation law of

temperature stress in the culvert wall were studied. The results show that the compressive stress on the inner and outer surfaces of the middle wall culvert is approximately equal caused by the temperature change, and there is no tensile stress on the inner and outer surface of the wall; the compressive stress of the middle section of the culvert is inversely proportional to the temperature difference, and the tensile stress is close to the temperature difference. The maximum tensile stress is 1.92 MPa, which appears in the middle section of the middle wall, and its value is in the range of tensile strength of concrete, so the wall is almost no cracks. By setting reasonable boundary conditions and environmental conditions to guide the laying of temperature monitoring points, which can provide reference for temperature crack control of related concrete construction.

key words: Structural temperature stress;temperature field; stress field; simulation Analysis; Culvert concrete wall; ANSYS

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多功能CPTU测试技术在港珠澳大桥地基处理设计中的应用

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摘　要："海上丝绸之路"的提出以及"十三五"的海洋规划，海上风电、跨海大桥等海上工程项目逐渐增多，海洋岩土工程不断发展。目前，海洋工程已经由传统工程项目向新型工程项目转变，由近海向远海发展，于此同时海洋工程的规模也不断增大。这对海洋工程的安全性、耐久性，特别是循环荷载效应影响相关设计参数的勘测提出了更高的要求。海洋CPTU测试技术在国外已经得到了广泛的应用，具有大量试验资料并总结出了较为可靠经验公式。本文基于多功能CPTU测试评价了土工参数，给地基处理提供理论支持，介绍了港珠澳大桥位置、岛隧的地基处理中固结系数与渗透系数参数的评价方法，并通过计算证明了CPTU是海洋工程中的重要测试技术，可以为海洋工程勘察设计作为参考。

关键词：CPTU；港珠澳大桥；地基处理；渗透系数；固结系数

Application of Hong Kong Zhuhai Macao Bridge Foundation Treatment Design Based on CPTU Technology

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Abstract: With the "Maritime Silk Road" put forward and "13th Five-Year" marine planning, offshore wind power plant, sea bridges and other marine projects gradually increased. Currently, ocean engineering has changed from traditional to new projects, the place changed from coastal to deep sea, and the scale of ocean engineering is increasing. This change has put forward higher requirements on the safety and durability of marine engineering, especially the effect of cyclic loading on the design

parameters. CPTU testing technology has been widely used in marine projects design over board, that projects provide large numbers of experimental data and a more reliable empirical formula. This paper introduced the basic information and the evaluation method of consolidation coefficient and permeability coefficient of the Hong Kong Zhuhai Macao Bridge island tunnel foundation treatment, and evaluated the soil parameters based on CPTU technology. It has been proved that CPTU is an important testing technology in ocean engineering, also can be widely used in China marine engineering investigation and design.

Experimental Study on Basic Engineering Properties of Lime-fly Ash Modified Silt Soill

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ABSTRACT

In view of the problems existing in the construction of high-speed railway, the lime-fly ash mixture was used to improve the silt soil. Through the analysis of grain size distribution, the limit moisture content test, the proctor compaction test, the direct shear test and the unconfined compressive strength test, the basic engineering properties of pure soil and lime-fly ash improved soil were studied. The change regulation of the basic engineering properties of improved soil with lime and fly ash content and the optimum percentage of the modifier were concluded. The test results showed that: compared with pure soil, for improved soil, with the increase of lime and fly ash content, the liquid limit and plastic limit increased, and the plastic index decreased; the maximum dry density also

increased, but the optimum moisture content decreased; the improved shear strength increased, with significant increasing amount of the cohesion C and the internal friction angle φ; the 7d unconfined compressive strength of improved soil with 20% lime-fly ash modifier was 295.74kPa, which could meet the standard requirements. The advised optimum percentage of lime and fly ash content was about 20%, with 5% of lime and 15% of fly ash.

KEYWORDS: silt soil; lime and fly ash; experimental study; basic engineering properties; high-speed railway

Influence of Vetiver Grass Roots on Physical Properties of a Decomposed Volcanic Tuff Soil

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ABSTRACT

The important role of vetiver grass roots on preventing water erosion and mass movement has been recognized in recent years. However, the detail influence of the grass roots on physical prosperities of soil has not been addressed especially under such local nature conditions. Through planting vetiver grass at the Kadoorie Farm in Hong Kong and leaving them growing without artificial maintenance, the paper studied the influence of vetiver grass roots on physical properties of soil. The tests consist of water content, density, grain-size distribution permeability. All items were conducted on rooted and non-rooted soil. The results show that under the natural conditions of Hong Kong, growth of the vetiver grass roots can reach to 1.1m depth after one and a half year from planted. The vetiver grass roots can increase soil water content and soil density as well as improve the coefficient of permeability. The percentage of grain size that less than 0.075mm in rooted soil is more than non-rooted soil, which indicates that vetiver grass roots can reduce soil erosion by locking the finer grain.

KEYWORDS: decomposed volcanic tuff; physical properties; vetiver grass; slope protection

Study on the Method of Slope Unit Zoning in Risk Assessment of Regional Geo-hazards

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ABSTRACT

Influenced by traffic construction and land utilization, the occurrence of geological hazards such as landslide and debris flow has been accelerated. Therefore, the regional geo-hazard risk assessment is rather essential for the village construction, and the assessment based on slope unit has certain advantages. Most literatures considered less about the impact of grid size and quantitative methods were rarely seen to calculate filling threshold and critical support area threshold when using the slope unit. For this reason, the suitable grid size is determined by calculating the root mean square error of slope gradient according to Hutchinson; filling threshold is adopted based on the calculated depth and practical one; support area is well analyzed by curve of drainage density critical support area" and the" blue line" technology. Through process mentioned above, this study has built a more complete quantitative method for the slope unit zoning and it was applied to the demonstration area Muyu, Shennongjia Forestry District, China. The results showed that the optimal grid size of Muyu was 25m×25m; the zoning coincided with the valley lines extracted from the satellite topographic map which reflect the geometry of slope. This quantitative method offered in this study can provide a reference for slope units zoning, and has practical significance in regional geo-hazards assessment.

KEYWORDS: Transportation planning; Slope unit zoning; Grid size; Filling threshold; Critical support area threshold

渝东北山区公路地质灾害特点及治理研究

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摘　要：山区丘陵地形是山城重庆最典型的地形，山区公路建设条件差，地质复杂，夏季多暴雨，造成公路地质灾害频发。特别是重庆东北部山区，是重庆公路地质灾害最严重的地区。本文主要对重庆东北部山区公路地质灾害的特点、成因进行了梳理分析，重庆东北部山区公路主要的地质灾害是滑坡和崩塌，并针对山区公路的特点提出了治理的措施建议。

关键词：山区；公路；地质灾害；治理；渝东北

文献标识码：A

Research on Geological Disaster Characteristics and Governance of Mountain Highway in the Northeast of Chongqing

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Abstract：Mountain hilly terrain is the most typical terrain mountain city of Chongqing, poor mountainous area highway construction condition, geological complex,heavy rains in summer, causing highway geological disasters.Especially in the mountains in the northeast of Chongqing which is the most serious geological disasters in chongqing highway area.In this paper, the characteristics and the causes of highway geological disasters in the northeast mountain area of chongqing were analyzed. chongqing northeast mountain area highway landslide and collapse is the main geological disaster in the northeast mountain area of Chongqing, and in the light of the features of the mountainous area highway governance measures are put forward.

key words：mountainous area;highwaay;geological disasters;govern； northeast of Chongqing

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一种可用于边坡加固的微生物生长条件优选

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摘　要：通过对比产地德国的巴氏生孢八叠球菌扩大培养菌液的脲酶活性，采用单因素控制法研究了温度、PH值、接种量、转速四因素对巴氏生孢八叠球菌生长的影响。研究结果表明：①当扩大培养菌液PH值为9，180 r/min，1%接种量时，32℃是该菌最适宜的生长温度，该温度下菌种脲酶活性最高，温度对该菌种生长影响较大。②当室温为32℃，转速为180 r/min，1%接种量时，PH值为8是最优的单一条件，但PH值的变化对该菌种生长影响不明显。③当扩大培养菌液PH值为8，室温32℃，180 r/min，最优接种量为5%。④当扩大培养菌液PH值为8，室温32℃，5%接种量时，转速为180 r/min下菌种的脲酶活性较高。

关键词：脲酶活性；巴氏生孢八叠球菌；优化；微生物；边坡加固

中图分类号：**U238**

Study on the Optimum Condition of Microbial Production for Slope Reinforcement

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Abstract: By comparing the urease activity of sporosarcina pasteurii produced from Germany,the effects of temperature, pH value, inoculation amount and speed on the growth of sporosarcina pasteurii were studied with single factor control method.The results showed that (1) ,When the pH of cultured bacteria was 9,180 r/ min and 1% inoculation amount, 32℃ was the most suitable growth temperature, and the activity of urease was the highest at this temperature and the effect of temperature on the growth of the sporosarcina pasteurii was larger.(2) When the culture medium's temperature was 32□,180r/min and 1%inoculation amount,PH value of 8 is the optimal single condition but the change of PH has no obvious effect on the growth of sporosarcina pasteurii. However, the effect of PH on the growth of sporosarcina pasteurii was not obvious. When the culture medium's PH was 8,32□,180r/

min, and the optimum inoculation amount was 5%. (4) When the culture medium's PH was 8,32□, 5% inoculation amount, the urease activity was higher at 180 revolutions per min.

key words: urease activity; sporosarcina pasteurii;optimization ; microorganism;Slope protection

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公路路域中汞污染研究进展小结

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摘　要：公路系统的高速发展带来经济和社会效益的同时，也带来了重金属污染。本文简要综述了公路路域中汞污染的研究进展，从汞污染的危害、来源及降雨径流影响三个方面分析了公路路域中的汞污染。

关键词：公路；汞污染；研究进展

Research Advancements regarding Mercury Pollution of Roadside

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Abstract: The high speed of development of highways benefits our economy and community, while brings heavy metals pollution. The scope of the current paper was to briefly review the research advance on mercury pollution in beside the roadside. The damage caused by mercury pollution, the pollution source and the influence of rainfall runoff are analyzed.

key words: highway; mercury pollution; research advance

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泡沫剂改良砂卵石土的试验研究

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摘　要：砂卵石土具有内摩擦角大、流动性差、渗透系数大等特点，在砂卵石地层的盾构施工中会引起出土困难、刀盘磨损、地下水喷涌等问题。通过泡沫优化试验，得到泡沫半衰期及发泡倍率最优时的发泡液浓度为2%ˉ3%。基于四川成都地铁盾构中的砂卵石地层，配制了卵、砾石含量为20%、40%、60%、80%的土体，通过掺入泡沫剂，进行了室内大型剪切试验、坍落度试验和渗透试验，发现随着泡沫注入率的增加，包裹在砂卵石土周围泡沫土的含量增加，砂石分离现象逐渐消失，抗剪强度和内摩擦角呈非线性降低，坍落度逐渐增大，抗渗性能明显提高，并得到了20%、40%、60%含石量砂卵石土满足盾构施工中"理想状态土体"要求的泡沫注入率。泡沫剂对低含石量砂卵石土的改良效果较好，而对于含石量80%的高含石量砂卵石土，泡沫剂改良效果不好。研究成果对砂卵石地层盾构掘进中的相关问题解决具有一定的意义。

关键词：砂卵石土；泡沫剂；注入率；抗剪强度；流动性；渗透性

中图分类号：TV 223　　　文献标识码：A

Study on the Improvement of Sandy Gravel Property in Foam

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Abstract: As we know, sandy pebble soil has the characteristics of large internal friction angle, poor fluidity and high permeability coefficient, therefore, a series of problems, such as unearthed difficulty, wear of cutter and ground water spewing, can be encountered in the construction of shield tunnel in sandy pebble stratum. Based on the experiment of bentonite slurry optimization, it is concluded that the relative volume quality and viscosity of sodium bentonite was better than that of calcium bentonite. Additionally, the optimal proportion between bentonite and water is 1:10, and the best time

of mud bulking is 18 hours. Through the lab large-scale shear test, slump test and permeability test, sand pebble soil with different sodium bentonite injection rate has been researched, it is founded that the shear strength, internal friction angle, fluidity and permeability of sand pebbles can be nonlinear variation with the increase of mud injection rate , and the 20%, 40%, 60% stone sand gravel soil to meet the requirements of the "ideal state soil" in the shield construction. Good improvement effect of foaming agent on the low stone content of sand pebble soil, and for the high stone content of sandy pebble soil stone content 80%, foam improvement effect is not good. The research results have a certain significance to solve the related problems of shield tunneling in sandy pebble stratum.

The result can be of great importance in solving of the problems encountered in the construction of shield in sand pebble stratum.

key words: sand cobble soil; foam; injection rate; shear strength; fluidity; permeability

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Analysis on Formation Mechanism and Three-dimensional Stability of Deposits Slope

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ABSTRACT

The problem of deposits slope is often encountered in constructions of hydropower projects in Southwest China. The study combines geology phenomena and drill core data, based on areal geology survey, rainfall data, and so on. The thought of engineering geology qualitative analysis is applied to study on the slope stability. On the basis of geological analysis, the deposits body has the feature of multi-stages and composite formation mechanism, and it is one of typical evolution models of the bank slope of Nujiang Great Canyon. The coupling effect mechanism of endogenic and exogenic geological processes of the deposits body is proposed. Aiming at spatial structure features and special location of

deposits slope, the finite-difference and strength-reduction method is adopted to compute its stability factors under natural, rainstorm, seismic conditions. The above discussions offer reasonable evidence to constructions of the project and partial reinforcements of the slope and provide reference for stability analysis of similar deposits slopes in the river basins.

KEYWORDS: deposits slope, multi-stages and composite formation mechanism, coupling effect mechanism of endogenic and exogenic geological processes, finite-difference and strength-reduction method

干湿循环作用下堆积体抗剪强度的试验研究

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摘　要：干-湿循环变化对堆积体剪应力-位移关系曲线具有转型效应，即随着干-湿循环次数的增加，堆积体结构势能即摩擦势能和黏聚力势能不断减小，其抵抗剪切变形的能力降低，因而，其剪应力-位移关系曲线表现出由应变硬化型向弱应变硬化型和理想弹塑性转变的趋势，且堆积体黏聚力和内摩擦角均是非线性减小的。在试验研究的基础上，借鉴损伤力学的观点，定义了干-湿循环条件下黏聚力和内摩擦角的水致弱化度，以定量评价水对堆积体抗剪强度的水致损伤弱化效应。随着干-湿循环次数的增加，黏聚力和内摩擦角的水致弱化度均呈现出非线性增大的趋势，黏聚力的水致弱化度 与干湿循环次数 之间近似为幂函数关系，内摩擦角的水致弱化度 与干湿循环次数 之间近似为指数函数关系。

关键词：干湿循环；堆积体；室内大型直剪试验；剪应力-位移关系曲线；抗剪强度

Experimental Study on Shear Strength of Accumulation Body Under Drying-wetting Cycle

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Abstract: With the increase of drying-wetting cycles, cohesion potential and internal friction angle potential of the accumulation body decreased continuously, and its shear ability also decreased, the shear stress-displacement curves show pattern transition from strain hardening to ideal elastic-plastic. Based on experimental research, in order to estimate water weaken effect on shear strength of the accumulation body quantitatively, degree of water weakening was defined under the conditions of drying-wetting cycles from damage mechanics point of view. With the increase of drying-wetting cycles, the degrees of water weakening of cohesion increase as power function curve, and the degrees

of water weakening of internal friction angle increase as exponential curve.

key words：drying-wetting cycles, accumulation body, lab large-scale direct shear test, relationship between shear stress and displacement, shear strength.

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Analysis of Deformation and Failure of Deposit Slope During Reservoir Filling and Rapid Drawdown

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ABSTRACT

Research on deformation and stability of reservoir bank slopes is always focused by scientists of the world. Took a deposit slope in the reservoir area as an example, FLAC-3D was adopted to analyze the deformation and failure characteristics of the slope with the rising and rapid drawdown of the reservoir level. It is indicated that deformation mainly occurred in the deposit body while the reservoir level fluctuating; the deposit body was divided into three regions according to the deformation characteristics: the front traction deformation area with the largest deformation, the middle transition area with the smallest deformation as well as the posterior passive traction deformation area.

Displacement monitoring points were set at different parts in the deposit body, so the displacement-time graphs during reservoir filling and rapid drawdown of reservoir level were obtained. The monitoring results suggested that local instability occurred at lower part of the slope during the rapid drawdown of reservoir level. Owning to the influence of water, two potential sliding failure surfaces in slope can be judged based on the shear strain increment.

KEYWORDS: fluctuation of reservoir water, deposit slope, strain-softening, tractive deformation zone, failure modes, local instability

Experiment Study on Compatible Deformation between Distributed Sensing Optical Fiber and Soil

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ABSTRACT

As a new monitoring method, the optical fiber sensing technology has been successfully applied in the geological and geotechnical engineering field up to date. However, the deformation discrepancy between the sensing optical fiber and the ground to be measured in the actual project, often poses a greater influence on the monitoring results. Multi-group loading test were performed in the paperto explore the relationship among optical fiber, load, as well as actual soil formation. Through comparative analysis, we find that the compatible deformation between the optical fiber and soil is affected by a variety of such variables as fiber type, constraint condition and buried depth of optical fiber. Appreciation of the evolution of compatible deformation between the optical fiber and soil can be capable of providing a reference for the application and popularization of optical fiber sensing technology in deformation monitoring of rock and soil.

KEYWORDS:distributed optical fiber, compatible deformation, loading, monitoring

The Centrifuge Tests of the Influence of the Socketed Depth on Bearing Capacity of Uplift Piles

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ABSTRACT

Uplift piles were wildly used in the transmission towers in the western China. The socketed depth of uplift piles was one of the important design concerns. In this paper, four centrifuge tests were conducted to explore the influence of the socketed depth on the pile capacity. The tests were conducted with the socketed depth assigned as 1D, 2D, 3D and 5D (D was the outside diameter of the pile). Special attentions were paid to the failure mode of the underlying bedrock, load-displacement curve, as well as axial force and skin friction. The test results show that the failure zone of the underlying bedrock was a complex three-dimensional zone consisting of an inverted cone zone and a cylinder zone. The skin friction observed in the upper sand range was negligible. The maximum skin friction appears at the middle point of the socketed length and the location of maximum moves downward with the increasing uplift load. The pile capacity were found almost increasing proportionally to the socketed depth.

KEYWORDS:Centrifuge test, uplifting pile, socketed depth, ultimate bearing capacity

季冻区运营期路基土模量衰减调查研究

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摘　要：针对季冻区公路路基在反复冻融循环作用下的强度衰减问题，考虑冻区、公路自然区划、大地标准冻深、土质的影响，对位于典型季节性冰冻气候区的公路路基进行了钻探取芯、原位测试、室内试验、承载板现场测试及FWD动态弯沉测试，综合相关研究成果，得到季冻区运营期路基土模量折减系数并提出了季节性冰冻地区路基设计回弹模量确定方法，为季冻区路基长期稳定和耐久性提供保证。

关键词：公路；路基土；回弹模量；强度衰减；运营期；季冻区

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Strength Decline Survey on Subgrade Resilience Modulus in Operating Period of Seasonal Frozen Region

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Abstract: According to the strength decline of subgrade under freezing and thawing cycles in seasonal frozen region, considering the influence of frozen zone, natural zoning for highway, standard frozen depth and soil，core drilling, in situ testing, laboratory test, loading plate test on site and FWD of highway subgrade in typical seasonal frozen climate zones are carried out, based on correlation research，the reduction coefficient of subgrade soil in operating period of seasonal frozen region is obtained and the design value of resilience modulus for seasonal frozen region is determined, it can proving a guarantee for long-term stability and durability of subgrade.

key words:highway; subgrade soil; resilience modulus; strength decline; operation period;　seasonal frozen region

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Rubber Cushion Role in the Joints of Concrete Linings in TBM Tunnel: Insight into 3D Finite Element Modeling

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ABSTRACT

Concrete segments play an important role in shield tunnel by tunnelling boring machine (TBM). To accommodate the mechanical behaviours of concrete segments, cushion materials such as rubber are often put into between tunnel rings and between rings and segments, which yield so called longitudinal and ring joints, respectively. Due to interaction between segments and joints, rather complicated stress and deformation usually occur to the joints and their corresponding sides of the segments. In this paper, finite element method is employed to solve the 3D problem of soil-tunnel structure interaction under static loadings. The Mohr-Coulomb law is used to describe the constitutive relations of surrounding soils and the Neo Hookean law is applied to characterize the constitutive law of rubber cushion meanwhile it is assumed that the concrete segment obeys the Hook's law in the simulations. The results of hierarchical numerical modelling for the tunnel system reveal that rubber cushion can smooth the stress distribution in the overall tunnel segments, particularly in the launching and break through areas where stress reduction approaches to be approximately 13% but deformations generally coincide with

that without including rubber cushions in the tunnel segments in the present study. The simulations also show that launching and break through effects should be paid much attention not only in tunnel design phase, but also in construction phase to keep the safety and stability of shield tunnel.

KEYWORDS: Shield segment, Tunnelling boring machine, 3D numerical modelling, Rubber cushion, Ring and longitudinal joints

养护压力对水泥固化高含水率淤泥强度的影响

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摘　要：采用水泥固化疏浚淤泥（CSM）作为滨海交通设施（路基等）填料能同时解决疏浚淤泥弃置问题和理想填料（砂土料等）日益短缺的问题。随着高速交通设施的大规模兴建，CSM填筑高度越来越大，下部CSM将受到较大养护压力，此时CSM强度特性的演化其实是物理固结与水泥–水–黏土颗粒化学反应的耦合效应，这与固结压力作用下饱和软黏土强度发展机理存在本质区别，固结压力对CSM强度发展的影响尚不明确。本文基于室内试验，测试了不同配合比与养护压力工况下的CSM强度指标，评价了采用养护后孔隙比e_{0t}和有效孔隙比e_{st}作为基本指标来描述养护压力对CSM强度影响的适用性，并探讨了养护压力对CSM强度影响的内在机理。结果表明：养护压力对CSM强度特性影响显著；e_{0t}和e_{st}不能被用来定量描述养护压力p_c对CSM强度的影响规律。由此推测养护压力对CSM强度影响的内在机理主要包括挤压固结效应和颗粒簇团间的"自锁"效应两个方面，并建立了表征养护压力效应的CSM的强度经验公式。

关键词：水泥固化淤泥；养护压力；强度；孔隙比；固结效应；自锁效应

Experimental Investigation on the Effect of Curing Stress on the Strength of Cement Stabilized Mud at High Water Content

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Abstract：An ideal solution for disposal of large volumes of unwanted dredged mud is to stabilize and use them as fill material for coastal embankment. This new kind of filling material (referred to as CSM from hereon) can also resolve the sand scarcity issue encountered in embankment construction in coastal areas. With the rapid development of high-speed transportation, coastal CSM embankments become higher and higher, and as a result, the lower portion of CSM will suffer from high effective

curing stress. The development mechanism of CSM strength under curing stress is totally different than that of saturated soft clay. The former involves both consolidation effect and chemical reaction effect while the latter involves only the consolidation effect. Hence, it's necessary to specifically identify the effect of curing stress on the mechanical properties of CSM. In this study, a series of laboratory tests is firstly conducted to acquire the unconfined compressive strengths (qu) of CSM with different mixing proportions and various curing stresses. Then, the applicability of two basic parameters, i.e. after-curing void ratio (eot) and effective void ratio (est), in describing the effect of curing stress on qu is evaluated. Finally, the influencing mechanism of curing stress on qu is studied. Results indicate that the curing stress has a significant influence on qu. However, both eot and est cannot be used to quantitatively describe the effect of curing stress on qu. It is speculated that the influence of curing stress on qu mainly includes two components - the consolidation effect and the "self-locking" effect among the particle clusters.

key words: cement stabilized mud; curing stress; strength; void ratio; consolidation effect; self-locking effect

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A Synthetic Material to Simulate Soft Rocks and Its Applications for Model Studies of Socketed Piles

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ABSTRACT

A detailed manufacturing procedure of the synthetic soft rock was presented, as well as its applications on the laboratory experiments of socketed piles. With the homogeneity and isotropy of the simulated soft rock, the influence of different variables on the bearing performance could be investigated independently. The constituents as cement, gypsum powder, river sand, concrete-hardening accelerator and water were mixed overall to form the specimens. Both uniaxial and triaxial compressive tests were conducted to investigate the stress-strain behaviour of the simulated soft rock. Additionally, the simulated soft rock specimens were used in the model pile tests and the simple shear tests of the pile-rock interface. Results of the simulated soft rock in both the uniaxial and triaxial compressive tests are consistent with those of the natural soft rocks. The concrete-hardening accelerator added to the mixtures improves the efficiency in laboratory investigations of soft rock specimens with curing time of 7 days. The similarities between the laboratory tests and the filed observations provide convincing evidence to support its suitability in modelling the behaviour of soft rocks.

KEYWORDS:simulated soft rock; laboratory experiment; stress-strain behaviour; socketed pile

基于GIS的南水北调中线工程禹州采空区沉陷预测研究

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摘　要：南水北调中线一期工程总干渠在禹州市通过煤矿区，采空区的稳定性问题是南水北调中线一期总干渠工程禹州段的重大工程技术问题之一，对采空区地表沉陷的预测分析和研究十分重要。在对采空区数据收集的基础上，建立了基于概率积分法采空区覆岩内部及地表移动变形预测模型，开发了基于GIS的南水北调中线工程禹州采空区沉陷预测系统。对禹州段5个采空区的沉陷量、水平移动量、倾斜、曲率等变形进行了预测。预测结果表明，在走向和倾向方向上地表移动变形均未超过"三下"采煤规程中的稳定指标值，说明现阶段采空区残余变形不会对渠道造成破坏。位于禹州市梁北镇郭村煤矿采空区和原新峰矿务局采空区预测值和监测值相对较大，且渠道经过该处或在影响范围之内，是工程安全监测的重点。

关键词：南水北调中线；采空区；沉陷；预测；GIS；概率积分法

Study on Subsidence Prediction of Yuzhou Goaf Area in the Middle Route of South-to-North Water Transfer Project Based on GIS

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Abstract: The main canal of the middle route of south-to-north water transfer first-phase project is crossing coal mining area in Yuzhou city,which is very important for predictive analysis of surface subsidence of the goaf.On the basis of the data collection of the goaf, the prediction system for Yuzhou goaf area subsidence is developed based on GIS. The subsidence, horizontal movement, tilt and curvature of the five goaf areas in Yuzhou are predicted.The results show that the surface movement and deformation in the direction of strike and dip are less than than the index values of coal mining regulation under buildings water-bodies and railways, It is relatively large for the forecast value and monitoring value of Guo cun coal mine goaf and original Xinfeng goaf Mining Bureau located in

Yuzhou City, Liang Beitown, and the channel are within the sphere of influence of goaf area, which is the focus of the project monitoring.

key words: Middle Route of South-to-North Water Transfer Project; goaf; subsidence; prediction; GIS; probability integral method

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全寿命周期内不同方案处理高液限红黏土路基经济效益分析

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摘　要： 采用高液限红黏土填筑路基会导致路面出现早期破坏，工程中不同路基处理方式其工程效果和经济效果不同。本文采用全寿命周期经济理论，以典型路面宽度为10米的二级公路为代表，统计分析25年内路面维修费用与初期不同路基处理方案增加费用，比较不同处置方式的综合经济效益，得出在沥青路面中，掺砂增加压实厚度在5年后总费用开始少于普通填筑方式，10年达到峰值，节约额度在44%，路基石灰处治和设置排水层处理方式8年后总费用开始少于普通填筑方式，20年达到峰值，节约额度在50%。在水泥路面中，掺砂增加压实厚度在5年后总费用开始少于普通填筑方式，10年达到峰值，节约额度在30%，路基石灰处治和设置排水层处理方式7年后总费用开始少于普通填筑方式，20年达到峰值，节约额度在30%。掺砂增加压实厚度在二级以下公路最为经济可行，路基石灰处治的初期投入最大，适用于初期投资较高且有较多不良土质地区，采用碎石排水层的初期投资稍低于路基石灰处治，更适用于降雨量更大、且地下、地表水丰富的特殊路段。

关键词： 路基，高液限红粘土；全寿命；经济效益

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Analysis on Economic Benefit of High Liquid Red Clay Subgrade with Different Treatment in Full Life

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Abstract: The construction of subgrade with high liquid limit red clay will lead to the early damage of pavement. The difference subgrade treatment methods had different engineering and economic effects. This paper adopts the life cycle economic theory, with a typical road width of 10 meters on the secondary road ， analysis the pavement of maintenance costs and increased cost of the initial different

subgrade treatment in twenty-five years, and compared with comprehensive economic benefits of different treatment methods. In asphalt pavement，it is the conclusion that the total cost of mixing sand and increasing compaction thickness is less than ordinary filling after the five years, reaches the peak for ten years, saving the amount of 44%. Meanwhile, the total cost of the lime stabilized subgrade and the drainage layer after eight years are less than the common filling, reach the peak on twenty years and saving the amount of 50%. However, in cement pavement, the total cost of mixing sand and increasing compaction thickness is less than the common filling after five years, reaches the peak on ten years and saving the amount of 30%. The total cost of lime stabilized subgrade and the drainage layer after seven years is less than common filling ways, reach the peak on twenty years and saving the amount of 30%. The mixing sand and increasing compaction thickness is the most economical and feasible way in the Secondary road. The initial investment of lime subgrade treatment is the largest, it is suitable in the initial investment is higher and more adverse soil areas. The gravel drainage layer is lower than the initial investment of lime subgrade treatment，it is more suitable for the special areas have large rainfall and rich underground and surface water.

key words: subgrade, high liquid red clay; full life; economic benefit

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An Introduction to the Four Dimensional Lattice Spring Model for Geomechanics

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ABSTRACT

This conference paper gives a brief introduction of a newly developed numerical model for geomechanics, in which 4D interactions were introduced to solve the Poisson's limitation in the classical lattice spring model. The four dimensional model has advantages on solving dynamic nonlinear problems of geomaterials. Compared with FEM, it is free of complex tonsorial operations for geometric nonlinear analysis. It doesn't require incremental integration of the noncentral/nonlocal interaction involved in classical discontinuum based methods such as the Discrete Element Model (DEM) or the Distinct Lattice Spring Model (DLSM). This work will introduce the basic concept of this four dimensional numerical model and numerical examples to highlight its features.

KEYWORDS: Lattice spring model, geomechanics, dynamic failure, extra dimension computing

温、湿度对粉砂质泥岩单轴力学性能的影响试验

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摘　要：为研究粉砂质泥岩经温、湿度作用后单轴力学性能的变化，开展了一系列试验，得到了粉砂质泥岩在不同温、湿度作用下的应力-应变曲线，并分析了其单轴力学指标的变化规律。试验结果表明：天然粉砂质泥岩的峰前应力-应变曲线符合塑-弹-塑性岩石的特征；粉砂质泥岩经历变温循环后，其单轴抗压强度、弹性模量及劈裂强度均降低，且降低的幅度与循环次数、变温方向、温差及平均温度相关；粉砂质泥岩浸水后，其含水率在初期增长较快，后期逐渐趋于平缓，且其单轴抗压强度、弹性模量及劈裂强度随含水率的增大而降低；温、湿度共同作用于粉砂质泥岩时具有增效作用，其作用效果大于温、湿度单独作用效果之和；粉砂质泥岩在单轴受压破坏时，根据其破坏的特征可分为六种破坏形态，且不同破坏形态的出现受温、湿度影响。

关键词：粉砂质泥岩；温、湿度共同作用；应力-应变曲线；强度；破坏形态

Experiment on the Affection of Temperature and Humidity on Uniaxial Mechanical Properties of Silty Mudstone

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Abstract: In order to study on the uniaxial mechanical properties of silty mudstone under the affection of temperature and humidity, a series of experiments were carried out. According to the result of these tests, the stress-strain curves of silty mudstone under different temperature and humidity conditions were obtained, and based on which, the change rule of uniaxial mechanical index was analyzed. The test results indicates that the pre-peak stress-strain curve of natural silty mudstone meet the characteristics of plastic-elastic-plastic rock. Under the temperature cycling, the uniaxial compressive,

elastic modulus and splitting strength of silty mudstone all decrease, and the decreasing range associated with the cyclic times, direction of temperature shift, temperature difference and average temperature. After soaking, the water content of silty mudstone increases rapidly at the early stage and tends to be gentle at the later stage, the uniaxial compressive, elastic modulus and splitting strength of silty mudstone decrease with the increase of water content. Temperature and humidity showed synergistic effect when they work together on silty mudstone, its effect are greater than the sum of the effects of temperature and humidity respectively. When the silty mudstone are destroyed under uniaxial compression, it can be divided into six kinds of failure mode according to the failure characteristics, and the occurrence of failure modes are all affected by temperature and humidity.

key words: silty mudstone; the interaction of temperature and humidity; stress-strain curves; strength; failure mode

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Mechanisms of Geotextiles in Early-stage Protection of Loess Side Slopes

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ABSTRACT

Aims: For loess-filled slopes in a loess region, the protection of slope surfaces is always a challenge. Ecological protection technology, where plants are used in conjunction with geotextiles, has been proven to be an effective method for the loess slope protection. However, slope surfaces are easily eroded by rainfall during the early stage of growing of the vegetation. Herein, in this paper, simulated washing experiments were conducted to investigate the protective mechanisms of geotextiles at the early stage of vegetation growing.

Methods: Four common materials are used in this article, namely: four-layer three dimensional (3D) vegetation net (FL3DVN), two-layer 3D vegetation net (TL3DVN), geogrid and geocell. Consequently, it was analyzed that the protection mechanisms for slope erosion control and impact factors of these geotextiles through studies on coverage ratio, velocity of slope surface runoff, sediment ratio of flow, and mass of debris on the sieves as well as their grain size distribution.

Results: The results indicated that geotextiles resulted being effective in decreasing the velocity of slope surface runoff, which is achieved mainly thanks to: increased roughness and runoff intercepting by fibers for the TL3DVN and FL3DVN, increased roughness for the geogrid, and water trapping structures for the geocell, respectively. Moreover, geotextiles can effectively reduce the sediment ratios in water flows on the slope surfaces as well as the mass and particle sizes of debris retained in the sieves. Moreover, geotextiles can effectively reduce the sediment ratios in water flows on the slope surfaces as well as the mass and particle sizes of debris retained in the sieves.

Conclusions: For geotextiles used for slope protection, it is very helpful to appropriately increase their coverage ratios, to strengthen their interaction with the soil, and to enhance their spatial structures, whereas to avoid the use of geotextiles with two-dimensional (2D) structures.

KEYWORDS: Geotextile; Loess slope surface; Erosion control; Coverage ratio of slope surface; Grain size distribution

Improved Plane Layout of Stabilizing Piles Based on the Piecewise Function Expression of Irregular Driving Force

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ABSTRACT

The paper proposes an improved plane layout of stabilizing piles based on the piecewise function expression of irregular driving force. In view of the specific morphological characteristics of the highway landslide, the piecewise function is used to calculate the irregular driving force via the landslide is divided in several sub-areas. Based on the piecewise function expression of the irregular driving force and the relevant research results of plane layout for stabilizing piles, the reasonable layout range and pile spacing can be obtained. A highway landslide is located in Guizhou province of Southwest China is studied as a case, and the results show the piecewise function expression of irregular driving force possesses better engineering practicability. In addition, the improved plane layout of stabilizing piles based on the piecewise function expression of irregular driving force reduces the investment of the whole stabilizing piles compared with the conventional plane layout scheme, with an obtainable savings of 28.6% in the number of stabilizing piles. The theory presented in the paper can provide theoretical support for the plane layout scheme of stabilizing piles with regard to the similar landslide control.

KEYWORDS: Highway landslide; Driving force; Piecewise function; Stabilizing pile; Plane layout

Study on Application of the Strength Reduction Method in Checking the Safety Factor of a Reinforced Soil Slope

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ABSTRACT

To investigate application of the strength reduction method for checking the stability of reinforced soil slopes, stress analysis was carried out on an intersection surface between the potential sliding surface and the geotextile of a reinforced soil slope.. We examined the suitability of calculating safety factors by reducing only the soil strength (the Strength Reduction Method of Soil, SRMS) and both the soil strength and the geotextile strength (the Strength Reduction Method of Soil and Geotextile, SRMSG). The FLAC3D software was used to carry out numerical simulations and the changes in safety factors of reinforced slopes with different slopes and geotextile lengths were analyzed. The results of theoretical analysis show that when only the soil strength was reduced, the safety factor was larger than the actual value; when both the soil strength and the geotextile strength were simultaneously reduced, the calculated safety factor was smaller than the actual value. The results obtained through FLAC3D agreed with those from the theoretical analysis, as follows: (i) the safety factor obtained by SRMS was greater than that obtained by SRMSG; (ii) with the increase of geotextile length, the difference between safety factors obtained via SRMS and SRMSG was zero initially, then increased, and finally stabilized, (iii) as the slope increased, the final difference in safety factor correspondingly decreased. Based on the consideration of the slope safety reserve, in reinforced soil slopes, the objects of strength reduction methods should include the strengths of the soil and the geotextile, and when the geotextile strength is reduced, the yield strength of the geotextile should be

selected to be reduced. Our study offered theoretical references for the application of the strength reduction method in checking the safety factor of a reinforced soil slope. This research would make a contribution to the safety evaluation of reinforced soil slopes.

KEYWORDS:reinforced soil slope, safety factor, strength reduction method, soil strength, geotextile strength

Study on the Deformation Property of Weathered Phyllite Filling Subgrade

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ABSTRACT

In order to study the deformation of weathered phyllite filling subgrade under the comprehensive effect of water and load, three weathered phyllite soil column models were filled in the laboratory and the deformation was tested in this paper. The results show that the deformation of the weathered phyllite soil column models were greatly influenced by water replenishment conditions and load conditions, furthermore, the deformation of models increased with the increased of the moisture content and the load. Besides, FLAC-3D finite element software was used to establish the numerical model of weathered phyllite soil column. Furthermore, the numerical simulation results were compared with the test results and it was found that they were extremely similar. Thus, the numerical simulation can be used to reflect the deformation of weathered phyllite filler roadbed under the effect of water and load. In conclusion, the results in this study can provide some guidance for the design of weathered phyllite filling subgrade.

KEYWORDS: Weathered phyllite filling subgrade; Soil column models; Water replenishment conditions; Load conditions; Numerical simulation.

Static and Dynamic Properties and Temperature Sensitivity of Emulsified Asphalt Concrete

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ABSTRACT

Asphalt concrete is a typical rheological material, which is hard brittle at low temperature and

reflects soft plastic fature at high temperature, the temperature has a great influence on the mechanical properties of asphalt concrete. In order to eliminate the environmental pollution caused by hot asphalt construction, cationic emulsified asphalt can be used. This paper transforms temperature control system for static and dynamic triaxial test equipment, which has achieved static and dynamic properties of emulsified asphalt concrete under different temperature and researched the temperature sensitivity of emulsified asphalt concrete materials including static stress-strain relationship, static strength, dynamic modulus of elasticity, damping ratio and so on. The results suggest that: (1) Temperature has a great influence on the triaxial stress-strain relationship curve of the asphalt concrete. The lower the temperature, the greater the initial tangent modulus of asphalt concrete, and the higher the intensity, the more obvious the softening trend, the smaller the failure strain of the specimen and the more obvious the extent of shear dilatancy. When the temperature is below 15.4 º C, the temperature sensitivity of the modulus and strength is stronger significantly. (2) With the temperature rising, the asphalt concrete gradually shifts from an elastic to viscoelastic, the dynamic modulus gradually reduces, and the damping ratio increases. When the temperature is above 15.4 º C, the temperature sensitivity is obviously stronger for the dynamic elastic modulus and damping ratio. (3) The static and dynamic properties of asphalt concrete are very sensitive to the temperature. The test temperature should be made clear for the static and dynamic tests of asphalt concrete. The specimen temperature and the test ambient temperature must be strictly controlled.

KEYWORDS: emulsified asphalt concrete, dynamic property, temperature sensitivity, static triaxial tests, dynamic triaxial tests

Study on Dynamic Shear Modulus and Damping Ratio of Different Depths Undisturbed Soil

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ABSTRACT

With the rapid development of economy and technology, the seismic problem of highway foundation becomes more and more important, and the basic problem is the dynamic characteristics of soil. Dynamic shear modulus and damping ratio are the most important parameters of soil dynamic analysis, which can be obtained by resonant column tests. There are many factors that influence the dynamic shear modulus and damping ratio of undisturbed soil, among which the depth of soil is one factor that cannot be neglected, there are few studies focusing on this factor so far. Thus it is of great value to research on depth factor on dynamic parameters and try to establish the quantitative relationship between the depth and dynamic shear modulus as well as damping ratio. To obtain the dynamic shear modulus and damping ratio of undisturbed samples at different depths, the GCTS column was used to test three kinds of undisturbed samples: silty clay, strongly weathered silty

mudstone and strongly weathered sandstone.The maximum dynamic shear modulus and the maximum damping ratio of soil samples were obtained by using H-D model. Then the normalised dynamic shear stiffness reduction curve and derivative damping ratio curve versus deviatoric strain were obtained. In the analysis, the results for samples from different depth were contrasted with each other, result of which could be helpful for real engineering project.

KEYWORDS: resonant column; undisturbed soil; dynamic shear modulus; damping ratio; various depth

Study on Moisture Migration and Frozen Disaster Treatment for Subgrade in Seasonal Frozen Region

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ABSTRACT

In this paper the rules of moisture migration during freezing-thawing period, and the effective treatment for frozen disasters in subgrade in seasonal frozen soil region are studied. A subgrade test section with typical frozen disasters was selected in Lanzhou-Xiangjiang Railway. Through monitoring ground temperature, characteristics of both subgrade surface temperature change and freeze-thaw were obtained. With the laboratory test for the samples in closed system, it was found that the growth rates of moisture content in the upper layer of the samples increased with the initial moisture content, but the growth rates almost did not change once the samples were saturated. With the degree of compaction increasing, the growth rates of moisture content in the upper layer of the samples decreased, but the

change rule was opposite to that in the saturated samples. This means that frozen disasters in subgrade can not be treated completely with increasing the degree of compaction only. The field observations showed in the untreated subgrade the moisture content at the depth of 0 to two thirds of the frozen soil layer increased dramatically, and the moisture content at 0 to 1m below the frozen soil layer decreased after freezing. In the subgrade treated with flexible permeable hoses, before winter the moisture content had be decreased effectively, so the heave could be restrained dramatically in winter.

KEYWORDS: seasonal frozen soil region, Lanzhou-Xiangjiang Railway, subgrade, moisture migration

Development of Slope Stability Calculation Method Based on Internal Horizontal Displacements

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ABSTRACT

This paper mainly proposes a horizontal displacement based method to search potential slip surface of slope. Firstly, a group of assumed lines are located in a model slope with a proper spacing in horizontal direction. horizontal displacement of each point on the lines is extracted. Then, with the data, every intersection of vertical lines with potential slip surface can be determined by an optimization model. At last, slip surface is fitted by least square method which different equations are applied to different type of soil based on these points. The feasibility and accuracy of the method is verified by numerical simulation, which a solid foundation is established through numerical simulation for further model test and practical application. In computational examples, the optimization model taking maximum of displacement increment

gradient as objective function shows superior accuracy. This method provides an idea appropriate for real-time analysis on the stability of slope. Combined with real-time monitoring sensor, the method can theoretically search slip surface and further calculate safety factor in real time.

KEYWORDS: slip surface, slope stability analysis, optimization model, numerical simulation, real-time monitoring

水泥改良千枚岩填料路基施工质量控制技术

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摘　要： "十天"高速公路安康东段分布着大量的强风化千枚岩，该填料不仅强度低，而且水稳定性差。为保证千枚岩填筑路基的水稳定性和强度，本文以强风化千枚岩填料路基施工质量控制技术为研究对象，提出了千枚岩路床填筑方案；基于弹性层状体系理论，采用弯沉反分析的方法确定了路床部分分层填筑的厚度和层数。研究结果表明：通过反算得到的与实际施工结果基本是吻合的。

关键词： 千枚岩；CBR；弯沉值；回弹模量

The Quality and Control Technology of Filling Roadbed with Cement-amelioration Phyllite

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Abstract: Massive strongly weathered phyllite which are distributed in the eastern An-Kang section of the "Ten days" highway and that phyllite is not only low in strength but also has poor water stability. In order to ensure the water stability and strength of the sedimentary roadbed of the phyllite, this paper focuses on the sedimentary roadbed of the phyllite construction quality and control technology and puts forward the Road Bed Construction scheme. Besides, this paper elaborates how to use the method of deflection analysis to make sure the thickness and the number of layers of road bed that is constructed dividedly. The results show that the result of inverse calculation is consistent with the actual results.

key words： phyllite; CBR;deflection value; modulus of resilience

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Elastopastic Simulation for Clay Considering Cyclic Degradation Behaviour Based on Kinematic Hardening Rule

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ABSTRACT

An anisotropic bounding surface model is modified based on kinematic hardening rule proposed recently. In the present study, the defect of the original model is analyzed, and then a modified bounding surface equation is derived in more rigorous theory based on the kinematic hardening rule. For the modified equation, the rotating bounding surface proposed by Crouch and Wolf is adopted to describe the initial anisotropy of clay induced by consolidation stress, and the kinematic hardening variable with explicit physical meaning is introduced to consider the effect of anisotropy induced by cyclic loading. The nonlinearity and hysteresis of stress-strain curve are captured by moving mapping centre, and the plastic deviatoric strain length is employed in plastic modulus interpolation function to character the cyclic degeneration behaviour of soil stiffness. The modified model is validated against the untrained cyclic triaxial test results of isotropic and anisotropic consolidated clay samples in literature. Compared with the original model, the performance of the modified model is improved for predicting the hysteresis, accumulation and cyclic degeneration behaviour of stress-strain curves.

KEYWORDS: clay; kinematic hardening; bounding surface equation; cyclic degeneration

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基于CPTU软土地基处理效果评价 [1]

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摘　要：针对气压劈裂法软土地基处理效果的评价问题，采用CPTU原位测试技术，对现场试验段的软土地基的固结渗透特性进行了研究。测试结果表明，气压劈裂真空预压法可以提高真空荷载向深层土体中的传递效率和加速超静孔隙水压力的消散，改善深层软土的加固效果，可加速地基固结。对加固前后孔压静力触探测试结果对比分析，论证了气压劈裂真空预压法加固深层软土地基的有效性和优越性。

关键词：CPTU；气压劈裂预压法；地基处理，固结渗透系数

中图分类号：U238

Evaluation of Ground Improvement with Cptu Tests

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Abstract: To evaluate the results of ground improvement by pneumatic fracturing method, CPTU tests are adopted to determine the consolidation and permeability of the pre-improved and post improved soft soils. The results show that pneumatic fracturing method can improve the transmission efficiency of loads into the deep soils, and accelerate the excess pore pressure dissipation. Comparison between the CPTU test results of pre-improved and post improved soft soils, it shows that the pneumatic fracturing method has lots of advantages in deep ground improvement.

key words: piezocone penetration test; pneumatic fracturing method; ground improvement, coefficient of consolidation and permeability

Composite Sliding Surface-based Limit Equilibrium Analysis for Surficial Stability of Soil Slope Considering Edge Effects EFFECTS

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ABSTRACT

The classical infinite slope method for surficial stability of soil slope doesn't take the edge effects of surficial landslides into consideration. Under saturated downslope seepage flow, stress conditions and limit stress state discrimination based on Mohr-Coulomb strength criterion in infinite slope were analyzed. A composite sliding mode including three sliding zones, namely, the upper tension zone, the middle shear sliding zone, and the lower compression zone were presented. With the application of finite differential method, failure surfaces of the upper and lower edge have been found and verified to be a log spiral trace. For surficial stability of soil slope with the consideration of edge effects, a semi-analytical framework has been proposed using composite sliding surface-based limit equilibrium analysis. Compared with finite element method and limit equilibrium method with sliding surface search, the semi-analytical method is easier to grasp the intrinsic relationship between parameters and directly determine the critical slip surface without the need to search. For assessing the validity of infinite slope method, a typical slope with silty sand soil was tested. The results show that: (1) with the length of slope increasing to infinitely long, the composite sliding mode will be recovered

to the infinite slope failure mode, and the infinite slope method is always conservative due to the neglect of the upper and lower edge resistance, particularly when the ratio of length to depth (L/zw) is less than 10; (2) The relative difference between predictions falls within 5% for benchmark of the proposed semi-analytical method with L/zw located between 21 and 38, at which the edge effects can be neglected reasonably and the infinite length assumption will be valid.

Investigation of Slope Deformation under Excavation Using Numerical Simulation and Smart Monitoring Techniques

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ABSTRACT

With the rapid industrialization and urbanization in China, the stability of excavated slopes has become a major concern for geotechnical engineers. In this paper, the deformation mechanism of soil slope under excavation was investigated through numerical and physical modelling techniques. First, numerical simulations were conducted to explore the distribution of internal strain of slope and to optimize the layout of fiber Bragg grating (FBG) sensors. The results show that there was close relationships between maximum horizontal strains and factors of safety, indicating the feasibility of using horizontally embedded FBG strain sensors for evaluating slope stability condition. A small-scale model test of a soil slope under stepped excavation was performed. The monitoring results

from the FBG strain sensors were validated against numerical simulation, and were shown to reveal the distribution and evolution of internal strain of the slope during excavation. It is indicated that numerical simulation and FBG-based smart monitoring techniques can be combined to capture the strain information within slope masses, hence improving our understanding of the deformation process and failure mechanism of slopes under excavation.

Multiscale Hierarchical Analysis of Rock Mass and Its Mechanical and Hydaulic Properties Prediction

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ABSTRACT

Engineering geological and hydro-geological characteristics of the foundation rock mass and surrounding rock mass are the main factors that contribute to the underground engineering stability. This paper presents the concept of multiscale hierarchical digital rock mass models to describe the rock

mass and their structures in different scales and their scale dependence. Image analysis and processing method, geostatistics and Monte-Carlo simulation technique are used to establish the multiscale hierarchical digital rock mass models, in which the main micro- and macro- structures of rock mass in different geological units and scales are reflected. A computer code has been developed for analyzing numerically the strength, fracture behavior and hydraulic conductivity of rock mass using the multiscale hierarchical digital rock mass models. By the models and analysis methods provide in this paper, the geological information in different engineering geological units and scales can be considered sufficiently. Therefore, it is more scientific and precise.

KEYWORDS: multiscale hierarchical; digital rock mass models; numerical test; evaluation of rock mass quality

Analysis on Bearing Behaviour of Screw Pile Composite Foundation in Silt soil

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ABSTRACT

With advantages of high bearing capacity and low cost, screw pile composite foundation has been widely applied in several high-speed railways and passenger dedicated lines. Its distinctive design with variable section makes that the stress mechanism and bearing behaviour of screw pile is far more complex than that of common straight pile. In order to analyse on bearing behaviour of screw pile composite foundation in silt soil. Based on the national key construction project Hohhot to Zhungeer new built railway engineering. A comparison analysis on bearing characteristics of single pile and single pile composite foundation of straight pile and screw pile has been made through model test. The results show that under the same condition of pile diameter and length, single pile ultimate bearing capacity of screw pile improves by 43% compared with that of straight pile, and the ultimate bearing capacity of single pile composite foundation of screw pile increases by 67% compared with that of straight pile. The screw pile exists a significant turning point at the juncture of straight and screw section in the distribution of axial force. The straight pile exists a negative frictional resistance area at the top of the composite foundation. The screw pile exists negative friction area below the junction of straight section and screw section in the screw pile composite foundation, which attracts attention on the treatment of variable cross-section in the process of engineering design and construction to prevent the destruction of negative friction on pile structure.

KEYWORDS: composite foundation;　bearing behaviours;　model test;　screw pile;　silt

Effect of Cement Fly-ash Gravel Piles-supported Approach Embankments on Abutment Piles: 3D Numerical Modeling

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ABSTRACT

The engineering problems associated with so-called "the bump at the end of bridge" in the bridge approach embankment are notoriously detrimental to the long-term operating safety and comfort of railways. The abutment piles in soft ground may inevitably be subjected to vertical and lateral loadings due to soil movements induced by the approach embankment. Despite of an amount of studies conducted to investigate the behaviour of abutment pile foundation, there is still lack of research into the effects of the piles-supported approach embankment on the behaviour of abutment piles. Therefore, this study attempts to mitigate this gap. On basis of the results obtained from a centrifuge model test carried out on a field case study, a series of three-dimensional numerical simulations was performed

with particular focus placed on the influence of the pile replacement ratio on the response of abutment piles in a soft ground. Results shows that the response of the abutment piles in terms of induced axial force, normal contact pressure, bending moment and deflexion e is significantly improved by the ground improvement through cement fly-ash gravel (CFG) piles. This can be mainly attributed to the confining effect of CFG piles against lateral soil movements and their load transfer mechanism towards deeper layers. In addition, the results also suggest that the response of abutment piles is substantially sensitive to the change in the pile replacement ratio m in case of m below 4.9 %, otherwise the effect of m is not important. From a perspective of bridge approach embankment design, it is essential to take into account the effects of different ground improvement methods on the behaviour of abutment piles in order to mitigate the risk of the bump at the end of bridge.

KEYWORDS: abutment pile; soil movement; ground improvement; load transfer

基于空间效应的弃渣场边坡稳定性方法探讨
——以某核电厂弃渣场为例

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摘 要： 弃渣场常见于基础设施的建设过程中，影响其边坡稳定的因素众多，其中坡面凹凸形态、滑体端部效应以及坡体走向等空间效应因素对边坡稳定性的影响尤为显著。针对走向为折线形（弃渣场上下区域走向存在夹角）的某核电厂弃渣场，进行边坡稳定性分析方法探讨。通过现场地质调查和区域划分，借助ANSYS建立三维复杂模型，利用FLAC3D强度折减法分析稳定性和潜在破坏机制，以此研究弃渣场走向夹角对其潜在破坏机制的影响；最后提出考虑走向夹角因素的不平衡推力推广法，并展开走向夹角和边坡倾角对弃渣场边坡稳定性影响的分析。结果表明：走向夹角影响弃渣场边坡应力场的分布形式和力的传递能力，走向夹角越大其稳定性越好；坡顶区域倾角越大，坡脚区域倾角越小时，其安全系数提升幅度随走向夹角的增大而显著提高。研究成果可为类似折线形走向边坡的稳定性分析和治理设计提供参考。

关键词： 弃渣场；边坡稳定性分析；空间效应；三维建模；强度折减法；不平衡推力法

中图分类号：U238

Discussion on Slope Stability Analysis Method of Abandoned Dreg Site Based on Spatial Effect: Taking a Certain Abandoned Dreg Site in Nuclear Power Plant for Example

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Abstract: It's common to see adandoned dreg site in construction projects. There are great many influence factors about slope stability, especially such as the spatial effect of concave and convex form, side-body-end and slope strike, which play vital roles in slope stability analysis. Taking a certain

abandoned dreg site in Nuclear Power Plant for example, of which the strike is a broken line (i.e. an angle of strike exists between upper region and lower region), the method of slope stability analysis is discussed. Then, through geotechnical field investigation and region division, with building the complex 3D-model by ANSYS and analyzing slope stability by strength reduction method in FLAC3D, the effect of angle of strike for potential failure mechanism of adandoned dreg site is studied. Finally, imbalance thrust force extension method considering the angle of strike is proposed, and then analysis of the effect of angle of strike and dip of slope for stability is made, respectively. The results show that, angle of strike has effect on the distribution of stress field and the capability of force transmission. Hence, slope stability improves with increasing the angle of strike. In addition, the improvement of safety factor significantly rises with increasing angle of strike, while the dip of slope top increases and the dip of slope toe decreases. The results provide some scientific references to evaluate stability and design treatment for slope of which the strike is a broken line.

key words: abandoned dreg site; slope stability analysis; spatial effect; 3D modeling; strength reduction method(SRM); imbalance thrust force method(ITFM)

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Study of Sedimentation and Self-weight Consolidation Behavior of Bed Sediment by Radioisotope Densitometer

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ABSTRACT

The settling tests were conducted using an acrylic cylinder container with an inner diameter of 0.2 m and a height of 2.0 m in the laboratory to investigate the sedimentation and self-weight consolidation behavior of bed sediment at Isahaya Bay, Ariake Sea, Japan. During the tests, the height of the interface between sediment and clear water was observed, and the variation of density with depth and time was measured by a gamma-ray transmission radioisotope densitometer. After the tests, the vane shear and micro-piezocone tests were conducted to investigate the relationship between the undrained shear strength (c_u) and the density of bed sediment. The test results show that the settling process of bed sediment can be classified into the flocculation stage, settling stage and consolidation

stage. The time of flocculation stage in freshwater is longer than that in seawater due to particles flocculate slower in fresh water. The settling rate of the bed sediment in the settling stage increases with the increase of temperature and initial water content. The measured density profiles by the radioisotope densitometer during the process of sedimentation and self-weight consolidation show that the density profile changes from the constant density profile to the linear density profile when the sedimentation process transfers to the self-weight consolidation process. The relationship between void ratio (e) and effective vertical stress (p') in very low pressure can be calculated from the measured density values after accomplish of self-weigh consolidation, and it can be used for the analysis of self-weight consolidation of bed sediment. The c_u value is almost the same when the density of bed sediment is less than 1.14 g/cm^3, and the c_u value increases linearly with the increase of the density when the density values are in the range of 1.14 to 1.2 g/cm^3.

KEYWORDS: Radioisotope densitometer, density, bed sediment, sedimentation, self-weight consolidation

Geothermal Energy for Bridge Deck and Pavement Deicing - A Brief Review

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ABSTRACT

Geothermal energy is characterized as renewable, sustainable, clean (i.e. zero carbon emission) and directly used energy, which has been widely used in many engineering applications, such as ground source heat pumps (GSHP), geothermal energy piles (GEP), and soil borehole thermal energy storage (BTES). This paper presents a literature study of geothermal energy for deicing approach pavement slabs and bridge decks. The background with respect to the related applications of geothermal energy was firstly introduced. The working principle and design criteria of geothermal system were then presented for future field applications where the soil thermal conductivity is a key parameter that can be studied by our newly developed thermo-time domain reflectometry (TDR) probe. Several case studies in Europe and Asia were also reviewed to further demonstrate the feasibility and applicability of this innovative technology. The long term cost-benefit was finally analyzed, and some recommendations for field implementation were also provided.

Compaction-induced Stress in Geosynthetic-reinforced Granular Base Course:A Discrete Element Model

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ABSTRACT

A discrete element method (DEM) model was created to simulate the development of compaction-induced stress in a granular base course, with and without geogrid reinforcement. The granular base course was modelled as a mixture of poorly graded balls and clumps. The geogrid was modelled as a series of equally spaced balls which interact with each other through a long-range attraction. The long-range interaction contact was also used to simulate a deformable soft subgrade layer. The compactor was modelled as a solid cylinder rolling at a constant speed. The numerical result showed that a single pass of roller compaction produced significant compaction-induced stress in the granular base course. Reinforced base course gained more compaction-induced stress due to the residual tensile stress developed in the geogrid. The residual tensile stress increased significantly after the first compaction pass. Subsequent compaction passes helped to improve the uniformity of the residual stress in the geogrid.

KEYWORDS: Compaction, Geosynthetics, Granular Soils, Numerical Analysis

The Unified Hardening (UH) Model with a Smoothed Hvorslev Envelope

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ABSTRACT

The original unified hardening (UH) model (Yao et al. 2009), in which a straight Hvorslev envelope was employed to determine the potential peak stress ratio of overconsolidated soils, is revised using a smoothed Hvorslev envelope (Hermite-Hvorslev envelope). A smoothed Hvorslev envelope is derived through Hermite interpolation to ensure a smooth change between the proposed Hvorslev envelope and the zero-tension surface as well as a smooth transition between the proposed Hvorslev envelope and the critical state surface (i.e., Mohr-Coulomb envelope). The Hermite-Hvorslev envelope is then integrated into the original UH model. The UH model revised by Hermite-Hvorslev envelope can well predict mechanical behaviors of normally consolidated and overconsolidated soils in drained and undrained conditions with the same parameters in the Modified Cam-clay model.

KEYWORDS: Constitutive model, Clay, Overconsolidation, Hvorslev envelope, Hermite interpolation

Innovation for Recognition of Pavement Distresses by Using Convolutional Neural Network

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Abstract

As an important part of highway management, highway disease detection is the base of highway maintenance. The disease detection is considered as a challenging job due to its strong concealment in highway structures. Highway ground penetrating radar (GPR) shows more efficient and non-destructive than other non-destructive testing technologies (NDT) in the field of disease detection. However, the manual process for GPR images to recognize different distresses has low efficiency and accuracy. This study presents an application of convolutional neural networks (CNN) in GPR images for recognition of highway distresses. GPR images with distresses were collected using different emission frequencies from different highway structures, and the types of distresses were recorded. Images were then imported well-trained CNN directly to extract disease features and recognize. The

results of recognizing were compared with the records corresponding to determine the recognition accuracy. Meanwhile, the effects of pavement structures and emission frequencies were discussed. The analysis and experimental results in this paper demonstrated that CNN could recognize different distresses including reflection crack, void, subgrade loose, pipe leakage, even mixed distresses with above 90% accuracy. And there was no conspicuous influence of highway structure on the recognition accuracy. And different emission frequencies affected the recognition accuracy of CNN by influencing resolutions of GPR images. So reasonable emission frequencies should be selected based on highway thicknesses in engineering application. In general, CNN used to recognize different distresses based on GPR images was feasible.

Key words: highway disease, convolutional neural networks (CNN), ground penetrating radar (GPR), image recognition, asphalt pavement

基于ABSQUS理论的基层快速修复–微裂技术的理论分析

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摘　要:结合国内外预裂缝技术特点，提出一种不加入早强性材料的基层修复技术，只是在通车早期进行限重，基层被碾压成网状的微细裂缝，和较宽的横向裂缝相比，沥青路面产生反射裂缝的概率较低；采用有限元ABSQUS软件，用两种理想的裂缝来模拟实际裂缝情况，对两种裂缝形式下的的沥青路面进行力学分析，并计算沥青路面的疲劳寿命。研究发现：微裂技术在一定程度上降低了沥青面层的寿命，但解决了常规修复技术中的容易产生反射裂缝的问题，并实现了快速修复的技术要求，因此微裂技术在基层快速修复中具有一定的可行性；由于裂缝形式是拟定的，实际裂缝形式下沥青面层的疲劳寿命及如何在施工中限定和控制裂缝的尺寸等相关问题有待于进一步的研究。

关键词：道路工程；微裂技术；有限元；基层快速修复；疲劳寿命

Theoretical Analysis of Microcracks Technology Based on ABSQUS Theory

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Abstract

Technical characteristics combined with the pre-crack at home and abroad, presents a grassroots early strength without the addition of material repair technology, but in the early period of heavy traffic be implemented at this time is rolled into the grass-roots space mesh micro-cracks, and a wider compared transverse cracks, reflective cracking of asphalt pavement probability decreases asphalt Pavement status also improved; finite element method to simulate the ideal type of crack, two kinds of mechanical asphalt pavement crack under the form of responses were analyzed, and calculate the surface layer of micro-cracking technology life asphalt pavement. The study found: micro-fracturing technique to some extent, reduce the life of the asphalt surface, but to solve the problems of the conventional repair techniques readily reflective cracks and achieve a rapid restoration of the technical

requirements, so micro-cracking technology quick fix in the grass has certain feasibility; due to cracks form is drawn up, the fatigue life of the asphalt surface and how to define and control the size of the cracks in the construction and other related issues need further study under actual crack forms.

Key words: Micro-cracking techniques;; finite element; roadworks grassroots quick fix; fatigue life

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基于关联规则的沥青路面病害现象隶属关系研究

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摘　要：本文通过对实体工程养护资料的统计分析，研究了沥青路面常见病害现象发生规律，运用关联规则得出了各种病害间的内在联系，并将常见病害现象分成了三大类，即一级病害现象、二级病害现象和车辙次生病害现象，其中二级病害和车辙次生病害100％隶属于一级病害现象，车辙次生病害100％隶属于车辙病害。沥青路面病害现象间的隶属关系解释了其内在联系，为沥青路面养护决策提供了新的思路，使养护方案更具针对性和前瞻性。

关键词：路面病害；关联规则；隶属关系；养护决策

Pavement Diseases Subordinate Relations Research Based on Association Rules

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Abstract

This article, with the statistical analysis of engineering literatures, the occurrence regularity of asphalt pavement general diseases was studied.Using association rules obtained the inner link between the various diseases. The diseases were classified threecategories: the primary diseases, the secondary diseases and the rut subsequent diseases. The secondary diseases were attached to the primary diseases completely, and the rut subsequent diseases were attached to rut, which was one of the primary diseases, completely. Subordinate relations between pavement diseases explain their inner relationship whichprovides new train of thought for asphalt maintenance decision-making in the future and makes the maintenance plan more targeted and forward-looking.

Key words: pavement disease; association rules; subordinate relations; maintenance decision

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高速公路沥青路面不同养护措施的使用效果评价

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摘　要：为评价沥青路面不同养护措施的使用效果，采用车辙深度、国际平整度和横向力系数以及相应的性能发展模型作为评价指标和评价模型，通过对实体工程大量数据分析，对ECA薄层罩面、就地热再生和微表处三种典型养护措施使用效果进行分析与评价。分析结果表明：ECA罩面措施对不同交通等级不同面层类型的高速沥青路面车辙状况的改善效果良好；就地热再生措施对初始抗滑性能差的路段长期使用效果相对有限；微表处措施对重、特重交通作用下的高速路沥青路面车辙和抗滑状况适用性差、长期效果不理想。因此，采取适当的养护措施才能获得更大的养护效益。

关键词：沥青路面；ECA薄层罩面；就地热再生；微表处；使用效果评价

Effectiveness Evaluation of Different Highway Asphalt Pavement Maintenance Treatments

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Abstract

In order to evaluate the using effect of different maintenance treatments of asphalt pavement, rutting depth, roughness and side-way force coefficient were chosen as evaluation indexes of effectiveness of maintenance treatments and the corresponding performance development models were used as evaluation models. Based on the real engineering of large amounts of data analysis, effectiveness of three different maintenance treatments(ECA overlay, hot in-place recycling and micro-surfacing) were analyzed. The results show that: ECA overlay treatment has good effect on highway asphalt pavement rutting condition with different traffic levels and different surface types; The effect

of hot in-place recycling measure on road sections with poor initial skid resistance is relatively limited; Micro-surfacing treatment is restricted in maintaining rutting and anti-sliding performance under heavy, very heavy traffic conditions of highway asphalt pavement, its long-term effect is not ideal too. Therefore, the appropriate maintenance treatments should be taken to achieve greater maintenance benefits.

Key words: asphalt pavement; ECA overlay; hot in-place recycling; micro-surfacing; effectiveness evaluation

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刚柔复合型铺装开裂特性及裂缝处治技术研究

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摘　要：泰州大桥刚柔复合型钢桥面铺装结构是国内首创且唯一的铺装方案。运营4年以来，铺装整体使用状况良好，铺装破损以施工缺陷导致的微损伤为主，目前已逐步步入预防性养护及小修保养阶段。因此，本文采用ABAQUS有限元软件，对刚柔复合型铺装受力特性进行模拟分析。结果表明：极端高温条件下，刚柔复合型铺装上层环氧易开裂；且开裂后，上层环氧集中受力、发生反拱，铺装层间产生脱空，在行车荷载作用下，上层极易被压断压碎。因此，针对环氧开裂特性，本文从渗透性、粘结性能、抗裂性能等多个指标对比研究了不同裂缝修复材料。结果表明：高粘、高变形能力、高渗透性的灌缝材料可以保证良好的裂缝处治效果，恢复铺装整体结构强度。试验对比得出，高性能D型环氧树脂材料，可以满足环氧铺装裂缝处治的各方面要求。同时，针对裂缝宽度及松散状况，提出了直接灌缝及开槽灌缝的处治工艺。本文研究成果对国内类似铺装性能的衰变规律研究及管养具有重要的借鉴意义。

关键词：钢桥面铺装；刚柔复合型；开裂特性；裂缝处治；高性能树脂

中图分类号：U443.33

Study on the Cracking Characteristics and Crack Treatment Technology of Rigid-flexible Composite Pavement

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Abstract

The rigid-flexible composite steel deck pavement structure of Taizhou Bridge is the initiative and unique pavement structure in China. After 4 years in service, the pavement is still in good condition with only some micro-damages caused by construction defects. Currently it has gradually entered the preventive maintenance and minor maintenance phase. So, the stress characteristic of the rigid-flexible composite pavement has been simulated and analyzed by ABAQUS in this paper. Result

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shows that under the condition of extreme high temperature, the upper epoxy layer tends to crack. And with the cracks occurring, stress concentrates in the upper epoxy layer, and a reverse arch emerges. In this condition, a void between two layers appears. So that under the traffic load, the upper layer will be easily crushed. In view of the epoxy cracking characteristics, different crack repairing materials have been compared by different indicators, including permeability, bonding performance, cracking resistance and so on. Results show that sealing materials with high strength, high viscosity, high deformation and high permeability can ensure good effect of crack treatment and restore the overall pavement structural strength. By comparison, the D-type epoxy resin with high performance can meet all aspects of crack treatment requirements. Meanwhile, according to the crack width and looseness condition, two kinds of crack treatment processes have been put forward, including direct crack sealing processes and cutting-and-sealing process. The research results of this paper have important meaning on the study of the pavement's Decline Law, as well as the management and maintenance.

Key words:　steel deck pavement, rigid-flexible composite pavement, cracking characteristics, crack treatment, high performance resin

Quick Cost Estimation of Expressway Routine Maintenance Based on Historical Data

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Abstract

Considering the difficulty in accurately estimating the repairing quantity while calculating the costs of expressway routine maintenance, the author thoroughly explores identified historical data of the costs of expressway routine maintenance by an improved Bootstrap method. Conclusion is drawn on the annual cost interval per lane kilometer of the routine maintenance of subgrades, pavements, bridges and culverts, tunnels and traffic facilities on expressways of Shaanxi Province as well as the proportion intervals of structures mentioned above. An efficient method by which calculations and

evaluations are based on cost intervals and proportion intervals respectively is proposed to estimate the engineering costs of expressway routine maintenance. The method is proved to be a new reliable and accurate one to estimate the costs of expressway routine maintenance as it efficiently calculates the engineering costs in real-life projects.

Key words: expressway; routine maintenance; improved Bootstrap method; annual costs per lane kilometer; quick cost estimation

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基于结构安全的在役桥梁水泥砼桥面铺装薄层改造关键材料与结构性能试验研究

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摘 要：上世纪八九十年代建设的大量桥梁采用了混凝土铺装方案，在行车舒适与安全性方面相比沥青桥面铺装存在明显不足，面临迫切的改造需求。国内研究主要集中于新建桥梁和长大纵坡混凝土桥面铺装技术，对桥面改造技术的系统研究有限。本文在分析桥面水泥砼铺装典型病害的基础上，提出了桥面加铺厚度与平整度之间的关系，并分别研究了2.5cm厚超薄桥面铺装、6cm厚薄层组合式等新型轻薄铺装改造结构以减轻桥梁二期恒载，同时在室内试验研究了适用于薄层桥面结构的水性环氧沥青防水粘结层、和易性高强沥青混合料、高弹改性沥青混合料的路用性能，并形成了在役桥梁混凝土桥面裂缝修复、墩顶负弯矩复合式应力吸收层反射裂缝防治及桥面铺装结构材料关键技术，研究成果在宁连高速新沂河大桥等桥面改造工程中得到成功应用，使用近2年效果优良，可为国内同类工提供参考。

关键词：桥面改造；超薄沥青铺装；组合式薄层铺装；水性环氧沥青；复合式应力吸收层

中图分类号：U443.33

Research on the Structure and Material Properties of Existing Concrete Bridge Deck Thin Asphalt Overlay

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Abstract

A large number of bridges were built in the eighties and nineties of last century. Driving comfort and safety of concrete deck didn't meet the requirements compared to the asphalt pavement. There is little research on the bridge deck reconstruction technology. This paper presented the relationship between the overlay thickness and the flatness of the bridge deck. And the concrete bridge deck thin overlay structure and materials properties were tested such as 2.5cm ultra-thin wear layer

and 6cm thin-layer pavement to minimize the burden of the bridge structure. And the concrete deck crack sealing materials was tested based on the analyzing of the bridge deck typical diseases. Also the waterproof materials such as waterborne epoxy, modified asphalt, and rubber asphalt were tested and evaluated comparatively. The performances of ultra-thin mixture and high elasticity modified Asphalt mixture were studied in the paper including strength, deformation, water stability and high or low temperature performance. It shows good performance by almost two years application.

Key words: ultra-thin asphalt overlay; composite thin-layer pavement; water-based epoxy asphalt; composite stress absorption layer

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路面工程交竣工质量检测评定若干问题浅析

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摘 要： 在一般公路工程建设项目中，路面工程是一项重要的单位工程。由于其投资额较高，在交竣工质量评定过程中其工程质量评分值占有很大的权重，对整个工程建设项目的质量评分具有很大的影响。然而笔者发现，在公路工程交竣工验收前的质量鉴定工作中存在一些影响鉴定结果的程序性以及技术性问题。为了使交竣工质量验收工作顺利进行，并能够科学、公平合理地评价工程建设质量，现就竣工验收程序、主线和匝道质量评分差异、路面抗滑指标选取进行讨论，希望能供今后的实际工程建设参考。

关键词： 路面工程；交竣工；质量检测；质量评定

Analysis on Several Problems of Inspection and Evaluation of Completion Quality of Pavement Engineering

Abstract: In a road construction project, the pavement segment is a very important unit project. Since the investment on pavement segment is usually higher than most of segments, its quality assessment score weighs a lot during the quality assessment of the whole construction project in the final acceptance, therefore influencing the final quality score for the whole project. However, according to the observation of the authors, some procedural or technical issues exist in the quality assessment of the final acceptance, which have negative impacts on the quality assessment results. In order to assess road construction quality scientifically, fairly, and reasonably and keep the quality assessment operating smoothly, the following items are discussed, including the final acceptance procedure, assessment scores of mainlines and ramps, and pavement surface skid resistance characterization. It is hoped that the discussions can help the final acceptance of construction in practice.

Key words: Pavement engineering, final acceptance, quality inspection, quality assessment

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Reduction in Water Demand of Cement Asphalt Emulsion Mortar Through Investigating the Effect of Emulsifier Dosage and Mixing Sequence

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Abstract

Cement asphalt emulsion (CA) mortar is a grouting material in China Railway Track System type I (CRTS I) slab track, but CA mortar has very high water to cement mass ratio (W/C) so that its water and frost resistances are poor. To reduce the W/C of CA mortar, the effect of emulsifier dosage and mixing sequence on the rheological properties of cement paste and CA paste was studied. Results show that the rheological properties of cement paste with superplasticizer and emulsifier are obviously affected by emulsifier dosage and mixing sequence. Reducing emulsifier dosage and using the pre-mixing superplasticizer sequence, which cement is firstly mixed with superplasticizer before emulsifier is added, lead to decrease in the apparent viscosity and yield stress of cement paste compared to the traditional mixing sequence. The two methods are also beneficial to reduce the apparent viscosity and yield stress of CA paste. Based on the findings, reducing the W/C of CA mortar with the suitable flow time can be achieved.

Key words: Cement asphalt emulsion mortar; emulsifier; mixing sequence; rheological properties.

手工铺砂法装砂密实性及构造深度评定标准

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摘 要： 针对手工铺砂法中量砂的密实性和构造深度检测的准确性，对装样层数和叩击次数经行了试验研究，两个试验因素对砂样振实密度影响显著，随叩击次数和装样层数增加都呈增大的趋势，存在振实密度的最大值，指出构造深度检测时应选择最不利条件，并对构造深度评定标准经行了探讨和分析。

关键词： 手工铺砂法　密实性　装样层数　叩击次数　构造深度

Filling Compactness of Manual Sanding and Evaluation Standard of Texture Depth

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Abstract

According to the compactness and the accuracy of texture depth detection by manual sanding, the sampling layers and tapping times by the experimental study, two experimental factors on sand compaction density significantly, with the tapping numbers and sampling layers increasing compaction density increases, and there is a maximum of compaction density, that structure depth detection should choose the most unfavorable conditions, and the evaluation standard of texture depth were discussed and analyzed.

Key words： manual sanding compactness sampling layers lapping numbers texture depth

Dynamic Backcalculation of Layer Properties of Asphalt Pavements with Various Base Types

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Abstract

Algorithms for calculating pavement responses are crucial in interpreting falling weight deflectometer (FWD) test results and backcalculating appropriate characterization of layer properties. Spectral element method (SEM) is presented to perform dynamic viscoelastic analysis for asphalt

pavement in this study. The modified Havriliak-Negami (MHN) model is used to characterize the linear viscoelastic behavior of asphalt mixture, other layers are treated as liner elastic materials. A numerical example for three-layer pavement structure is presented to verify the performance of SEM in dynamic viscoelastic analysis of asphalt pavement. The SEM method is used as the forward analysis engine to backcalculate field FWD data collected from asphalt pavements with various base types, and the backcalculated surface deflections are in good agreement with measured deflections. The result of asphalt layer is complex modulus master curve, or in other words the dynamic modulus and phase angle master curves, while only frequency-independent elastic modulus are backcalculated in traditional method. Master curve can represent the mechanic behavior of asphalt concrete in a wide frequency range. Modulus for elastic layers obtained from proposed procedure are significantly different with those from traditional elastic method. For different base types, the normalized differences between two approaches also show significant different. Comparison indicates that the effect of dynamic loading is different for pavement with various base types and should be considered in forward and backcalculated analysis.

Key words: Asphalt pavement; Dynamic analysis; Viscoelasticity; Falling weight deflectomete

基于单轴贯入试验的玄武岩纤维改性沥青混合料抗剪性能研究

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摘　要：为了评价玄武岩纤维改性沥青混合料的抗剪性能，选用Sup-13、Sup-20以及Sup-25三种不同级配沥青混合料，掺入0.3%掺量的6mm短切玄武岩纤维，在60℃空气浴、50℃水浴、55℃水浴以及60℃水浴四种养护条件下，采用单轴贯入抗剪强度测试方法对其进行抗剪性能试验，同时对混合料的抗剪评价指标进行分析。试验结果表明：在Superpave级配中，掺入玄武岩纤维有助于提高沥青混合料的抗剪性能，但随着矿料粒径的增大，6mm短切玄武岩纤维对混合料的性能提高幅度逐渐下降；玄武岩纤维改性沥青混合料的抗剪强度随着矿料公称最大粒径的增大而增大；55℃水浴养护条件与60℃空气浴养护条件对其抗剪性能的影响效果较为接近。因此，玄武岩纤维能够有效提高沥青混合料的抗剪性能，但是为了充分发挥其在不同公称最大粒径混合料中的增强效果，需要选择玄武岩纤维的合适长度、掺量。

关键词：玄武岩纤维；沥青混合料；单轴贯入试验；抗剪性能；公称最大粒径；养护条件

Research on Shearing Properties of Asphalt Mixture Composed of Basalt Fibre by Single Penetration Shear Test

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Abstract

In order to assess the shearing properties of asphalt mixture modified by basalt fiber, some types of mixtures with different aggregate gradations are subjected to the single penetration test under the curing condition of 60℃ air-bath and 50℃, 55℃, 60℃ water-bath. 0.3% and 6mm basalt fiber is selected. The results show that the shearing properties of the mixtures increases with the increment of the nominal size. Basalt fiber can improve the shearing properties, but basalt fiber on the performance of mixture increase gradually decline, with the increase of nominal maximum aggregate size. Under the curing conditions of 55℃ water-bath and 60℃ air-bath, the shearing properties is more close.

Key words: basalt fibre; asphalt mixture; single penetration shear test; shear strength; nominal maximum aggregate size; curing condition

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短切玄武岩纤维高模量沥青混合料路用性能研究

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摘 要： 为了全面分析短切玄武岩纤维高模量沥青混合料的路用性能，在混合料中单掺和复掺ZQ、BFCS两种改性剂，并与SBS改性沥青混合料进行高温稳定性、低温抗裂性、水稳定性与抗疲劳性能对比试验研究，通过动稳定度、弯曲破坏应变、残留稳定度及疲劳寿命等指标来评价5种混合料的路用性能。研究表明：单独掺加BFCS可以使沥青混合料高低温性能有一定程度的提升；单独掺加ZQ可以大幅度提高混合料的高温抗车辙、水稳定性和抗疲劳开裂性能；而采用BFCS和ZQ对沥青混合料进行综合改性，可使其路用性能更趋完善，特别是对混合料的疲劳性能提升效果显著，可达SBS改性沥青混合料的2倍左右。

关键词： 短切玄武岩纤维；高模量；沥青混合料；路用性能；疲劳性能

The Pavement Performance Study of Basalt Fiber Chopped Strand and High Modulus Asphalt Mixture

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Abstract

In order to analyze the pavement performance of basalt fiber chopped strand and high modulus asphalt mixture entirely, the mixture with ZQ, the mixture with BFCS, the mixture with the two modifiers and SBS modified asphalt mixture were tested to contrast their high temperature stability, low temperature crack resistance, water stability and anti-fatigue performance. Then the five kinds of mixtures' road performance were evaluated through the dynamic stability the degree of bending, failure strain, residual stability and fatigue life index. Results indicate that BFCS can make the asphalt mixture's high and low temperature performance improved to a certain degree and ZQ could greatly enhance anti-rutting, water stability and anti-fatigue cracking resistance. Besides, asphalt mixture

modified by both BFCS and ZQ make pavement performance better. And in particular, the fatigue performance of the composite modified asphalt mixture increases significantly, which is two times of SBS modified asphalt mixture.

Key words: basalt fiber chopped strand; high modulus; asphalt mixture; pavement performance; fatigue performance

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美国裂缝填封养护时机研究综述及对中国未来研究建议

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摘 要： 裂缝是沥青路面最主要的病害类型，裂缝填封作为目前最常用的裂缝处治方法，道路养护部门每年都投入大量的资金。随着中国公路发展从建设高峰期逐步迈入养护期，养护需求加大，养护资金越来越不能满足养护需求。为使有限的养护资金创造最大的养护效益，对裂缝填封养护时机的研究将更为重要。然而，目前中国裂缝填封研究还处于初期阶段，集中在施工材料和技术方面，对养护时机的研究才刚起步，而美国在裂缝填封养护方面的研究起步比较早，可供中国借鉴，以少走弯路。因此，本文对美国最新裂缝填封养护时机的研究进行了整理综述，并为中国未来裂缝填封的研究需求提供了建议。

关键词： 文献综述；裂缝填封；养护时机；未来研究需求

中图分类号：U238

Critical Review of Optimal Crack Sealing/Filling Timing Studies in U.S. and Recommendation for Future Studies in China

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Abstract

Crack is one of the most commonly occurring distresses in asphalt pavement. As the most commonly used preventive maintenance methods, highway agencies have spent significant portions of their highway budgets on crack sealing/filling (CS/CF). Applying CS/CF at the right time is crucial for maximizing the return on investment. This is especially important for China, which is quickly moving from roadway construction to roadway maintenance. However, CS/CF study in China is still at its early stage, focusing on sealant and techniques. US has a vast store of CS/CF studies and practices, this paper critically reviews the up-to-date CS/CF studies and practices in the US, focusing upon CS/CF timing. Based upon this critical review, this paper then identifies the CS/CF research needs in China.

key words: literature review; crack sealing/filling; maintenance timing; research needs

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基于动态贝叶斯网络的桥梁性能退化安全可靠度评估

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摘 要：鉴于目前桥梁结构性能退化预测和安全状态评价存在的不足，本文提出了基于动态贝叶斯网络的既有桥梁性能退化及安全可靠度评估方法，针对桥梁结构性能随机过程，根据桥梁结构性能退化的实际特点，建立能有效预测桥梁结构性能退化的动态贝叶斯网络模型进行安全可靠度评估，并应用于实际桥梁结构。结果表明，该方法从静态的思路转向动态思路，在一般统计规律基础上，通过在结构生命过程中不断得到的新信息，更新已有信息，从而进一步校准既有桥梁结构原有性能预测、安全可靠度评估、检修决策等各方面。

关键词：既有桥梁；动态贝叶斯网络；性能退化；可靠度评估

中图分类号：U441; U448.21+7

Assessment of Bridge Performance Deterioration and Safety Reliability Based on Dynamic Bayesian Networks

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Abstract

Owing to the defects in deterioration of the bridge structure performance prediction and safety condition assessment, a method for assessing the deterioration of existing bridge performance and the safety reliability based on dynamic Bayesian networks was proposed. According to the actual characteristics of bridge structure performance deterioration, a dynamic Bayesian networks model which can effectively predict the deterioration of bridge structure performance, aiming at bridge structure performance stochastic process, was established to assess the safety reliability, and it was applied to the actual bridge structure. The results show that the method transforms the static thought into a dynamic thought. On the basis of general statistical rules, the proposed method can update the existing information through new information which is continually being collected during the process

of structural life, thus it can further calibrate the original performance prediction, safety reliability assessment, maintenance decision and other aspects of the existing bridge structure.

key words: existing bridge; dynamic Bayesian networks; deterioration of performance; reliability assessment

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The Material Variability Analysis Based on
Simple Digital Image Processing

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Abstract

There is variability in engineering parts and each stage of lab tests. It has influence on the guiding role of a single test result. Finding the influence factors of variability and its corresponding influence degree that influence the test results has very important practical significance for more efficient use of the test data. The non-uniformity of the materials can cause variability in the asphalt mixture performance test. The paper analyses the variability of different asphalt pavement materials on the composition through digital image processing method and then compares the data with the variability of mechanical lab test results of the corresponding materials. It shows that the image analysis based material variability analysis results in certain degree match well with that from the lab test results.

Key words: Asphalt mixture, Lab tests, Material variability, Digital image processing

Treatment Strategy of Existing Asphalt Pavement with Semi-rigid Base

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Abstract

Aiming at the problem that treatment strategy of existing asphalt pavement with semi-rigid base, the pavement structure analysis model was established by using the Abaqus software. Influence of pavement parameters on the fatigue life of semi-rigid subbase was analyzed. And the calculation results were verified by the actual data of the typical sections of expressway in Beijing. The results show the effects of base thickness, subbase thickness, asphalt surfacing thickness and traffic load on the fatigue life of semi-rigid base are more obvious than that of subgrade modulus and subbase modulus. The effects of surfacing modulus and base modulus are relatively small. The practical application of the expressway also shows that the relationship between asphalt pavement overhaul period of the first time and the thickness of asphalt surfacing is more significant than that of the pavement structure total thickness. The flexible pavement with thicker asphalt surfacing has a longer service life. The decline of material modulus does not affect the durability of the pavement structure. If not a comprehensive renovation, the measures that existing asphalt pavement with semi-rigid base increase the overlay can improve durability and prolong the service life of pavement. Based on the discussions, the treatment strategies of existing asphalt pavement with semi-rigid base course were put forward.

Key words: highway engineering, treatment strategy, semi-rigid base, fatigue life, influencing factors

多点激光路面车辙检测偏移误差分析

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摘　要： 为研究多点激光检测车横向偏移对不同形态车辙深度检测偏移误差的影响，采用非均布13点激光检测设备获取110组实测车辙横断面数据，基于MATLAB软件开发了车辙横向偏移误差计算程序，针对有隆起和无隆起两类典型车辙横断面形态，考虑了两个偏移方向和三个偏移距离的影响，分析了偏移前后车辙深度测量误差变化规律及其对严重等级判定结果的影响。研究结果表明：随着偏移距离不断增大，无隆起车辙的车辙深度逐渐减小，有隆起车辙的车辙深度先减小后增大；当偏移距离从100mm至500mm时，73.4%的无隆起车辙严重等级被低估，有隆起车辙分别最大有31.0%和25.9%的严重等级被高估和低估。

关键词： 道路工程；沥青路面；13点激光车辙检测；车辙横断面形态；检测车横向偏移

中图分类号：U411

Error Analysis of Multi-laser Vehicle Offset on Rutting Measurement

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Abstract

In order to research the impact of multi-points laser detecting vehicle lateral offset on rut depth of diverse shape, getting 110 groups of realistic light level rut profile data from 13-points laser detecting vehicle. Based on the MATLAB software, developing a programming which can simulate the rut lateral offset and calculate rut depth, aim to two representative rut shape that are upheaval rut and none upheaval rut, with two offset directions and three offset magnitude condition, analyze the regularities and reason of rut depth error and effect of judgement for rut severity classification during before and after lateral offset situation. The result show that with the magnitude of lateral offset increases, the rut depth of upheaval rut fall down and go up later, while none upheaval rut decline all the time; In the lateral offset range from 100mm to 500mm, 73.4% none upheaval rut's severity

classification be underestimated, upheaval rut have extremely 31.0% be overestimated and 25.9% be underestimated, respectively in judgement of rut severity classification.

Key words：road engineering; asphalt pavement; 13-points laser detection; rut shape；vehicle lateral offset

Assessing Foundation Layer Support Conditions of JPCP with Premature Distresses

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Abstract

Pavement distressing is a widespread problem that has gained great interests to transportation engineers. As pavement rehabilitations always focus on improving pavement surface conditions, there is a need of research to finding causes and solutions in terms of pavement foundation support conditions. Currently, falling weight deflector (FWD) test is a commonly used method to estimate the support conditions of pavement foundation layers. In this study, modulus of subgrade reaction (k), related deflection basin parameters representing support conditions at different layers, and load transfer efficiency (LTE) were backcalculated based on FWD data. Results were statistically analyzed in comparison between uncracked and longitudinally cracked jointed plain concrete pavements. The D0, kFWD-Static-Corr, surface curvature index (SCI), base damage index (BDI), and base curvature

index (BCI) values showed statistically significant differences between cracked and uncracked panels. As all cracked panels were located in the cut area, the fill areas showed better support conditions than in the cut areas. No statistically significant difference was noticed in LTE and I-values either between the cracked and uncracked panels or between the cut and fill areas. The benefits of this study were to provide guidance for implementing in situ testing and evaluation and improving performance-related designs and specifications for pavement foundations. (203 words)

Key words: Pavement foundation, support condition, premature distress, falling weight deflectometer, stiffness, deflection basin.

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A Review of Microwave Application in Maintenance of Asphalt Pavement

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Abstract

Various kinds of damages exist inevitably in the asphalt pavement because of the natural factors and the traffic load. The maintenance is the essential mean to restore the function of the pavement. The study of maintenance is therefore a field of research that has become crucially important in the

pavement engineering. The microwave heating has been verified to be technically and economically feasible in maintemance and hot in-place recycling of asphalt pavement. The successful application of microwave in asphlat pavement has gone through a lengthy process and a lot of people have made their efforts to promote the development of the microwave application in asphalt pavement. This paper summarizes the related researches and describes the background, course and latest development. Some views on its prospect are further suggested.

Key words: Microwave; Asphalt pavement; Hot in-place recycling; Maintemance

低噪抗滑超表处在路面养护中的应用

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摘 要：低噪抗滑超表处技术，是在系统研究现有养护技术的基础上，提出的新型路面预防性养护工艺。该技术是将层间界面剂、高粘复合改性乳化沥青、耐磨抗滑降噪材料、表面保护剂通过专用设备同步施工到原路面，形成Ⅰ型（厚度3mm）、Ⅱ型（厚度6mm）或Ⅲ型（厚度8mm）的路面养护结构层。经过多路段施工验证，低噪抗滑超表处路面具有行车噪音低、满足抗滑性、封水、延缓反射裂缝、美化路面、快速开放交通和延长使用寿命等优点。

关键词：低噪抗滑超表处技术；预防性养护；施工验证

中图分类号：U238

The Application of Low-noise Anti-slip Super-surfacing in Pavement Maintenance

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Abstract

Low noise anti-slip surfacing technology is a new pavement preventive maintenance process proposed by our company based on the comprehensive studies on the existing conservation technology. Using this technology to synchronously construct the interlayer interface agent, thermoplastic reactive compound modified ＆ emulsified asphalt, wear-resistant anti-skid noise reduction materials, surface protection agent to the original pavement through special equipment, forming type Ⅰ (thickness 3mm), type Ⅱ (thickness 6 mm) or type III (thickness 8 mm) pavement maintenance layer. After more than two years of road construction verification, ultra surfacing with driving low noise and meet the advantages of skid resistance, water sealing and delay the reflection crack and beautify the pavement, quick traffic and prolong the service life of the anti sliding and low noise etc..

Key words: low noise anti-slip surfacing technology; pavement preventive maintenance; construction verification

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基于FWD的沥青路面静态弯沉预测模型

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摘　要：为了提高上海市路网弯沉检测效率和精度，分别利用回归分析技术和BP神经网络智能方法，建立了基于落锤式弯沉仪(FWD)动态弯沉预测静态弯沉的预测模型，分析了模型影响因素，并对比了两种模型的预测效果。结果表明：弯沉检测层位、FWD系统误差、弯沉测试范围均对弯沉预测模型有较大影响；与回归模型相比，BP神经网络模型的均方根误差降低了10μm，平均相对误差降低了4.6%，预测效果较优；回归模型的路网结构强度评价结果偏于不安全。

关键词：路面工程；弯沉；落锤式弯沉仪；贝克曼梁；神经网络；回归分析

中图分类号：**U416.03**

Predictive Models of Pavement Static Deflection Based on Data from Falling Weight Deflectometer

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Abstract

In order to effectively utilize the falling weight deflectometer (FWD) instrumentation and improve the efficiency and precision of the road network deflection detection in Shanghai, regression model and BP(back-propagation) neural network model are used to establish relationship between the dynamic deflection and the static deflection. The measured data show that, structural layer, the system error of FWD and the strength of pavement structure have a great impact on the model; compared with the regression model, the mean square error of BP neural network model is reduced by 10μm, and the average relative error is reduced by 4.6%; compared with BP neural network model, the evaluation result of road network structural strength in Shanghai based on regression model is unsafe.

Key words: pavement engineering; deflection; falling weight deflectometer; Beckman beam; neural network; regression analysis

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道路养护领域文献计量研究

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摘　要：本文主要以国内外道路养护领域的研究进展和论文发表情况为研究对象，借助文献计量软件Histcite、Citespace、和文献管理软件NoteExpress，运用文献计量学分析方法，分别对Web of Science数据库中的2238篇相关外文文献，和中国知网（CNKI）系统中的1904篇相关中文文献进行了计量分析。并以文献统计数据及计量分析结果作为支撑，对国内外道路养护领域的历史发展脉络以及主要研究方向进行了梳理，从中筛选出了被引次数较多、具有较大影响力的经典文献。同时，明确了道路养护领域当前的学术研究前沿，也为未来研究的发展趋势提供了参考。

关键词：道路养护；养护维修；数据库；文献计量

中图分类号：**U418**

A Study on Bibliometric in the Field of Road Maintenance

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Abstract

This research mainly focuses on the research progress and the paper published in the field of road maintenance at home and abroad with the aid of bibliometric software Histcite, Citespace and literature management software NoteExpress. Through the bibliometric analysis, 2238 relevant English papers in the database of Web of Science (WOS), and 1904 Chinese related articles in the China National Knowledge Infrastructure (CNKI) were studied and analyzed. Based on the statistical data

of the literature and the results of the econometric analysis, the historical development and the main research direction of road maintenance at home and abroad are reviewed. In this paper, we selected the classic literature which has been cited more frequently and has great influence. At the same time, it defines the current academic research frontier in the field of road maintenance, and provides a reference for the future research.

Key words: road maintenance; maintenance and repair; database; bibliometric

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城市街道机动车排放污染物扩散规律研究

马鑫旺，魏中华

摘　要： 近年来，北京市雾霾频发成为了公众越来越关心的环境问题。造成这一现象的原因有很多，但是由机动车排放物造成的污染是一个不可忽视的方面。相对于机动车驾驶员来说，自行车骑行者和行人首当其冲的受到污染物的危害。为了研究PM2.5的横向扩散的对周围的周边环境的影响，本文使用PM2.5手持测量仪器，选择在适当的条件下，在北京市几条典型道路的横断面上取点，测量每个点的PM2.5浓度的值，对污染物横向扩散规律进行研究，通过处理得出PM2.5浓度变化曲线，对不同条件下得到的曲线进行对比分析，发现在拥堵条件下，PM2.5浓度呈现出机动车道中央高，并向道路两侧逐渐降低的趋势；而在车辆行驶顺畅时，其浓度变化呈现出机动车道中央低，而机非车道交界处浓度高，在自行车道附近则又降低的趋势。基于扩散规律，我们对自行车线到干道的距离进行分析，并认为需要改进。这个研究结果将用于估计PM2.5对自行车骑行者和行人的影响，并协助有关机构采取合理的对策，提高基础设施，如改善主干道与自行车道、人行道的距离。

关键词： PM2.5；城市交通；雾霾天气；

Study on the Diffusion of Pollutants in Urban Street

Ma Xin-wang, Wei Zhong-hua

Abstract

In recent years, the haunting haze whether in Beijing has become a serious environmental problem, which has largely attracted public's attention. The reasons for this phenomenon are various, but the pollutants from the vehicles emissions, especially particle matter (PM) 2.5, are a primary origin, which make bicyclists and pedestrians inhale hazardous particles. In order to investigate the impact of lateral diffusion of PM2.5 on peripheral surrounding environment, the roads around a residential area in Beijing are selected. Typical street cross sections are picked to collect the concentrations of PM2.5 by detectors in appropriate conditions. The PM2.5 concentration change curve are compared to analyze the diffusion regularity in different conditions. It is concluded that, in traffic congestion, the concentration of PM2.5 in middle of the road is higher than that in roadsides; on the country, in

free flow condition, the concentration of PM2.5 in roadside is higher than that in middle of road, and decreasing near the bicycle lines. Based on the diffusion regularity, the installment of the bicycle line distance to the arterials are analyzed and considered to be improved. Findings from this research will estimate the effect on bicyclists and pedestrians and assist relevant agencies in taking reasonable countermeasures to improve the installment of infrastructures, such as improve the bicycle line and pavement distance to the arterials.

Key words: diffusion of PM2.5; urban traffic;haze whether.

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不中断交通条件下高速公路改扩建工程路面结构方案研究

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摘　要：高度城镇化、周围路网流量饱和决定了江广高速改扩建不具备交通分流条件，如何在老路结构极其复杂、水网密集地区，既要在不具备交通分流条件下实施高速公路改扩建，又要保证扩建高速公路长期耐久和经济合理，成为研究目标。本文重点针对基于无损检测的旧路面结构整体性评价、保障施工组织的路面结构方案、新旧路面拼接及裂缝防治措施等方面进行了研究探讨。

关键词：改扩建工程；无损检测；保障施工组织；路面结构；拼接抗裂

Study on the Pavement Structure Scheme of the Expressway Reconstruction and Extension Project Under Uninterrupted Traffic Conditions

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Abstract

The distribution of traffic flow can hardly be adopted in the reconstruction and extension project of Jiang-Guang Expressway, due to high urbanization and saturated traffic flow. Thus it is well worthwhile to investigate how to carry out extension projects in circumstances of having complicated road network and river network. In the meanwhile, the durability and construction cost of extension projects need to be considered as well. This paper investigates the evaluation of the integrity of overlays based on non-destructive examination technology, and compares paving structures on the premise of guaranteeing construction management. Apart from that, the prevention of crack in the joint of new and old pavements is also discussed.

Key words: reconstruction and extension projects; non-destructive measurement; construction management; prevention of joint crack

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Power Spectral Density (PSD) Roughness Based International Roughness Index (IRI)

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Abstract

International Roughness Index (IRI) plays a key role in pavement performance evaluation, while power spectral density (PSD) of road surface plays an equally important role in simulation and assessment of vehicle ride quality. To link these two statistics, the stochastic process theory is used to find the relationship between IRI and PSD. For a homogenous roughness with Gaussian distribution, the average of the absolute response of quarter-car model used for calculating IRI is proportional to the standard deviation of that response quantity. This result enables us to further derive IRI based on PSD roughness. Based on the PSD-based road classification proposed by the International Standardization for Organization (ISO), it is found that a linear correlation exists between IRI and standard deviation of roughness. In addition, corresponding to the ISO road classification, an IRI-based road classification is provided to categorize pavement into five classes, ranging from very good to very poor surface conditions.

Key words: international roughness index, power spectral density, pavement, quarter-car model, stochastic process, road classification

Infrastructure Sensor System for Weigh-In-Motion Measurements

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Abstract

In this paper, an infrastructure sensor system was developed for weigh-in-motion (WIM) measurements based on fiber Bragg grating (FBG) sensors. A FBG were packaged by fiber reinforced polymer (FRP) materials as an infrastructure sensor to measure the WIM. Field testing was performed at MnROAD facility, Minnesota DOT (MnDOT), which approved the effectiveness of the developed infrastructure sensor system for WIM measurements. The advantages of the robustness of the proposed system will enable a reliable WIM measurements for both low-speed and high speed WIM without any sensors on-board a vehicle.

Key words: Weigh-in-motion measurement, fiber Bragg grating sensor, fiber reinforced polymer, structural health monitoring

Surface Monitoring of Rehabilitated Pavements
on the National Freeways

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Abstract

Due to the significantly increasing traffic intensities and higher axle loads than in the past, the premature distress of pavement were frequently found on the open-graded friction course of the national freeways in Taiwan. In order to ensure the better performance with pavement longevity and minimize closures to traffic, concerns have been raised with high-speed wearing course replacement using the porous asphalt concrete (PAC) as rehabilitated pavements. However, there is lack of information about the effects of lift thickness, traffic volume and aggregate size on field performance. The objectives of the study were to monitor and evaluate surface performance of PAC rehabilitated pavements. The results showed that PAC possessed good permeability and skid resistance although air voids were decreased. With stable structural condition together with proper construction practice, the PAC pavement performance of rutting, smoothness and durability could be in a good service condition over a given period of time.

Key words: Porous asphalt concrete; Rehabilitation; Permeability; Skid resistance; Rutting; Riding Quality

Evaluation of Pavement Performance for Reclaimed Asphalt Materials in Different Layers

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Abstract

Most highways of asphalt pavements in China, especially in the developed areas, are facing such serious pavement distresses as rutting at high temperatures, cracking at low temperatures, moisture damage and fatigue cracking. The maintenance and rehabilitation of existing pavements has been the most urgent problem to be solved for the departments of transportation. This paper aims to analyze the pavement performance of reclaimed asphalt pavements (RAP) materials in the upper and middle

layers, compared with the corresponding new asphalt mixtures with or without the same gradation as RAP mixtures, by conducting 4 laboratory tests, including the dynamic creep test, the semi-circular bending (SCB) test, the freeze-thaw indirect tension test and the semi-circular fatigue test. Based on the results of laboratory tests, it could be discovered that the high temperature performance of RAP mixtures declined a lot due to the fining of gradation, which means the coarse aggregates decrease and the fine aggregates increase. The SCB test results showed that the RAP mixtures performed worse at low temperatures, and the gradation had little impact on the low temperature performance while the asphalt binder had a large contribution to it. The moisture stability and fatigue performance of RAP mixtures also declined and the fatigue lifetime had a worse susceptibility to stress compared with the new asphalt mixtures.

Key words: Pavement Performance, RAP Mixtures, Dynamic Creep Test, Semi-Circular Test, Freeze-Thaw Indirect Tension Test.

莆田市道路交通噪声现状分析与预测模型

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摘　要:运用数理统计知识,针对莆田市城区道路交通噪声的监测数据,分析道路交通噪声的污染现状,依据交通噪声的评价指标,结合交通量与车速进行深入分析,并对其进行评价。借助SPSS分析软件,从交通量、车速、距离等影响因素对交通噪声进行建模分析,建立适合莆田市道路交通噪声预测模型。

关键词:道路; 交通噪声; 交通流; SPSS软件; 预测模型

Analysis and Prediction Model of Road Traffic Noise in Putian

Abstract

the monitoring data of road traffic noise was analyzed by mathematical statistics knowledge in Putian．According to the evaluation index of traffic noise with the traffic volume and speed,traffic noise are analyzed and evaluated．By means of SPSS analysis software,the traffic noise model is analyzed from the traffic volume,speed,distance and other factors,and road traffic noise prediction model suitable for Putian is established．

Key words:road,traffic noise,traffic flow,SPSS,prediction model

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基于道路载荷地图的公路路面实时监测技术

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摘　要：尽管新政下最大限度降低了短期路面结构性破坏（永久性变形及断裂等）的可能性；但在实际道路荷载长期作用及高频次轮载荷冲击力下，公路路面性能仍会不断疲劳衰减；同时，建设中的隐蔽性结构缺陷、使用中程度各异的损伤和何时该发生功能性失效事件等问题依然无法预测；所以，在新的形势下高速公路利用物联网技术、云计算及大数据技术，建立健康诊断、智慧养护的运维模式是很有必要的。

本文推荐的是：埋入式光纤传感器技术与道路载荷地图融合，实现公路路面在线实时监测，帮助和提升高速公路养护信息化水平。

关键词：道路载荷地图、路面检测、动态称重、车型自动分类、车辆外廓尺寸测量、分布式光纤传感器、公路健康诊断

Real-time Monitoring Technology of Highway Pavement Based on Road Load Map

Abstract

Although the mandatory laws and regulations can minimize the possibility of short-term pavement structural damage; but in the long-term use, the highway under impact load of high frequency, the pavement performance is still continuous fatigue decay; at the same time, road builders cannot find concealed structural defects. Road maintenance workers can not accurately diagnose the long-term use of the degree of injury. Highway managers cannot predict when failure occurs; so in the new situation, it is necessary to use the IoT technology, cloud computing and Big-Data technology, build a set of pavement health diagnosis platform, and intelligent pavement maintenance management mode In the subject , the embedded optical fiber sensor technology is combined with the road load map to realize the online real-time monitoring of road surface, and to help and improve the level of highway maintenance information

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全景巡查在道路养护管理中的优势及应用

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摘 要：道路巡查可以为养护管理提供决策的基础数据，是养护管理的重要环节。 根据目前全景地图在各个领域广泛应用，笔者提出全景地图与巡查结合的全新巡查系统，并将全部实施方案进行细化。

关键字： 全景地图; 道路巡查; 养护管理

The Advantages and Application in Maintenance Management with Panoramic Road Watch

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Abstract

Road Watch can offer the data base for Maintenance Management decision-making, it is an important link in full Maintenance Management. According to the Panoramic Map be widely used in every field, the author propose a full new watch system, that is Panoramic Map combined with Road Watch, and let all implementation plan be further clarified.

Key words: Panoramic Map;Road Watch;Maintenance Management

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Multi-objective Model for Logistics Distribution Programming Considering Carbon Emission and Service Level

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Abstract

In order to seek the low-carbon environmental protection and high service level of logistics distribution,a multi-objective optimization model of logistics distribution network is proposed.Firstly, the multi-objective optimization model of logistics distribution network is established by using the multi-objective optimization theory, which takes the total network logistics cost as the minimum, the least carbon emissions and the maximization logistics service level as the goal. Secondly, the fuzzy programming method is used to transform the multi-objective programming model into a single objective programming model, and the tabu search algorithm based on priority is used to solve the model.The simulation results of the model and the algorithm are verified.The simulation results show that the 10 solutions and 10 logistic distribution schemes are affected by the subjective preferences of the decision-makers by solving the mutli-objective optimization model.In addition,the total cost of the logistics of each scheme is inversely proportional to the level of service. A scientific and feasible logistics network planning method with low carbon and high customer satisfaction is obtained.

Key words: Logistics distribution network; load-based carbon emissions; logistics service level; multi-objective; priority-based tabu search algorithm

基于近景摄影测量的路基变形监测技术应用研究

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摘 要：本文采用近景摄影测量的方法对路基变形监测进行从外业到内业全程探索，并辅以传统全站仪变形测量手段，将两种测量的方法进行对比，以此来评价近景摄影测量的精度和适用性，为以后的变形监测方法提供技术支持，对于提升路基变形监测工作效率、加快进近景摄影测量工程化进度均具有重要意义。

关键词：近景摄影测量；路基；变形监测；监测技术

Research on Subgrade Deformation Monitoring Technology Based on Close-range Photogrammetry

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Abstract

In this paper, the method of close-range photogrammetry is used to explore the roadbed deformation monitoring from the field to the whole industry, and the traditional total station deformation measurement method is used to compare the two methods to evaluate the accuracy of close-range photogrammetry And the applicability of the method, and provide technical support for the later deformation monitoring method, which is significant for improving the working efficiency of roadbed deformation monitoring and accelerating the progress of near-field photogrammetry.

Key words：close-range photogrammetry；subgrade；deformation monitoring；monitoring technology

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一种基于姿态速度位置匹配的传递对准方法

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摘　要：为了提高机载分布式POS中子POS的测量精度以及主子系统之间的基线精度，补偿机翼的挠曲变形，在传统方法基础上，将由机翼挠曲运动产生的挠曲变形角和挠曲变形角速度增广为卡尔曼滤波的状态变量，设计了基于"姿态+速度+位置"匹配方式的卡尔曼滤波器。仿真结果表明，新的匹配方法对姿态精度有一定提升，并成倍提高位置精度。仿真结果验证了该方案的可行性，为机载分布式POS提供了工程应用参考。

关键词：分布式POS　挠曲变形　卡尔曼滤波器

中图分类号：**V21**

A Method Based on Attitude Velocity Position Matching for Transfer Alignment

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Abstract

in order to improve the precision of slave POS(position and orientation system) in distributed POS and the baseline precision between main POS and slave POS, and compensate for the wing's flexure deformation of aircraft，the flexure angle and its angular rate were added to the state variables of the Kalman filter, a new Kalman filter based on "attitude+velocity+position" matching is designed. The simulation results show that the attitude accuracy is improved obviously and the the position accurate is improved several times more. All these characteristics show that the scheme is feasible and can provide references for the engineering application of the distributed POS.

Key words: distributed POS; flexure deformation; Kalman filter

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Wireless Localization Algorithm of Intelligent Vehicles Based on Deep Learning Theory

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Abstract

The wireless location is one of key technologies for the application of intelligent vehicles. The traditional wireless location algorithm based on received signal strength indication (RSSI) is vulnerable to the environment to cause large errors in actual distance measurement, and the calibration of path-loss model is a very tedious work. Deep learning is a branch of machine learning based on learning representations of data, and can extract the potential rules among objects from the big data. In this study, a classic deep learning method, convolution neural network (CNN), is proposed to design a wireless location algorithm to solve the tedious calibration of path-loss. The structure and logic flow diagram of wireless location algorithm based on CNN is introduced in detail. The field experiment is carried out on the Microsoft campus in Redmond, WA, and the sample data is collected to validate the location accuracy of intelligent vehicle. The location accuracy and the error distribution of the proposed wireless location algorithm are analyzed. The results show that the average error of wireless location algorithm based on CNN is 51m, which is better than the average error of classic RSSI trilateral around 169m. Furthermore, the data of location accuracy less than 70 m of proposed wireless location algorithm accounts for 77.1%, which is acceptable for the wireless location.

Key words: Deep Learning Theory, Convolution Neural Network, Intelligent Vehicle, Wireless Localization, RSSI.

跨海工程长距离精密高程传递方法与应用

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摘　要：本文通过GNSS（BDS）高程传递法、光学测量法（经纬仪倾角法）以及似大地水准面模型法等三种不同长距离精密高程传递方法的综合应用，为宽海域跨海工程建立了陆海统一高程基准，通过外符合检校，其成果精度优于国家二等水准精度，满足外海工程施工的需要。

关键词：高程传递；高程基准；GNSS（BDS）；似大地水准面模型

The Method and Application of Long Distance Precise Elevation Transfer for Wide Sea-crossing Project

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Abstract

In this paper, the comprehensive application of GNSS（BDS）elevation transfer method, optical measurement method (theodolite tilt-angle method）and geoid model method to establish the land and sea unified height datum for wide sea-crossing project. The accuracy is better than the national second-class leveling accuracy to meet the needs of offshore project.

Key words：Elevation transferring; Height datum; GNSS（BDS）;Geoid model

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Image Deblurring Strategy and Robust and Accurate Inliers Selection Framework: Application to Stereo Visual Odometry

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Abstract

This paper proposes an innovative stereo based ego-motion estimation approach with image deblurring strategy and robust feature detection and matching framework. We notice that blurred image is a great challenge for localization with a sharp turn. So we attempt to mitigate the impact of blurring with anti-blur algorithm. What's more, many different 2D invariant feature algorithms have been employed in visual odometry taking efficiency and robustness into consideration. After carrying out varied comparable experiments, an improved sparse multiscale 2D local invariant feature detection and description algorithm accelerated-KAZE is adopted to extract the feature points and match the descriptors. Experiment show that the presented ego-motion scheme achieves significantly performance with respect to the other state-of-the-art VO approaches. Even in a considerably cluttered environment, the superiorities of our algorithm are proved.

Key words: image quality evaluation; image anti-blur; stereo visual odometry; local invariant feature;AKAZE

基于分布式滤波器的高可靠性多源信息融合方法

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摘　要：组合导航技术本质上是对多源信息的融合估计，传统集中式融合滤波算法精度高，但容错性差，不能满足导航系统可靠性要求。本文首先基于分布式滤波器提出了一种高精度、高容错性的快速有效的多源信息融合方法。其次，本文基于此滤波算法利用残差检验法，采取相应的状态估计和融合策略，对组合导航系统进行故障检测与隔离，验证了此融合方法相比于传统集中式的高可靠性。最后，在MATLAB环境下将此融合方法应用于船用组合导航系统（INS/GPS、INS/DVL），进行估计滤波。此方法计算量小、可靠性高，利于系统的故障检测与隔离，可以弥补传统网络滤波器的不足。

关键词：组合导航；分布式滤波；信息融合

中图分类号：V241.6

High Reliability Multi Source Information Fusion Method Based on Distributed Filter

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Abstract

The advantages of various navigation subsystems are complementary, which constitute the integrated navigation multi sensor network system. Based on the diffusion filter a method of multi-source information fusion is proposed with high precious, high reliability, high fault tolerance, which can make up for the traditional filter's disadvantages. Then, based on this method a fault detection is designed, which is applied on the integrated navigation system. Finally, the simulation is carried out in MATLAB, which proves the high reliability and fault tolerance of the filter.

Key words: Integrated navigation; Distributed filtering; Information fusion

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多MIMU同时标定方法

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摘 要：随着微机电系统(MEMS, Micro Electro Mechanical System)技术的发展，微小型惯性测量单元（MIMU, Micro Inertial measurement unit）在大众车辆导航领域表现出巨大的潜力，随着市场需求的增加，提出了对多个MIMU同时进行标定的新要求。基于MIMU系统建立了含有33项误差系数的系统误差模型；在六位置正反速率标定方案的基础上，提出了一套多MIMU同时标定的误差系数解算算法，角速度通道用最小二乘法解算出全局最优误差系数值，加速度通道解算方法有效避免了杆臂效应对解算加速度计零偏系数的影响。最后进行标定实验验证，并对MIMU进行补偿，最终实验结果显示该标定方法有效。

关键词：多MIMU同时标定；误差建模；六位置正反速率

中图分类号：U666.12

Multi-MIMU Simultaneous Calibration Method

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Abstract

With the development of Micro Electro Mechanical System (MEMS) technology, Micro Inertial Measurement Unit (MIMU) has great potential in mass vehicle navigation. Because of the increase of market demand, a new requirement for simultaneous calibration of multiple MIMUs is proposed. A system error model of MIMU with 33 error coefficients is established. On the basis of the six-position positive and negative rate calibration scheme, a set of multi-MIMU simultaneous calibration error coefficient solution method is proposed. The global optimal error coefficients of angular velocity channel is solved by least square method and acceleration channel solution method can effectively avoid the influence of the arm effect on the bias of the accelerometer. Finally, the calibration

experiment is carried out and the MIMU is compensated. The final self-test shows that the calibration is valid.

Key words: Multi - MIMU simultaneous calibration; error modeling; Six position positive and negative rate

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Simulation and Testing Method for Evaluating the Effects of Position Error, Communication Delay and Penetration Rate to Connected Vehicles Safety

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Abstract

Uncertainties of connected vehicle (CV) system, such as vehicle position error, communication delay and penetration rate would significantly influence the systematic performance. A simulation and testing method for evaluating the effects of uncertainties to connected vehicle safety is proposed in this paper. To construct the basic simulation environment, a five-subsystem simulation structure is designed. And Gaussian distribution based vehicle position error model, uniform and Rayleigh distribution based communication delay model and penetration rate model are introduced and implemented to enhance the reality of the simulation. Then a simulation scenario, which is composed of vehicle overspeed as traffic hazard, nonlinear segmented vehicle braking (NSVK) model as pre-warning method and uncertainties models as system disturbances, is set up to evaluate the effects of uncertainties to connected vehicle safety. A High Level Architecture (HLA) based simulation platform is established to verify the proposed method. The results show that, with position error in the scenario, successful warning rate is 88%. And the successful warning rate increases when the deceleration of pre-warning approach decreases. In in the scenario with communication delay, successful warning rate reaches 100%. And successful warning rate increases with Origin Destination (OD) value and penetration rate, and penetration rate influences more.

Key words: traffic engineering; connected vehicle safety; system uncertainties modelling; simulation scenario; testing and verification

Car-following Model Based on Driving Visual Angle

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Abstract

Driving visual angle is a significant factor that affects the vehicle following behaviour, the fact that the following vehicle is closing-in or shying-away a leading vehicle in front of it inevitably causes the change of driving visual angle in the real traffic conditions, while many car-following models did not take it into account. This paper introduced the driving visual angle and its change rate into FVD (full velocity difference) model, the FVD model was modified and the 3D car-following model based on driving visual angle was established. The stability of model was analysed through the linear stability theory, getting the width of vehicle, the height difference between the driving eyes and the vehicle head, the headway and the length of vehicle head have a great impact on the stability of traffic flow, and finding the stability of traffic flow is asymmetric, which is correspond with the reality and proves the utility of the model.

Key words: driving visual angle, car-flowing model, linear stability analysis, traffic flow

区间计重法解决目前我国ETC发展难题设想

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摘　要：本文重点介绍了设计应用"区间计重法"实现WETC的设想，进而解决我国目前制约ETC全面铺开的最大难点问题。

关键词：区间计重法；高速公路；收费站；机电维护；机电维修；电子收费；ETC；WETC；

中图分类号：**U491**

The Assumption of Using "New Range of Weight Method" to Solve the Current Problems of the Development of ETC in China

Abstract

This paper mainly introduces the assumption of design and apply "New Range of Weight Method" to realize WETC and solve the current biggest problem of the development of ETC in China.

Key words: New Range of Weight Method；Expressway；Toll station；Mechanic and electronic maintenance；ETC；WETC

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A Coordinated Ramp Metering Algorithm for Improving Efficiency and Equity Performance

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Abstract

Ramp metering (RM) has been widely applied due to its effectiveness in improving motorway traffic conditions by limiting inflow from on-ramps. A great deal of experimental and simulation based studies have proven system-wide benefits of motorways from RM. Benefits attributed to RM in the literature include reducing travel times, increasing motorway throughputs and decreasing fuel consumption and emissions. However, RM benefits might be costing more to some motorway users, e.g. some on-ramp users might be experiencing longer delay than others, which lead to an unfair allocation of RM benefits. This paper presents a coordinated ramp metering strategy, which is aimed at reducing the inequity among motorway users using different on-ramps and investigates trade-offs between efficiency and equity for the proposed strategy. Total travel time is used to measure efficiency while Gini coefficient is used to measure equity. A combined index is proposed incorporating the two measures to serve as an objective function to solve the bi-objective control design problem. The performance of the proposed strategy is verified by comparing against a well-established coordinated ramp metering strategy HERO using micro-simulation software AIMSUN. Simulation results revealed that the equity of the motorways system can be improved significantly using the proposed strategy without compromising much on the efficiency of the system.

Key words: Ramp metering; Efficiency; Equity; AIMSUN

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Cubature Kalman Filter-based Vehicle Position and Attitude Estimation Using Fusion of GPS/INS

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Abstract

In order to solve the problem of the GPS based vehicle navigation system failure when the antenna is obstructed, lower positioning accuracy and other issues，a Cubature Kalman Filter-Based vehicle Position

and Attitude Estimation using Fusion of GPS/INS is proposed. The GPS and INS integrated navigation system using the observation of position, velocity and attitude are described, and the dynamic equations for the integrated system are set up. The optimal estimation fusion structure of the Cubature Kalman Filter was built. Experimental results shows that the proposed method can provide real-time, stable and reliable vehicle location parameters compared with the GPS subsystem and the INS subsystem.

Key words: Intelligent vehicle; Localization technology; Parameter estimation; Information fusion

基于多目标模糊决策的城市交通诱导可变信息板选址模型研究

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摘　要：可变信息板（VMS）是实现交通诱导的重要工具。可变信息板布局规划的合理与否会影响交通诱导的效果，而现有的VMS设置主要依靠交通管理者的经验确定，缺乏科学严密的布局理论做支撑。本文结合VMS布设影响因素，确定了路网设置VMS的三个指标，即可替代路径好、路段流量大和前方道路易拥堵，并建立了各自的隶属度函数，并通过多目标模糊决策理论算出各个路段设置VMS板的可能性大小，得到交通诱导可变信息板VMS初始选址方案，再借助TRANSCAD进行仿真验证。

关键词：可变信息板; 交通诱导; 多目标模糊决策

中图分类号：U238

Location Model Research of Traffic Guiding Variable Message Sign based on Multi-objective Fuzzy Decision Theory

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Abstract

The Variable Message Sign (VMS) is the important tool for city traffic guiding. The VMS layout planning is reasonable or not will affect the effect of traffic guidance. Nowadays the traffic managers set the VMS relying on the the experience without scientific rigorous layout theory. This paper selects three indicators for setting VMS, good alternative, road traffic volume and front road congestion, and set up their membership functions. Through the multi-objective fuzzy decision theory to calculate the possibility of various sections for setting VMS. Then we can get the initial location scheme, and simulate with the help of TRANSCAD.

Key words: Variable Message Sign; Traffic Guidance; Multi-objective Fuzzy Decision

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Rail-highway Grade Crossings: Point Cloud-based Roughness and Rideability Indices

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Abstract

In this paper, two 3D point cloud-based quantitative rail-highway crossing assessment indices are developed. A "Crossing Roughness Index," is computed to indicate roughness due to combined crossing surface condition and reference profile. The metric can be used to compare the performance of a given crossing over time and correlates well with the surface condition of the crossing. A second metric, termed "Crossing Rideability Index" is calculated as the second derivative of the actual crossing vertical profile. Because the second metric predicts accelerations due to both crossing condition and grade profile, it can be used to compare and rank different crossings for improvement plans.

Key words: Rail-highway grade crossing, Roughness, Rideability, LiDAR, 3D.

Parameter Analysis of Optimal Ramp metering

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Abstract

Ramp metering is a motorway control method to avoid onset congestion through limiting the access of ramp inflows into the main road of the motorway. The optimization model of ramp metering is developed based upon cell transmission model (CTM). With the piecewise linear structure of CTM, the corresponding motorway traffic optimization problem can be formulated as a linear programming (LP) problem. It is known that LP problem can be solved by established solution algorithms such as SIMPLEX or interior-point methods for the global optimal solution. The commercial software (CPLEX) is adopted in this study to solve the LP problem within reasonable computational time. The concept is illustrated through a case study of the United Kingdom M25 Motorway. The optimal solution provides useful insights and guidances on how to manage motorway traffic in order to maximize the corresponding efficiency.

Key words: Cell Transmission Model (CTM), Optimal Control, Linear Programming, Ramp Metering, Sensitivity Analysis

Research on Visual and Physiological Characteristics of Drivers under Urban Road Environment

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Abstract

In actual driving circumstances, drivers are easily distracted by the outside environment, such as vehicles or pedestrians. There are overtaking, irritating or even attacking behaviors during driving. Driving behavior is often the external manifestation of a driver's psychological and physiological changes. By using the actual road driving test to analyze the driving safety, we can effectively get the actual road driving action information, and systematically describe the relationship between a driver's eye movement changes and road environment. Research results are capable of providing the basis for the analysis of traffic accidents.

Key words：Drivers, Driving safety, Eye movement changes, Road environment

Speed Estimation in a Data Poor Environment,
A Case Study Site Along Interstate-75 in Kentucky

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Abstract

Today traffic congestion is a severe problem that is faced all over the world, including China and the United States. To study this problem, traffic speed is a necessary parameter. With the development Intelligent Transportation System (ITS) and connected vehicles, the speed data is easier to obtain, but in the case of a data poor environment, speed estimates can be derived from the traditional HCM methods. In addition, the development of new technology, such as GPS and Bluetooth, for speed data collection, allows validation of speeds estimated using the traditional HCM methods.

FREEVAL, a tool developed by North Carolina State University, is used to simulate traffic conditions, such as traffic flow speed. The tool estimates speeds based on HCM methods that includes reliability factors, such as crash incidents, weather, changing traffic demand, etc. To verify the study given by

FREEVAL, a test site along Interstate-75 in the state of Kentucky was modelled. This case study serves as an example of a model built in a data-poor environment to predict the traffic speed using the HCM manual methods built into FREEVAL.

The traffic speed data for both northbound and southbound direction of the study segment have been predicted from the FREEVAL models using three different kinds of free flow speed (FFS) inputs, including 85th percentile speeds obtained from observed speed data, HCM, and speed limit of the study segment. All results were validated with GPS speed data from a private data vendor, and the goodness of fit of each model outputs were calculated. Based on the results we conclude that the HCM-based FREEVAL software is adequate for mid to high-level speed modelling applications in a poor data environment. This research will help future researchers and transportation agencies to estimate speeds with limited data available.

Key words: Reliability, Speed, FREEVAL, GPS, Highway Capacity Manual, HCM,

The Influence of Truck Platooning on Traffic and Fuel Efficiency of Highway Stretch

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Abstract

Highway network in China is confronted with serious congestion. Advanced system control methods to solve mitigate metropolis highway traffic congestion in China have been proposed, which include control strategies of dedicated truck lane and connected truck platooning among others are planned to apply. However, the traffic and fuel efficiency of these control strategies on highway basic stretch is still not clear. In this paper, the control strategy of combining truck platooning with dedicated truck lane is studied via microscopic simulation. This strategy is modeled and implemented in VISSIM. Several test seniors with different system flow demand and different connected truck ratio are simulated. Simulation results reveal two main findings. Firstly, the traffic efficiency is better than the situation of no dedicated commercial lane if the connected truck ratio higher than 80%, irrespective of the demand level. Secondly, the fuel efficiency is better than the situation of no dedicated commercial lane if the ratio higher than 40%, irrespective of the demand level.

Key words: Dedicated Truck Lane; Connected Truck; Traffic Efficiency; Fuel Efficiency

Measurement of Heavy Vehicle Wheel Wander using Advanced Image Processing Technology

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Abstract

Wheel wander is a common phenomenon observed on roads and airfields. The lateral distribution of wheel load has long been recognised to have an impact on the pavement design thicknesses. The effect of wheel wander on design traffic can be accounted for by assuming a presumptive wander distribution in routine pavement design. While there are different methods to measure the wheel wander, this paper presents an advanced image processing scheme that utilises a mobile and non-intrusive camera setup to measure heavy vehicle wheel wander in selected Queensland roads.

The major steps in the proposed image processing scheme include frame acquisition, RGB to grayscale image conversion, road region extraction, frame difference detection, vehicle region

detection and finally the calculation of the lateral distance of passing by wheels.

Based on experimental analysis in this study, it was found that a camera with 1080p resolution can be used to achieve a lateral resolution between 9 to 28 mm. This method is suitable for preliminary wheel wander investigation and other situations where intrusive sensor installation on roads are not suitable. It was concluded that the measurement technique can accurately determine the vehicle length, number of axles and the lateral wander distribution. In one of the measurement site, a wander distribution with a standard deviation of 15 mm was reported and this is similar to wander distribution reported in other similar studies.

Key words: Image Processing, Wheel Wander, Pavement Design

浅析高速公路ETC系统

王玉卓

摘　要：城市化进程的加快为城市的交通状况带来了不小的压力，已严重影响了交通安全，而智能化交通是改善这一问题的有效措施。本文详细介绍了ETC系统的研究背景、构成、工作原理及方式并对应用ETC系统的优缺点进行了分析。

关键词：智能交通；交通；ETC

Analysis of the Highway ETC System

Wang Yu-zhuo

Abstract

The speeding up of urbanization has brought a lot of pressure to urban traffic, urban traffic has seriously affected the traffic safety,but intelligent transportation is effective measures to improve this problem. This paper introduced the research background, composition, working principle and the way Of ETC system,and the advantages and disadvantages of application of ETC system are analyzed.

Key words： Intelligent transportation; traffic; ETC

公路建设植被可恢复性评价与实证—以青藏公路沿线为例

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摘　要：评价植被的可恢复性（植被恢复潜力）是指导植被恢复困难区域开展植被恢复实践的基础，在矿山复垦领域有着一些应用，但在当前公路行业却是一个薄弱研究领域。当前评价中对于不同等级的可恢复性判断大多缺乏实证，本项目以青藏公路走廊为依托，进行了环境因子评价分区，并在此基础上结合典型区域植被恢复工程的长期跟踪观测，验证各区域的植被的可恢复性，并提出适用的植被恢复工程技术，结果表明：该方法具有良好工程指导性，在青藏公路走廊带按照该方法划分的等级为3-5级区域，可实现植被有效恢复；纯自然恢复仅适用于4-5级区域，且要求边坡具有较好土质条件；在恢复难度大的2级区，采用适合的技术仍可将植被恢复到自然覆盖水平的80%以上，但不同技术措施、不同扰动区恢复效果差异大，边坡、护坡道、取土场恢复难度依次降低；客土喷播可加速植被恢复进程，并能在持久地维持在恒定覆盖水平，是适用于该区域的良好技术；由于可防止牲畜放牧，土工格室+喷播植被效果明显，基本可恢复到接近自然覆盖水平；由于工程结构受冻融毁坏，预制方格+喷播植被效果较差；披碱草、老芒麦、梭罗草、碱茅等植物为适应高寒区的优良植物。

关键词：植被恢复潜力，环境分区，青藏公路，生态工程

中图分类号：U417.2

Vegetation Restoration Potential Evaluation Based on Environmental Zoning During Road Construction: a Case Study of Qinghai Tibet Highway

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Abstract

The evaluation of vegetation restoration potential is the basis of the practice of vegetation restoration in the difficult area, which is mainly under research in the mine land reclamation while still remain weak in highway. In view of the current evaluation for different levels of restoration is still lack of empirical judgment, we carried a vegetation restoration potential zoning the Qinghai Tibet

Highway Corridor, based on the environmental factor zoning assessment, then summarized the tracking investigation data for typical restoration engineering, and verified the restoration potential grade, and put forward the suitable vegetation restoration engineering technology. The results show that this method has a good guide for the engineering, grade 3-5 area in Qinghai Tibet Highway Corridor according to the method, could be effective restored of vegetation; plain naturally restored vegetation applies only to the 4-5 grade area, which need the slope has good soil conditions; in the 2 grade area, which has difficulties being restored, proper measures also could make the cover of natural vegetation be restored for over 80%, whereas big restoration difference between technologies and road zones, with slope, slope embanking area, cutting land restoration difficulty decreased. Spraying soil can accelerate the process of vegetation restoration, and in the long-term to maintain a constant coverage level, which is a good technology for the region. Due to the prevention of livestock grazing, the effect of geocell + hydroseeding has obvious performance, and which could restore the vegetation near to a level of natural cover. As for the destroy of freezing and thawing, the prefabricated grid + hydroseeding has a poor effect; There are several plant species with good adaptation to the local environment which including Elymus dahuricus, and Thoreau grass, Alkaligrass plants etc

Key words: Vegetation restoration potential, environmental zoning , Qinghai Tibet Highway，eco-engineering

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基于BIM、物联网和5G技术建设"数字化高速公路"的策划和展望

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摘　要：本文从信息化的角度，论述了如何利用BIM、物联网和5G技术建设"数字化高速公路"和利用此项技术建设"数字化高速公路"的意义。提出了采用数字化建筑组件进行三维立体设计的方法和思维方式。并就"数字化高速公路"对人类未来发展的美好愿景进行了展望。

关键词：数字化高速公路、BIM、物联网、5G

Exploration and Planning of "Digitized Free Way" Base on the Technologies of Building Information Model, Internet of Things and Fifth Generation Mobile Communications Technology

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Abstract

This article expounds to bind the technologies of Building Information Model (BIM), Internet of Things (IoT) and Fifth Generation Mobile Communications Technology (5G) to design "Digitized Free Way" and its application value. Present the function and the way of thinks that use 3-D building model on general design of freeway industry. And describe the benefit of Digitized Free Way and greet opportunity of human on the future.

Key words: Digitized Free Way, Building Information Model, Internet of Things, Fifth Generation Mobile Communications Technology

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智能网联汽车体系结构与关键技术研究

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摘 要： 智能网联汽车（Intelligent Connected Vehicles，ICV）是无人驾驶技术的核心载体，产业链长，市场巨大，受到越来越广泛的关注。目前，国内外众多汽车厂商和信息企业都纷纷投向 ICV 的研发与测试，部分 ICV车型已进入量产阶段，而新的概念车型也陆续提出。本文主要针对新型 ICV 的发展现状与关键技术进行了探讨，从 ICV 智能化和网联化两个维度对 ICV 中涉及到的相关技术进行了分析，并进一步从信息处理的三个层次（感知层、决策层、控制层）构建了 ICV 发展过程中的关键技术体系结构。实现 ICV 的市场推广与普及应用，需要首先克服关键技术障碍，并实现多种技术间的相互支撑与融合。

关键词： 智能网联汽车； 无人驾驶；自动驾驶；车路协同系统

中图分类号：U495

Architecture and Key Technologies of Intelligent Connected Vehicles

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Abstract

Intelligent Connected Vehicles (ICV) are the core carrier of self-driving technology that attract more and more attention because of the long industrial chain and the vast potential in the market. At present, the majority of car manufactur-ers and information institutions all over the world have dedicated to the development and testing of ICV. Some ICV models have been on the stage of mass production, and the new concept vehicles have been put forward. In this paper, the current development and key technologies of new ICV are discussed and the related technologies of the ICV are analyzed from the two dimensions of intelligent and networked. Furthermore, the key technology architecture of ICV is constructed from the three levels of information processing (perception, decision and control). To achieve the popularization and application of ICV, it is necessary to overcome the key technical barriers and realize the support and fusion of various technologies.

Key words：intelligent connected vehicles; self-driving; autonomous car; cooperative vehicle infrastructure system

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Eco Approaching at an Isolated Signalized Intersection Under Partially Connected and Automated Vehicles Environment ECO

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Abstract

This research proposed an eco-driving system for an isolated signalized intersection under partially Connected and Automated Vehicles (CAV) environment. This system guarantees mobility while improving fuel efficiency and optimizes the entire traffic flow by optimizing speed profiles of the CAVs. The optimal control problem was solved using Pontryagin's Minimum Principle. Simulation-based before and after evaluation of the proposed design was conducted. Fuel consumption benefits range from 2.02% to 58.01%. The CO_2 emissions benefits range from 1.97% to 33.26%. Throughput benefits are up to 10.80%. The variations are caused by the market penetration rate (MPR) of CAVs and v/c ratio. No adverse effect is observed. Detailed investigation reveals that benefits are significant as long as there is CAV and they grow with CAV's MPR until they level off at about 40% MPR. This indicates that the proposed eco-driving system can be implemented with a low MPR of CAV and could be implemented in a near future. The investigation also reveals that the proposed eco-driving system is able to smooth out the shock wave caused by signal controls and is robust over the impedance from

conventional vehicles and randomness of traffic. The proposed system is fast in computation and has great potential for real-time implementation.

Key words: Eco-Driving, Isolated Signalized Intersection, Mobility.

Development of Agent-Based On-line Adaptive Signal Control (ASC) Framework Using Connected Vehicle (CV) Technology

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Abstract

In this study, we developed an adaptive signal control (ASC) framework for connected vehicles (CVs) using agent-based modeling technique. The proposed framework consists of two types of agents: 1) vehicle agents (VAs); and 2) signal controller agents (SCAs) including signal head sub-agent (SH-SA), information processing sub-agent (IP-SA), transition feasibility management sub-agent (TFM-SA) and decision making sub-agent (DM-SA). Within the communication range, each VA communicates with other VAs and SCA and transmits the estimation or prediction of its key statistics, such as position (at the lane level), speed, turning intention and anticipated time-of-arrival (TOA). Then the IP-SA may collect VAs' statistics and aggregate them into some critical metrics (e.g., queue length, delay, and time utilization rate) at the lane or movement level to support the signal control. With the constraints on phase transition feasibility (e.g., minimum green and movement compatibility), the DM-SA can determine in real-time if the current phase should be extended or switch to another phase. In addition, we proposed a new performance measure, called anticipated green utilization rate (GUR), to evaluate the system performance at traffic signals. Preliminary study in simulation validates the proposed ASC framework using an isolated intersection. The results showed that the ASC algorithm with anticipated GUR outperformed the fine-tuned fixed signal timings (with knowledge of hourly traffic demands) in terms of mobility and environmental sustainability by the range of 11% - 18% and 4% - 6%, respectively.

Key words: Connected and automated vehicles (CAVs), multi-agent system (MAS), adaptive signal control (ASC), environmental sustainability

Optimal Lane Sequence Guidance Based on Connected Vehicles

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Abstract

Connectivity among vehicles and infrastructure has great potential to improve the performance of today's Advanced Driver Assistance Systems (ADAS) in terms of mobility, safety and driving comfort. The aim of this study is to examine a specific connected vehicle application that assists with lane selection, i.e., finding the best lane route in terms of individual mobility improvements based on the lane-level traffic state prediction results. In this paper, both the Spatial-Temporal model (ST model) which utilizes spatial and temporal information of road cells and the Temporal model (T model) that only makes use of temporal information of road cells were used as traffic state prediction approaches. A comparative study was conducted between the ST-model based and the T-model based lane selection assistance systems. A comprehensive simulation study has been conducted under various scenarios, e.g. under different penetration rates and traffic volumes. The evaluation results revealed several interesting findings, including: 1) individual travel time has been decreased by over 20% by ST-model based lane selection assistance systems when compared with baseline; 2) the application could be implemented under conditions where the penetration rate of communication-capable vehicles is as low as 20%, which means the application can be effective even under early deployment of Connected Vehicle (CV) technologies; 3) the application has obvious mobility benefits on decreasing individual travel time especially under very heavy traffic condition.

Key words: Connectivity, lane-level traffic prediction, temporal-spatial discretization, optimal lane sequence guidance, travel time per trip

Research on Driving Safety and Avoiding Strategies on S-curved Road Segments Based on Vehicle Dynamics

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Abstract

In order to explore the causes of accidents in the curved road segments, the corresponding line design schemes and safe driving strategies have been proposed based on the vehicle safety response analysis. First, use the road design software HintCAD and the Adams/Car Road Builder module to build an actual 3D roadway model, including three successive reverse curves and one S-Curve with a small radius. Then, simulate the conditions of vehicles driving along a curved road and avoiding (the vehicles driving at the opposite direction) on curved road based on the Adams/Car and by using the human-vehicle-road collaborative simulation system. The control strategy of driving along the centerline of a curved road at a constant speed is adopted. The adverse circumstances to driving (namely circumstances prone to arouse accidents) will be analyzed from various vehicle dynamics indexes, including the lateral acceleration of tires, yaw rate, steering wheel angle and speed. In the vehicle collision avoidance simulation, it is important to consider the impact of the selection of speed and avoidant path on driving safety. The results show that: the radius of curve, easement curve length and superelevation are the main factors affecting the driving safety on a curved road; the vehicle is likely to have a sideslip when the sideway force coefficient is close to the tire-road friction coefficient. This is consistent with the existing road design theories. Therefore, it is necessary to set easement curves, increase the radius of curve and add superelevation of curve whenever possible on low-grade highways. In case of avoiding on curved, as the outside-lane avoiding may arouse accidents, so, it is necessary to avoid in advance, and it is important to return to the road centerline slowly after the avoiding. Meanwhile, decreasing

the vehicle speed appropriately in the curved segments is conducive to driving safety.

Key words: human-vehicle-road； avoiding on curved； S-curve； road safety； dynamics

浅谈高速公路沥青路面积水安全
隐患治理的措施

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摘 要：本文通过对运营高速公路沥青路面积水治理实践，阐述了其技术措施和经验，供其他类似高速公路运营机构借鉴与应用。

关键词：高速公路；沥青路面积水；治理

Discussion on Measures of Preventing Hidden Dangers of Waterlogging in Expressway Asphalt Pavement

Abstract

this article through to operating highway asphalt area of water management practice, expounds the technical measures and experience to provide reference for the other similar highway operations and applications.

Research on Speed Limit Value Model and Evaluation Method of Urban Arterial Road

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Abstract

To decrease the probability or severity of traffic accidents, improve traffic capacity of road and ensure the traffic moving in high-efficiency and safe manner, speed limit is always the important traffic management method of urban arterial road. On the basis of detail analysis of current speed limit value determination method, multielement method is proposed in the paper. Firstly, safe speed for alignment and stable traffic flow is determined to be as base value. Then exit-entrance amount, the width of the lane, interference degree from wayside and surface condition of the road are taken into consideration as correction factors. Thus multielement speed limit model is established. Then speed scatter and ratio of maximum-minimum of car-truck are put forward as elevation index. At last, a project example is provided to prove the method.

Key words: Traffic engineering, speed limit, multielement, speed scatter

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A Method for Identifying Hazardous Segments of Mountainous Highways Based on a Fuzzy Expert System

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Abstract

In order to identify hazardous segments of newly built mountainous highways, decision-makers require assistance to determine the sections that may pose risks to travelers, thereby enhancing the level of road safety management and capital utilization efficiency. In this research, traffic accident economic losses (TAEL) are used as evaluation indices to characterize 35 horizontal curve sections of roadway as research objects. These highway sections are divided into five levels based on their evaluated level of risk. With the effects of multiple factors and the characteristics of uncertainty, the theories of mathematical statistics and fuzzy expert systems (FES) were used to determine the factors contributing to hazardous segments of mountainous highways (HSOMH). According to accident data and expert experience, the membership functions and fuzzy rule base were decided; the method for identifying hazardous segments of mountainous highways (IHSOMH) based on the FES was established. Using this method, the risk values of the 35 groups of horizontal curve sections were obtained; good results were achieved using the method to identify the HSOMH by examples. The results showed that the horizontal radii, slopes, and declination angles of the horizontal curves greatly affected the HSOMH classification. The results obtained by FES agreed overall with actual accident data.

Key words: Mountainous Highways; Fuzzy Expert System (FES); hazardous segments of mountainous highways (HSOMH); identifying hazardous segments of mountainous highways (IHSOMH)

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多功能应急保障车设计应用方案

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摘　要：为了提升公路应急救援综合能力，保障救援机械高效运转，开发了一种多功能应急保障车，主要应用于冬季大型应急救援机械的辅助启动，其他还可用于应急照明及日常照明；公路野外施工或救援现场一般用电及办公设备的供电；有、无电源场所为其他（车载）蓄电池进行充电；其他用电设备如警报器、LED指示牌、扩音器、探照灯等的扩展使用。

关键词:多功能；应急保障车；方案

Design and Application Scheme of Multifunctional Emergency Vehicle

Abstract

To improve the comprehensive ability of highway emergency support and high efficient performance of support machinery, a multifunctional emergency support vehicle has been developed. It is mainly applied to the auxiliary start of large emergency support machinery and emergency illumination and general illumination. In addition, it also supplies general electricity for highway outdoor construction, rescue scenes and office facilities. Moreover, the support vehicle charges electricity to other storage battery in the place with or without electricity. The other equipment includes alarming apparatus, LED indicator board, helicopter and searchlight.

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EPON技术在高速公路视频监控中的应用

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摘 要：为了分析与探讨EPON技术应用于高速公路视频监控的可行性，对EPON技术原理进行分析，并阐述高速公路视频监控中EPON技术的结构，对EPON技术应用与高速公路视频监控中的问题与措施展开论述。OLT设备在通信站内部采用以太网的方式向高速公路传输平台连接，以此使其和监控平台通信功能得以实现，在高速公路视频监控互联网传输中较为适用。高速公路视频监控中有效组合应用视频技术和EPON技术，对EPON技术的实际应用价值予以明确，为我国高速公路视频监控传输建设的有效性与可行性鉴定良好基础。

关键词：EPON技术；高速公路；视频监控；应用

Application of EPON Technology in Expressway Video Surveillance

Abstract

in order to analyze the feasibility and the application of EPON technology in Expressway video surveillance, the principle of EPON technology are analyzed, and described the structure of EPON technology of highway video surveillance, discusses on the problems and measures of application of EPON technology in video surveillance and highway. The OLT device is connected to the highway transport platform in communication station using internal Ethernet, so that the communication function is realized and the monitoring platform, are suitable for the video monitoring Internet transmission. The effective combination of video technology and EPON technology of highway video surveillance, EPON technology application value to be clear, for the effectiveness and feasibility of the appraisal foundation construction of our country highway video surveillance transmission.

Key words: EPON technology; expressway; video monitoring; application

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高边坡施工安全动态风险评估模型

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摘　要：为有效量化高边坡施工安全风险，动态跟踪风险源的变化，提出一种高边坡施工安全动态风险模糊综合评估方法，分为勘察设计阶段风险预评估、开工前总体风险评估及施工过程中专项动态风险评估。利用风险传递路径对三阶段的风险因素进行辨识分析，构建风险指标体系，将德尔菲法与层次分析法相结合确定各评价指标的权重，运用模糊风险理论计算各指标隶属度，建立了模糊综合评估模型，并给出了三阶段风险控制流程图。实例验证结果表明：高边坡施工安全动态风险模糊评估方法能够有效的进行风险溯源，在掌握高边坡施工现场动态数据信息的情况下，应用该方法可以获得较好的风险评估结果。

关键词：高边坡；施工安全；动态风险评估；模型

中图分类号：**U416.1+4；**

Dynamic Risk Assessment Model for High Slope in Construction Safety

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Abstract

In order to effectively quantify the construction risk of high slope and dynamiclly trace risk changes, a fuzzy comprehensive dynamic risk assessment method of high slope in construction safety was proposed, which includes pre-assessment in exploration and design stage, overall risk assessment before construction and special dynamic risk assessment in construction. The risk transfer path was used to identify risk factors, the risk index system was established, each index weight was determined by combining Delphi method and Analytic Hierarchy Process method, the fuzzy membership was calculated through fuzzy risk theory, and thus the fuzzy comprehensive assessment model was established, the risk control process was also put forward. A practical example was verified, it is shown that the risk source can be effectively traced by the risk assessment method of three stages and in

mastering dynamic construction site data, better safety assessment results can be achieved.

Key words: high slope; construction safety; dynamic risk assessment; model

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A Robust Stochastic Optimization Approach for Location-allocation Problem in Emergency Logistics

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Abstract

The location of relief distribution centers and allocation of relief commodities are two of the most challenging issues in emergency logistics. This paper develops a multi-objective robust stochastic optimization model to determine the optimal location-allocation for emergency logistics problem considering the priority of demand points, the equity level between two demand points and the average removal time and cost for each relief commodity. In our model, not only demand, but also supplies and the state of roads in the post-disaster phase are considered as uncertain parameters. The proposed model simultaneously attempts to minimize the average of the weighted response times and the sum of the expected value and the variance of the total cost in the preparedness and response phase. Considering the global evaluation of two objectives, a compromise programming model is formulated

and solved to obtain a non-dominating compromise solution. A case study of our robust stochastic optimization approach for disaster planning for the Great Sichuan Earthquake in China is presented to demonstrate that the proposed model can help in making decisions on both facility location and resource allocation in cases of disaster relief efforts.

Key words: emergency logistics; preparedness and response phase; location-allocation problem; robust stochastic optimization

The Comparative Research on Two Equivalent Mechanical Models of Liquid Sloshing into Tanks

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Abstract

Using Quasi-Static model, move trajectory of mass center of liquid in the tank was used to solve, found that mass center of liquid trajectory is the same as the tanks length-width ratio of the ellipse. According to the principle of mechanical equivalence, two kinds of impact equivalent mechanical model of liquid sloshing into tank is established, the spring - mass model and the pendulum model, and the two models of relevant model parameters are derived. The simulation result is that the equivalent mechanical model can more accurately describe linear motion phenomenon of liquid sloshing. For tank liquid vibration frequency division, the fluid dynamics simulation results compared with ANSYS FLUENT software under the condition of the corresponding test results, it is concluded that the equivalent mechanical model is more suitable for liquid vibration frequency range. Using the simulated test bench to verify two kinds of equivalent mechanical model, the results show that both equivalent mechanical models can be used to describe tank liquid sloshing phenomenon, but the pendulum model is more suitable.

Key words: tank truck; roll stability; liquid sloshing; Equivalent mechanical model.

城市应急救援车辆路径优化研究

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摘　要：城市突发事件发生时，救援车辆能否快速、准确、安全地到达事发现场是决定事故造成的损失能否得以降低的重要因素。本文针对突发事件下短时间内道路通行能力减小，城市道路阻塞等特点，修订救援行程时间模型，并引入路段连通可靠性和路段安全性等指标，建立带约束的多目标路径优化模型，继而结合惩罚函数实现模型单目标化，运用Dijkstra算法获取动态最优救援路径，最后通过实例对该模型和算法有效性进行验证。

关键词：应急救援车辆；行程时间；路段连通可靠性；路径优化

中图分类号：U238

Routing Optimization for Urban Emergency Rescue Vehicle

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Abstract

When an emergency occurs, reaching the scene quickly, accurately and safely for emergency vehicles is extremely important to decide whether it is able to reduce losses caused by disasters. In this research, considering of road capacity decline, urban roads congestion and other characteristics in a short time under sudden disasters, the rescue travel time model is improved. Then indicators including connectivity reliability and security of road section are imported to build a multi-objective path optimization model with constraints. The idea of Penalty Function method is applied for the model deformation and the traditional shortest path algorithm, Dijkstra algorithm is used to obtain the optimal path. Finally an example is presented to illustrate the effectiveness of the proposed model and the algorithm.

Key words: Emergency Vehicle; Travel Time; Connectivity Reliability of Road Section; Path Optimization

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Analysis of Asphalt Pavement Skid Resistance Based on
Friction Contact Theory

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Abstract

The skid resistance in pavement analysis and vehicle driving safety was usually described as the coefficient of friction, which was decided by the contact mechanics between tire rubber and pavement at the same time. In order to investigate the characteristics of tire-road skid resistance and analyze the interaction between rubber and asphalt pavement, rubber friction theory developed by Presson was introduced with the fractal features of asphalt pavement to build the tire-road friction model. The relation between sliding velocity

and friction coefficient was achieved in this study, which is verified by previous study. A new method is proposed to predict the fitting parameters in Savkoor friction model. Furthermore, asphalt pavement with larger fractal dimension is recommended to achieve higher skid resistance. The value of upper wave vector in the theory is recommended in this paper, and the contacting area ratio is calculated on each scaling length.

Key words: Skid Resistance, Tire-road Coupling, Rubber friction theory, Energy dissipation, Fractal Dimension

冬季高速公路滑溜路面应急救援对策研究

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摘　要： 在寒冷的多雪地区，石灰、砂、碎石及防冻剂作为处理高速公路滑溜路面的应急对策，导致的管理成本增加和环境污染破坏等负面作用已不容忽视，而且在温度较低积冰的道路上，防冻剂不足以改善冬季冰雪路面的摩擦系数，为了提高冬季高速公路的安全运营效率，提出快速有效抵御高速公路冰雪滑溜路面的应急处治措施，以供公路相关部门参考。

关键词: 冬季；环境；高速公路；冰雪路面；应急对策；

中图分类号：U238

Research on Emergency Rescue Countermeasures of Winter Highway Slippery Pavement

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Abstract

Management costs and environmental pollution cannot be ignored by which are caused of rescue countermeasures on highway slippery road using lime, sand, breakstone and antifreezing agent as antiskid material.In addition,antifreezing is not enough to improve the coeffcient of friction of low temperature icing pavement.To enhance the operation efficiency of winter highway safety,this paper proposes a quickly and effectively emergency treatment to resist slippery ice highway pavement and provides reference to relavant departments.

Key words： winter；environment；highway；icing pavement；emergency treatment；

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影响路面滚动阻力的因素研究概述

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摘　要：滚动阻力是能量衰减的一种形式，它是由轮胎和路面的相互作用引起的。从经济和环保的角度来看，这项特性是轮胎和路面最重要的特性之一。降低滚动阻力可以极大程度上减少车辆的燃油消耗，减少由于轮胎、路面相互作用产生能源消耗，从而降低二氧化碳排放量和提高能源利用率。本文总结了欧洲范围内对于滚动阻力研究的基本参数、作用机制、研究方法及研究结果，旨在提出关于轮胎和路面滚动阻力相互作用的基本认识，希望能够为国内开展滚动阻力的研究提供有益的参考价值。

关键词：滚动阻力；参数；路面

Summary of Research on the Influence Factors of Rolling Resistance on Pavement

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Abstract

Rolling resistance is a form of energy attenuation, which is caused by the interaction of tires and pavement. From the point of view of economy and environmental protection, this feature is one of the most important feature of tires and the road. Reduce the rolling resistance can greatly reduce the vehicle's fuel consumption and energy consumption due to the interaction of tires and pavement, thereby reduce carbon dioxide emissions and improve energy efficiency. This paper summarizes the basic parameters, mechanism, research methods and research results of rolling resistance research in Europe, designed to present a basic understanding of the rolling resistance which interaction between tire and pavement and hope to provide a useful reference value for domestic research on rolling resistance.

Key words：rolling resistance; parameter; pavement

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基于车-路相互作用的路面不平度与车辆平顺性研究

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摘　要： 为研究车-路相互作用下路面不平度对车辆行驶平顺性的影响，本文基于分形几何的原理，利用W-M函数得到不同仿真工况下的路面不平度模型数据，并通过车辆动力学仿真软件CarSim建立车-路系统动力学仿真模型，分析不同分形维数和尺度参数条件下车辆总加权加速度均方根值的变化。仿真结果表明，随着分形维数D的增加和尺度参数G的减小，均方根值呈减小趋势，行驶趋于平顺。特别地，随着D值的增大，均方根值的减小速率由大变小，甚至出现极小值。当D值小于1.70，G值大于5E-4时，路面过于不平整，车辆无法正常行驶。当D值大于1.80，G值小于1E-3时，车辆行驶较为平顺。因此，为了提高车辆行驶的平顺性，建议尽可能D值大G值小，D值宜大于1.70，G值宜小于1E-3。

关键词： 不平度；分形几何；Carsim仿真；车-路系统；平顺性

A Study on Pavement Roughness Based on Vehicle-Road Interaction and Ride comfort

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Abstract

In order to study the effect of pavement roughness on vehicle ride comfort under vehicle-road interaction, the data of pavement roughness model can be obtained by W-M function simulation under different situations based on fractal geometry. Through the vehicle dynamics simulation software CarSim, the simulation model of vehicles - road system dynamics is established for analysis of the vehicle total weighted acceleration RMS under conditions of different fractal dimension and scale parameters. The simulation results showed that with the increase of fractal dimension D and the decrease of the scale parameter G, the root mean square value showed a decreasing trend and the ride comfort tended to be better. Especially, with the increase of the D value, the rate of the root mean square value decreases was from the larger to the smaller and the RMS even reached the minimum

value. Besides, when the D value was less than 1.70 and the G value was greater than 5E-4, the road surface was too uneven to make vehicles run normally. When the D value is greater than 1.80, and the G value is less than 1E-3, the vehicle could run smoothly. Therefore, the fractal dimension D is recommended as much as 1.70, while the G value should be less than 1E-3.

Key words:　roughness; fractal geometry; Carsim simulation; vehicle-road system; ride comfort

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基于承载力分析的公路隧道结构健康度评价方法

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摘 要：隧道投入运营后，受周边工程活动、雨水下渗等因素影响容易引起围岩裂化，以致拱部松动荷载增加，衬砌出现较大变形、甚至开裂，严重影响结构继续服役能力，有必要合理评价结构健康状态，提出相应的维修处治方案，延长其使用寿命。目前针对松动荷载作用下衬砌结构健康状态评价方法的研究相对较少，已有成果多是采用定性评价指标，缺乏结构剩余承载力的量化评价依据，不利于维修处治方案的确定。本文利用室内模型试验及数值仿真手段，研究不同围岩条件下结构受力变形规律及破坏特征，探明松动荷载作用下结构损伤演化机理，提炼结构健康评价关键指标，制定基于承载力的健康度分级标准，指导结构健康状态的评价工作。通过研究，提出：1）拱顶松动荷载下衬砌破坏过程分为三个阶段：以拱顶开裂、主裂缝张开为分界点，破坏时拱顶内侧、拱腰外侧钢筋拉断，形成三铰拱体系；2）衬砌结构承受相同荷载100kPa时，抗力系数1.58MPa/m的工况拱顶下沉3.3cm，抗力系数200MPa/m的工况拱顶下沉0.23cm；抗力系数从1.58MPa/m增大到200MPa/m时，极限承载力从196kPa增大到1840kPa；3）以衬砌开裂、拱顶下沉3cm、拱顶钢筋屈服、拱腰钢筋屈服、拱顶钢筋拉断为关键节点，制定了衬砌结构健康度的5级划分标准，并以拱顶下沉及边墙收敛作为简易评价指标。

关键词：隧道；衬砌结构；健康度；松动荷载；承载力

中图分类号：**TU47**

Health Evaluation Method of Highway Tunnel Structure Based on Bearing Capacity

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Abstract

During the tunnel operation periods, large displacement and cracking are occurring in lining, seriously impacting on the service abilities of structure ,because of the increase of loosening rock pressure caused by the construction activities, the rain infiltration, etc，therefore，reasonable structural health status evaluation and reinforcement countermeasures are needed to prolong its service life. At present, there are few study on structural health status evaluation under loosening rock pressure, most of which are using qualitative assessment methods with the lack of quantitative assessment on residual bearing capacity of structure and having difficulty in determining maintenance options. Through indoor model test and finite element analysis software , considering the different grade of surrounding rock, according to the studies on the deformation rules and failure mode, this paper proves the structure damage evolution mechanism, extracts the key points of health status evaluation, sets classification standard for health grade based on the ability of bearing capacity and guides the health assessment. Through the research, we can draw the following conclusions. 1) the lining destruction procedure can be divided into three stages: primary loading to lining crack, lining crack to main crack opening, main crack opening to lining failure. When lining failure happened, the steel on the inside of arch crown and on the outside of arch haunch are occurred with tension failure, at the same time , the structure turned into three-hinged arch. 2)Under the same load, the higher rock level, the less the structure deformation is. Arch crown settlement are 3.3cm with resistance coefficient 1.58MPa/m and 0.23cm with resistance coefficient 1.58MPa/m under the same load of 100kPa. Resistance coefficient increases from 1.58 MPa/m to 200 MPa/m, the load capacity increases from 196 kPa to 196 kPa; 3) The health grade is divided into 5 level, based on cracking of concrete, arch crown settlement reaching to 3 cm, arch crown steel yield, arch haunch steel yield and arch crown steel break, besides, the assessment is based on the settlement of arch crown and convergence of side wall .

Key words: tunnel; health grade; loose load; bearing capacity

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An Analysis on Traffic Safety of General National Trunk Highway

(For Presentation Only, without Full Paper)

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Abstract

Pavement friction and texture characteristics are important aspects of road surface safety. Many different types of equipment have been developed and used to measure these properties. This paper investigates the suitability of using several novel texture indicators for skid resistance analysis. First, discrete wavelet transform is implemented to decompose pavement macrotexture data, which were collected from a high-speed profiler on the six high friction surface treatment (HFST) sites in Oklahoma, into multiple wavelengths. The Total Energy (TE) and Relative Energy (RE) are calculated as indicators to represent macrotexture characteristics at various wavelengths. The macrotexture energy within wavelengths from 0.97 mm to 3.86 mm contributes positively, while the energy within wavelengths from 15.44 mm to 61.77 mm shows negative impacts on pavement friction collected using a Grip Tester. Second, recognizing that Mean profile depth (MPD) is a 2-dimentioal (2D) indicator, five categories of 3-dimensional (3D) areal parameters are explored to characterize pavement texture attributes. Pavement texture and friction data are collected in parallel at predefined locations on the Long Term Pavement Performance (LTPP) Specific Pavement Study 10 (SPS-10) in Oklahoma via a portable ultra-high resolution 3D laser scanner and a Dynamic Friction Tester (DFT). Correlation analyses among the twenty-four 3D texture parameters are conducted to exclude those who exhibit strong correlations. The core material volume and the peak density are identified as the most influential macro- and micro-texture parameters which exhibit fairly good correlation with DFT friction data at high- and low-speed. Subsequently, multivariate linear friction prediction models are developed incorporating the novel texture indicators. The results indicate those texture parameters could provide better alternatives to characterize pavement surface texture attributes with respect to the pavement friction performance.

普通国省干线公路通车初期交通安全研究

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摘　要：本文首先介绍了课题研究背景，并从人、车、路及环境等方面总结归纳了普通国省干线公路通车初期交通事故的成因，最后提出了普通国省干线公路通车初期的交通安全改善对策。

关键词：背景；事故成因；改善对策

An Analysis on Traffic Safety of General National Trunk Highway

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Abstract

this paper firstly introduces the background. Then based on six traffic accidents of S270 in Pizhou, this article analyzes causes of those accidents according to several factors. furthermore, this paper summarizes some improvement measures of traffic safety.

key words: background; causes；improvement measures

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Risk Assessment of Operation Safety of Highway Bridges in China

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Abstract

Highway bridges, as significant links of road networks, can provide efficient and convenient transportation service, while suffering from negative effects under adverse weather conditions. Based on characteristics of highway bridges, this paper attempts to identify their operation risk and the mechanism of various risk factors. Moreover, two mathematical models including the Expert Evaluation Method and the Ordered Logit Model are used to analyze the levels of accident severity

and their corresponding probabilities. Finally, according to the Sutong Bridge, the levels of accident risk in rainy days were calculated and the corresponding countermeasures were proposed to improve operation safety.

Key words: Operation Safety, Risk Assessment, Expert Evaluation Method, Ordered Logit Model

Evaluating the Impacts of Traffic Flow Conditions on the Risks of Secondary Crashes on Freeways

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Abstract

This study aimed to develop a secondary crash risk prediction model on freeways using real-time traffic flow data. The used crash and traffic data were collected on the I-880 freeway for five years in California, United States. The random effect logit model was then used to link the probability of secondary crashes with the real-time traffic flow conditions, primary crash characteristics, environmental conditions, and geometric characteristics. The results showed that real-time traffic variables significantly affect the likelihood of secondary crashes. These traffic variables include the traffic volume, average speed, standard deviation of detector occupancy, and volume difference between adjacent lanes. In addition, the primary crash characteristics, environmental factors and geometric factors also significantly affect the risks of secondary crashes. These results have the potential to be used in advanced traffic management systems to develop proactive real-time traffic control strategies to prevent the occurrences of secondary crashes on freeways.

Key words: Secondary crashes; Real-time; Traffic flow; Random effect logit model

探讨设计施工一体化模式下的公路景观营造
—以贵州省S313线册亨至安龙公路改建景观营造为例

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摘　要：本文总结了设计施工一体化模式在国内外的发展现状，概括了设计施工一体化模式的优缺点，并结合贵州省S313线册亨至安龙改建公路景观营造，阐述了设计施工一体化模式下公路景观营造的优势，进而提出适合我国公路景观建营造的设计施工一体化模式的建议，这在国内同行业研究报道中尚少，抛砖引玉，以期为公路景观营造提供新的思路。

关键词：设计施工一体化；公路绿化；S313线；　景观营造

Take the Landscape Construction of S313 Road from Ceheng to Anlong in Guizhou Province for Example to Discuss Landscape Construction Under the Mode of Integrated Design and Construction

Abstract

This paper summarizes the status of the design and construction integration model at home and abroad, generalizes the advantages and the disadvantages of highway landscape construction under the mode of integrated design and construction.Combined with Guizhou province S313 line Ceheng to Anlong road landscape construction, this paper elaborates the superiority of landscape construction under the mode of integrated design and construction, and puts forward some suggestions on the integration of design and construction for highway landscape construction in China, to provide new ideas for the highway landscape construction. This is still less in the domestic industry research reports.

Key words: Design and Construction Integration; Highway Greening; S313 Line; Landscape Construction

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探索普通国省干道绿色公路景观建设新方法

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摘 要：随着国家公路网的日益完善以及交通部绿色公路建设指导意见的颁布，普通国省干道绿色公路建设受到广泛关注，本文在总结国内外绿色公路发展现状的基础上，结合贵州省S313线册亨至安龙绿色公路"畅安舒美"景观建设实例，提出了普通国省干道绿色公路景观建设的要求，阐述了普通国省干道绿色公路景观建设的思路及方向，为普通国省干道绿色公路景观建设提供参考，这在国内外同行研究报道中尚少。

关键词：国省干道；　绿色公路；景观建设

Study on the New Way of National Trunk Road Green Road Landscape Construction

Abstract

With the national road network increasingly perfect and the Ministry of Communications green road construction guidance issued, the provincial highway green road construction has been widespread concern. On the basis of summarizing the present situation of green highway development both at home and abroad, this paper puts forward the requirements of the construction of green highway landscape in the national highway, expounds the thinking and direction of green highway landscape construction in national trunk roads, to provide reference for the construction of green highway landscape. This is still less in domestic and foreign peer research reports.

Key words: State Road　Green Road　Landscape Building

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Uniformity Evaluation on Paving Temperature and Compaction of Asphalt Pavement

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Abstract

In order to further improve the uniformity monitoring level of asphalt pavement during the construction process, and to explore the correlation between the temperature uniformity and the compaction uniformity. Firstly, the infrared thermal imaging system was adopted to capture the thermal images of asphalt mixture at paving stage. Thermal images are utilized to calculate the temperature parameters (average value, range, and coefficient of variation) to evaluate the temperature uniformity. Secondly, compaction values were measured by the non-nuclear density meter, the difference in the pavement compaction at different section is discussed, the representative compaction, qualified rate, and variation coefficient are given. Finally, the correlation between the paving temperature uniformity and compaction uniformity is studied. The results show that the pavement compaction quality is jointly influenced by temperature parameter, actual condition of construction and construction technology, but after ensuring the temperature uniformity of the asphalt mixture, it is more important to conduct the compaction work strictly by following the construction specifications to improve the quality of compaction; In macroscopic level, the uniformity of asphalt pavement compaction is highly correlated with its temperature uniformity. In the microscopic level, there is no strict position correspondence between them except for the position with significant temperature variation.

Key words: asphalt pavement, paving temperature uniformity, compaction uniformity, correlation analysis, inferred camera, non-nuclear density meter

Evaluating Disaster Relief Capability of Village Road Using Cloud Model

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Abstract

Road disaster relief capacity has great impacts on post disaster reconstruction and disaster relief. In order to improve the disaster relief capability of village road, this study analyzes the influencing factors of disaster relief capability for village road, and constructs the evaluation index system of village road's disaster relief capability from three dimensions including environmental conditions, engineering construction and emergency maintenance. Considering the fuzziness and randomness of evaluation index, cloud model is used to calculate the weight of evaluation index based on expert scoring. Finally, Tuyang village is selected as a case study, and the disaster relief abilityof village road is evaluated. The case study verifies the feasibility of evaluation method, and provides quantitative criteria for improving the disaster relief capability of village road.

Key words: village road; disaster relief capability; evaluating method; cloud model; disaster managemet

红砂岩地质桥梁桩基质量缺陷与施工技术探讨

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摘 要：阐述声波透射法进行桩基质量检测的基本原理，介绍了进行检测数据处理及桩身质量判定的特征指标临界判断值。对红砂岩地质特殊的物理力学性质进行了概括总结，结合工程实践，剖析红砂岩地质条件下常见的桩基质量缺陷，对红砂岩地质条件下施工技术要进行了总结。针对某高速某大桥2#墩3#桩基出现的断桩质量缺陷，结合现场施工情况，总结了预防断桩质量事故出现的技术要点。同时，对桩基塌孔质量问题出现的原因及如何预防进行了归纳。

关键词：桩基础；声波透射法；红砂岩；断桩；塌孔

中图分类号：U 238

Discussion on Quality Defects and Construction Technology of Bridge Pile Foundation Under Red Sandstone Geological Condition

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Abstract

In this paper, basic principles of using acoustic transmission method to detect the quality of pile foundation are described, the critical judgment value of the characteristics which is used to process the detection data and determine the quality of the pile body is introduced. The physical and mechanical properties of red sandstone are summarized. Based on engineering case, common defects of pile foundation quality under red sandstone geological conditions are analysed, and the construction technology under the red sandstone geological conditions is summarized. Aiming at the broken pile in 2-3 pile foundation of a bridge of Xing Gan High speed, key technology and method of preventing the quality accident of broken piles are summarized combined with the construction of the scene. At the same time, the causes and prevention of the quality problems of pile foundation hole collapse are

generalized.

　　Key words：pile foundation; transmission method; red sandstone; breaking pile; hole collapse

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浅论我国公路建设质量问题及对策

Discussion about the Issues in Terms of Construction Quality in China, as well as the Relative Solution

李长治

摘 要：公路建设是交通部门的一项重要职责，而质量问题更是重中之重，本文试从影响公路建设质量的因素进行剖析，进而提出提高公路建设质量的对策与建议，最终为了保证提高公路建设质量，确保公路畅通。

关键词：交通工程　公路建设　质量问题　对策

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Quantitative Analysis-based Method for Perception of H2S, Explosion and Environmental Pollution Risks in Sichuan Gas Field

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Abstract

Nowadays, paroxysmal crisis incidents emerge in frequently, which bring serious psychological influence. This study takes risk perception as important psychological factor of research in risk events. We selected Sichuan Puguang gas field as research area, three high-probability risk events, including gas leak, fire and explosion and sudden environmental pollution accidents, as the key risk events, aimed at the risk perception process, risk perception of the impact factor analysis and quantitative calculation of perceived risk. We concluded that people consider these three risks as fatal and unpredictable. Based on different ages and psychological states, the elderly tend to be classified as risk refusing type, the middle-aged people tend to be risk controlling type, the young people and children tend to be safe type

and unconscious type. Respectively, using the risk perception quantitative calculation model, the risk perception quantitative value calculation of three types was completed. The measured value was found to be higher than actual risk events value, which indicates that local residents generally feel that risk events make a major impact on them, and their emotional level had already exceeded the expected level of the governor decision-maker.

Key words: Risk management ; Risk perception; Quantitative analysis; Puguang gas field; Types of crowd

The Impacts of Extreme Weather on Rail and Road Transport Network, Evaluating the Vulnerability: The Case of Devon & Cornwall, UK

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Abstract

Transport infrastructures have been affected by climate change in different ways, for instance, flood caused by an increase of sea level, heavy snow, as well as other extreme weather. These kinds of adverse weather will definitely reduce the stability, quality and availability of all modes of transport, including roads, rail,waterways and so on. Built on a systematic review of existing literature, this paper intends to focus the relevant impacts of extreme weather on transport system, furthermore, evaluating the vulnerability for future improvement. Through the case study of Devon & Cornwall, this paper will give out more specific results and analysis about the situation in the UK.

Devon is known as Devonshire, a county of England. It is part of South West England, bounded by Cornwall to the west, Somerset to the northeast, and Dorset to the east. Devastation result from

Devon and Cornwall storm in 2014, has caused extensiveconcern all over the world. Particularly, in Dawlish, transportation infrastructure was disrupted badly. This case will be discussed in detail in later part of this dissertation, along with some theoretical and practical reflections.

Key words：Transport Infrastructure, Climate Change, Vulnerability, Disruption, Devon & Cornwall

A Conceptual Framework of Complex Multi-attribute Large-group Decision-Making for Infrastructure Sustainability

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Abstract

The sustainable success of public major infrastructure projects is becoming a dominant driving force of the new-type advancing urbanization boom in developing countries globally. Infrastructure Sustainability (IS) evaluation among project design alternatives with multi-level and multi-dimensional attributes is essentially a Complex Multi-Attribute Large-Group Decision-Making (CMALGDM) problem conducted by multidisciplinary decision-makers with diversified backgrounds, preferences, and expertise in integrated sustainable design stages. This research, therefore, designs a system of multiple and hierarchical IS attributes for CMALGDM by exploring sustainability dimensions from Buildability, Maintainability, Adaptability, and Coordinability respectively. In addition, this research develops a conceptual framework of CMALGDM for IS through bringing together intuitionistic fuzzy theories for determining decision-makers' and attributes' weights, aggregating heterogeneous decision-makers' information, and prioritizing IS alternatives. More significantly, it is original that the CMALGDM framework integrates decision-makers' interdisciplinary properties and infrastructure projects' characteristics in determining critical decision-making parameters. Prospectively, the main findings of this research can contribute to the knowledge and practice in the field of infrastructure project management

by demonstrating how to define multiple and hierarchical IS dimensions with a systematic taxonomy and how to manage IS decision-making information represented by large-group interdisciplinary stakeholders.

Key words: Complex Multi-Attribute Large-Group Decision-Making (CMALGDM); Infrastructure Sustainability (IS); Information Integration; Intuitionistic Fuzzy Environment

Agent-based Simulation for Monitoring Critical Path Change in Nuclear Power Plant Outages

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Abstract

Nuclear power plant (NPP) outages involve large number of maintenance and repair activities with tight schedules, complex teamwork and zero-tolerance for accidents. These features of NPP outages call for a real-time, robust, effective workflow control to ensure the safety and productivity while avoiding resource wastes. In nuclear power plant (NPP) outages, the critical path method (CPM) is the popular method used to identify important tasks in the workflow and coordinate resource allocations among tasks. However, CPM has limitations in coordinating tight outage schedules that involve high uncertainties and frequent changes in packed workspaces. In outage schedules, the critical path or even task sequences could change due to newly discovered tasks, human errors, or uncertain resource availabilities. Moreover, tight schedules and packed workspaces cause high probability of error and uncertainty propagation throughout tasks that share the limited time, space, and resources on job sites, further increasing the probability of critical path shifting. Therefore, properly modeling and forecasting the changes of critical paths in outages schedules considering the influence of various uncertainties will help predict and control the outage productivity and avoid propagative incidents and accidents.

Object-oriented and agent-based modelling (ABM) and simulation methods can help predict impacts of various uncertainties on task sequences and process efficiencies considering complex interactions between human, workspace, and tasks. This paper presents an ABM simulation platform that quantitatively predict how uncertainties of task durations influence critical path changes in outages. Object-Oriented and agent-based modelling makes this platform flexible and extensible – modifying parameters, types of events and objects in a defined simulation model could result in new simulation models represent different scenarios and workflows. Such extensibility and flexibility of this platform could bring a broad benefit for different projects that are similar as outages.

Key words: Nuclear power plant outages, critical path method, agent-based modelling, progress, monitoring

Capturing Time Effect of Pavement Carbon Footprint Estimation in the Life Cycle

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Abstract

Pavement carbon footprint in the life cycle is currently estimated by aggregating the greenhouse gases (GHGs) together despite discrete emission timings, leading to a loss of temporal information in evaluating the impacts. This study proposed a time-dependent methodology to dynamically assess the global warming potentials (GWP) with two time parameters, time horizon (TH) and time of evaluation (TE). The former defines the time period of life cycle assessment (LCA) and the latter decides when the GWP is evaluated. Both time factors significantly influence the GWP calculation. The case study of regular (20-year) and long-life (40- and 100-year) pavement designs indicate current calculation method substantially, slightly and does not overestimate the GWP for the 20-, 40- and 100-year pavement designs but does not alter the cross-over points of the comparisons of the three designs. And time effect is critical in evaluating different emission plans with the existence of miscellaneous GHG components. The proposed methodology is capable of reporting various GWP scenarios with regards to time factor.

Key words: life cycle assessment; global warming potential; time effect; long-life pavement

Study of Sedimentation and Self-weight Consolidation Behavior of Bed Sediment by Radioisotope Densitometer

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Abstract

The settling tests were conducted using an acrylic cylinder container with an inner diameter of 0.2 m and a height of 2.0 m in the laboratory to investigate the sedimentation and self-weight consolidation behavior of bed sediment at Isahaya Bay, Ariake Sea, Japan. During the tests, the height of the interface between sediment and clear water was observed, and the variation of density with depth and time was measured by a gamma-ray transmission radioisotope densitometer. After the tests, the vane shear and micro-piezocone tests were conducted to investigate the relationship between the undrained shear strength (c_u) and the density of bed sediment. The test results show that the settling process of bed sediment can be classified into the flocculation stage, settling stage and consolidation stage. The time of flocculation stage in freshwater is longer than that in seawater due

to particles flocculate slower in fresh water. The settling rate of the bed sediment in the settling stage increases with the increase of temperature and initial water content. The measured density profiles by the radioisotope densitometer during the process of sedimentation and self-weight consolidation show that the density profile changes from the constant density profile to the linear density profile when the sedimentation process transfers to the self-weight consolidation process. The relationship between void ratio (e) and effective vertical stress (p') in very low pressure can be calculated from the measured density values after accomplish of self-weigh consolidation, and it can be used for the analysis of self-weight consolidation of bed sediment. The cu value is almost the same when the density of bed sediment is less than 1.14 g/cm3, and the cu value increases linearly with the increase of the density when the density values are in the range of 1.14 to 1.2 g/cm3.

Key words: Radioisotope densitometer, density, bed sediment, sedimentation, self-weight consolidation

云南省公路工程安全生产工程量标准清单编制方法思考

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摘　要： 本文提出了安全生产工程量标准清单编制的新思路和新方法，即通过对公路工程单位、分部和分项工程进行具体分析，针对其中技术较为复杂或者安全风险较高的分部（分项）工程进行安全专项方案研究，对相应施工危险源进行研究分析，找出安全生产费用发生的原因和对应措施，进而分析出安全生产费用的相关清单子目，最终形成标准清单。

关键词： 公路工程　安全生产　清单编制　方法

Thinking on Compilation Method of Engineering Quantity Standard List of Highway Engineering Safety in Yunnan Province

Abstract

This paper puts forward the new ideas and new methods of standard engineering quantity list of safety production. Through deep and comprehensive analysis of the unit projece, part project and subentry project of highway engineering, special program researches are carried out for those which are characterized by technical complexity or high security risks. Then, researches and analysis of corresponding construction hazard sources are carried on and the reasones and corresponding measures of safety production cost are found out. Finally, the list items of safety production cost are put forward and the standard list is formed.

Key words: highway engineering, safety production, form the list, method

The Use and Requirements of Simulation and Data Analytics for Building Energy Efficiency

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Abstract

Buildings account for about 40% of total U.S. energy consumption, and 90% of them are energy inefficient to some extent. In order to improve energy efficiency, simulation and data analytics techniques have been widely developed to support building management professionals for efficiency related decisions and actions. However, to date no work has established a comprehensive and clear understanding about the use and requirements of simulation and data analytics for building energy efficiency. This paper proposes a nationwide survey conducted on building management professionals. From the 535 distributed questionnaires, 92 responses were collected. Preliminary results of how decisions are made by building management professionals, how simulation and data analytics are used in their current decision-making process, and how simulation and data analytics should be improved for further leveraging building energy efficiency, are presented.

Key words: building; energy efficiency; survey; decision making; data analytics; simulation; current use; requirement

A Life Cycle Analysis of Sustainable Infrastructure
Design and Construction

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Abstract

Urban infrastructure including transportation systems is an important economic section in the United States. Compared to the building construction area where the concept of sustainability is accepted and the number of green buildings is growing fast, fewer efforts in the engineering and construction of capital projects are towards achieving sustainability. Higher initial costs are a critical barrier to the implementation of sustainable design and construction in urban infrastructure projects. However, the barrier can be overcome when adopting a philosophy of life cycle analysis. In addition, few assessment tools are available to help designers and engineers to integrate the concept of sustainability in the infrastructure's design and construction. This work aims to demonstrate an effort that uses an approach of life cycle analysis to elucidate the costs and benefits that a sustainable project causes. As an illustration of the analytic method, this paper also provides a case study which occurred in the State of Michigan in America.

Key words: Sustainability, Construction management, Energy efficiency, Built environment

路域自然地理环境条件的识别与阅读

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摘　要：道路工程是人类为持续改善自身的交通条件，满足经济社会发展的需求，集多学科知识和技术的集成过程，是广大民众按通行制规则共同使用的社会产品。需求是工程建构的始末，经济是工程建构的基础。自然地理环境和经济社会环境条件是工程建构的边界阻尼必要条件，具有相对性的工程建构方案的论证和研究、比较和选择，首先是对自然地理环境条件的比较和选择，是工程与其合作共生，发挥积极耦合效应，而经济社会环境条件是人类认识自然的理性回归和总结，是维持经济次序持续发展的规则，具有时代性和严肃性，是与经济持续发展相协调，是满足要求和规定的符合性，是严格执行。那么，从具有相对性特征的"非唯一性"建构方案中，辩证的理性的选择具有的"必然性"的，众望所归或者认可的工程建构方案就是建构的宗旨和职业的境界。本文采用续文的形式，应用辩证法的思维和哲学的观点，利用事物的因果关系和逻辑思维推理，阐述从道路工程具有"非唯一性"的解决建构问题方案中，推理出与自然地理环境相适宜，与经济社会环境相协调的"必然性""合理"答案的辩证思维和因果、逻辑关系和方法，与同仁一起学习探讨相对的必然性问题。

关键词：道路工程　建构　非唯一性　必然性

Identification and Reading of Natural Geographical Environment of Road

Abstract

Road engineering is an integration process of multiple sciences and technologies,during which humans have endeavored to improve the transport conditions to meet the demand of socio-economic development. Demand serves as the cause of project construction and economic development the foundation. Natural geographic environment and economic and social environment conditions are the necessary conditions fro boundary damping of project construction.The relative demonstration and research, comparison and choice of project construction schemes are firstly the comparison and choice of natural geographic environment conditions and the result of coexistence of the project and the conditions exerting active coupling effect. Whereas,the economic and social environment

conditions are the rational recovery and conclusion of humans' recognition of the nature, the rule of maintaining the sustainable development of economic order, epochal and solemn. It goes in ling with economic sustainable development. This paper adopts continuation,dialectic viewpoint of thought and philosophy, utilizes the cause-and-effect relationship and logical thinking reasoning, and expounds the relevance of the road engineering and the natural geographic environment and the dialectic thinking, cause-and-effect, logical relationship and method from construction scheme of uniqueness so as to explore the inevitability issue with the scholars of the same field.

云南高速公路工程建设成本控制状况分析与思考

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摘要： 道路工程是人类为持续改善自身的交通条件，满足经济社会发展的需求，集多学科知识和技术的集成过程，是广大民众按通行制规则共同使用的社会产品。需求是工程建构的始末，经济是工程建构的基础。自然地理环境和经济社会环境条件是工程建构的边界阻尼必要条件，具有相对性的工程建构方案的论证和研究、比较和选择，是对自然地理环境条件的比较和选择，是工程与其合作共生，发挥积极耦合效应，而经济社会环境条件是人类认识自然的理性回归和总结，是维持经济次序持续发展的规则，具有时代性和严肃性，是与经济持续发展相协调，是满足要求和规定的符合性，是严格执行。那么，人机料是影响工程成本的三大要素，自然地理环境和经济社会环境条件是工程的边界条件，工程的经济性是任何时代的追求，追求工程的性价比，追求工程价廉物美。本文统计分析云南通车高速公路和相临省份近5年来建设的七千公里造价，从历史的时间纵向和自然地理环境条件和时期基本相近的横向分析，了解云南工程造价控制的状况，以指导今天明天工程的建设。

关键词： 道路工程　建构　非唯一性　必然性　造价　性价比

Analysis and Consideration of Cost Control of Expressway Construction in Yunnan Province

Abstract

Construction of highways is a course of people to improve transport conditions, to meet the requirements of economic and social development, and to utilize various knowledge and technologies, and highways is a social product used by the public in accordance with the common regulations. Need is the motive force of formulating the construction of highways, while economy is the basis of formulation of highways construction. Natural & geographical environment and economic & social environment are necessary boundary damping conditions. Demonstration & research and comparison & selection of construction plan are comparison & selection of natural & geographical environment; while economic & social environment affects people's rational judgment of highways projects.

Generally speaking, people, machine and materials are three main elements influencing the cost of construction, natural & geographical environment and economic & social environment are boundary conditions of projects, and low cost and good quality are the eternal goal of any projects. This thesis analyzes the construction cost of 7000 km expressway that has been constructed and open to traffic in Yunnan and neighboring provinces in recent 5 years, presents the status of cost control of construction in Yunnan by historical vertical comparison and horizontal comparison of highways projects with similar natural & geographical environments and construction periods, and puts forward some proposals for the future projects.

Key words: Highway Projects Formulation Nonuniqueness Inevitability Construction Cost Cost Performance