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Editorial

Achievements and Prospects of Functional Pavement: Materials and Structures

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Abstract: In order to further promote the development of functional pavement technology, a Special Issue of "Achievements and Prospects of Functional Pavement" has been proposed by a group of guest editors. To reach this objective, articles included in this Special Issue are related to different aspects of functional pavement, including green roads to decrease carbon emission, noise, and pollution, safety pavement to increase skid resistance by water drainage and snow removal, intelligent roads for monitoring, power generation, temperature control and management, and durable roads to increase service life with new theory, new design methods, and prediction models, as highlighted in this editorial.

Keywords: functional pavement; green road; safety pavement; intelligent road; durable road; pavement materials; asphalt pavements

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A Special Issue of "Achievements and Prospects of Functional Pavement: Materials and Structures" has been proposed and organized to present the recent achievement of functional pavement, and to promote the development of functional pavement technology. This Special Issue contains 20 technical articles [1–20], which have been peer-reviewed under the journal's rigorous review criteria. The collection includes invited papers from experts in international communities and articles that have been selected from the 2019 World Transport Convention (WTC) held in June 2019 in Beijing, the 4th International Conference on Transportation Infrastructure and Materials in Jinan, Shandong, China in 2019, and the 5th Chinese-European Workshop on Functional Pavements in 2019 in Changsha, China.

Research institutions in pavement research, such as Changsha University of Science & Technology (5 papers), Delft University of Technology (4 papers), Michigan Technological University (3 papers), Southeast University, Khalifa University of Science and Technology, Nanjing Institute of Technology, Tongji University, Dongguan University of Technology, Hefei University of Technology, Korea University of Technology and Education, Jilin University, Lanzhou Jiaotong University, Shijiazhuang Tiedao University, Shenyang Jianzhu University, and Technological University Dublin, have contributed their research achievements to this Special Issue. A summary of the articles is given in this editorial.

Research on the application of waste material in pavement construction is considered to be one of the most economical ways to achieve sustainable, designed green pavements. Nader et al. [1] investigated the use of waste oyster shells as a novel bio-filler in pavement, which is not only able to improve the quality of pavements but also to reduce the cost of their construction and solve the waste problem. Wang et al. [2] studied the complex interaction between bitumen and crumb rubber as well as the addition of warm-mix additives, and proposed a second-order polynomial function to characterize the viscosity–temperature dependence. Guo et al. [3] developed a new modified open grade friction course (OGFC) by replacing the fine aggregate below 4.75 mm in OGFC with oil shale waste, and a silane coupling agent modifier was used to assist modification. The modified OGFC preparation is an effective technique for improving the strength and stiffness of the OGFC and reducing environmental degradation.

Materials modification technologies are thus widely used in pavement engineering to improve the performance of pavement materials. In this Special Issue, rock asphalt (RA) [4,5], diatomite [4], Styrene-Butadiene Rubber (SBR) [5], nano-CaCO3 [5], and Bio-Char [6] were used as modifiers for bitumen and were evaluated in detail. The viscoelastic properties, fatigue properties, rutting resistance, anti-cracking properties, and microstructure of bitumen are presented in this Special Issue.

High technologies are applied in intelligent pavement construction, which improves the functions or endows new functions to pavements. Zhou et al. [7] studied induction heating-assisted compaction of pavement structure, which appeared to be an effective way to improve mix compaction and compatibility at low temperature. Xu et al. [8] applied calcium alginate microcapsules encapsulating an asphalt bitumen rejuvenator to improve the self-healing of bitumen once a crack initiates in the asphalt mixture. Wang et al. [9] studied the nano-TiO2 photocatalytic coating on the surface of pavement, which endows the pavement with air-purifying and self-cleaning abilities. Wei et al. [10] explored the relationship between concrete pavement texture characteristics and tire/pavement noise of grooving concrete pavement, which helps to reduce the noise of the pavement. Wang et al. [11] proposed an algorithm for two-dimensional virtual aggregates modelling for the reconstitution of virtual aggregates and specimen.

Characterization research on pavement materials is important for durable pavement design and construction. The fatigue performance of asphalt mixture was investigated by Sun et al. [12], Wang et al. [13], and Zhang et al. [14]. Sun's study [15] focused on fatigue cracking resistance of a high viscous asphalt sand stress-absorption layer and rubber asphalt stress-absorption layer, and the fatigue cracking resistance of the different layer materials were evaluated by force-controlled fatigue crack propagation tests. Wang's research [13] reported on fatigue performance and a model of polyacrylonitrile fiber-reinforced asphalt mixture produced with different fiber contents and asphalt contents. Zhang et al. [14] investigated the possibility of using multiple stress creep and recovery tests to evaluate the fatigue performance of bitumen binders. Besides fatigue performance, rutting performance is also important for asphalt pavement. Si et al. [16] investigated the dynamic response of rutting resistance of high modulus asphalt concrete pavement, which provided a foundation for the performance research and further engineering practice of high modulus asphalt concrete. Top-down cracking is also a common distress phenomenon for asphalt pavement. Sun et al. [12] proposed new initiation and propagation mechanisms of top-down cracking, and validated the mechanisms through both accelerated pavement testing in the field and uniaxial repeated loading penetration tests in the laboratory at different temperatures. Asphalt aging also has a significant impact on the performance of pavement. Jing et al. [17] investigated the evolution of the chemical and mechanical properties of asphalt mortar during aging and found a higher aging level for mortars produced by first mixing and then aging, compared to the mortars produced by mixing aged bitumen with filler and sand.

Apart from the surface layer of pavement, several other researchers have characterized the mechanical properties of the aggregate base and subgrade. Guang et al. [18] and Lv et al. [19] characterized the mechanical properties of cement-treated aggregate base materials. More specifically, Guang et al. [18] developed a proprietary true triaxle apparatus to simulate the spatial status of principal stresses to conduct compressive strength tests, and the strength model analysis results suggested that the Double-Shear-Corner Model is more suitable to characterize cement-stabilized macadam's strength performance. In the research of Lv et al. [19], a fatigue equation was established based on the true stress ratio for cement-treated aggregate base materials, which provided a theoretical method and basis for unifying the mix design parameters and the construction quality control parameters. Finally, the subgrade is the natural material underneath constructed road layers, which provides the foundation to support the pavement. In the research of Yuan et al. [20], characteristics of resilient modulus of the improved red clay at different additive content were studied through conducting laboratory repeated load triaxial tests, and they developed a comprehensive prediction model, which can be utilized to reflect the influence of compactness, moisture content, additive content, and stress state on resilient modulus.

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