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Editorial

Special Issue "Nanomaterials and Other Additives to Enhance Asphalt Pavement Performance"

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1. Introduction

This Special Issue is dedicated to the modification of asphalt binders using certain additives as nanomaterials or special modifiers to enhance the performance and durability, seen through improved resistance to ageing caused by climatic conditions, of the asphalt concrete forming the core layers of flexible pavements. However, asphalt pavements also comprise other types of untreated and treated layers that are essential in the overall resistance needed to withstand traffic loads and climatic activity. Moreover, the load burden has been amplified over the last two decades by climate changes. Moreover, the current predictions are even worse for the decades to come, with increasing air temperature and precipitation and the rising sea level, which will affect coastal areas, among other effects. All of these issues demand better materials to cope with these new conditions. In addition, using by-products and recycled materials in the different layers of flexible pavements is an additional goal toward the increased use of sustainable construction materials, which should also be possible under the expected worsening load conditions.

A total of 13 contributions were published. Eight contributions are classified in the first group, "Use of nanomaterial modified binders", and five in the other group, "Pavement layer mixtures' modification".

2. Use of Nanomaterial Modified Binders

In this group of papers, four papers [1–4] addressed the stabilisation of granular and other types of (marginal) materials, referred to as New-Age (Nano) Modified Emulsions (NME). These emulsions were developed through accelerated field pavement tests and practical applications. The authors described and indicated in the four abovementioned articles, using field analysis and experiences, the engineering properties of those stabilised materials, the chemistry fundamentals of this type of stabilisation, the identification and solving of the mechanism of distresses found in practice, construction situations successfully employed on the road network, and uses of these stabilised materials for road pavement design. In addition to these aspects, an evaluation of cost-effective modified binder thin chip and cape seal surfacing on an NME-stabilised base can be seen in the article [5] and the fundamental principles ensuring successful implementation of the NME in the article [6]. Finally, the same authors, for the opportunities created by the possible use of the mentioned stabilised materials, contribute [7] to the relevance of nanotechnology applications towards sustainable road surface maintenance, generating employment opportunities in the post-COVID-19 era.

In this group of papers, the last one [8] deals with the effect of ageing on bitumen before and after modification using nano-clay (NC)-modified bitumen (NCMB). In addition to conventional tests on the bitumen, Fourier transform infrared spectroscopy (FTIR) was used to observe the microstructural distribution of the modified binder before and after ageing. The authors concluded that using the indirect tensile strength for mixtures made with modified bitumen showed better resistance against ageing when NC was added. This result is aligned with what they observed in the more conventional tests of the bitumen.

3. Pavement Layer Mixtures' Modification

This second group of papers [9–13] includes several different methods of improving flexible pavement layers, namely, asphalt concrete and granular layers.

The study [9] uses wax obtained directly or as a by-product from plastic waste to modify binders, specifically by blending it with conventional or modified bitumen and other additives applied in manufacturing asphalt mixtures. Different tests were used: thermogravimetric and spectroscopic analysis, consistency tests, testing of dynamic viscosity at various temperatures, and assessment of the rheologic properties of the binders. As a result, several crucial findings were reached: this sustainable wax promotes lower handling temperatures and improved consistency and rheological behaviour, providing, for example, lower temperature susceptibility and higher permanent deformation resistance.

The use of plastic waste as an enhancer of bitumen qualities and an asphalt mixture binder also contributes to the value of this type of waste. The study [10] analysed four types of plastic waste using different plastic contents added by the dry process in asphalt concrete manufacturing and compared the results with a conventional mixture without plastic. A set of laboratory tests were used, and the results show that although the addition of plastic waste reduces workability, satisfactory handling conditions are guaranteed, the asphalt concrete becomes more elastic, and its stiffness values are adequate to apply the material in a pavement surface layer. In addition, the resistance to fatigue cracking was observed at a suitable level. Moreover, the resistance to permanent deformation generally improved, although the performance was dependent on plastic type and use context.

A material that can be used to increase the stiffness of asphalt binders is gilsonite. This was the object of the study [11]. A modified asphalt binder with gilsonite was introduced by the wet-process, aiming to improve rutting resistance and to replace (by mass and volume) part of the coarse fraction of the aggregate with recycled concrete aggregate; this study experimented with these aims for two hot-mix asphalts with different gradations. In conclusion, both materials (gilsonite and recycled concrete aggregate formulated by volume) could be used in hot-mix asphalts for thick-asphalt layers in high-temperature climates and any level of traffic. However, they are not recommended for thin-asphalt layers in low-temperature climates.

The study [12] examines the effect of Styrene–Butadiene–Styrene and crumb rubber on the rutting, moisture-induced damage, and workability properties of hot-mix asphalt (HMA) mixtures. In this study, three types of mixtures/binders —namely, control (CB), crumb rubber-modified (CRMB), and polymer-modified (PMB)—were evaluated. The results indicate that CRMB mixtures were less workable and exhibited better resistance to rutting than the PMB and CB mixtures. Furthermore, the PMB mixtures had increased resistance to moisture-induced damage, while the effect of the CRMB mixtures was negligible compared to the CB mixtures.

The study [13] dealt with construction and demolition waste (CDW) and coconut husk materials to be used in the construction of cement-bound granular mixtures (CBGM) to be applied as base and sub-base layers of road pavements. The CDW can be used to obtain good-quality recycled aggregates (RA), and the coconut husk can be processed into coconut fibre (CF). The mechanical performance of CBGM with RA and CF reinforcement was compared with a conventional CBGM with natural aggregate (NA). The results concluded that the CBGM with RA performs similarly to the CBGM with NA. Furthermore, using CF effectively reinforced the integrity of the CBGM specimens at post-test, indicating potential gains in durability after cracking.

4. Final Considerations

The Guest Editors believe that the group of papers published in this Special Issue fosters awareness about the use of different additives to modify asphalt binders, mixtures, and other materials to obtain more efficient and longer lasting flexible road pavements.

Most of the published works were validated in practice, and enhancement of the presented studies is ongoing to achieve validation of their use. Therefore, the supplied information is an excellent resource researchers and practitioners interested in developing and applying these solutions or similar ones.

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