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Editorial

High-Performance Fiber-Reinforced Composites: Latest Advances and Prospects

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1. Introduction

Fiber-reinforced composites (FRCs) have been extensively utilized in various fields of engineering throughout the world. Currently, numerous researchers and experts are developing and manufacturing high-performance FRCs with enhanced durability and bonding properties [1,2]. These high-performance FRCs can be employed internal or external reinforcement in order to prevent structural damage to various concrete structures, including buildings, bridges, and parking garages, etc. The short and randomly distributed fibers with a high elastic modulus that FRCs possess could transfer stress and enhance their tensile strength, as well as their resistance to cracks [3]. The development of high-performance FRCs with new applications in the construction sector has attracted widespread attention in recent decades [4]. Synthetic fibers, chemical fibers, natural fibers, nanofibers, and other fibers are currently adopted in order to fabricate the high-performance FRCs [5].

This Special Issue 'High-performance Fiber-reinforced Composites: Latest Advances and Prospects', focuses on the development and application of high-performance FRCs in various fields of engineering. This Special Issue gathers four papers that focus on high-performance fiber-reinforced composites, new trends in their design and manufacture, their modification and production of their fibers, novel experimental techniques for FRCs, analytical and numerical models for enhancing FRC components, and FRCs in civil structures, among others. This Special Issue provides a comprehensive summary of the latest advances in and prospects of FRC to material engineers, researchers, and experts in civil engineering and material science. An overview of these papers is given as follows.

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2. Overview of This Special Issue

Ren et al. [6] studied the bond–slip behavior of steel–steel fiber recycled aggregate concrete. In their study, push-out tests of 16 specimens were performed, and their results demonstrated that the fracture cracks of the specimens primarily included bond cracks and expansion cracks. The bond–slip process that occurred between the steel–steel fiber and recycled aggregate concrete involved five stages: the slight-slip, slow-slip, accelerated-slip, sharp-slip and load-steep-drop, and gentle-slip stages. The factors that influence bond strength were also analyzed. The bond strength initially increased then declined as the steel fiber volume and steel fiber aspect ratios rose; meanwhile, the bond strength was enhanced as the thickness of the steel protective layer was upgraded. The ultimate bond strength diminished slightly as the steel embedded length was augmented. Moreover, the equation required to calculate the characteristic bond strength of the steel–steel fiber recycled aggregate concrete was established, which revealed that the calculation results were in good agreement with the test results.

In the study conducted by Kristýna Hrabová et al. [7], the mechanical and fracture properties of steel fiber-reinforced concrete were numerically and experimentally evaluated. Their conclusions can be divided into two parts. The first part concerns the experiment in which the results exhibited a high variance of values even though the specimens had identical compositions and were fabricated with an identical number of fibers. The second part relates to the evaluation of the fiber type and length. Longer fibers possess greater values than the alternative type, which is consistent with the assumption that enhanced shear properties correlated with longer fibers. The conclusions presented in this study reveal the necessity of performing a mathematical evaluation of the results obtained via laboratory tests, especially in the case of the high dispersion found. It is thus recommended that a mathematical analysis of correlation and regression is performed in order to obtain a stronger evaluation of the experiments.

In order to promote the application of reactive powder concrete (RPC) in practical engineering, Mo Liu et al. [8] studied the mechanical properties and microstructure of a basalt fiber reactive powder concrete. In their study, the RPC was prepared using conventional and economical natural river sand rather than quartz sand, and by employing economical basalt fiber (BF) instead of steel fiber. The macroscopic properties of basalt fiber reactive powder concretes (BFRPCs) with varying fiber contents, such as the flowability, failure mode, compressive strength and splitting tensile strength, were studied, and the strength calculation formula for BFRPC was established based on the mechanical property results. Their results revealed that BF has a minor effect on the compressive strength of RPC, while BF significantly enhances the splitting tensile strength. According to the microscopic analysis, a reasonable fiber content is able to optimize the internal microstructure of the BFRPC, but an excessive BF content could lead to agglomeration and overlap, resulting in the loss of strength. Based upon the gray correlation analysis method, it was concluded that the particle area ratio and pore fraction dimension were closely correlated with the mechanical properties of BFRPC. In addition, the feasibility and applicability of the BFRPC strength calculation formula were summarized.

Yu Ruiguang et al. [9] investigated, experimentally and numerically, the effects of various building materials and treatments on the sound field characteristics of a concert hall. The architectural treatment solutions that did or did not incorporate sound absorption into the design of the ceiling and sound absorption on the side walls, were analyzed in terms of the influence of the ceiling form on the acoustic characteristics of the hall at various positions on the first and second floors. Their simulation results revealed that there was little difference in the reverberation time at various reception points, and that the speech transmission index was elevated with the distance of the reception point. The language performance of the positions on the second floor was better than that on the first floor. The sound pressure level (SPL) diminished as the distance from the receiving point was increased. The ceiling form had no significant effects on the acoustic characteristics of the multifunctional concert hall, and the reverberation time was reduced when acoustic materials were used in the ceiling, compared to when they were employed in the side walls.

3. Conclusions

In this Special Issue, four papers were collected regarding the latest advances and prospects of high-performance fiber-reinforced composites. These articles reflect the state-of the-art in research, and aim to provide detail of the development and application of high-performance FRCs in various engineering fields.

However, the papers assembled in this Special Issue are limited, and further studies that focus on the mechanical bonding of FRCs, their durability properties, their failure and cracking, new experimental techniques, and new trends in their design and manufacture, etc., ought to be included in future Special Issues.

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