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Editorial: Mechanical properties of advanced materials and structures for energy absorption

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Editorial on the Research Topic
Mechanical properties of advanced materials and structures for energy absorption

This editorial summarizes the contributions to the Frontiers Research Topic "*Mechanical properties of advanced materials and structures for energy absorption*."

Mechanical properties of advanced materials and structures for energy absorption focuses on how structures and materials can be best designed to absorb energy in a controllable and predictable manner. Advanced structures with optimized geometrical properties and material selections could outperform conventional uniform structures in terms of energy absorption capacity. Advanced geometrical configuration could reduce the initial peak load as well as increase the mean crushing load, which provides the structure the possibility to collapse in a more controlled manner and have a remarkable energy-absorbing efficiency. The materials have wide-challenging properties such as viscoelastic behavior, deformation behavior, and damage initiation and propagation mechanisms, which are important in assessing the mechanical properties of the structure. The advanced materials could be used in multi-purpose applications with their flexibility, energy absorption, and the possibility of utilizing new fabrication methods such as 3D-4D printing.

Advanced materials and structures have appealed tremendous interest for their advantages in a range of engineering problems in fulfilling requirements in safety, environment, affordability, and cost over recent decades. As an effective approach, new systems of advanced materials and structures intend to exploit the benefits and characteristics of different materials to maximize their practical characteristics in lightweight structures, thereby improving their corresponding material efficiency. The common shortcoming, brittleness, higher material cost, sensitivity to the environment, etc., could be mitigated to a certain extend by means of new types of advanced materials and optimized structural topology, which enhances overall performance in a synergetic method and demonstrates substantial competence of balancing mechanical performance and material cost while attaining a primary goal of mechanical property modification and specific energy absorption.

Zhou et al. investigated the durability of basalt-fiber-reinforced ordinary silicate mortar under exposure to unilateral salt freezing. The results demonstrated that even a small amount of basalt fiber could significantly improve the mechanical properties of cement mortar under unilateral salt freezing and its resistance to salt freezing erosion. Their work provides concrete evidence for changes in the porosity of mortar under exposure to unilateral salt freezing, with these changes showing an exponential relationship with mortar mass loss and a strong linear correlation with changes in the compressive strength, flexural strength, and chloride ion diffusion coefficient of the material.

Xing et al. studied the explosive damage effects of tungsten fiber-reinforced Zr-based bulk metallic glass matrix composite shell. Compared with 40CrMnSiB steel shells, the fragments produced by the WF/Zr-MG shell exhibit a larger aspect ratio, smaller average size, and a greater number of fragments at distances of 3 m and 5 m, with an equal number of fragments at a distance of 8 m. They proved that WF/Zr-MG can be used as a shell material for explosive fragmentation projectiles, which can enhance their destructive power.

Miao et al. explored the energy absorption, the damage of the impacted surface, and the back surface of aramid/epoxy composite through the drop weight impact test. The results show that the average energy absorption of new yarn in the first layer can absorb more energy than that in the fourth layer at one configuration, but the result is contrary when the structure is in different configuration. The fundamental research can provide design ideas and supports for aramid composite.

Ding et al. established a simplified model of projectile penetration into target plates using dynamic simulation software ANSYS to determine its vibration modes and low-pass filtering frequency. Marshall hammer tests were carried out on rubber pads of different materials and thicknesses, confirming the validity of the simulation results and the feasibility of rubber filtering. The research results provide a reference for protective methods of hard target-penetration fuze.

Li J. et al. studied use of steel fibre together with coal gangue coarse aggregate, coal gangue fine aggregate/sand in various concrete mixes. The effect of volume dosages of steel fibre and different levels of replacing nature coarse aggregate and river sand with coal gangue aggregates on concrete compressive strength was investigated. Orthogonal test was adopted to study concrete mixes with 3 factors, namely, coal gangue coarse aggregate, coal gangue sand and steel fibre, and each at 3 levels. The microstructural characteristics and failure mechanism of steel fiber reinforced coal gangue concrete was also studied and discussed.

Li et al. designed four-level and four-factor orthogonal tests with coal gangue ceramide substitution rate, coal gangue ceramide sand substitution rate, steel fiber content, and polypropylene fiber content as independent variables. The influence of fiber and coal gangue on the microstructure was studied by scanning electron microscopy, and the influence law of interfacial transition zone on the strength of concrete was explored, which provided a theoretical basis for the study of solid waste utilization of coal gangue.

Author contributions

XZ: Writing–original draft, Writing–review and editing. XX: Writing–original draft, Writing–review and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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