frontiers in Materials

EDITORIAL
published: 19 September 2019
doi: 10.3389/fmats.2019.00229

Editorial: Vibration Mitigation Materials and Structures

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Keywords: vibration mitigation materials, material preparation, material mechanical properties, dampers, structural analysis

Editorial on the Research Topic

Vibration Mitigation Materials and Structures

For more than half a century, vibration mitigation technology has made significant contributions to social development and human progress. With the excellent hysteretic behavior and energy dissipation capability, vibration mitigation materials, and structures can effectively reduce the damage induced by harmful vibrations, and guarantee the safety of the equipment, infrastructure, environment, and human life. A lot of researchers have made substantial achievements in this field. New vibration mitigation materials successively spring up and continually update the traditional vibration mitigation structures. The new passive vibration mitigation materials (e.g., viscoelastic materials, rubber), new smart materials (e.g., magnetorheological fluid, magnetorheological elastomers, piezoelectric ceramics), new damper types, and new vibration mitigation structures have appeared in rapid succession, leading to the booming of this young field.

The Research Topic "Vibration Mitigation Materials and Structures," as the tip of the iceberg, provides a window to let people know about the flourishing of this young field. Twelve original research papers and one review paper have been included in this Research Topic to represent the recent development of vibration mitigation technology. The vibration mitigation material manufacture process, testing, analysis, and application have completely thoroughly studied. The articles in this topic are divided into five areas, namely (1) next-generation vibration mitigation materials manufacturing, (2) mechanical properties tests of vibration mitigation materials, (3) mechanical models of vibration mitigation materials, (4) vibration mitigation materials application, and (5) non-linear dynamic analysis of a structure reinforced by vibration mitigation materials.

The new generation vibration mitigation materials manufacture is the most interesting area. Liu and Han present a new kind of PVA-steel hybrid fiber reinforced cementitious composite (PVA-steel HyFRCC). The material mechanical properties of the material are discussed, together with the different fiber contents, fiber types, and fiber shapes. Due to the fiber hybridization, the material with a suitable fiber status can have excellent peak strain, compressive toughness, and post-peak ductility. PVA-steel HyFRCC, as a new generation vibration mitigation material, can enhance the energy dissipation and damage control capacity of vibration mitigation structures.

The study of the mechanical property tests of vibration mitigation materials is a multidisciplinary area. Guo et al., established the hybrid test system, which consists of upper computer and lower machine. The test system control method and hybrid test procedure are introduced. This hybrid test system is employed to test the dynamic performance of nominal viscoelastic material, which provided the robust operate program and benchmark index for research of viscoelastic material.

Edited and reviewed by:
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Specialty section:
This article was submitted to Structural Materials, a section of the journal Frontiers in Materials

Received: *07 August 2019*
Accepted: *04 September 2019*
Published: *19 September 2019*

Citation:
Xu Z-D, Li S-D, Shah PAA and Lu Y (2019) Editorial: Vibration Mitigation Materials and Structures. Front. Mater. 6:229. doi: 10.3389/fmats.2019.00229

Establishing mathematical models to express material behavior is significant for vibration mitigation materials. Huang et al. transformed the Equivalent Standard Solid model into time domain by two-step approach and present the time domain oriented mathematical model to describe the behavior of the viscoelastic material. Sun et al. introduced the dynamic sandwich-type shear test for the viscous damping wall and presented the simplified method to calculate the velocity exponent, storage modulus and loss modulus of the polymer in viscous material. Based on the temperature-frequency equivalent principle, Xu et al. described the non-linear mechanical behavior of the viscoelastic material by modified the traditional seven parameters fractional derivative model. The influence of environment temperature and loading frequency was taken into account.

The application of vibration mitigation materials is a popular field in vibration mitigation technology. In reality, most vibration mitigation materials are designed as dampers to ensure the maximization of material efficiency. New damper design, mechanical model of the damper and control of the damper are three subareas of vibration mitigation materials application. Based on the vulcanizing-consolidating technology, Tu et al., designed a new leak-proof magnetorheological damper, and employed the correction factor of the pressure gradient to describe the energy dissipation and fluid-structure interaction property of the viscoelastic material. Jiang et al. designed a new combination damper based on the metallic vibration mitigation material and the viscoelastic vibration mitigation material. The damper has stable hysteretic behavior and excellent deformability, which is applied in the replaceable coupling beams. Wang et al. designed a new friction damper which was used in hybrid coupling beam, and established the thermal-mechanical model to describe the thermomechanical coupling effect of damping material existing in the friction damper. Zhou et al. investigated a new viscoelastic damper with hybrid non-linear properties and present the mechanical model to describe the multiple non-linear behavior. Guo et al. present the particle swarm optimization algorithm to change the mechanical behavior of magnetorheological damping material. The effective control and efficient utilization of smart vibration mitigation material was achieved.

Vibration mitigation materials will be used in practical projects after the procedures of manufacturing, testing, analyzing, and applying, which are combined with the traditional structures. The complete vibration mitigation structure system is then formed. The non-linear dynamic analysis and design of a structure reinforced by vibration mitigation materials and damper is the last step. He et al. introduced the design and analysis method of the vibration mitigation structural component taking a concrete filled steel tube structure as an example. Shi et al. present the design and analysis method of the vibration mitigation structural joint, taking the steel reinforced concrete structure as an example.

"Vibration mitigation materials and structures" is a broad and constructive topic. Recently, new passive vibration mitigation materials and new smart vibration mitigation materials appeared in a short time and are widely applied in civil engineering, mechanical engineering, and aerospace engineering. Viscous damping material, viscoelastic damping material, metallic material, magnetorheological elastomer, shape memory alloy, magneto strictive material, and piezoelectric ceramic material have been the focus of studies (Xu et al.). Although there are only 13 papers in this Research Topic, we still tried our best to present every aspect of vibration mitigation materials and structures in a complete way. It is expected that (1) wide temperature domain and wide frequency domain research of vibration mitigation materials, (2) new hybrid vibration mitigation materials manufacture, (3) new material mechanical models and (4) new application of vibration mitigation materials will continue to play a role in this young topic. We wish more cutting-edge achievements will arise to benefit mankind and continually promote the development of vibration mitigation materials and structures.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

ACKNOWLEDGMENTS

We would like to acknowledge all the authors, reviewers, editors, and publishers, who have supported this Research Topic. Furthermore, S-DL, as our assistant, had join our editorial group to help us to deal with the work of this Research Topic. The contribution of S-DL involves, but are not limited to, the preparation of the editorial article and the management of the Research Topic. Our editor group want to represent our thanks for his long-time help, and decide to add S-DL as our co-author into the author list for this editorial.

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.