MULTI-SCALE ADVANCED MODELLING AND DESIGN OF VARIABLE-STIFFNESS COMPOSITE STRUCTURES

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ABSTRACT

Composite materials have become increasingly attractive to modern industries due to their exceptional properties and diverse applications. The advent of new technologies, such as automated fibre placement, has opened unexplored possibilities for composites, allowing tailored structures to meet specific design requirements. Despite these advancements, several challenges persist in designing and verifying composite structures, primarily due to the lack of appropriate methodologies and analysis tools.

The proposed Mini-symposium, titled "Multi-scale Advanced Modeling and Design of Variable-Stiffness Composite Structures" aims to provide a comprehensive overview of the current state-of-the-art and prospects in simulating modern composite structures. This collaborative forum seeks to unite scientists and researchers to share innovative ideas and recent findings related to modelling and design for both classical laminates and variable-stiffness composite structures.

The Mini-symposium will delve into various topics, including the development of composite beam, plate, and shell models. Additionally, it will explore multi-scale methodologies to bridge the gap between micro- and macro-scale modelling, homogenization techniques, and capturing complex interactions at different length scales.

A crucial focus will be on addressing the challenges of uncertainty analysis to account for variations in material properties, manufacturing defects and loading conditions and how those affect design optimization. Other topics of interest include, but are not limited to, composite structures failure and damage modelling, delamination, cohesive mechanics, plasticity, impact, vibration, robust design, surrogate modelling and AI-based optimization techniques.

Through this Mini-symposium, we aim to foster interdisciplinary discussions and encourage knowledge exchange, providing a platform for researchers to explore innovative ideas and approaches. This collaborative event will create a network of experts dedicated to driving progress in composite materials research and promoting their adoption in real-world engineering challenges.

Researchers from academia and industry are welcome to contribute their work and expertise in advancing the field of composite materials. The Mini-symposium offers a unique opportunity to build valuable connections, leading to the development of novel methodologies and tools for the design and optimization of variable stiffness composite structures.

REFERENCES

[1] A. Pagani, M. Petrolo, A.R. Sanchez-Majano, "Stochastic characterization of fibre-matrix interface stress state in composite variable stiffness plates considering multiscale material uncertainties", *Int J Eng. Sci.*, Vol. 183, art. no. 103787, (2023).

[2] A.R. Sanchez-Majano, "Buckling and fundamental frequency optimization of tow-steered composite plates using layer-wise structural models and evolutionary algorithm", *AIAA J*, (2023). DOI: 10.2514/1.J062976.

[3] R. Vescovini, "Ritz R-function method for the analysis of variable stiffness plates", *AIAA J*, Vol. 61(6), pp. 2689–2701, (2023). DOI: 10.2514/1.J062702.

[4] C.A. Yan, R. Vescovini, L. Dozio, "Framework based on Physics-Informed Neural Networks and Extreme Learning for the analysis of composite structures", *Comp & Struct*, Vol. 265, art. no. 106761, (2022). DOI: 10.1016/j.compstruc.2022.106761.

[5] M. I. Izzi, M. Montemurro, A. Catapano, "Variable-stiffness composites optimisation under multiple design requirements and loads", Int. J. Mech. Sci., Vol. 258, art. n. 108537, (2023).

[6] M. I. Izzi, A. Catapano, M. Montemurro, "Strength and mass optimisation of variable-stiffness composites in the polar parameters space", Struct. Multidiscip. Optim., v. 64, pp. 2045-2073, (2021).

[7] M. Montemurro, A. Catapano, "A general B-Spline surfaces theoretical framework for optimization of variable angle-tow laminates", Compos. Struct., v. 209, pp. 561-578, (2019).

[8] G. Giunta, D.A. Iannotta, M. Montemurro, "A FEM Free Vibration Analysis of Variable Stiffness Composite Plates through Hierarchical Modeling", *Materials*, Vol. 16(13), 4643.