Lamb wave propagation in damaged sandwich structures using high order finite plate elements

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Keywords: Carrera Unified Formulation; Structural Health Monitoring; homogenised honeycomb sandwich.

Abstract. A major concern with the use of honeycomb-core sandwich structures in aerospace applications is the phenomenon of debonding at the skin-core interface, which can significantly compromise structural integrity. While these composite assemblies offer superior mechanical properties, the numerical simulation of wave-damage interaction presents a formidable challenge. The multi-scale nature of the honeycomb geometry, combined with the high-frequency excitation required to resolve debond regions, typically demands extremely fine discretisation, making conventional 3D simulations of wave-damage interaction computationally demanding. This paper proposes an efficient modelling framework utilising the Carrera Unified Formulation (CUF) to address these constraints for debond damage analysis. The following study examines the efficacy of this homogenised layer-wise model in capturing Lamb wave propagation and interaction with debonded regions in sandwich components. Results demonstrate that the combination of high-order CUF kinematics and core homogenisation provides a robust balance between local damage sensitivity and global resource efficiency. This approach maintains high fidelity in predicting wave-front distortions while achieving a substantial reduction in degrees of freedom and runtime compared to full-scale 3D models. The study demonstrates a scalable solution for the rapid development and validation of damage detection algorithms in complex aeronautical structures.

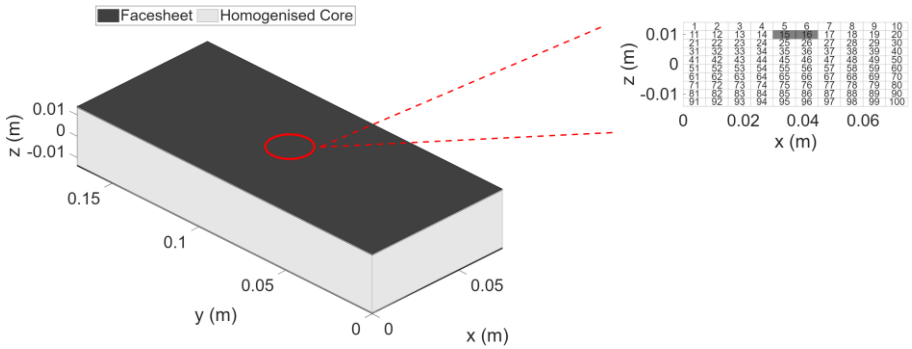

Figure 1: Damaged elements between the upper facesheet and core at the center of the sandwich

Acknowledgements

This research has been carried out within the ASSESS Project – Automated Online Monitoring of Smart Composite Structures – funded by the Marie Sklodowska-Curie actions grant agreement no. 101168031.

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