A cost-effective isogeometric approach for composite plates based on a stress recovery procedure

A. Reali[1], J.-E. Dufour[1], P. Antolin[2], A. Patton[1], G. Sangalli[3], F. Auricchio[1]

[1] University of Pavia
Department of Civil Engineering and Architecture
Via Ferrata 3, 27100, Pavia, Italy
Email: alessandro.reali@unipv.it Webpage: www.unipv.it/alereali

[2] École Polytechnique Fédérale de Lausanne EPFL
Mathematics Institute of Computational Science and Engineering
MA B2 505 (Bâtiment MA), Station 8, CH-1015 Lausanne, Switzerland

[3] University of Pavia
Department of Mathematics
Via Ferrata 1, 27100, Pavia, Italy

ABSTRACT

This work focuses on the development of an isogeometric method for composite plates taking advantage of the accuracy and high-regularity properties of isogeometric analysis to build a cost-effective stress recovery procedure. The proposed technique simulation strategy consists of using 3D isogeometric computations with a reduced number of elements in the thickness (namely, one) and a layer-wise integration rule, or, when possible, an homogenized approach, granting an inexpensive and accurate approximation of the in-plane response. This solution is then post-processed in order to obtain also an accurate stress state through the thickness, based on the integration of the equilibrium equations in strong form. Such an approach allows to drastically reduce the number of degrees of freedom and, accordingly, the overall computational time as compared to the standard full 3D layer-wise approach where every layer corresponds to an element through the thickness. The post-processing operation is in fact very fast and its cost does not increase significantly with the number of degrees of freedom. Several numerical experiments are shown, revealing the very good accuracy-to-cost ratio of the method, which appears to be particularly effective on composite stacks with a large number of layers. Finally, the isogeometric collocation version of the approach is also discussed.