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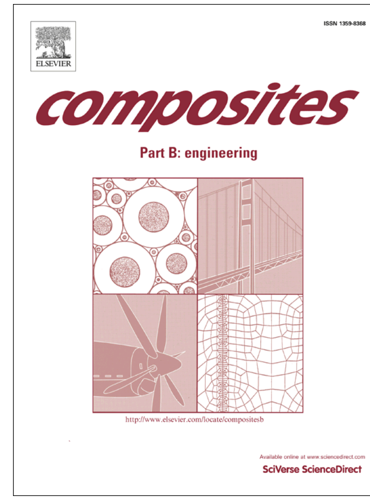

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FREE VIBRATIONS OF FREE-FORM DOUBLY-CURVED SHELLS MADE OF FUNCTIONALLY GRADED MATERIALS USING HIGHER-ORDER EQUIVALENT SINGLE LAYER THEORIES

Francesco Tornabene*[1], Nicholas Fantuzzi[1], Michele Bacciocchi[1]

ABSTRACT. The theoretical framework of the present manuscript covers the dynamic analysis of doubly-curved shell structures using the generalized displacement field of the Carrera Unified Formulation (CUF), including the Zig-Zag (ZZ) effect given by the Murakami's function. The partial differential system of equations is solved by using the Generalized Differential Quadrature (GDQ) method. This numerical approach has been proven to be accurate, reliable and stable in several engineering applications. The current paper focuses on Functionally Graded (FG) doubly-curved shells and panels using various higher-order equivalent single layer theories, introduced and applied for the first time by the authors to completely doubly-curved shell structures, and different through-the-thickness volume fraction distributions, such as four-parameter power law, Weibull and exponential distributions. Moreover, the classic theory of mixtures is compared to the Mori-Tanaka scheme for the calculation of the mechanical properties of the materials. In particular, the numerical applications presented in this work are related to particular FG configurations in which it is possible to model a soft-core structure using a continuous variation of the mechanical properties of the materials at hand. The natural frequencies and mode shapes of several structures are presented and compared to numerical solutions taken from the literature.

KEYWORDS: A. Layered structures; B. Vibration; C. Numerical analysis; C. Computational modelling; Functionally Graded Materials.

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