

A model for multilayered beams undergoing end loads

G. Davi¹, A. Milazzo¹, C. Orlando²

- 1 Università di Palermo, Dipartimento di Ingegneria Civile Ambientale, Aerospaziale, dei Materiali, 90128 - Palermo, Italy
- 2 Università di Enna Kore, Facoltà di Ingegneria Architettura e delle Scienze Motorie - Enna, Italy

Composite laminated materials have some advantages with respect to metallic media, such as the high strength and stiffness per unit weight, the path loads management capability as well as the possibility to manufacture large size structures, that motivate their extensive use. However they exhibit complex behaviour crossing plies interfaces and thus the proper modelling of composite laminated beam is a crucial point in design step. Analytical and numerical 3-D solutions represent the most accurate approach in modelling such materials but they have high computational costs. As a consequence, to reduce the computational effort, one-dimensional beam model are used instead, even though the accurateness of the solution lowers. In this work, an alternative theory for laminated beams subjected to axial, bending and shear loads is developed with the aim of obtaining a 1-D beam model capable of ensuring the equilibrium and continuity conditions at layers' interfaces. In particular, a layer-wise kinematical model is developed in such a way the point-wise balance equations are fulfilled. Moreover, by imposing the continuity of displacements and equilibrium of tractions relationships at plies' interfaces, the layer-wise kinematical quantities are written in terms of the primary variables of one layer only. The computational effectiveness of the equivalent single layer theories is then obtained preserving the solution accuracy of the layer-wise model, avoiding any a-priori selection of enriching functions. The equivalent beam constitutive relationships as well as the problem governing equations are last written in terms of generalized variables. Results obtained for a cantilever graphite-epoxy [0/90] beam, that has slender ratio $L/h=10$ and undergoes a tip shear force $F = 10\text{ N}$, are eventually shown in figure 1 in comparison with 2-D FEM simulation. Good agreement is obtained highlighting the effectiveness of the developed model.

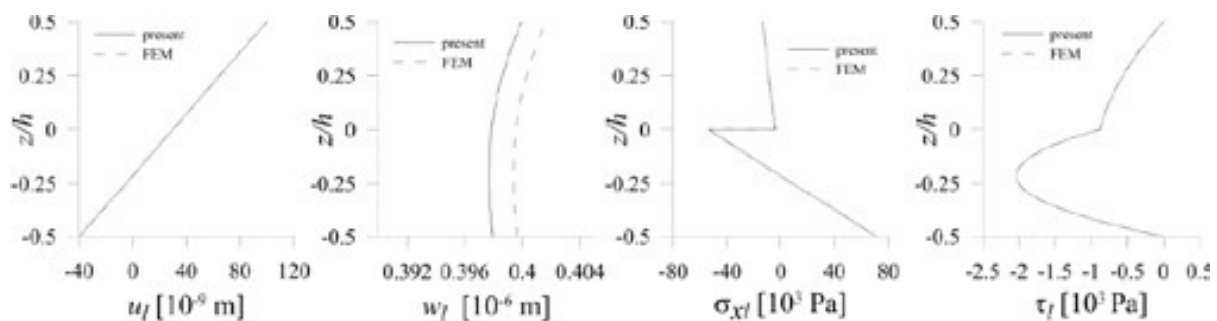


Figure 1. [90/0] beam through the thickness variables distribution at $x/L=0.5$.