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ANALYSIS OF LAMINATED BOX BEAMS USING 1D CARRERA UNIFIED FORMULATION

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In this article, the refined one-dimensional(1D) beam theories are implemented for the analysis of laminated composite structures. According to Carrera Unified Formulation (CUF),Taylor and Lagrange polynomials are used to interpolate the displacement field over the beam cross-section. Finite elements are obtained by employing the principle of virtual displacements along with CUF. In this work particular attention is focussed on box beam and open cross-section beam.

The use of Taylor type expansion has some intrinsic limitations: the introduced variables have a mathematical meaning (derivative at the beam axes); higher order terms cannot have a local meaning, they can have large cross-section properties only; the extension to the large rotation formulation could experience difficulties. To overcome these problems, this work uses new beam theories whose cross-section displacements fields is described by Lagrange type polynomials. The choice of this kind of expansion functions leads us to have displacement variable only [1].

Composite materials are quite popular due to their well known attractive properties such as high specific strength and stiffness, excellent fatigue and corrosion resistance. They are now extensively used in various weight sensitive structures like high speed aircraft, rocket, launch vehicles, etc. On the other sides the behavior of composite structure is governed by a wider number of parameter than conventional materials and, hence, the study of the mechanics becomes difficult. Furthermore, new problems arise such as the delamination and reliable structural models become essential in order to predict the distributions of normal and transverse shear stresses [2]. Many refined beam models have been developed over the last decades for the analysis of composite structure. CUF for higher order 1D models is very unique due to their higher archical capabilities which makes the choice of expansion functions (F_τ)and their order arbitrary [3].

In the present analysis of laminated structures, CUF is used along with Taylor or Lagrange displacement functions. Initially, the numerical problems have been solved and compared with results given by classical beam theories (Euler-Bernoulli and Timoshenko). Then a number of numerical problems using the Taylor model and the Lagrange model of laminated beam are solved. The static and free vibration analysis of laminated beam has been performed with different lamination sequences, boundary conditions and cross-sections. It is observed that the present models are very accurate and gives us almost a 3D like solution with minimum computational efforts. Lagrange models are more accurate because of the use of finer discretization at the loading point.

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