"Enhancements in Analysis of Beam-Like Structures using Asymptotic Methods"

March 25
MK317

Abstract:
The state-of-the-art Variational Asymptotic Method (VAM) and a mixed formulation of Geometrically Exact Beam Theory (GEBT) are employed in this work, as a complement to conventional FEA. This framework is very fast, provides rigorous physics-based material models for composites while ensuring efficiency and accuracy. In the present work, some major issues with use of VAM-based framework for solving thin-walled structures have been identified and fixed, whose solution involved a theoretical modification in the existing VAM-based framework. Further, the overall framework has been facilitated with analysis of piezoelectric materials, analysis involving structural damping and a method to obtain, store and visualize time-histories of 3D stresses, strains and displacements.

Finally, a method to use dimensional reduction techniques for solving beam-like structures, such as aircraft wings, involving complex and intricate 3-D geometries is demonstrated. Thus, the present work enhances the analysis of beams using asymptotic methods, expands the scope of VAM-based beam theory and provides extensive validation for implemented techniques with the commercially available 3-D FEM tools. As a complement to conventional FEA, state-of-the-art Variational Asymptotic Method (VAM) and a mixed formulation of Geometrically Exact Beam Theory (GEBT) are employed in this work, which is very fast, provides rigorous physics-based material models for composites while ensuring efficiency and accuracy.

In the present work, some major issues with use of VAM-based framework for solving thin-walled structures have been identified and fixed, whose solution involved a theoretical modification in the existing VAM-based framework. Further, the overall framework has been facilitated with analysis of piezoelectric materials, analysis involving structural damping and a method to obtain, store and visualize time-histories of 3D stresses, strains and displacements. Finally, a method to use dimensional reduction techniques for solving
beam-like structures, such as aircraft wings, involving complex and intricate 3-D geometries is demonstrated.

Thus, the present work enhances the analysis of beams using asymptotic methods, expands the scope of VAM-based beam theory and provides extensive validation for implemented techniques with the commercially available 3-D FEM tools.

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