The Unified Formulation: a high-fidelity tool for the analysis of structures with enhanced computational efficiency

Abstract

This talk presents the key pillars of the Unified Formulation, referred to as CUF, from the early ideas of the late 90s to the most recent advances concerning nonlinear analyses and interface with commercial codes. The CUF governing equations date back to two decades ago with applications related to plates and shells via strong- and weak-form solution schemes. The CUF proved to be particularly fit for detecting the 3D distributions of stress in multilayered structures with multifield capabilities. Furthermore, early works highlighted the versatility of the framework in dealing with advanced modeling schemes such as layer-wise and the RMVT.

The second wave of CUF models focused on beams. The 1D approach resulted in further computational efficiency with up to twofold saving in memory and time if compared to 3D FEM. The 1D CUF led to the introduction of the Component-Wise approach (CW) to model multicomponent structures. e.g., aircraft wings and fuselage, launchers, fiber/matrix cells, via 1D models relying on the same family of FE arrays with direct and physically meaningful coupling.

Further applications favored by the 1D CUF are the rotordynamics, progressive failure analyses and the evaluation of free-edge effects.

This talk delivers the theoretical background and broad application overview spanning most of the current research topics of the MUL2 group, such as the nonlinear multiscale framework, global-local strategies, and interfaces with commercial codes. Finally some guidelines on the choice of the best generalized variables for high-fidelity, and low cost with a particular focus on multifield and perspectives on machine learning assisted structural analyses.