EFFICIENT NONLINEAR FINITE ELEMENTS ANALYSIS OF METALLIC AND COMPOSITE STRUCTURES

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ABSTRACT

Nonlinear phenomena dominate many engineering problems in various fields. At least one of the three main nonlinearities is often involved: geometrical (stability), physical (material nonlinearities) and unknown boundary condition (contact, impact). Finite Element Methods is by decades the most suitable computational method for both linear and nonlinear problems. Linear problems consist of one-shot analysis, nonlinear ones require multi-shot analysis. This simple fact is the most significant distinction between linear and nonlinear analysis; that is the approximation, e.g. errors in linear analysis, could propagate in a multi-shot case. Therefore, in order to solve in a suitable manner nonlinear problems very efficient ' as a whole' numerical models are required. It is a well-known fact that assumption of classical beam, plate and shell theories often lead to solutions that could deviate significantly from the exact ones. On the other hand, the use of simplified nonlinear relations (such as von Ka'rma'n approximations) could lead to large errors to detect the correct solutions when the equilibrium path is far from the unreformed configurations.

In recent years, the author and co-workers have successfully introduced and extended the Carrera Unified Formulation, CUF, which is a hierarchical framework to develop any theory of structures for beams, plates and shells including laminated structures and multifield loadings. These have been extended and applied to various nonlinear problems with excellent and unique accuracy. FEs applications have been developed extensively. It has been shown that such accuracy could be only achieved by the use of solid-3D Finite Elements if commercial software is referred to, nevertheless, the computation costs of 3D analysis could become prohibitive. This talk will first overview some of the most interesting problems solved by CUF: buckling and post-buckling of thin-walled structures, plasticity, progressive failure in laminates, low-velocity impact. The extraordinary advantages of CUF usage with respect to other models will be made clearly evident. Particular attention will be given to the application to stability analysis in both linearized and nonlinear cases, via the so-called vibration-correlation technique (VCT).