5346: MITC9 SHELL ELEMENTS BASED ON RMVT AND CUF FOR THE ANALYSIS OF COMPOSITE PLATES AND SHELLS

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In the two dimensional modelling of multilayered plates and shells, the main interest is to study the mechanical response, that may change in the thickness direction. In particular, the transverse shear and normal stresses are required to be continuous in each layer interface (Interlaminar Continuity, IC).

Among the computational techniques developed for layered constructions, a predominant role is played by Finite Element Method (FEM). In this regard, two variational formulations are available to reach the stiffness matrices, the *Principle of Virtual Displacement* (PVD) and the *Reissner Mixed Variational Theorem* (RMVT) [1]. The PVD, formulated with only displacements, cannot describe a priori IC for transverse stresses. On the contrary, they can be a-priori assumed in the framework of RMVT, which consists of a mixed principle for multilayered structures.

It is known that when FEM is used to study shell structures, the phenomenon of numerical locking may arise: the so-called *membrane and shear locking*. A well known remedy for the locking is the use of the Mixed Interpolated Tensorial Components (MITC) technique.

In this paper, we introduce a strategy similar to MITC approach in the RMVT formulation in order to construct an *advanced* locking-free finite element to treat the multilayered plates and shells. Following this suggestion, we propose a finite element scheme based on Carrera's Unified Formulation (CUF) that exhibits both properties of convergence and robustness.

References:

[1] Carrera E., "Developments, ideas and evaluations based upon Reissner's Mixed Variational Theorem in the modelling of multilayered plates and shells", Applies Mechanics Reviews, 54(4), 301-329, 2001.