MITC9 finite elements based on RMVT for the analysis of laminated shells.

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The efficient load-carrying capabilities of shell structures make them very useful in a variety of engineering applications. The continuous development of new structural materials, such as composite materials, leads to ever increasingly complex structural designs that require careful analysis. The finite element method is considered a fundamental numerical procedure to solve shell mathematical models of complex structures.
Anisotropy as well as complicating effects such as the C_z^0-Requirements (zigzag effects in the displacements and interlaminar continuity for the stresses) and the couplings between in-plane and out-of-plane strains make the analysis of laminated shells difficult in practice. The *Reissner's Mixed Variational Theorem (RMVT)* plays a significant role toward a better understanding of the mechanical behavior of multilayered structures [1]. Assuming the transverse shear and normal stresses as independent variables, the continuity at the interfaces between layers is easily imposed.
In [2], the authors have introduced a strategy similar to Mixed Interpolated of Tensorial Components (MITC) approach, in the RMVT formulation, in order to construct an advanced locking-free finite element.
Following this suggestion, the authors propose a finite element scheme based on Carrera's Unified Formulation (CUF) [3] that permits to easily obtain shell models with different through-the-thickness kinematic. It is shown that, in the RMVT context, the element exhibits both properties of convergence and robustness in respect to membrane and shear locking phenomenon. Furthermore, it allows to fulfill a-priori C_z^0-Requirements in the analysis of laminated shells. The numerical results are compared with benchmark solutions from literature.

References

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