INVERSE DIFFERENTIAL QUADRATURE METHOD FOR 3D STATIC ANALYSIS OF COMPOSITE BEAM STRUCTURES

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Modelling of laminated structures requires adequate computational frameworks which can accurately estimate displacement and stress fields resulting from systems of high-order partial differential equations [1]. The recently developed inverse differential quadrature method (iDQM) [2] shows promising outcomes for obtaining solution of high-order systems of equation. In this study, we perform static analysis of composite structures based on the theory of Unified Formulation (UF) and mixed methods, comprising of a combination of high-order Finite Element (FE) Method and the new iDQM. According to the theory of UF, a 3D structure is geometrically reconfigured by separating the kinematics governing the 2D cross-section from the 1D axial deformation. In this context, the so-called Serendipity Lagrange Element [3] is employed in a FE framework to capture the cross-sectional deformation with enhanced accuracy without the need for remeshing or loss of numerical stability. On the other hand, the deformation of the refined 1D structure is captured by a new iDQM-based beam element which is either characterised by approximation of derivatives of intermediate order (in a mixed iDQM framework) or highest derivatives (in a full iDQM framework) of the 1D displacement fields. By invoking plane strain and simple support conditions, FE-iDQM predictions of stresses for different laminate configurations show good agreement with Pagano's exact solution and compare well with DQM solutions with the same level of discretisation as shown in Figure 1.

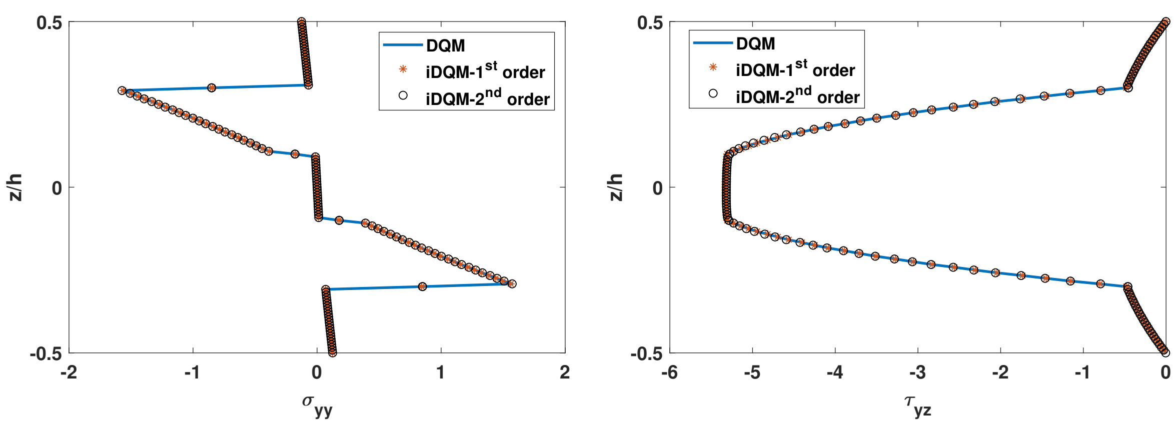

Figure 1: Nondimensionalised $\sigma_{yy}(y = L/2)$ and $\tau_{yz}(y = 0)$ through-the-thickness profiles

References

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