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NEW GENERATION OF ROTATION-FREE TRIANGLES FOR ANALYSIS OF THIN AND THICK PLATES AND SHELLS

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ABSTRACT

The paper describes recent advances for the development of rotation-free triangles for plate and shell analysis. The elements formulation is based on the approximation of the bending (and membrane) strains over adequate elemental and nodal patches. The ingredients for the element formulation are: a Hu-Washizu mixed functional, a linear interpolation for the displacement field and a finite volume approach for computing the resultant stresses and the generalized strains over a patch of elements. It is shown that the use of a quadratic approximation of the displacement field considerably enhances the membrane performance of the element. A new methodology for introducing the effect of shear deformation in the formulation in an iterative manner is presented. The nodal deflection degrees of freedom (DOFs) of the original BPT element are enhanced with the two shear deformation angles. This allows to compute the bending and shear deformation energies leading to a simple triangular plate element with 3 DOFs per node. For the thin plate case the shear angles vanish and the element reproduces the good behaviour of the original thin BPT element. As a consequence the element is applicable to thick and thin plate situations without exhibiting shear locking effects. This approach makes the rotation-free element applicable to both thin and thick plate situations as well as for the analysis of composite plates and shells.

Examples of the good performance of the rotation-free triangles proposed to a number of academic and practical problems, including the aeroelastic analysis of thin membrane structures and inflatable shelters, and simulation sheet metal forming processes are presented.

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