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NEW THREE-NODE ASSUMED STRAIN MINDLIN PLATE FINITE ELEMENTS

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Two new three-node Mindlin plate finite elements T3-LSC and T3-LSI for linear-elastic analysis of plates with small deformations are presented. They are developed by generalising the constant shear strain expression of the two-node Timoshenko beam element with problem-dependent cubic linked interpolation along each of the element side, which results in linear shear strain fields in global coordinate directions. For the T3-LSC element, the rotational fields are derived in a way that the whole formulation is kinematically consistent in every point inside the element domain, whereas for the T3-LSI element, the rotational fields are interpolated independently and have a special property which reduces the interpolation to the linear level if reduced integration is carried out for the bending part of the stiffness matrix. Additionally, the rotational fields are nonconforming for both finite elements.

The T3-LSI element passes the patch test for the constant bending state regardless of the element size, so that the convergence towards a solution can be reliably expected in all cases. Results from the numerical examples support the claim for convergence, while indicating robustness and effectiveness. That is also the case with the T3-LSC element, which passes the constant bending patch test only when the size of the elements become infinitesimal, even though the element formulation itself is capable of providing the exact stress resultants regardless of the element size. Moreover, the numerical results also show that both elements are completely free of shear locking, which makes them suitable for the analysis of very thin to thick plate cases. All in all, the presented elements are: simple in formulation, computationally efficient, shear locking free, exhibiting high performance in all cases, robust and effective, thereby suitable for practical application.

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