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A NEW CONFORMING FINITE ELEMENT FOR NON POLAR MODELS: THE KIRCHHOFF PLATE CASE

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In this contribution, we present a new formulation for a class of quadrilateral conforming elements for the case of pure bending Kirchhoff plate problems, within a displacement based formulation. The rational enrichment of the bi-cubic Béezier basis, proposed by J. Gregory in 1974 for obtaining G^1-continuous surfaces is the starting point of the proposed approach, see [1]. In this way a rational element with 20 degrees of freedom is obtained, in which two different twisting rotations at each corner are introduced as degrees of freedom. The element so obtained presents discontinuities on the second derivatives at the corners, that prevent the satisfaction of the patch test. In order to overcome this drawback, we show that performing a projection from the rational interpolation space to the polynomial interpolation space a 16 dof's element is recovered, that allows to correctly model states of uniform curvature. The dof's so obtained can be also interpreted as side rotations, similarly to the semi-loof interpolation, see [2]. The interpolation presents a polynomial and a rational components, the second one can be considered as measure of the torsion of the connection of the configuration space of the generalized non-polar plate model. The shape operator for this model is in general non symmetric. By enforcing the symmetry of the shape operator, i.e. the torsion free property for the configuration space, the plate model recovers the symmetry. In the implementation, the rational component introduced for obtaining an implicit conforming finite element, is removed by means of a Langrangian multiplier, in order to simplify the assemblage procedure. Examples demonstrate that the proposed formulation is free of the C^1-locking, presenting optimal rate of convergence and high robustness with respect to mesh distortions even on non-structured meshes. The proposed interpolation can be considered a generalization of the bi-Hermitian interpolation to the case of the unstructured meshes. Furthermore, this approach is suitable to design isogeometric interpolation for non polar multi patch problems.

REFERENCES

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