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Combining linear tetrahedral elements to solve problems with incompressible behaviour through an iterative force based method

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ABSTRACT

In the presentation we shall extend the method previously proposed by the first author (*Int. J. Num. Meth.* ***61****,1710-40)* for plane strain problems, to three dimensional incompressible problems. In the edge based formulation proposed earlier, a new concept based on using nodal forces was introduced to convert a problem with artificial compressibility to a problem with incompressible behavior. In this way, the velocity/displacement field is split to deviatoric and volumetric parts and the volumetric part is eliminated through a simple iterative algorithm. Such an iterative feature of the method makes it very cheap and practical to implement in any FEM program. The force based feature of the method helps to bypass the evaluation of pressure values during the iteration and thus the formulation may be categorized in the velocity/displacement based ones. Such a feature is mostly desirable in formulation of water and structure interaction.

In this work we aim at extending the method to 3D problems with tetrahedral elements. In 3D problems the control volumes are to be constructed in a face-based form, i.e. when parts of two adjacent elements with a sharing face contribute to a generic control volume. It will be seen that even in this simple form, the formulation is slightly different from the one previously proposed for 2D problems. We shall also examine the performance of the method when the control volumes are constructed in a node based manner. To give more insight, each type of control volumes, i.e. the face-based and the node-based ones, are constructed in two forms, one with overlapping control volumes (known also as patches) and another with non-overlapping ones (the approach used in Reference [1] is classified as non-overlapping edge based ones).

Along with some new results for 2D plane strain problems using linear triangles and new control volumes, we shall present results on 3D problems using tetrahedral elements. The 3D examples include 3D cavity and 3D tube with internal pressure. The

results show that although all the new control volumes can be used in the proposed method, some of them are cheaper.

REFERENCES

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