ADDED MASS EFFECTS OF COMPRESSIBLE AND INCOMPRESSIBLE FLOWS AND SOLUTION METHODS FOR FSI

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ABSTRACT

The subiteration method which forms the basic iterative procedure for solving fluid-structure-interaction problems is based on a partitioning of the fluid-structure system into a fluidic part and a structural part. In fluid-structure interaction, on short time scales the fluid appears as an added mass to the structural operator, and the stability and convergence properties of the subiteration process depend on the ratio of this apparent added mass to the actual structural mass. In the present paper, we establish that the added-mass effects corresponding to compressible and incompressible flows are fundamentally different. For a model problem, we show that on increasingly small time intervals, the added mass of a compressible flow is proportional to the length of the time interval, whereas the added mass of an incompressible flow approaches a constant. We then consider the implications of this difference in proportionality for the stability and convergence properties of the subiteration process, and for the stability and accuracy of loosely-coupled staggered time-integration methods.

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