Finite element time domain equivalent fluid model for the acoustic wave equation

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Non-locally reacting acoustic absorbers are often modeled using an equivalent fluid. The homogenized fluid's acoustic behavior is described by complex-valued, frequency-dependent material parameters (equivalent density and bulk modulus). In this case, convolution integrals of the material parameters and the acoustic pressure arise when the Helmholtz equation is transformed into the time domain. The numerically demanding direct calculation of the convolution integrals is circumvented by applying the auxiliary differential equation (ADE) method, according to Dragna, *et al.* [1]. This approach introduces additional auxiliary variables and ADEs coupled with the wave equation. In doing so, the frequency response functions (FRFs) of the equivalent fluid parameters have to be approximated using a sum of rational functions consisting of real and complex poles with corresponding residues. The rational function approximation can thereby be obtained using the vector fitting method [2]. The number of introduced ADEs and unknowns depends on the order of approximation, i.e., the number of poles. The finite element method (FEM) is applied to solve the set of coupled differential equations. Multiple test cases present the formulation's capability. Furthermore, the passivity of the model is addressed.

Keywords: ICTCA 2023; equivalent fluid; time domain; finite element method.

References

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