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An Evolutionary Optimization Method applied to Absorbing Poroelastic Systems

Francisco Silva[a] and Renato Pavanello[b]
[a]Unité de Mécanique (UME), ENSTA, Chemin de la Hunière, 91761 Palaiseau, France
[b]Depart. of Computational Mechanics - FEM - Unicamp, POBOX 6122, Rua Mendeleiev, s/n - Cidade Universitária, 13083-970 Campinas, Brazil

Poroelastic materials can be used in engineering applications such as: noise control of automobiles, acoustical insulation systems for aircrafts, industrial, environmental and domestic sound quality control, etc. The insulating systems must be as light as possible and the acoustic absorption in the low frequency domain must be maximized for certain gaps. Topology Optimization is frequently used to design structures and acoustic systems in a large range of engineering applications. In this work, we propose one method to maximize the absorbing performance of insulation poroelastic systems using a coupled finite element model and Evolutionary strategies. The goal is find the best distribution of poroelastic material on insulating systems. The absorbing performance of the poroelastic material samples in a Kundt tube is simulated using a coupled poroelastic and acoustic finite element model. The Biot-Allard Coupled Model is used to represent the foam material. The porous material model is coupled to a waveguide using a modal superposition technique. A sensitivity number indicating the optimum locations for porous material removing is derived and used in a numerical hard kill scheme. The sensitivity number is used to form an evolutionary poroelastic optimization (EPO) algorithm which is verified though numerical examples.