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On heterogeneous blankets: Analytical solution for the interaction between masses and poro-elastic layers

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There has been substantial research over the last five decades on control of aircraft cabin noise. One new passive approach is the heterogeneous (HG) blanket where a traditional acoustic blanket treatment is altered by adding mass inhomogeneities into the poro-elastic/viscoelastic layers. These masses act like distributed vibration absorbers and can be used to reduce vibration and sound transmission by targeting modes of the fuselage. The natural frequency of a mass inhomogeneity is determined by the mass itself and by the effective stiffness of the porous layer due to the mass/poro interaction. An experimental 1st order approach to predict the effective stiffness based on the shape of the mass inhomogeneities is reviewed. An analytical model for poro-elastic media proposed by Allard et al. was simplified for low frequencies and is used to validate and extend the 1st order approach. It is shown that the effective stiffness depends on mass shape, the foam thickness and material constants such as the modulus of elasticity and Poisson's ratio. Furthermore the model can be used to calculate the stress and displacements fields in the blanket in order to give further insight into the behaviour of the HG blankets.