Homogenization in vibro-acoustic problems involving perforated plates

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We consider problems of the acoustic wave propagation through vibrating periodically perforated plates. The aim is to reduce the noise produced by a source, transmitted through the acoustic fluid and influenced by perforated compliant plates. There are many challenging applications of this problem in the aerospace and automotive engineering.

The acoustic problem described by the Helmholtz equation involves homogenized transmission conditions imposed along a compliant plate. For the rigid plate the transmission conditions were derived in [1]. Recently this result has been extended for compliant plates, where the framework of Reissner-Mindlin's theory was used under the assumption of cylindrical shapes of the holes. The model was derived by homogenizing a fictitious transmission layer which contains the acoustic fluid and the elastic perforated plate. For a given wave frequency, the periodic unfolding method is applied to analyze asymptotics of the coupled system involving the Helmholtz equation and the Reissner-Mindlin plate equations, cf. [2], with respect to the plate thickness and size of the holes. In principle, combination of the vibro-acoustic transmission with the band-gap effects of the phononic plate makes possible to use the phononic effect in the plate for damping of the acoustic field.

According to [1], in general, there is coupling between transverse and surface acoustic waves, however, this phenomenon vanishes when the plate perforation prevents transverse isotropy (e.g. the case of cylindrical holes). Therefore, to allow for a general geometry of the holes, we develop a model of the vibro-acoustic transmission on the perforated plate by upscaling from a 3D elastic problem. The goal is to design optimal perforations which would contribute in controlling the acoustic field around the plate [3]. *The research was supported by projects P101/12/2315 and 13-00863S of GAČR.*

References

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