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Efficient dispersion curve computations for periodic vibro-acoustic structures using the (generalized) Bloch mode synthesis

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Periodic structures such as metamaterials and phononic crystals hold potential as promising compact and lightweight solutions for the noise and/or vibration attenuation in targeted frequency ranges, called stopbands. The performance of these structures is usually investigated by means of dispersion curves which represent the wave propagation in the corresponding infinite periodic structure. The input for dispersion curve computations is often a finite element model of the corresponding unit cell. Nowadays, the vibration and noise attenuation of these innovative periodic structures are generally tackled as separate problems and their performance is separately investigated with either structural or acoustic dispersion curves, respectively. Recently, vibro-acoustic metamaterials which exhibit simultaneous structural and acoustic stopbands have come to the fore [1]. However, the vibro-acoustic coupling is usually not taken into account during the dispersion curve computations. To take this coupling between acoustics and structure into account during their performance assessment, the computation of vibro-acoustic dispersion curves is required. Although vibro-acoustic dispersion curves provide valuable information, the associated computational cost rapidly increases with unit cell model size. Model order reduction techniques are important enablers to overcome this high computational cost. In this work, the Bloch mode synthesis (BMS) and generalized BMS (GBMS) [2,3,4] model order reduction techniques are extended to be applicable for 2D and 3D periodic vibro-acoustic unit cells. Through several verification cases it is demonstrated that the methodologies are able to reduce the dispersion curve calculation time while maintaining accurate predictions.

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