

Superelement modelling of elastic metastructures and their anti-homogenisation

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Abstract : Engineered elastic structures (often referred to as metastructures) are promising in applications where filtering, focusing or channeling of elastic waves is required. Besides academic research interest, metastructures are gradually permeating the industrial sector and several associated modelling notions are entering engineering practice. Spatially-resolved finite-element models of large collections of unit-cells inevitably call for mathematical approximations and accurate reduction schemes. In this talk, we exploit well-known finite-element model order reduction techniques: an exact superelement, an eigenmode based superelement and an asymptotic based superelement. We show how the latter two can be obtained from the exact superelement. In the context of metastructural design, we highlight their benefits in terms of reduced computational time with respect to standard full-size finite-element solutions. Specifically, we define the superelements starting from unit cells of three-dimensional metastructures and use those to solve mathematical problems of general interest: (i) polynomial Bloch-Floquet eigenvalue problems associated with complex dispersion diagrams (i.e. complex Bloch vector as a function of frequency), and (ii) time-harmonic response of finite assemblies of unit cells. Differently from the rationale of homogenisation theories - where an approximating continuum is sought - superelements tend at further discretizing or "anti-homogenising" metamaterials.

Keywords :