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ROTATIONAL AND ANISTROPIC METASOLIDS: A GENERALIZED ANALYTIC MODEL

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Abstract

In this talk, an analytical approach will be presented to model a metasolid accounting for anisotropic effects and rotational motions. Based on the initial experiences reported in [1], the aim of this study is to give a generalization of the method introduced by the same group [2] to describe the physics of this metasolid. This structure, made of either cylindrical or spherical hard inclusions embedded in a stiff matrix via soft claddings, exhibits negative mass densities near the translational-mode resonances (local resonance for translational motions). Within the large wavelength limit, in micro level hypothesis of rigid solid behavior has been made for both the inclusion and the matrix in this three-component medium. This assumption simplifies the analytical study of the problem, while yielding the physical dynamics of the medium.

In this work, firstly we give the frequency-dependent components of the effective mass density that appears to be anisotropic considering the cylindrical inclusions. Figure 1 (left) shows this result for cylindrical or spherical inclusions, obtained by continuum model, as well as those from the discrete model based on an analogy with mass-spring system. The latter, which can be easily derived from quasi-static homogenization of the soft cladding [3], may be useful to tune effective metasolids with desired acoustic properties. We systematically investigate the limit of the validity of this discrete model, which gives a very accurate estimation of the first local-resonance frequencies of the structure.

The second extension concerns the rotational modes, which exhibit similar properties at different frequencies: a negative density of moment of inertia near the rotational resonances is observed and well-estimated by a simple discrete model based on inertia-

torsional spring. As such, the effective density of moment of inertia, shown in Figure 1 (right), is introduced to characterize the homogenized material with respect to its rotational mode. This kinematics is different from those found in [4] or [5].

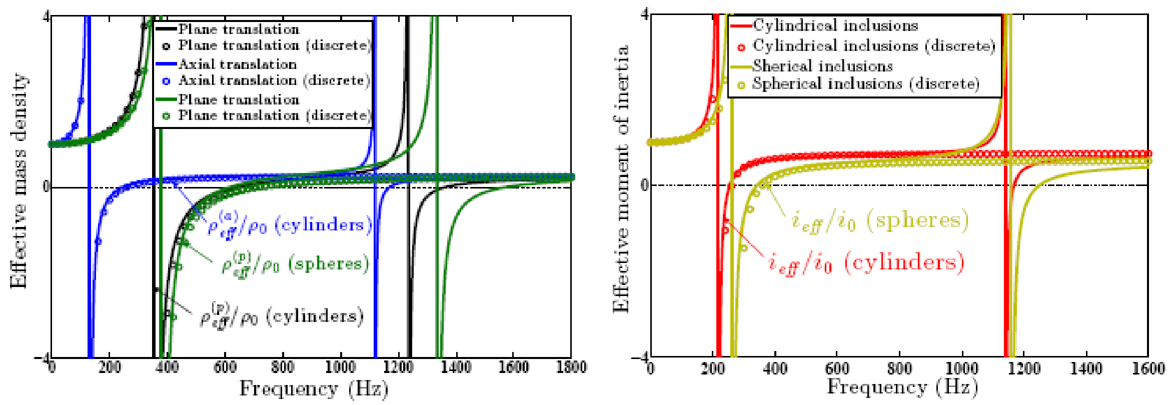

Figure 1. Effective mass densities (left), and effective moment of inertia (right).

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