

Self-Consistent Methods in the Problem of Elastic Wave Propagation Through Matrix Composite Materials

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The problem of monochromatic elastic wave propagation through composite materials reinforced with isolated inclusions is considered. The hypotheses of two main self-consistent schemes (effective field and effective medium methods) that allow to construct the mean wave fields in such composites are analyzed and compared. The effective medium method is in fact a group of methods based on the hypotheses that for the evaluation of the wave field inside a typical inclusion in the composite the medium outside some vicinity of such an inclusion may be changed for the effective medium with overall properties of all the composite. The effective field method is based on the other hypothesis that every inclusion in the composite behaves as an isolated one in the original matrix, and the presence of the surrounding inclusions is taken into account via the effective external wave field that acts on every inclusion. The main hypotheses of the method concern the structure of the effective field. In the work the dispersion equations for the wave numbers of the mean wave field in the composites are developed in the framework of both methods. The long wave and short wave asymptotic solutions of these equations are obtained in closed analytical forms. Numerical solutions of these equations are constructed in a wide region of frequencies of the incident field that covers long, middle and short regions. The predictions of both methods are compared for matrix composites reinforced with isolated spherical inclusions and unidirectional cylindrical fibers.

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