Numerical analyses on a new method to solve wave fields in heterogeneous structure

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A new method was proposed by one of the authors for computing the wave field in an isolated finite body with the most general structures in frequency domain. Keeping the possible extension to general cases in mind, we examined the basic nature of this theory in the simplest case: a finite one-dimensional elastic body. Spatial variation of material parameters in the wave equation is converted to a set of several quantities representing separately the continuity and the discontinuity of different orders as a function of space by means of hyperfunctions. With a set of the converted parameters, wave equation described by differential equation is rewritten to a linear system model expressing the external excitation as output and the wave field as an input, where the contribution from discontinuity is brought to a self-excitation term containing impedance contrasts at the discontinuities. This linear equation is converted to an inverse system model expressing the external excitation as input and the wave field as an output all in frequency and wavenumber domain. This inverse system model is represented by FWR, the frequency and wavenumber response characteristics, free from grid dispersion. Multiplying the excitation to FWR represented in frequency and wavenumber domain, we obtain the wave field as a dispersion relation. The computed numerical result on the simple structure involving discontinuity was consistent with what we expect theoretically.

In conclusion, we have validated the present theory. We shall demonstrate several examples of computed wave field; role of an absorbing layer to eliminate reflection, wave field in the medium with material dispersion, etc.