STABILITY AND REFLECTIVITY OF M-PML FOR ANISOTROPIC ELASTIC MEDIA

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Numerical simulation of elastic wave propagation takes place within a target area, which is included in an unbounded domain (space, half-space). Because of this reason one needs to introduce special boundary conditions preventing non-physical reflections of outgoing waves. In recent years a number of new techniques have been introduced which are capable to deliver desired accuracy for isotropic media. One of the most efficient and widely used of them is the Perfectly Matched Layers or PML (Berenger, 1994). At the same time application of these techniques, including PML, for anisotropic media may cause the instability (Becache et al., 2003). Anisotropic media are studied by the geophysical community nowadays, thus efficient numerical methods to simulate wave propagation in such media are required and reflectionless boundary conditions are part and parcel of numerical simulation of waves.

We provide here a study of a recently published modification of PML known as Multiaxial-PML (M-PML) (Meza-Fajardo et al., 2009). This modification is free from instability. However, it happens that the new approach may cause artificial reflections higher than those observed with regular Berenger's PMLs do. The principal topic is the construction of stable M-PML possessing as low level of artificial reflections as possible. The algorithm to construct the optimal stabilization parameter with minimal artificial reflections is developed.

To illustrate the efficiency of M-PML a series of numerical experiments is performed. Simulation of elastic waves is done by finite difference scheme on a staggered grid. We considered models of 2D orthorhombic elastic media, which do not satisfy stability criteria for Berenger's PML, see (Becache et al., 2003). Presented numerical results demonstrate instability of Berenger's PML appearing at relatively low instants. On contrary, use of M-PML preserved stability. The second series of numerical experiments was done to represent efficiency of M-PML for simulation of wave propagation in 2D isotropic elastic media with sharp interfaces. Implementation of Berenger's PML in case of sharp interfaces present in the model leads to instability while use of M-PML stabilizes the problem.

We proved that for an arbitrary anisotropic problem one can construct stable M-PML. In addition, as it follows from numerical simulations, implementation of M-PML overcomes stability problems caused by presence of high-contrast interfaces. We also proved that M-PML is not perfectly matched and it possesses higher artificial reflections than regular PML thus it requires more computational resources to keep the reflections at a desirable level. To reduce the cost of the M-PML an algorithm to construct the optimal stabilization parameter is formulated and implemented.

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