A PERFECTLY MATCHED LAYER FOR THE THIN-LAYER METHOD

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In the last two decades, the Thin-Layer Method (TLM) has been successfully applied to the simulation of seismic and elastic wave propagation in multi-layered media. The method is a useful numerical tool for the analysis of stresses, deformations, and wave motions in laminated media [1]. In a nutshell, the TLM combines the Finite Element Method in the direction of layering together with analytical solutions in the remaining directions. In particular, the TLM provides various Green’s functions, which are the key element of the boundary integral equation method. The calculation procedure is based on the superposition of the normal modes of wave propagation, and is able to make exact inversions from the wavenumber domain into the space domain. Also, the TLM can be used to obtain consistent transmitting boundaries at the lateral edges of islands of finite elements, while waves radiating vertically down into an infinitely deep half-space are currently modeled in the TLM by means of paraxial approximations (PA) [4]. It has been found, however, that the TLM combined with PA has only limited accuracy, particularly in the far-field responses and/or at low frequencies [2]. Applying a perfectly matched layer (PML) technique to SH wave case, the limited accuracy has been improved [3].

In the current presentation, we first extend the PML technique of the authors for analyzing the SVP wave motion in a horizontally layered system by following the same procedure as applied to SH wave [3]. We then formulate the TLM discrete equation for the PML, and present the Green’s functions for displacement responses of multi-layered media modeled by the TLM together with the PML. By solving a canonical problem with known exact solution, namely a homogenous half-space subjected to a harmonic line load, we determine the optimal parameters for the PML needed to be applied to the TLM. Furthermore, we will discuss on a physical interpretation of the optimal PML parameters that are determined in this study. Also, we assess the efficiency of the PML by comparing the calculated displacement in the frequency domain against the results obtained from a conventional TLM combined with the PA. In addition, we will evaluate the performance of the PML technique of this study in simulating time-domain synthetic seismograms where the wide-band frequency simulation is required. It will be shown that the optimal PML parameters for this purpose should be slightly modified.

Reference