17th Symposium on Earthquake Engineering
November 14-17, 2022
IIT Roorkee, India
Paper No. 608

A Fast Staggered Grid Finite Difference Modelling of Rayleigh Wave

Mrinal Bhaumik[1], Tarun Naskar[1]

[1]Indian Institute of Technology Madras, Chennai, India

Abstract

Staggered grid finite difference methods are extensively used for elastic wavefield modelling of Rayleigh waves due to their stability and easy implementation. However, the technique requires a very high spatial grid resolution in the presence of low velocity layers near the surface. The fine grid increases the computational cost and causes oversampling for relatively longer wavelengths at deeper depths. To overcome these challenges, we propose a vertically non-uniform staggered grid finite difference approach that significantly reduces the computational cost without sacrificing accuracy. The non-uniform discretization strategy is based on the Rayleigh wave dispersion relation, where the penetration depth is assumed to be roughly one and a half of a wavelength. Using the above assumption, an exponential relationship between grid size and grid number is established. After applying the systematic discretization, the finite difference coefficients are calculated at respective main and staggered grid positions. The proposed modelling method is applied to different synthetic models. The accuracy of the proposed approach has been demonstrated by comparing the vertical and horizontal responses and dispersion images. The proposed approach produces identical dispersion images using only 1/3rd to 1/4th of the computation time compared to the uniform grid approach.

Keywords: Staggered grid finite difference, Synthetic seismogram, Non-uniform grid, Rayleigh wave