REVERSE TIME IMAGING OF SEISMIC BEAMFORMING DATA IN SUBWAY TUNNELS

Yuxiao Ren, Shandong University; Shucai Li; Lanbo Liu, University of Connecticut; Bin Liu, Shandong University; Xinji Xu, Shandong University; Fengkai Zhang, Shandong University; Lei Chen, Shandong University; Zhichao Yang, Shandong University; Senlin Yang, Shandong University

To ensure the safety and efficiency of subway tunnel constructions, there is an increasing need for an effective forward-prospecting method to detect unknown geological conditions ahead of tunnel face. Although seismic prediction has been considered a suitable approach for geology prospecting in tunnels, it suffers limitations including: a) limited tunnel space available for seismic setup, which means small offset and insufficient observation datum; b) low SNR (Signal to Noise Ratio) of observation datum due to severe interference from construction site and ground human activities like traffic. Considering that reverse time migration (RTM) technique could make the best use of full waveform information and present high resolution imaging results, seismic wave beamforming technique could realize directional propagation of wave field, thus improve the SNR of observation data, a combined method is proposed for RTM imaging in tunnels. This method is called Seismic Beamforming Reverse Time Migration (SBRTM), which introduces seismic beamforming in RTM imaging by setting a time delay either in seismic source array or geophone records. Different delay time means different seismic wave propagation direction and a sweep mode of data acquisition is proposed by increasing the angle between the main wave energy propagation direction and the tunnel axis. Numerical simulations achieved by a 2D staggered grid finite-difference (FD) algorithm indicate that a) seismic beamforming either in source array or geophone records could present the same RTM results and beamforming of geophone records is easy to achieve in practical applications; b) mirror tail of RTM image could be suppressed by superposition of the sweep mode results, that is, sweep mode data could lead to a cleaner and better RTM result in forward-prospecting in tunnels; c) SBRTM imaging could identify the existence of lithological interface and its inclined angle, and will have a good application effect in forward-prospecting in tunnels.