

Interaction between Trapezoidal Hill and Subsurface Cavity under SH Wave Incidence

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Abstract : It is an important subject of seismology on the influence of local topography on ground motion during earthquake. In mountainous areas with complex terrain, the construction of the tunnel is often the most effective transportation scheme. In these projects, the local terrain can be simplified into hills with different shapes, and the underground tunnel structure can be regarded as a subsurface cavity. The presence of the subsurface cavity affects the strength of the rock mass and changes the deformation and failure characteristics. Moreover, the scattering of the elastic waves by underground structures usually interacts with local terrains, which leads to a significant influence on the surface displacement of the terrains. Therefore, it is of great practical significance to study the surface displacement of local terrains with underground tunnels in earthquake engineering and seismology. In this work, the region is divided into three regions by the method of region matching. By using the fractional Bessel function and Hankel function, the complex function method, and the wave function expansion method, the wavefield expression of SH waves is introduced. With the help of a constitutive relation between the displacement and the stress components, the hoop stress and radial stress is obtained subsequently. Then, utilizing the continuous condition at different region boundaries, the undetermined coefficients in wave fields are solved by the Fourier series expansion and truncation of the finite term. Finally, the validity of the method is verified, and the surface displacement amplitude is calculated. The surface displacement amplitude curve is discussed in the numerical results. The results show that different parameters, such as radius and buried depth of the tunnel, wave number, and incident angle of the SH wave, have a significant influence on the amplitude of surface displacement. For the underground tunnel, the increase of buried depth will make the response of surface displacement amplitude increases at first and then decreases. However, the increase of radius leads the response of surface displacement amplitude to appear an opposite phenomenon. The increase of SH wave number can enlarge the amplitude of surface displacement, and the change of incident angle can obviously affect the amplitude fluctuation.

Keywords : method of region matching, scattering of SH wave, subsurface cavity, trapezoidal hill

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