Seismic Response of reduced micropolar elastic half-space

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Abstract

Traditionally earthquake resistant design of structures is based on translational ground motions. Recently it has been recognized that rotational ground motion effects the response of the structures. Due to advances in instrumentation, ring laser technology has succeeded in recording seismic rotational ground motions. These instruments have been recording rotations for many strong earthquakes, and a ground motion database is available for several combinations of magnitude and rupture distances. It is observed that classical elastic theory is not capable of explaining these rotational motions. Takeo (1998) and Yin et al. (2016) found that the analytically calculated rotations from linear elastic theory do not match well with the recorded ground motion rotations. This mismatch in the analytical and recorded rotations forced researchers to explore the micropolar theory of elasticity to model the rotations. This theory requires five constants in addition to constants of classical elasticity and applies to an ordered configuration of particles. For the micropolar theory of elasticity, there are two sets of basic equations available in the literature given by Eringen (1999) and Nowacki (1972). These two formulations use different material constants and constitutive relationships. The formulation of Eringen (1999) has been used in the literature to derive solutions for semi-infinite media subjected to static and dynamic loads (Dhabu and Raghukanth, 2019). However, these solutions are not available using the formulation given by Nowacki (1972). The difference in the numerical and analytical solutions using both the formulations are also not available in the literature. The present paper derives expressions for displacements and rotations in a homogeneous reduced micropolar half-space subjected to an arbitrary, time-harmonic, finite, buried source using the equations of Nowacki (1972). Analytical solutions for a uniformly distributed circular load embedded in the semi-infinite media in both horizontal and vertical direction are derived using the method of potentials. Green's functions for displacements and rotations are also derived for unit impulse applied in the horizontal and vertical direction. The Green's functions are further used to obtain displacements and rotations for semi-infinite media subjected to double couple sources. The obtained expressions are compared with that derived from Eringen's (1999) formulations. Dispersion analysis of P-wave and S -waves and the band-gaps obtained in the propagation of S-waves through the reduced micropolar medium from both the formulations are reported in this paper.

Keywords: Reduced micropolar Medium, Micro-rotations, Half-space, double-couple, dispersion analysis