Rotational Components of Elastic Waves on the Half-Space Surfaces

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Abstract

The rotational components associated with the dynamic responses of rigid, elastic bodies as surface and subsurface topographies in an elastic or poro-elastic half space have always been known to be substantially important as the actual deformations, and must be included in all structural deformation analyses and calculations.

The basic theory of elasticity shows that the Euclerian strain tensor of deformations is expressible in terms of the linear strain tensor and the second order terms of rotation tensor. At present, all structural analyses already dealt with the generalized displacement of the 3 components of translations and the 3 components of rotations as the 6 independent components. And these six generalized components are often simultaneously estimated using the kinetic equations of forces and moments.

It is noted earlier that since rotations are defined in terms of derivatives of translations, there always should exist and available these analytic expressions for rotations in terms of translations. This is definitely affirmative when the translation components are given in rectangular coordinates.

Using surface waves, the method of Trifunac (1971) for generating artificial, synthetic strong motion accelerograms can thus immediately be extended to generate both synthetic torsional and rocking accelerograms and of their response spectra (Lee and Trifunac, 1985, 1987). They are constructed from the horizontal and vertical acceleration components. These rotational components of strong ground motions are gaining significant attention more and more as it is becoming evident that they contribute decisively to the overall response of structures to excitation by earthquake motions.

In addition, the many scattering and diffraction problems for surface and subsurface topographies, these components of translational displacement are often expressed in terms of displacement potential functions in coordinate systems other than the rectangular coordinate systems, like the cylindrical (polar) and parabolic two-dimensional coordinate systems, or the three-dimensional spherical coordinate system.

This note includes a summary presenting the analytical expressions of the rotational components of displacement in terms of the displacement potential functions, in the many coordinate systems other than rectangular coordinate systems that has been used and studied in many of the wave scattering and diffraction problems.

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