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Semi-analytical solution for a problem of a uniformly moving oscillator on an infinite beam on a two-parameter visco-elastic foundation

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Keywords: transverse vibrations; moving oscillator; constant and harmonic load; normal force; induced frequency; two-parameter foundation; semi-analytical solution.

Abstract

In this paper a semi-analytical solution for transverse vibrations induced by a moving oscillator is derived and validated. It is assumed that the oscillator is moving uniformly on an infinite beam, which may be subjected to a normal force, and is supported by a two-parameter visco-elastic foundation. Full evolution of deflection shapes is derived with the help of integral transforms and methods of contour integration. Analytical solution of the problem is presented in the Laplace domain. In the time domain, vibrations are given by a sum of truly steady-state part, induced harmonic part and transient vibration that has generally low importance and rapidly decreasing tendency. Except for the transient vibration, solution is expressed as a finite sum of analytical expressions (sum of residues), of which each has at most one parameter that has to be obtained numerically. With the help of iterative techniques proposed in this paper, these parameters can be easily determined with any precision. These parameters are named as the induced frequencies and as such can identify the onset of unstable behaviour. Thus, derivations in this paper allow to predict not only the onset of instability, but also its severity, which is important for mitigation measures.

Transverse vibrations obtained for infinite beams are validated by analyses on long finite beams, exploiting a program written in Matlab software, that was previously validated by finite element software LS-DYNA. The effects of the normal force, Pasternak modulus, harmonic component of the vertical force and foundation damping are discussed.