Revealing the characteristics of a nonlinear gradient elasticity model for the prediction of seismic waves

Fărăgău, Andrei B.; Hollm, Marten ; Dostal, Leo; Metrikine, Andrei V.; van Dalen, Karel N.

Publication date
2023

Document Version
Final published version

Citation (APA)
Fărăgău, A. B., Hollm, M., Dostal, L., Metrikine, A. V., & van Dalen, K. N. (2023). *Revealing the characteristics of a nonlinear gradient elasticity model for the prediction of seismic waves*. Abstract from 12th International Conference on Structural Dynamics, EURODYN 2023, Delft, Netherlands.

Revealing the characteristics of a nonlinear gradient elasticity model for the prediction of seismic waves

Andrei B. Fărăgău, Marten Hollm, Leo Dostal, Andrei V. Metrikine, Karel N. van Dalen
TU Delft, the Netherlands
TU Hamburg, Germany

Abstract
The prediction of the so-called seismic site response (i.e., the response of the top soil layers induced by seismic waves) is important for designing structures in areas prone to earthquakes. For seismic loads that induce large soil strains, accounting for the nonlinear behaviour of the soil can be of importance for accurate predictions. In Ref. [1], the authors propose a nonlinear gradient elasticity model for predicting the seismic site response. In the said model, the nonlinear constitutive behaviour of the soil is governed by the hyperbolic soil model, in which the secant shear modulus is dependent on the shear strain through a non-polynomial (hyperbolic) relation. Moreover, the classical wave equation was extended to a nonlinear gradient elasticity model to capture the effects of small-scale heterogeneity/micro-structure. Compared to the classical continuum, higher-order gradient terms are introduced into the equation of motion, which lead to dispersive effects [2] prohibiting the formation of un-physical jumps in the response. The aforementioned model is used in this work too, in which a Gaussian pulse is imposed as an initial condition and the solution is determined using a novel finite difference scheme (see Ref. [1]). This work investigates the behaviour of the proposed model for different levels of initial nonlinearity (i.e., induced by the initial conditions). More specifically, we focus on explaining and studying the appearance of a non-zero plateau trailing behind as the initial shape propagates away. It is shown that the higher the initial nonlinearity, the more pronounced the plateau, indicating that the non-zero plateau is a characteristic of the system's nonlinearity. The in-depth investigation of the proposed model's characteristics can be helpful when using it to accurately predict the seismic site response.

Literature
[1] Dostal L., Hollm M., Metrikine A.V., Tsouvalas A., van Dalen K.N., *Localized stationary seismic waves predicted using a nonlinear gradient elasticity model*, 2022. Nonlinear Dyn. **107**, 1107-1125.

[2] Metrikine A., *On causality of the gradient elasticity models,* 2006. J. Sound Vib. **297**, 727-742.