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Nonlinear Finite Element Modeling of Deep Beam Resting on Linear and Nonlinear Random Soil

Authors : M. Seguini, D. Nedjar

Abstract : An accuracy nonlinear analysis of a deep beam resting on elastic perfectly plastic soil is carried out in this study. In fact, a nonlinear finite element modeling for large deflection and moderate rotation of Euler-Bernoulli beam resting on linear and nonlinear random soil is investigated. The geometric nonlinear analysis of the beam is based on the theory of von Kàrmàn, where the Newton-Raphson incremental iteration method is implemented in a Matlab code to solve the nonlinear equation of the soil-beam interaction system. However, two analyses (deterministic and probabilistic) are proposed to verify the accuracy and the efficiency of the proposed model where the theory of the local average based on the Monte Carlo approach is used to analyze the effect of the spatial variability of the soil properties on the nonlinear beam response. The effect of six main parameters are investigated: the external load, the length of a beam, the coefficient of subgrade reaction of the soil, the Young's modulus of the beam, the coefficient of variation and the correlation length of the soil's coefficient of subgrade reaction. A comparison between the beam resting on linear and nonlinear soil models is presented for different beam's length and external load. Numerical results have been obtained for the combination of the geometric nonlinearity of beam and material nonlinearity of random soil. This comparison highlighted the need of including the material nonlinearity and spatial variability of the soil in the geometric nonlinear analysis, when the beam undergoes large deflections.

Keywords : finite element method, geometric nonlinearity, material nonlinearity, soil-structure interaction, spatial variability
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