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Rocking motion of a single rigid rectangular block – analysis of the block slenderness assumption

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Abstract

Rocking motion of a single rigid rectangular block on rigid base subjected to base acceleration function, with the assumption that friction between block and base is large enough to prevent sliding motion, is analyzed. In literature, such analysis has been carried out using a linearized equation of motion assuming slender geometry of the block and small rotations [1, 2].

The analysis herein additionally addresses the cases when the block is non-slender and can undergo large rotations. With the aim to investigate the influence of assumptions introduced into linearized analysis [1, 2] on the accuracy of solution, three types of analysis are carried out: (1) linearized analysis assuming slender geometry of the block, (2) quasi-nonlinear analysis, i.e. linearized analysis taking real geometry of the block into account, and (3) nonlinear analysis. Newmark's method with average acceleration is used for numerical integration and Newton-Raphson iterative procedure is used to solve the nonlinear equation. Free and forced rocking motion of slender and non-slender rigid rectangular block with varying initial conditions are analyzed. Analytical solutions of the linearized and quasi-nonlinear equation of motion are compared to numerical results.

References

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[2] W. G. Housner. The behavior of inverted pendulum structures during earthquakes. Bulletin of the Seismological Society of America, Vol. 53, No. 2: 404-4017, 1963.