World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:12, No:06, 2018

Verification of a Simple Model for Rolling Isolation System Response

Authors : Aarthi Sridhar, Henri Gavin, Karah Kelly

Abstract : Rolling Isolation Systems (RISs) are simple and effective means to mitigate earthquake hazards to equipment in critical and precious facilities, such as hospitals, network collocation facilities, supercomputer centers, and museums. The RIS works by isolating components acceleration the inertial forces felt by the subsystem. The RIS consists of two platforms with counter-facing concave surfaces (dishes) in each corner. Steel balls lie inside the dishes and allow the relative motion between the top and bottom platform. Formerly, a mathematical model for the dynamics of RISs was developed using Lagrange's equations (LE) and experimentally validated. A new mathematical model was developed using Gauss's Principle of Least Constraint (GPLC) and verified by comparing impulse response trajectories of the GPLC model and the LE model in terms of the peak displacements and accelerations of the top platform. Mathematical models for the RIS are tedious to derive because of the non-holonomic rolling constraints imposed on the system. However, using Gauss's Principle of Least constraint to find the equations of motion removes some of the obscurity and yields a system that can be easily extended. Though the GPLC model requires more state variables, the equations of motion are far simpler. The non-holonomic constraint is enforced in terms of accelerations and therefore requires additional constraint stabilization methods in order to avoid the possibility that numerical integration methods can cause the system to go unstable. The GPLC model allows the incorporation of more physical aspects related to the RIS, such as contribution of the vertical velocity of the platform to the kinetic energy and the mass of the balls. This mathematical model for the RIS is a tool to predict the motion of the isolation platform. The ability to statistically quantify the expected responses of the RIS is critical in the implementation of earthquake hazard mitigation.

Keywords : earthquake hazard mitigation, earthquake isolation, Gauss's Principle of Least Constraint, nonlinear dynamics, rolling isolation system
Conference Title : ICEES 2018 : International Conference on Earthquake Engineering and Seismology
Conference Location : San Francisco, United States
Conference Dates : June 06-07, 2018