A nonlinear model for multilayered rubber isolators based on a co-rotational formulation

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Abstract

This article proposes a geometrically nonlinear co-rotational model aimed to characterize the mechanical behavior of elastomeric seismic isolators. The model is able to capture the axial and lateral coupling in both axial directions, i.e. compression and tension of the isolator. Also reproduces the instability the loads in tension as well as in compression, and provides theoretical evidence of the non-symmetric behavior of the isolator in these two directions. To validate model results, a quasistatic analysis was performed on a typical isolator with many different shape factors. From the parametric analysis performed, it is observed that buckling loads are higher in tension than in compression. However, as the shape factor of the isolator increases, the behavior in compression and tension becomes symmetric. It becomes apparent that significant differences in normal stresses and strains under tensile and compressives loads are observed for axial loads smaller than 10% of the nominal buckling load. The example presented shows that lateral displacements of about ±25% of isolator radius and tension forces up to 10% of the buckling load are possible without inducing cavitation in the rubber. Accuracy of the model was also tested against finite element model results and experimental data showing satisfactory results. Furthermore, a response-history analysis of an isolated structure is presented and compared for two isolator models: the two-spring model and the model proposed herein. Finally, material nonlinearity was introduced in the dynamic analysis using a Bouc-Wen type element in parallel with the isolator. The responses are similar between models; however, significant differences occur locally in the isolator for high axial loads and/or large lateral displacements.

Keywords: Multilayer rubber isolator||Non-linear behavior||Axial-lateral coupling||Tension and compression buckling||Time-history analysis
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