17th Symposium on Earthquake Engineering
November 14-17, 2022
IIT Roorkee, India
Paper No. 241

Understanding the Effect of Localized Impacts in Seismic Response of Electrical Cabinets and Control Panels

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Abstract

The safety-related electrical equipment used in important structures must be seismically qualified. The seismic demands on electrical equipment are governed by the dynamic response of electrical cabinets and buildings. The seismic demand on the electrical equipment is represented by in-cabinet response spectrum (ICRS). A cabinet may exhibit several small gaps at the cabinet base, between its door and the main structural frame, or between two cabinets located next to each other. Such gaps can result in localized impacts which can induce high frequency vibrations inside the cabinet leading to functional failures of electrical equipment. In this paper, we conduct a fundamental study using a single degree of freedom system with a gap to study the effect of such localized impacts. It is shown that such localized impacts lead to high frequency spectral amplitudes in the ICRS which are otherwise not present in an ICRS generated using a linear analysis. Moreover, the secondary peaks tend to occur in a periodic pattern. To understand and explain this behavior, a single degree of freedom (SDOF) system with gap is subjected to harmonic ground displacement of various amplitudes and excitation frequency. The major difference between behavior of nonlinear and linear systems is the transient behavior. The response of nonlinear model is governed by its transient response which is reinitiated each time the gap closes. Furthermore, the impact on SDOF acts as an impulse load which explains the occurrence of high frequency peaks and valleys in the ICRS.

Keywords: Equipment response, High–frequency accelerations, Geometric nonlinearity, Localized impact