A computer interface for the asynchronous seismic excitation of bridges simulated in ANSYS

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Summary

During earthquakes, it is expected that bridge structures are subjected to excitation that is non-uniform along their longitudinal axis in terms of amplitude, frequency content and arrival time, a fact primarily attributed to the wave arrival delay, their loss of coherency and the effect of local site conditions. Although considerable research has been carried out over the last twenty years in all the aforementioned directions, the knowledge gained has only partially been reflected on modern seismic code provisions and design procedures due to the significant complexity in predicting the spatially variable earthquake wavefield. As a result, and due the major advances in numerical analysis tools, the FE models developed are often disproportionally refined compared to the earthquake loading assumptions made. The scope of this paper, is to present a modular scheme for integrating state-of-the-art knowledge in earthquake, structural and geotechnical engineering into the dynamic analysis of bridges, by coupling through the APDL scripting language, a comprehensive algorithm for the generation of multiple support excitation scenarios, a module complying with the (simplified) latest Eurocode 8 provisions and the finite element development environment of ANSYS. It is concluded that not only the aforementioned link is feasible and effective, but also the use of more realistic earthquake ground motion patterns can potentially reveal significant aspects of the dynamic response of a bridge structure while the assumption of synchronous excitation can strongly underestimate the imposed seismic demand.

Keywords

Seismic analysis, bridges, ANSYS, APDL, software development

1. Introduction

From all the parameters that define the non-linear dynamic response of complex structures such as bridges, the earthquake ground motion has by far the highest level of uncertainty. The last three decades, different approaches, methodologies and tools have been utilized to deal with this uncertainty and put it in a framework that can be predicted and quantified, thus uniformly interpreted by the practicing engineers and the scientific community. Along these lines, the extensive use of actual, refined or code-defined response spectra and the utilization of natural or artifficial accelerograms that correspond to different soil and seismotechtonic conditions is a precious source of information regarding the potential excitation of bridges, which when combined with the increasingly enhanced capabilities of specialised inelastic dynamic analysis software, provides a very good estimate of the expected seismic excitation and response of bridge structures. Nevertheless, the