Evaluation of Spectrum Compatible Bidirectional Seismic Input

Alan Rivera-Figueroa, Luis A. Montejo

University of Puerto Rico at Mayaguez, Mayaguez, PR

Contact: luis.montejo@upr.edu

Abstract

We investigate 4 methodologies to generate sets of horizontal ground motion components compatible with a target RotD100 spectrum, including amplitude-scaling and different spectral-matching approaches. The sets generated are used as seismic input to bidirectional inelastic time history analyses of circular cross-section reinforced concrete single column piers. It is shown that the traditional approach of separately matching each horizontal component to the target RotD100 generate peak inelastic and total strain energy demands that are substantially larger than the demands imposed by sets of amplitude-scaled records. However, the sets generated by simultaneously modifying both components to direct match RotD100 provoked mean peak inelastic responses closer to the amplitude-scaled sets while reducing the variability in the estimates.

Keywords: seismic input; spectral matching; nonlinear dynamic analysis; reinforced concrete; inelastic demand; ductility; strain energy.

1 Introduction

Inelastic time-history analysis is recognized as the most accurate method for design verification of new structures and seismic assessment of existing ones. A challenging step when performing this type of analysis is the construction of a set of ground motion pairs consistent with a specified level of seismic hazard, commonly characterized in design codes through a target spectrum that combines the two orthogonal directions of spectral demand into a single measure of intensity. Modern design codes are moving from geometric mean to orientation independent target spectra. ASCE7-16 [1], for example, uses a RotD100 spectrum (maximum spectral acceleration observed in any orientation of horizontal ground motion shaking). This article investigates 4 different approaches to generate sets of horizontal ground motion components compatible with a target RotD100 spectrum: (1) amplitude-scaling, (2) separately matching each component to the target, (3) separately matching then amplitude-scaling each component to improve RotD100 match and (4) simultaneously modifying both components to directly pursue match with the target RotD100. The sets generated are used as seismic input to bidirectional inelastic time history analyses of circular cross-section reinforced concrete single column piers. The numerical models are developed using fibre-base elements that closely replicate the behaviour of the columns starting at the material level, and therefore, key milestones of the seismic response like concrete crushing and rebar yield and rupture can be directly identified. The modelling approach is initially validated and calibrated using experimental data from large scale shaking table tests, then, the columns length and reinforcement are adjusted to evaluate the effect at different levels of inelastic demand and period of vibration.