ON THE PERFORMANCE OF A CONVERGENCE-BASED TIME INTEGRATION ACCELERATION TECHNIQUE IN ANALYSIS OF BRIDGES UNDER MULTIPLE-SUPPORT EXCITATION

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The number of long bridges around the globe is considerable. The study of their behaviours under the action of strong ground motions generally involves time-consuming step by step integration analyses and usually requires an investigation of multiple-support excitations. Considering general time integration analysis against seismic records, a technique has previously been proposed (Soroushian, 2008), to replace the integration step size proposition

$$\Delta t \le \begin{cases} \text{Min}\left(\frac{T}{10}, h_s, {}_f\Delta t\right) & \text{for linear problems} \\ \text{Min}\left(\frac{T}{100}, h_s, {}_f\Delta t\right) & \text{for nonlinear problems} \end{cases} \tag{1}$$

by the following comment

$$\Delta t = n\,{}_f\Delta t \le \begin{cases} \text{Min}\left(\frac{T}{10}, h_s\right) & \text{for linear problems} \\ \text{Min}\left(\frac{T}{100}, h_s\right) & \text{for nonlinear problems} \end{cases} \tag{2}$$

(where T stands for the smallest dominant period of the response, h_s implies the maximum step size preventing integration instability, ${}_f\Delta t$ denotes the size of steps, by which, the strong motion is digitized, and n is the largest positive integration satisfying Eq. (2)). This leads to

$$R_C = \frac{n-1}{n} 100 \quad (\%) \tag{3}$$

reduction of run times for linear analyses.

Since 2008, the technique is successfully implemented in linear and nonlinear seismic analysis of many structures, including frames, mid-rise and tall buildings, water tanks, silos, lifelines, etc.. Even, a conference paper (Soroushian et al., 2011), and a book chapter (Papadrakakis et al., 2013) have been published on the implementation of the technique on seismic analysis of bridges. Now, in continuation of the past researches, and considering the importance of multiple-support excitation in bridge analysis and design, a theoretical/numerical study is carried out, and reported here, in view of real bridges subjected to multiple-support excitations. Though the study is still in progress, the theoretical explanation about the success of the technique, in linear regimes, is based on the past experiences, the validity of the superposition principle, and the independence of the technique from the excitation and the response under consideration, and in nonlinear range, relies on the incremental nature of nonlinear analyses and equivalently the fact that in bridges seismic analyses the main nonlinearities are material nonlinearity and the pounding of the bridges decks. Numerically, simple implementation of the technique in analyses of seismic behaviours of real bridges multiple-support excitations (in a manner very similar to the past experiences; merely considering the displacement records instead of the acceleration records) has demonstrated the validity of the theoretical claims; and in short, the good performance of the technique in accelerating the seismic analysis of bridges multiple-support excitations.

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