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A GENERAL PRACTICAL PROCEDURE FOR A RECENTLY PROPOSED SEISMIC ANALYSIS COMPUTATIONAL COST REDUCTION TECHNIQUE

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Time history analysis is the most powerful analysis approach to study seismic behaviours, and time integration is a versatile tool for time history analysis, especially in cases with nonlinearity, close natural frequencies, and non-classical damping (Chopra, 1996; Clough and Penzien, 1993). The parameter of time integration, i.e. the integration step size, is effectual in both the accuracy and the computational cost, reversely (Belytschko and Hughes, 1983). Accordingly, comments exist for assigning appropriate values to the integration step sizes (Bathe, 1996; Clough and Penzien, 1993; McNamara, 1974). In seismic analyses, however, the excitation step size may govern the recommended step size, leading to considerable additional computational cost. In 2008, based on the essentiality of convergence (Henrici, 1962), and the convention of second order of accuracy for transient analyses, the author proposed a technique to replace the earthquake strong ground motion record with a record digitized at larger steps (Soroushian, 2008), and successfully implemented it in many seismic analyses, including mid-rise buildings, tall buildings, bridges, silos, and reservoirs, e.g. see (Bahar and Ramezani, 2011; Garakaninezhad et al., 2014; Nateghi and Yakhchaliann, 2011; Sabzei, 2013; Soroushian, 2010; Soroushian, 2011; Soroushian and Aziminejad, 2011; Soroushian et al., 2011a; Soroushian et al., 2011b; Soroushian, 2012; Soroushian et al., 2014). However, the parameter of the technique, i.e. the number of times the strong ground motion step size is being enlarged, needs to be set with some *a priori* knowledge about the response, which apparently may not be available in advance.

To overcome the above mentioned deficiency in a computationally inexpensive manner, some attempts are carried out for special types of structures, e.g. mid-rise buildings, leading to reliable results. In this paper, a general upper-bound is set for the parameter of the technique, and the concept of a conventional broadly accepted accuracy controlling method (Clough and Penzien, 1993; Harier et al., 1993) is put together with the technique, such that, in implementing the new method, the value assigned to the parameter of the technique can be automatically adjusted during the implementation.

In short, the recently proposed technique is upgraded to an enhanced technique (or a procedure for implementing the technique proposed in 2008) for practical simple implementation in general time integration analyses against strong ground motions. Specifically, because of using cheap repetition of analyses instead of any *a priori* knowledge about the least oscillatory period with considerable contribution in the response, the proposed method is more reliable still practically inexpensive compared to its predecessor. Merely it is notable that in cases that the predecessor method is not applicable, the proposed approach may or may not be applicable and in the latter case the computational cost will increase to at most 50% for linear problems. The adequacy of the performance is demonstrated via examples, and stages towards further improvement of the technique, specially, regarding the above mentioned 50%, are discussed.

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