IMPROVED NUMERICAL INTEGRATION PROCEDURE FOR APPLICATION TO SEISMIC HYBRID SIMULATION

Maedeh ZAKERSALEHI
PhD Candidate, TarbiatModaresUniversity, Tehran, Iran
m.zakersalehi@modares.ac.ir

Abas Ali TASNIMI
Professor, TarbiatModaresUniversity, Tehran, Iran
tasnimi@modares.ac.ir

Mehdi AHMADIZADEH
Assistant Professor, Sharif University of Technology, Tehran, Iran
ahmadizadeh@sharif.edu

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Abstract

Hybrid simulation is a powerful test method for evaluating the seismic performance of structural systems.Thismethod makes it feasible that only critical components of structure be tested experimentally while the rest of the structure is numerically modelled. This paper presents a newly proposed integration algorithm for seismic hybrid simulation which is aimed to extend the capabilities of hybrid simulation to a wide range of systems where existing methods encounter some limitations. In the proposed methodwhich is termed Variable Time Step (VTS) integration method, an implicit scheme is employed for hybrid simulation by eliminating the iterative phase on experimental element, the phase which is necessary in regular implicit applications.In order to study the effectiveness of the VTS method, a series of numerical investigations are conducted, in them the restoring force of the column is assumed to be achieved experimentally. The results show the successfulness of VTS method in obtaining accurate, stable and converged responses.Also in a comparative approach, the improved accuracy of VTS method over commonly used integration methods isdemonstrated utilizing two error indicators.

Introduction

Severe earthquakes have repeatedly demonstrated the vulnerability of civil structural systems. It is therefore imperative that all available tools be deployed to mitigate earthquake effects. The tools of structural investigations are numerical analysis, experimental testing and collecting field data. Among these tools, numericalanalysis is the most powerful tool in the sense that behavior of the structure can be studied at a low cost. On the other hand,experimental testing is the most realistic method especially for novel structural systems and materials. Hybrid simulation which is a relatively new test method,takes advantage of both numerical and experimental methods to achieve the seismic performance of structural systems(Mahin and Shing 1985;Shing et al. 1996; Nakashima and Masaoka 1999).In this method the structure is divided into several experimental and numerical substructures in which only parts of structure with unknown or complicated behaviour are tested experimentally. The most important advantage of this test method is that its results are comparable with shake table test while its expenses are considerably lower. The procedure of a typical hybrid simulation is shown in Fig. 1: