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EFFICIENT APPLICATION OF THE SECANT METHOD FOR CAPTURING THE PEAK RESPONSE OF COMPLEX MULTI-STORY BUILDINGS

Terrence F. PARET[1], Ayhan IRFANOGLU[2], Mahmoud M. HACHEM[3], and Sigmund A. FREEMAN[4]

SUMMARY

The Secant Method is an iterative method in which the peak displacement response of a structure or structural component is determined from linear dynamic analyses of a model whose stiffness is updated to reflect a computed degree of degradation that is consistent with the computed peak displacement. Numerous descriptions of the Secant Method and related procedures exist in the literature. Division 95 of the City of Los Angeles Building Code, for example, includes a formulation of the Secant Method that is specifically intended for evaluation and rehabilitation of infill frame buildings with limited ductility. In the Secant Method, the degree of degradation of a structure is derived from the secant as determined from nonlinear force-displacement relationships for the structure as a whole or from appropriate sub-assemblies and this information is substituted into the linear dynamic analysis environment. In this way, the dynamic analysis model is updated to approximate intermediate states of degradation until a rational and consistent convergence in each sub-assembly as well as the whole structure is achieved. The Secant Method can be unwieldy, however, when applied to multistory complex structures, due to the involvement of a number of modes in their dynamic response and due to the requirement that convergence be achieved for the system as a whole and for its various sub-assemblies. In this paper, we explain the basic Secant Method, apply it to complex multi-story buildings, and describe an iterative routine that facilitates capturing higher mode and torsional response while greatly reducing the number of iterations required to achieve convergence.

BACKGROUND

Substitute-Structure Method

The Secant Method is one of a number of analytical procedures available to earthquake engineers today for predicting the earthquake performance of structures. Sozen has been credited with having developed progenitor procedures, the Substitute Damping Method [1] and the Substitute-Structure Method [2], from which the Secant Method can be derived [3]. A signature of these methods is their reliance upon the

[1] Senior Consultant, Wiss, Janney, Elstner Assoc., Inc., Emeryville, CA, USA. Email: TParet@wje.com
[2] Associate III, Wiss, Janney, Elstner Assoc., Inc., Emeryville, CA, USA. Email: AIrfanoglu@wje.com
[3] Associate III, Wiss, Janney, Elstner Assoc., Inc., Emeryville, CA, USA. Email: MHachem@wje.com
[4] Principal, Wiss, Janney, Elstner Assoc., Inc., Emeryville, CA, USA. Email: SFreeman@wje.com