CORRECTION FACTORS INCLUDING NONCLASSICAL NATURE OF SOIL-STRUCTURE INTERACTION SPECTRAL ANALYSIS

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ABSTRACT

The problem of non-classical dynamic analysis of structures resting on flexible bases is studied in this paper. Because of presence of the underlying soil in the dynamic model of structure that acts like an energy sink, the damping matrix is not proportional to structural mass and stiffness and theoretically a non-classical approach should be followed in modal analysis. Considering one to twenty-story buildings, two types of soils, and several suits of ground motions each containing 10 earthquake records specifically selected for each building, the seismic responses are calculated using a time history modal analysis in this paper. Three cases are considered: fixed-base buildings with classical analysis, flexible-base buildings with classical and non-classical analysis. Using the nonclassical analysis, it is shown that soil-structure interaction should not be taken into account for moment frame buildings with the fundamental fixed-base periods smaller than 1 second. Cases for which the base flexibility should be considered for the higher modes too are distinguished. Finally, it is made clear that on each soil type, when the actual non-classicalnature of the SSI system must be accounted for.

INTRODUCTION

Unlike fixed-base systems in which the source of vibration damping is more or less uniquely attributed to the structural system and is hence almost uniform, in a soil-structure-interaction (SSI) system a considerable part of damping is contributed by the totally different medium of soil. The damping matrix of such a complex system is a non-uniform combination of structure and soil damping values and therefore is not classical.

This is while in daily spectral analysis of structures the damping matrix is always presumed to be classical, i.e., proportional to mass and stiffness matrices. When there is a doubt on validity of this basic assumption, likein SSI problems as discussed above, availability of a spectrum analysis methodology corrected for nonclassical damping while retainingits simplicitywill be very helpful.

The work of Veletsos& Venturawas an important step forward in this regard. They simplified the nonclassical modal analysis through giving insight to the physical meaning of differentterms of the formulation and converted the complex-valued equations to their real counterparts. They derived equations for determining natural periods and mode shapes of nonclassical systems resulting in free vibration responses and a Duhamel integral formulation for computing the dynamic response (Veletsosand Ventura, 1986).

Ziaeifar and Tavousi developed formulas for calculating the modal values of the response maxima based on the work of Veletsos& Ventura (Ziaeifar and Tavousi, 2005).