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INVESTIGATION OF JACOBSEN'S EQUIVALENT VISCOUS DAMPING APPROACH AS APPLIED TO DISPLACEMENT-BASED SEISMIC DESIGN

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SUMMARY

This paper discusses the approximation of the maximum displacement of nonlinear hysteretic systems through the use of an equivalent linear system with effective properties (i.e. reduced stiffness and equivalent viscous damping). Because of its simplicity in application, this concept has been widely utilized in the displacement-based seismic design procedure. This paper aims to investigate the accuracy and potential problems associated with the equivalent viscous damping concept as applied to direct displacement-based seismic design, and to suggest a modification to Jacobsen's approach that is based on ground motion characteristics. The parameters considered include: Earthquake time history (reversal and fling-type events), hysteretic models ranging from origin centered systems to Takeda-type response systems. Results of the research indicate that the fundamental period of the ground motion is a critical variable in assessing the accuracy of the equivalent viscous damping concept. In general, results from non-linear analysis conducted with regular sinusoidal events is excellent, which is expected given the assumptions of sinusoidal response in the equivalent viscous damping approach, however, results from real time histories indicate more scatter. Recommendations for the use of the equivalent viscous damping approach in direct displacement-based seismic design are presented for SDOF system based on the results of 100 earthquake records and 95,000 inelastic time history analyses.

INTRODUCTION

Direct displacement-based seismic design (DDBD) focuses the design directly on displacement demand which is more attractive than strength as a damage measure. Due to the fact that structures in seismic regions are designed to respond in-elastically and the design procedure needs to be simple, methods of approximating maximum displacement of inelastic system gain primary importance in DDBD.

One of the methods used to determine the maximum displacement of a non-linear system is the inelastic response spectrum, where an exact spectrum could be obtained for a SDOF system with a selected period and hysteretic rule. Unfortunately, the resulting R-μ-T relationships vary also as a function of earthquake and soil type. The other method being used involves representing the nonlinear system by

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