EXAMINATION OF THE EQUIVALENT VISCOUS DAMPING APPROACH

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ABSTRACT

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 recommendation to modify Jacobsen's approach that is based on level of ductility and hysteretic model used. The parameters considered include: Earthquake time-history and 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 Jacobsen's approach, however, results from real time histories indicate more scatter. In this paper, results for two hysteretic models based on 100 earthquake records and 125,000 inelastic time-history analyses indicate that Jacobsen's approach overestimates damping which requires a reduction factor that will be introduced in a future study for 4 hysteretic models and based on 280,000 inelastic time-history analyses.

Keywords: Equivalent Damping, Jacobsen's Approach, Displacement-Based Design.

1. INTRODUCTION

1.1 Direct Displacement-Based Design

In the Direct Displacement-Based Design (DDBD) approach, a structure is designed such that a predefined displacement limit is achieved when the structure is subjected to a predefined earthquake that is consistent with that assumed for the design. The design procedure utilizes Jacobsen's approach [1] for equivalent viscous damping and the Gulkan and Sozen [2] substitute structure concept to approximate the displacement of an inelastic system with equivalent elastic system. The DDBD approach 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

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