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INELASTIC DISPLACEMENT PATTERNS IN SUPPORT OF DISPLACEMENT-BASED DESIGN FOR MULTI-SPAN BRIDGES

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SUMMARY

Described in this paper is a study aimed at identifying inelastic displacement patterns for multi-span bridges in support of the direct displacement-based seismic design method. Target displacement profiles for multi-span bridges have a significant impact on the end result of the design; therefore, a recent study was conducted for six different multi-span bridge configurations to identify the possible scenarios for deflection. Three different scenarios were identified, namely: (1) Rigid body translation, (2) Rigid body translation and rotation, and (3) Flexible profile. Those three scenarios were found to be highly dependent on the relative stiffness between superstructure and substructure, bridge regularity and abutment type. The first two scenarios require minimal effort in the direct displacement-based design approach since the target profile and SDOF structure are already determined while the third scenario requires more computations. The goal of the study is to describe a set of common criterion to identify different inelastic displacement scenarios and to develop analytical techniques for calculating inelastic displacement profiles. In order to achieve this objective a large series of nonlinear dynamic time history analysis were conducted on multi-span bridges. Variables considered included superstructure stiffness, substructure stiffness, bridge regularity and symmetry, abutment conditions, column flexural strength, and earthquake time history. Results are presented which provide recommendations for selection of non-linear displacement patterns that are then implemented into the direct displacement-based design approach. An example application of the process is also presented.

INTRODUCTION

With the advent of performance-based design, the need for a fully developed, yet simple, design approach is significant. Such approaches should allow the engineer to control the bridge deflected shape, and hence damage, for a variety of performance limit states and earthquake intensities. One such approach is the direct displacement-based design approach. In 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 the inelastic system with equivalent elastic system. A nonlinear system which has initial

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