Bi-directional Seismic Response Control for Bridge Structures

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Summary

Special bridges are those curved, skew and long-span bridges; require special considerations in their analysis; design and construction. Typically, these bridges exhibit complex behaviour in which the vertical, lateral, and torsional motions are often strongly coupled that raises many concerns about their behaviour under dynamic loads. Application of passive control devices has been shown to be effective to protect bridges under seismic excitation. The effect of bi-directional seismic excitation is essential for analysis and design of seismically isolated bridges, since the bi-directional motion is coupled and two independent unidirectional models could not accurately describe the bi-directional behaviour. The seismic response of lumped-mass bridge model to bi-directional harmonic and real earthquake ground motions is investigated; the biaxial interaction Bouc-Wen model is used to account for the direction and magnitude of the bearing resultant hysteretic forces, the system response with biaxial interaction is compared with those without interaction. Numerical results show that the isolated bridge is significantly influenced by the interaction of bearing forces.

Keywords: Biaxial interaction; Bi-directional excitation; Special bridges; Seismic response control.

1. Introduction

Special bridges are those curved, skew and long-span bridges that require special considerations in their analysis; design and construction [1, 2]. Typically, complicated nonlinear time-history analyses are involved in their design, which is a challenge to bridge structural engineers, due to a lack of knowledge about how to design earthquake response modification systems for these special bridges, hence it is difficult to develop standardized design procedures and specification provisions. To address these needs, this study seeks to characterize a cost-effective control system for the seismic protection of targeted bridges from destructive earthquake ground motions and provide an additional mechanism to meet multiple performance objectives. The difficulties that will be confronted in seismic analysis of the isolated bridge will contain how to determine the precise moving trajectories and how to obtain the correct stress conditions of the isolator concerned, so there is an urgent need to investigate bi-directional interaction of bearings in order to understand the behaviour and evaluate the efficacy of the structural control concept. This study objective is to characterize the effects of biaxial interaction on the response of the isolated bridge structures subjected to bi-directional excitations by comparing the system response with and without interaction, and to investigate the influence of bridge dynamic characteristics in both directions on the seismic isolation effectiveness for earthquake resistant design.

Bi-directional coupling effects are observed in earthquake testing of an isolated bridge model subjected to near field ground motions [3]. The effect of bi-directional seismic excitation is essential for analysis and design of seismically isolated structures [4 ~ 7], since the bi-directional

https://doi.org/10.2749/weimar.2007.0068