A Novel Method for Assessing the Critical Excitation Direction of Curved Bridges

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Abstract

This study proposes a resultant force-based (RFB) method to directly assess the critical excitation direction of curved bridges. A numerical model for a typical curved bridge is built and multiple factors associated with structural and ground motion characteristics, including horizontal girder curvature, column height and frequency characteristics of ground motions are evaluated to identify the sensitivity of the critical excitation direction to these factors. Results indicate that the RFB method can capture the critical excitation direction of curved bridges with sufficient precision (no more than 2.5% for this study) and minor computational efforts (only requiring 0° and 90° as the incidence angles) compared with the response history analyses at multiple ground motion orientations, which can be easily applied in computing software to guide the seismic design of bridges. Among the factors studied, horizontal girder curvature tends to be the most influential factor affecting the critical excitation direction of curved bridges.

Keywords: critical directions; assessment method; horizontally curved bridges; response spectrum method; resultant responses; influential factors

1. Introduction

Horizontally curved bridges have been commonly applied in highway interchanges and urban roads. Owing to the horizontal curvature, more severe damage occurs in the components of curved bridges than straight bridges during a seismic event. On top of that, as the ground motions can act along any horizontal direction for most active tectonic regions [1], structural responses under different excitation directions are diverse. For structures with relatively sophisticated seismic behaviors like curved bridges, it is more difficult to predict their real performance. To ensure the

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