Seismic Analysis of High-Speed Railway Irregular Bridge-Track System under Obliquely Incident Waves

Zhihui Zhu, Yongjiu Tang

Central South University, Changsha, CN

Contact: zzhh0703@163.com

Abstract

This study mainly explores the influence of different seismic incident angles on the damage of irregular bridge track systems in complex topography regions. The seismic ground motions of the V-shaped canyon site were simulated through SH wave theoretical analysis. Nonlinear seismic response analyses of irregular simply supported railway bridge–track systems were performed under the different incident angles of seismic (0°~ 60°). The effects of different seismic incident angles on the seismic response of the bridge-track system are analyzed. The results show that the seismic displacement responses of piers top, transverse movable bearings, and fasteners are significantly different under different seismic incident angles, and the unfavorable seismic incident angle is 60°. Underestimate the maximum 37 % seismic displacement response of pier top, transverse movable bearings, and fastener without considering the influence of incident angle.

Keywords: incident angle; topography effect; seismic damage; irregular bridge; asymmetric V-shape; analytical solution; ballastless track.

1 Introduction

Railway bridges are inevitably built near faults along with high-speed railway extending to the western complex mountainous areas and high-intensity seismic regions in China. At this time, the ground motion input of the railway bridge cannot assume the vertical incident of ground motion as the far-field earthquake due to the existence of the incident angle [1, 2]. Moreover, different seismic incident angles in mountainous topography cause the spatial variability of ground motion, resulting in significant differences in ground motion input of different piers of railway bridges [2]. And then cause seismic damage of the bridge-track system is incorrectly evaluated and threatens the safety of train operation.

There have been many studies on the influence of different seismic incident angles on the seismic damage of tunnels [1, 3, 4], dams [5-7], and highway bridges [8, 9]. The results show that the seismic response of the structure is underestimated without considering the seismic incident angle, and the damage underestimation range is about 30% - 200% due to different structural forms (bridge, tunnel and dam types, etc.) [2, 8, 10, 11]. However, the influence of the spatial variability of ground motion caused by the incident angle of ground motion on the seismic damage of railway bridges in mountainous areas with track structures is the insufficient study [2, 12], which causes incorrect assessment of the seismic damage of railway bridges and threaten the safety of train operation. Therefore, the seismic ground motions of the V-shaped canyon site were simulated through SH wave theoretical

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