Seismic performance of rigid-frame suspension composite bridges

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Abstract: Rigid-frame suspension composite bridges can improve the problem of continuous mid-span deflection of traditional long-span continuous rigid-frame bridges. In this paper, a rigid-frame suspension composite bridge with a span combination of (70+130+80) meters was selected as the case study. The elastoplastic three-dimensional dynamic finite element model of the bridge was built by OpenSees software. Nonlinear time history analysis and fragility analysis were carried out. The results show that the dynamic characteristics of the rigid frame suspension bridge are similar to those of rigid frame bridge. The rise-span ratio affects the displacement at the top of tower, the bending moments at the bottom of tower and at the top of pier in the transverse direction. The results of fragility analysis show that the bridge tower remains elastic under earthquakes.

Keywords: seismic performance; rigid-frame suspension composite bridges; rise-span ratio; fragility analysis

1. Introduction

The structural feature of rigid-frame bridges is that the main beam is rigidly connected to the bridge piers. Its most obvious advantage is that the pier and beam can work together to resist external forces. Compared to bridges with smaller spans, the response of large-span continuous rigid-frame bridges to earthquakes is more significant, and their seismic analysis is more complex. Based on existing research results, it is concluded that vertical seismic effects have a relatively small impact on internal forces of the structure. In seismic response, the control section of high-pier and large-span continuous rigid-frame bridges is located at the bottom of the pier, the root of the main beam, and the mid-span. [1]

Suspension bridges, due to their strong crossing ability, long structural period, and small response, have gradually become the preferred bridge type in high-intensity earthquake areas. According to the literature [2-3], some suspension bridges with small spans in Japan have suffered local damage due to earthquake action. For example, one of the main towers of the Atakawa Bridge with a main span of 90m was fractured in the Kanto earthquake, and the upper chord of the Gosho Bridge's stiffening girder was bent and the anchorage moved 20cm in the Fukuoka earthquake [4].

The bridge type studied in this article is a combination of rigid-frame and suspension bridge systems. It combines the advantages of large rigidity of rigid-frame bridges and strong crossing ability of suspension bridges, which makes the middle part of the bridge beam more flexible. However, since this bridge type is proposed for the first time, its seismic performance needs to be studied.

2. Project Overview

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