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Test and Simulation of Pedestrian-induced Vibrations in a Double-arch Footbridge with Curved Girder

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Abstract

This article carries out the dynamic tests and analyses based on a special-shaped footbridge of Guangzhou Science City. The experiment of pedestrians crossing the footbridge contains these cases: a pedestrian crossing the footbridge at different speeds, several pedestrians in line crossing the footbridge at a specific speed. After comparison, the FEA calculate results are quite close to the measured responses of the footbridge. It shows that the response of the footbridge is increased by the foot frequency. It also finds that, when the foot frequency is higher than 3Hz, the vertical vibration of left span and right span goes opposite phase. The lateral vibration of left span and right span affect each other a lot. The higher foot frequency is, the more obvious it becomes. The forced vibration frequency of the footbridge is closed to the exciting frequency while the resonance doesn't occur.

Keywords: Footbridge; special-shaped; dynamic analysis.

1 Introduction

In the past decades, with the continuous development of China's economy and society urban footbridges have become an indispensable travel infrastructure. Apart from basic needs of passage, beautiful and special appearance of footbridges has become an important factor in the design process so as to attract visitors. When pedestrians cross the footbridge, the similar frequency of the pedestrians step and main beam would easily cause intense vibration to the main beam, which will result in pedestrians' discomfort, and even seriously, the crash of the footbridge.

2 Discription of the bridge

The bridge site is loacted at the acrossroad of the Kaitai Road and Lingyu Road in Science City, Guangzhou. It links an office building, a park and a culture square. A great amount of office worker would cross the bridge to the office building, as well as tourists would bound for the culture square or the park(Figure 1).

The bridge is a double-arch structure with a curved girder. Both of the two arches lie in vertical planes, and the angle of them is 123.146 . Cross-section of the arches is rectangular box with stiffeners. The width of section is 1.6m, height of it is 2.0m at arch foot gradual changing to 1.2m at arch roof. The effective span of each arch is 64m, height is 20.4m, so the rise-span ratio is 1/3.1. The girder is a circular arc in plan view, the bending radius of it's central line is 97m. Total length of the girder central line is 147.817 m. The width of the girder is 5.2m with 3.5m passage. Constant section of the girder is a 5.2m×1.3m steel box with stiffeners. The two coners at bottom of the box is fillet. At the top of

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