A New Method for Calculating Bridge Influence Surface

Haibing Wu, Wei He

College of Civil Engineering, Hunan University, Changsha, Hunan Province, China

Lu Deng

College of Civil Engineering, Hunan University, Changsha, Hunan Province, China

Key Laboratory for Damage Diagnosis of Engineering Structures of Hunan Province, Hunan University, Changsha, Hunan, People's Republic of China

Contact: denglu@hnu.edu.cn

Abstract

Bridge influence surface (BIS), which reflects the relationship between the bridge response and the unit load moving on the bridge, has been commonly used in bridge weigh-in-motion, bridge damage detection, etc. Generally, the BIS can be obtained by interpolating bridge influence lines (BILs) at different lateral positions. In field tests, the BILs are usually extracted from the bridge response induced by a moving calibration vehicle with known axle loads. However, when taking the axle loads of the calibration vehicle into calculation, the impacts of the transverse distance between coaxial wheels and the unbalance of the coaxial wheel loads are ignored. Hence, errors may be brought to the calculated BIL and then propagated to the BIS. To remove these impacts, a new BIS calculation method, which takes the load of each wheel rather than each axle into calculation, is proposed in this research. Numerical simulation shows that the BIS can be successfully estimated by this method.

Keywords: bridge influence surface; bridge influence line; wheel load; axle load.

1 Introduction

A bridge influence line (BIL) is the bridge response curve under a unit concentrated load crossing a bridge along the longitudinal direction [1]. A bridge influence surface (BIS) is the lateral extension of the BIL, which is the contour of bridge response under a unit concentrated load traveling throughout the entire bridge deck [2]. The BIL and BIS have been widely applied in bridge engineering such as damage detection [3-5], safety evaluation [6-8], model correction [9-10], and bridge weigh-in-motion [11-12].

Obtaining the BIS via the finite element (FE) analysis is economical and convenient, but getting a reliable FE model is usually difficult. Therefore, field tests are usually adopted for BIS identification. There are generally two types of field test methods: the static loading method [13] and the dynamic loading method [14]. In the static loading method, the bridge deck firstly needs to be meshed into grids. Then a concentrated load is set to act at each grid point in turn, and the BIS can be obtained from the recorded bridge response after being divided by the size of the concentrated load. This method is simple and direct, but not efficient [15] due to the point-by-point loading. Thus, the dynamic

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