Damage Quantification of Concrete Tied Arch Bridge Based on Step-forward Loading Method

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Abstract

A method of structural damage distribution and quantification on tied arch bridges is presented in this paper. The damage identification and quantification process is proposed, which includes: 1) moving the testing trucks load forward step by step from one end of the bridge to the other end and obtaining the deflection matrix along deck alignment; 2) creating a program connecting Finite Element (FE) and field testing deflection matrix and using the optimization method to control the model updating to satisfy the real rigidity distribution; 3) verifying the method by theoretical model and related computation results. This method was later applied to a 52m span concrete arch bridge, and its damage quantification is analysed using field deflection matrix after step-forward loading test. Compared with other studies, the method shown in this paper shows a damage identification method which can quantify the structural rigidity distribution. The testing data used is obtained from step-forward loading which collects the response reflecting each zone's working condition of bridge. And data used in paper is based on static test to reduce the testing error and insure input accuracy.

Keywords: concrete bridge; deflection; step-forward loading; rigidity; damage; identification.

1. Introduction

Quantified damage identification includes dynamic test method and static test method. For the dynamic method, the effect of elastic bearings should be considered before testing [1-4]. For example, bearing of beam can be transferred to free elastic supporting before exciting [2-4]. Compared with the dynamic method, static method using deflection and strain data is less affected by boundary conditions and ambient noise. For bridges, mid-span section loading case is usually used to obtain deflection data [5-7]. Because of the restriction of data for such loading case, the accuracy and number of identification zones is limited. For example, each T-shape girder and all diaphragms have been selected as identifing parameters[4]. And a numerical simple supported beam model is also identified [5] and results show that the accuracy of qualification decreases with increasing number of element and damage grade. To increase the applicability and accuracy of static identification method, step-forward loading method is proposed in this paper. With a tied-arch bridge as background, testing trucks load was moved step by step from one end of the bridge to another and the deflection of each principle section was measured. Then FE model is updated until the deflection of computation matches the testing results. The principle, identification process and the accuracy of method were studied.

2. Identification Principle

To simplify the problem, identification of bridge sections is usually transformed to the identification

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