Dynamic load test analysis of upper bearing arch bridge

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Abstract. The bridge load test is an important means to evaluate the completed performance, construction quality and structural bearing capacity of the bridge structure, including determining the dynamic load test to determine the natural frequency, damping ratio and vibration mode of the bridge structure or structure, so as to determine the structural rigidity. The quality is an important factor to determine the basis. However, for the dynamic characteristics measurement method of the upper bearing arch bridge, the specification does not give a detailed detection method or recommendations. Combining with the analysis results of the field test data of the upper bearing arch bridge, this paper obtains a more accurate arrangement of test points.

1. Introduction

Arch bridge is a kind of bridge system widely used in our highway construction. Its mechanical characteristics are significantly different from those of beam bridge. Under the action of vertical load, the support not only generates vertical reaction force, but also generates horizontal thrust force. Because of the horizontal thrust, the bending moment of the arch under the same span is far less than that of the beam, which makes the whole arch bear the main pressure. However, due to the action of external load, temperature, pier displacement and other structural reasons, cracking will occur and the section stress will be re-distributed. With the continuous development of cracks, the structural system will be transformed and the internal force of the structure will be re-distributed. Therefore, the assessment of the bearing capacity of arch bridge has always been a research topic in the bridge field at home and abroad.

Based on the shuangla river bridge located at K8 + 296.377 of highway K8 + 296.377 in the section between zhongluo and liuku of G219 national road, this paper analyzes the test data of load test of the upper bearing arch bridge and gets a more accurate arrangement of measuring points. The elevation of shuangla river bridge is shown in figure 1
2. Test Design
The load test was carried out in 6 steps, that is, the test data were collected, the location of measurement points was determined according to the data, the modal measurement points were arranged, the instruments were placed, the modal testing was carried out, the data was processed and the final results were analyzed. The specific process was shown in figure 2.

The modal test using instrument for DH5908, using modal test method, test excitation method the environmental vibration method (also called pulsating method), refers to the deck without any traffic load and near the bridge site rules under the condition of vibration source, through the determination of bridge caused by the random incentives, such as wind load, and the pulse of the slight vibration, through the modal analysis, it is concluded that the vertical vibration of bridge vibration mode, damping ratio and natural frequency, etc. The specific arrangement diagram of pulse test point is shown in figure 3.
Figure 3. Test site arrangement plan.

During the modal test, the high sensitivity vibration sensor was used to match the DH5907N wireless modal test system to measure the small and irregular vibration of the bridge caused by various external factors.

In order to more accurately measure the vertical vibration modes of the bridge, bridge will be roughly divided into ten main arch ring, and when the point near the arch on pillar, will point to the pillar at the top of the bridge deck, to make the site of the deck vibration as far as possible close to the corresponding position of the main arch ring, so that we can more accurately measure the vibration of the bridge type.

3. Results analysis and discussion
Based on the finite element software MIDAS theoretical calculation on the bridge vibration characteristics, the bridge before the second order vertical bending natural frequency calculated value is 3.266 Hz, 4.613 Hz, vibration mode distribution as shown in figure 4, figure 6, frequency domain analysis of the bridge foundation frequency test, the bridge can be obtained before two order vertical bending natural frequency measured values were 6.014 Hz, 6.689 Hz, vibration mode distribution as shown in figure 5, shown in figure 7. The pairs of theoretical analysis and measured results are shown in table 1.

Table 1. Comparison of vertical vibration frequency test results.

| Modal order number | Theoretical frequency value /Hz | Measured frequency value /Hz | Measured damping ratio |
|--------------------|---------------------------------|------------------------------|------------------------|
| The first order    | 3.266                           | 6.014                        | 0.012                  |
| The second order   | 4.613                           | 6.689                        | 0.019                  |
Figure 4. Calculation value of natural frequency of first order vertical bending (3.266Hz).

Figure 5. Measured natural frequency of first order vertical bending (6.014Hz).

Figure 6. Calculation value of natural frequency of second order vertical bending (4.613Hz).
4. Conclusion
Based on the analysis of the experimental results, the following conclusions can be drawn

1. The measured frequency of the first and second order vertical vibration of the bridge is higher than the theoretical frequency, and the measured mode is consistent with the mode simulated by finite element software.
2. It shows that when measuring the frequency and mode of vibration of the upper bearing arch bridge, the measuring points should not be simply arranged at the same distance on the bridge, and the measuring points should be arranged at the upper end of the column when it meets the column.
3. The experimental method can be used to determine the vibration pattern and frequency of the upper bearing arch bridge.

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