

Study on Concrete Quality of Box Girder Based on Acoustic CT Technology

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Abstract. The twenty-ninth span 1# box girder of grand bridge on a Expressway in Yunnan, China, which is broken suddenly during the hoisting and transportation, resulting in the overturning of the beam and partial breakage. This paper focuses on the study of concrete appearance and concrete strength by CT technology. The results show that the average wave velocity of concrete in the area detected by the left web CT is 4.60 Km/s, and the coefficient of variation is 0.12; the average wave velocity of concrete in the right web area is 4.68 Km/s and the coefficient of variation is 0.11. The concrete pouring quality of the box girder is grade B. There are some abnormal areas in the concrete of the left and right web, which have certain influence on the bearing capacity of the bridge.

1. Introduction

The background of this project is located on a super grand bridge on a highway in Yunnan, China. During the hoisting and transportation of the twenty-ninth span 1# box girder of the bridge, the beam abruptly broken when the raining road is slippery and the beam carrier turns, and the position of 2.5 meters at one end of the flange plate is partially damaged.

The beam body was repaired by removing damaged area and pouring high-strength concrete. The quality of the box girder is evaluated after a period of maintenance. According to the corresponding criteria, the main inspection are: concrete appearance, concrete strength, using sound wave CT technology to detect the quality of the concrete pouring of the left and right web of the box beam (compactness and uniformity). The cross section of the box beam is shown in Figure 1.

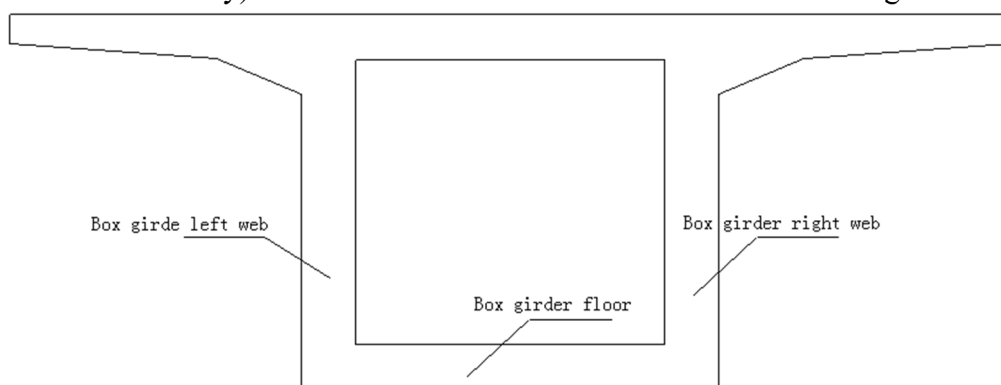


Figure1. Cross section diagram of box girder

2. Evaluation of appearance and strength

The appearance quality is composed of photo taking and field record. It mainly adopts visual measurement combined with steel tape, camera, crack observation instrument and so on. The examination found that the left and right web plates of the box girder were smooth, and there was no large area of voids and pits, and no cracks.

According to the requirements of the specification, the measuring area is set up, and the rebound value is measured by the rebound apparatus and the springbuck value is measured and converted according to the specifications. The concrete strength of the left and right web of the box girder is determined to be 53.5MPa and 54.7MPa respectively, which meet the design requirements.

3. Quality inspection of concrete pouring

Sonic CT method is used to detect the quality of concrete placement of beams and plates, to see whether the concrete placement of beams is dense, and whether it is uniform.

Acoustic CT nondestructive testing is based on the geometric kinematic principle of acoustic radiation, using the most advanced acoustic emission and receiving system, and using sound wave scanning to detect the body, and then using computer inversion imaging technology is used to present the acoustic velocity of concrete in each tiny unit of the detected body. Finally, the quality, uniformity and compactness of the tested body were evaluated. The arrangement of acoustic CT acquisition are shown in Figures 1 and 2.

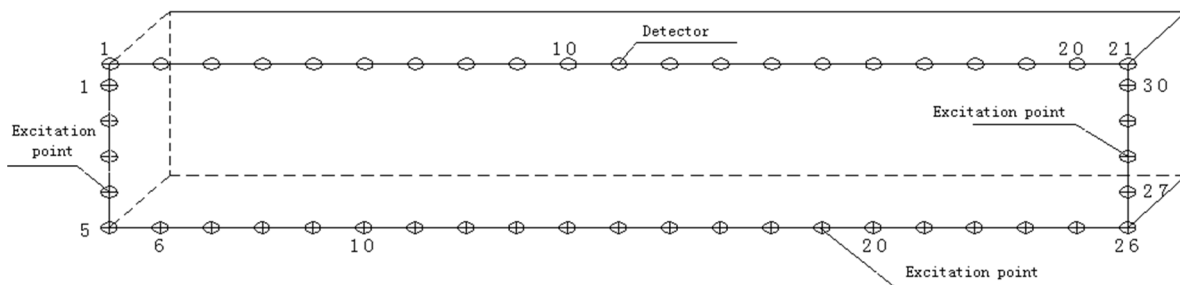


Figure2 Acoustic CT acquisition layout - left

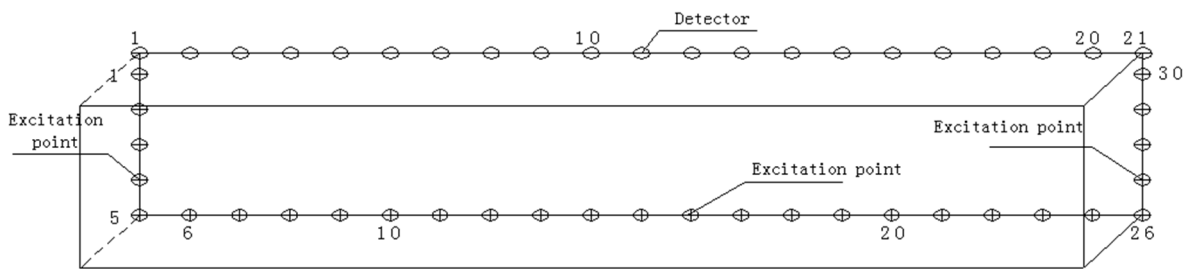


Figure3 Acoustic CT acquisition layout - right web

The geophone is arranged on the roof of the beam body, and the excitation points are arranged on the other 3 sides of the web section. The spacing between the excitation points is 0.5m, and finally a closed plane is formed.

The density and uniformity of concrete pouring quality are evaluated according to the comprehensive quality of its engineering properties for the following three grades, as shown in the table1.

Table 1 Quality rating scale for concrete pouring

Quality level	Compactness and uniformity of concrete	Note
A	Qualified:the concrete is uniform and dense, and there is no abnormal wave velocity region.	
B	Qualified:the area of abnormal wave velocity is smaller, slightly incompact or smaller.	Mending and strengthening
C	Unqualified:The area of abnormal wave velocity is large, and there are many leakiness empty places affecting the use of structure.	Further test verification

The test results of concrete pouring quality are divided into three cases:

1) The concrete age is more than 28 days, the average velocity of sound wave is above 4.60Km/s, the coefficient of variation is smaller, the velocity distribution is uniform, there is no mutation and no low velocity anomaly. It means that concrete pouring is uniform and dense, and the quality of construction is excellent.

2) The low velocity region of concrete appears, the average velocity of sound wave is below 4.60Km/s, the coefficient of variation is relatively large, and the area of low wave velocity area is less than 3%. It indicates that the concrete part is slightly not dense or has smaller holes. The construction quality is general. After reinforcement, the bridge structure can still be used, and it can be judged to be B class.

3) There is a large area of low wave speed in concrete. The average velocity of sound wave is below 4.30 km/s, the coefficient of variation is larger, and the area of low wave velocity is above 3%. It indicates that the concrete pouring is not uniform and dense, which seriously affects the use of bridge structure, and it can be judged to be grade C.

The results of box girder concrete left and right web acoustic wave CT analysis are shown in Table 2. The velocity inversion diagram of the detection results is shown in Figure 4.

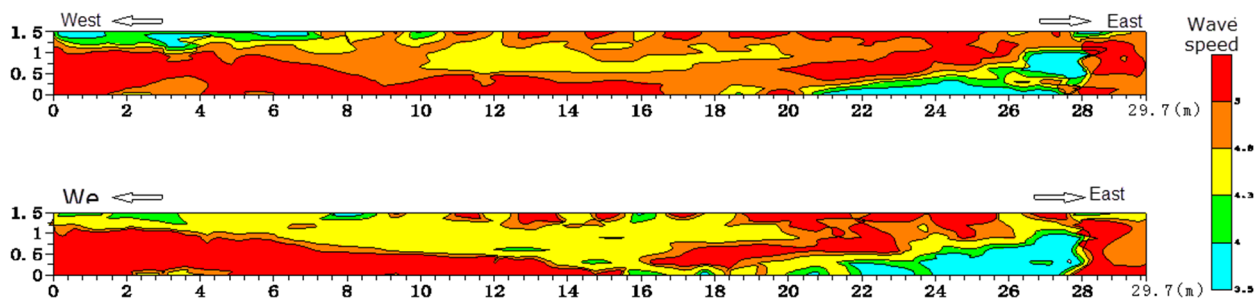


Figure 4 Inversion graph of wave velocity of detection results

Table 2 Quality test result of concrete pouring of box girder

Section	Concrete wave velocity (Km/s)	Coefficient of variation	Rating
Left web	4.60	0.12	B
Right web	4.68	0.11	B

Analysis of the test results:

The average velocity of concrete in the area detected by the left web is 4.60 Km/s, the quality of concrete pouring is general and the coefficient of variation is 0.12, indicating that there is a certain difference in the uniformity of concrete. The web is near the large mileage end 1.5-4.0m, which is 0-1.0m from the bottom plate. There is an abnormal area in the area.

The average velocity of concrete in the area detected by right web is 4.68 Km/s, the quality of concrete pouring is general and the coefficient of variation is 0.11, indicating that there is a certain difference in the uniformity of concrete. The web is near the large mileage end 1.5-4.0m, which is 0-1.0m from the bottom plate. There is an abnormal area in the area.

4. Conclusion

After appearance, strength and CT detection, it was found that:

- 1) The appearance and strength of the box girder analyzed in this paper meet the requirements.
- 2) The concrete pouring quality of this box girder reaches grade B.
- 3) There are abnormal areas in the left web and right web concrete, which have certain influence on the bearing capacity of the bridge.

Acknowledgment

Project Source: Yunnan Provincial Department of Education(2017ZZX319)

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