Journal of World Architecture, 2023, Volume 7, Issue 1
http://ojs.bbwpublisher.com/index.php/JWA
ISSN Online: 2208-3499
ISSN Print: 2208-3480

Structure Bearing Capacity Testing and Evaluation of Existing Bridges

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Abstract: The bearing capacity testing and evaluation of the existing bridge engineering structure is not only the key to clarify its structural quality and safety performance, but it also can lay a solid foundation for subsequent repairs and maintenance work. To ensure the bearing capacity, durability and reliability of existing bridges, this paper analyzes the importance and methods of testing and evaluation of structural bearing capacity of a bridge. This analysis aims to provide scientific reference for the quality assessment and subsequent repair and maintenance of existing bridge engineering structures.

Keywords: Existing bridge; Bridge structure; Bearing capacity detection; Bearing capacity evaluation

Online publication: February 14, 2023

1. Introduction

With the development of social economy and science and technology, the transportation industry has also made great progress. As an important engineering foundation in modern transportation, the bearing capacity of existing bridge structures is directly related to the application effect and safety of the existing bridge engineering itself. Therefore, suitable technology should be utilized to test and evaluate the structural bearing capacity of bridges, so as to provide a scientific reference for the operation, maintenance, and repair of existing bridges.

2. The importance of testing and evaluating the bearing capacity of existing bridge structures

With urbanization and the advancement of transportation engineering in China, the bearing capacity of existing bridge engineering structures has also been increasingly emphasized. Especially with the continuous increase of traffic load, the load borne by existing bridges is gradually increasing. After a long period of continuous use, the existing bridge structures are prone to some quality problems. If these problems cannot be discovered and dealt with in time, the bearing capacity of the existing bridge structure will reduce overtime, and even cause traffic accidents in severe cases. To prevent these situations from happening, scientific inspection and evaluation of the existing bridge structure need to be carried out using reasonable technical measures. In this way, it is possible to timely and accurately discover the location of insufficient bearing capacity in the existing bridge structure, thereby discovering its structural defects and problems in a timely manner, and formulating effective measures for the repair of structural problems and the improvement of structural bearing capacity [1]. This is very important for the improvement of the structural quality of existing bridge engineering, and the guarantee of bridge transportation effect and safety.

3. Testing method of bearing capacity in existing bridge structures

In the operation and maintenance inspection of existing bridges, static and dynamic inspection are important inspection in the evaluation of structural bearing capacity. Through the reasonable application of these two detection methods, the structural bearing capacity can be determined scientifically, thus ensuring its quality and safety. The following is an analysis of the application of these two detection methods.

(1) Static testing method

The static testing method is one of main methods of testing whether the existing bridge engineering structure is in a good state and suitable for use. The static testing method is also called the static loading method. Its main principle is by simulating the loading of the existing bridge engineering structure under various working conditions using a truck, and by various advanced testing equipment such as total station, crack gauge, deflection gauge, dial indicator, resistance strain gauge, and many more. Besides, the distribution law of the control section and the lateral load of the control section in the bridge structure under various load test conditions, and the possible occurrence of cracks, stress, deformation, and deflection are tested [2]. Based on the data obtained, the relevant parameters of the existing bridge engineering structure can be obtained. Stress calculations are performed according to different loads, and the calculation results are compared with relevant specifications. Then accurate its structural strength, crack resistance and toughness can be calculated accurately to determine its structural bearing capacity.

(2) Dynamic testing method

Dynamic testing is also an important method in structural bearing capacity testing. As far as the current dynamic testing of bridge engineering structures is concerned, the main methods include natural vibration analysis, dynamic response testing, and cable force testing.

Among them, natural vibration testing is generally carried out through random environment excitation method and forced vibration method. The vibration stimulated under excitation through such as ground pulsation and wind load is detected. The main principle of the forced vibration method is to excite the bridge structure through excitation equipment and obtain its natural vibration parameters based on the resonance effect.

In dynamic response testing, loading vehicles are driven through the testing track under various working conditions to generate corresponding excitation, and various dynamic parameters are calculated based on the effect of the load on the bridge structure. These parameters include impact coefficient, dynamic amplification coefficient, dynamic strain coefficient and moving displacement coefficient, and many more [3]. At the same time, the change of its structural state can also be detected through dynamic strain gauges, photoelectric devices, displacement sensors, and many other equipment, and the change in values of parameters can be acquired accurately.

The main principle of cable force detection is to first determine the transverse vibration frequency of the existing bridge cable structure, and then calculate the cable force based using the obtained value. Then, the values are corrected according to the type of bridge structure and the characteristics of its cable, which will then be used to calculate the structural bearing capacity.

4. Evaluation method of bearing capacity of existing bridge structures

There are four main evaluation methods for structural bearing capacity for existing bridges, the first is defect investigation and empirical analysis, the second is comprehensive analysis, the third is analytical calculation, and the fourth is load experiment. The following is an analysis of the application strategies of these evaluation methods.

(1) Problem investigation and empirical analysis

For existing bridge projects, defect investigation and empirical analysis are relatively traditional means of bearing capacity assessment. In this method, the staff have to be clear on various relevant professional specifications and have sufficient professional knowledge and on-site working experience. When inspecting the existing bridge structure, in addition to the basic inspection, it is also necessary to find out the damaged or defective parts of the structure, carry out rigorous inspections on them, and use this as a basis to evaluate the damage or defects. Reasonable assessment should be made including the assessment of the nature of the damage or defect, the severity of the damage or defect, and the impact of the damage or defect. During this process, staff also need to rely on past experience to analyze the main causes of bridge structure damage or defects and evaluate how the existing damage and defects will affect the existing structure [4]. In this way, the structural bearing capacity of the bridge can be scientifically evaluated, and targeted repair and maintenance plans can be formulated.

(2) Comprehensive analysis and evaluation

A comprehensive analysis and evaluation can not only make a reasonable evaluation of the basic conditions of the existing bridge itself, but also scientifically check and calculate the reduction of structural bearing capacity. In a comprehensive analysis, the damage of the structural materials is evaluated by analyzing the results obtained after detecting the cracks between the existing bridge engineering structures. For the calculation of bearing capacity, non-destructive testing technology can be used to test the performance of its structural materials, such as steel corrosion, concrete thickness, chloride ion content, resistivity, carbonation degree, and concrete strength. In this way, scientific judgments can be made on the performance of various structural materials in existing bridges, so as to realize the effective evaluation of the overall structural bearing capacity and provide scientific reference for the subsequent maintenance of existing bridge projects [5].

(3) Analytical calculation evaluation

In the operation and maintenance inspection of existing bridge projects, the analytical calculation evaluation method is also an important method in the evaluation of the structural bearing capacity. In this evaluation, a basic inspection of the bridge structure is first performed, and relevant data obtained from the inspection is used to analyze and calculate its structural performance [6]. This evaluation method involves not only the calculation theory of bridge structures, but also the corresponding bridge experience coefficients. Therefore, the bearing capacity of existing bridge structures can only be calculated and analyzed through theoretical calculation methods or empirical coefficient conversion methods. Because different analysis and calculation methods have different adaptation factors and applicable conditions. Therefore, experts and staff need to make a reasonable choice of specific analysis and calculation methods based on whether the load level coefficient of the existing bridge is known, if the coefficient is known, it can be analyzed and calculated by theoretical calculation method; if the coefficient is unknown it can be analyzed and calculated by empirical coefficient conversion method [7]. In order to ensure the accuracy of the evaluation results, all load measurement parameters and material strength parameters should be subject to real conditions during specific analysis and calculation. In this way, it is possible to make a scientific assessment of the structural bearing capacity of the existing bridge engineering, discover insufficient bearing capacity in time, and is helpful for the repair and maintenance of its corresponding structures [8].

(4) Load test evaluation

Load test evaluation tests and evaluate the actual operating state of the existing bridge engineering structure. Through the reasonable application of this method, the bearing capacity of the bridge structure can be evaluated more intuitively, and the reliability of the evaluation results can be ensured [9]. In this method, structural load capacity is first tested through static and dynamic tests, and the results of the

tests are collected. The data are then analyzed, and the results are compared with the structural performance parameters in the existing bridge project [10]. In this way, the actual performance parameters of each part of the structure can be scientifically determined. Through further analysis and evaluation of these performance parameters, the structural bearing capacity of each part of the existing bridge project can be accurately identified, and a scientific assessment of its structural damage and defects can be made.

5. Conclusion

In conclusion, the structural bearing capacity is the key to ensure its application effect, service life, and safety. Based on this, relevant units, experts, scholars and staff must do a good job of testing and evaluating the bearing capacity of such bridge structures. By carrying out scientific and reasonable testing and evaluation, problems such as structural damage and defects can be found in time, the location of damage and defects can be identified, and the degree of damage and defects can be reasonably evaluated and its impact on the overall bridge structure can be determined. In this way, not only can the bearing capacity of existing bridge engineering structures be determined, but scientific reference can also be provided for the formulation of structural repair plans and the improvement of the quality of follow-up operation and maintenance. This will have far-reaching implications for the protection of the structural bearing capacity of existing bridges, the improvement of the overall performance of existing bridges, and the development of the bridge engineering industry.

Disclosure statement

The authors declare no conflict of interest.

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