Influence Of Overload On Transverse Distribution Of T-beam Bridge

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Abstract. In order to study the influence of overload on the transverse load distribution of T-beam bridge, according to the different failure position and failure form of main beam, nine working conditions are divided for finite element simulation, and the transverse distribution value of each main beam under each working condition is obtained, and compared with the value under general load. The results show that: if the bridge transverse connection is damaged, the lateral load distribution capacity of the structure will be reduced again, and the stress form of the structure will become more unreasonable.

1. Introduction
Simply supported T-beam bridge is widely used because of its clear stress, simple structure, convenient prefabrication and installation [1-2]. With the development of China's highway transportation, driven by economic interests, many adverse phenomena occur frequently, and the load of many vehicles exceeds the limit value of bridge design, which often has adverse effects on bridge structure, that is, overload effect. The overload will affect the transverse distribution of the bridge load, and in serious cases, it will cause harm to the bridge and endanger the bridge safety [3-6]. Therefore, it is necessary to study the lateral distribution of bridge load under the overload load.

2. Establish the finite element model

![Figure 1: Size of main girder and diaphragm](image-url)
The finite element model established in this paper is referred to [7]. It is a reinforced concrete simply supported T-beam bridge. The upper structure is assembled and spliced by five T-beams, and there are five diaphragms in the transverse direction of the bridge. The standard span is 19.5m. The main beam is rigidly connected with the flange plate. The section form of the main beam and the diaphragm beam is shown in Figure.1 (unit cm).

ANSYS is used to establish the model, in which the slip between reinforcement and concrete is not considered, and the overload is applied to each girder one by one (exceeding the design load by 10%). In the modeling process, the longitudinal main reinforcement is established according to the separated model, the SOLID65 unit is selected for the concrete, and the link8 unit is used for the reinforcement; the stirrup and other reinforcement are established according to the integral model, which is realized by setting the concrete unit parameters.

3. Analysis of simulation results without damage

According to the data obtained by the finite element software, the transverse distribution values of the above-mentioned bridges under the action of general load and overload load are obtained respectively, and compared (Figure. 2) to analyze the influence of overload. It can be found that the lateral load distribution value of each girder will change after the bridge is subjected to the overload load, and the overload load will weaken the lateral load distribution capacity of the bridge structure and reduce the uniformity of the load transverse distribution. This will affect the overall stress of the structure, which is disadvantageous to the main girder directly bearing the load, and is easy to cause damage, and even has adverse impact on the stability and safety of the bridge.

![Figure. 2 Numerical comparison curve of transverse load distribution of each girder](image)

(a) beam 1  
(b) beam 2  
(c) beam 3
4. Analysis of simulation results under damage condition
Simulate the transverse connection damaged bridge under the action of over limit load. According to the comparison between the simulation results and the general load, the change of transverse distribution value of the damaged bridge under the overload load is analyzed.

The transverse load distribution of each beam is analyzed when damage occurs at A in Figure. 1, and the simulation results are shown in the Figure. (Type I-1 indicates damaged flange connection, type I-2 indicates damaged diaphragm connection, and type I-3 indicates damage to two parts.)

4.1. Result analysis of side beam
Taking No. 1 beam as a representative, the influence of lateral load distribution on the side beam is analyzed. The comparison curve is shown in Figure. 3. The results of case I-1 under the action of over limit load is equivalent to that of I-3 under general load, which indicates that the damage that does not need to be treated after the action of over limit load needs to be repaired and strengthened; and the damage that needs maintenance and treatment has developed to the point that the structure will be damaged at any time without reinforcement, especially in case of condition I-3, in addition, the worst value difference under this condition has also been improved 0.915, which indicates that the load directly acting on the edge beam is almost borne by the edge beam alone, and the stress characteristics of single beam are very obvious, which indicates that the structure has lost the ability of lateral load distribution.

Figure. 3 Numerical comparison curve of lateral load distribution of side beam
4.2. Secondary side beam result analysis
Taking No. 2 beam as a representative, the influence of secondary side beam is analyzed, and the comparison curve is shown in Figure. 4. It can be seen that the variation range of lateral load distribution of secondary side beam increases with the increase of damage degree. In addition, the difference of the maximum value of the lateral load distribution under the three working conditions is increased, which indicates that the overload will also reduce the uniformity of the lateral load distribution of the secondary beam.

![Figure 4 Numerical comparison curve of lateral load distribution of secondary side beam](image)

4.3. Result analysis of intermediate beam

![Figure 4 Numerical comparison curve of lateral load distribution of secondary side beam](image)
Taking No. 3 beam as an example, the influence of transverse load distribution on the middle beam is analyzed. The comparison results of transverse load distribution values are shown in Figure. The effect of over limit load on the middle beam is basically the same as that of the first two main beams, which will also reduce the uniformity of the lateral load distribution.

5. Conclusion
(1) When the bridge is intact, if the bridge is under the action of over limit load, the cooperative working ability of the main beams will be reduced, the inhomogeneity of the transverse distribution of the structural load will be increased, the load proportion of the main girder directly affected by the load will be increased, and the load proportion of the other main beams will be reduced, which is very unfavorable to the main beam directly bearing the load and easy to cause its damage.

(2) If the lateral connection is damaged, the adverse effect on the lateral distribution will be further increased, and the stress of the structure will become more unreasonable. Therefore, the simply supported T-beam bridge is subjected to overload after the transverse connection damage, which is undoubtedly worse for the lateral load distribution of the structure.

In a word, the damage of transverse connection and the action of over limit load will cause adverse effects, which will reduce the cooperative working ability of the structure and change the original stress form of the structure. When these two conditions occur at the same time, the influence will be superimposed, making the bridge structure in the most unfavorable state. Therefore, in the actual project should try to avoid, especially the two at the same time, if it has occurred, we should take measures to repair and strengthen the bridge structure.

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