Comparative test and analysis on flexural behavior of RPC100 foot-slabs

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Abstract. In order to judge normal service condition of RPC100 foot-slabs, and study its application value in practical engineering. In this paper, the crack bending moment of RPC100 and ordinary reinforced concrete is compared by using the test method of hydraulic jack single point centralized loading simply supported plate, which combines with the test data of macroscopic observation, deflection and strain. The results show that the safety coefficient of RPC100 furrow cover applied to the pavement is greater than 1.8, which is in a safe state and can meet the demand for carrying capacity of the sidewalk in normal use.

1. Introduction

With the continuous development of urban traffic volume and infrastructure construction, the carrying capacity and quality of pavement cover have been put forward higher requirements. The pavement and cable trench cover plate in China are mostly made of ordinary reinforced concrete material, which has the characteristics of large volume, low bearing capacity and inconvenient transportation. So, it is urgent to adopt new materials for improvement.

Gang Wang [1] determined the compressive strength and flexural strength of RPC specimens with different mix ratios, and studied the mechanism of the influence of each constituent material on the mechanical properties of RPC. In order to study what factors affect the shear strength of RPC simply-supported beam members, Lingzhi Jin [2] et al. conducted the shear the bearing capacity experiment by comparing 2 groups of rectangular beam members with shear span ratio of 2.25 and 3.0 respectively, and also analyzed the influence of stirrup ratio on the shear bearing capacity of the members.

In practical engineering applications, we do not expect it to reach the boundary state of stress, and usually nip the danger in the cradle before its failure. Therefore, based on the actual working state of pavement trench cover plate, the experimental study on the cracking moment and bearing capacity of the new material RPC100 foot-slabs has important value in the practical application.

2. Test Design.

The C1 type (744 mm × 494 mm × 25 mm) cover plate with the calculated span of 670mm was used for loading test, and the test load was carried out by self-made pressure test instrument, as shown in Figure 1.

(1) Arrangement of strain measuring points

The measuring points of strain gauge are arranged in the span of the long side of the cover plate. Respectively, there are three strain gauges at the 100mm and 1/2 width from the long side of the cover plate. The 1/4 bridge (public compensation [3]) bridge of wheat stone is used to connect the strain strength, as shown in Figure 2.
(2) Deflection measuring point arrangement

In this test, deflection measuring points are set in the middle of the span, and bearing subsidence is considered, so deflection measuring points is set at both ends of the bearing to monitor the bearing subsidence [4]. The specific arrangement of measuring points is shown in Figure 3.

Hydraulic jacks are used for single point centralized loading. The loading point is set in the center of the cover plate. The loading beam is I-beam with length of 50cm and width of 7.5cm. Load value is directly read by the force sensor. The plate is simply supported. The bending strain is collected by pasting 3 resistance strain gauges in the middle of the bottom span of the plate. The static strain is using Donghua wireless strain data acquisition instrument (DH3819) to collect plate bottom strain changes. A dial gauge is set at two supports and midspan to test deflection variations. Through the experiment's phenomenon, combined with the strain and deflection mutation situation, comprehensively judge whether crack of the plate bottom. The loading mode is about 1kN per grade of load. After loading, oil pressure is stabilized for 5 minutes before reading. The loading condition is mainly the maximum bending moment in the middle span, and the cracking of the cover plate is concerned with the real-time dynamic strain curve during the test.

3. Results analysis and discussion

Combined with the load-strain curves in Figure 4 and Figure 5 and the time of on-site crack occurrence. It can be concluded that the deflection, strain, load and bending moment data measured in mid-span at the critical points of elastic stage and the yield stage of the two materials. They are shown in table 1 respectively:
Figure 4. Load-Strain curve of common concrete 1#~3# slab

Figure 5. Load-Strain curve of RPC1#~3# slab

Table 1. The measured data of two kinds of materials under cracking load

| Cover plate number | Ordinary concrete 1 | Ordinary concrete 2 | Ordinary concrete 3 | RPC1 | RPC2 | RPC3 |
|--------------------|---------------------|---------------------|---------------------|------|------|------|
| Deflection /mm     | 0.14                | 0.14                | 0.34                | 1.11 | 1.12 | 1.19 |
| Strain /με         | 143                 | 106                 | 114                 | 251  | 241  | 223  |
| Load /kN           | 13.52               | 13.73               | 15.89               | 4.15 | 4.17 | 3.67 |
| Cracking moment /kN-m | 2.26              | 2.30                | 2.66                | 0.70 | 0.70 | 0.61 |
| Safety coefficient | 9.06                | 9.20                | 10.65               | 2.78 | 2.79 | 2.46 |

In this test, the load is distributed in the mid-span transverse bridge direction, so the whole of cover plate can be considered as simply supported plate, so that cracking moment can be calculated by the calculation formula of the maximum mid-span bending moment of simply supported beam in Mechanics of Materials.

As shown in table 1, the load value borne by RPC100 foot-slabs when it cracks is 3.67~ 4.17kN, about 4.0kN, which is basically the same as that of RPC200 pavement cover plate when it cracks. According to TB 10002.1-2005 Fundamental Code for Design on Railway Bridge and Culvert [5] to checking the pavement plate of vertical concentrated load, and the safety coefficient calculation of each plate as shown in table 1. The safety coefficient in the table is the measured the ratio of cracking moment with the design of bending moment. Safety factor comparison is show in Figure 6.

Figure 6. Safety factor comparison chart

Due to the reinforcement resistance bending moment is added into ordinary reinforced concrete, the bending moment is borne by both of them, so the section height of ordinary reinforced concrete cover plate is much higher than RPC100 foot-slabs, and the cracking bending moment value is much higher than RPC100 foot-slabs.

Under the condition of meeting the requirements of bearing capacity, the thickness of RPC100 foot-slabs is only 1/4 of that of ordinary reinforced concrete plate. Therefore, the thickness reduces the space occupied by the cover plate in the process of transportation and facilitates the transportation and
installation.

4. Conclusion
The time of crack occurrence of RPC100 foot-slabs and ordinary reinforced concrete cover plate was determined by the test phenomenon and Strain - Load curve, so as to determine the cracking moment. Combined with the analysis of test results, the following conclusions can be drawn:

(1) The safety coefficient of RPC100 trench cover plate is greater than 1.8 when applied to pavement, which is in a safe state and can meet the bearing capacity of pavement cover plate in normal use.

(2) For the pavement trench cover plate, RPC100 foot-slabs are easier to transport and install than ordinary reinforced concrete cover plate under the condition of meeting the carrying capacity in normal use.

5. Expectation
In order to make it better and safer to be used in practical engineering, later research can be carried out on the cover plate after a certain number of years to conduct an experimental comparison and verify its durability.

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