Analysis of bending failure process of RPC100 foot-slabs

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Abstract. In order to study the failure modes of RPC100 foot-slabs, three pavement plates with the same calculated span were used for the uniaxial bending experiment. Meanwhile, the failure process of three groups of ordinary reinforced concrete was compared. The test showed that: during the experiment, the failure process of the two was basically the same, and RPC100 showed a certain ductility. So RPC100 foot-slabs was a plastic material.

1. Introduction
RPC100 (Reactive Powder Concrete [1]) is a cement-based composite material developed by the Germany Youlinsheng Limited Liability Company through certain configuration process. Its characteristics are good toughness, high strength, strong durability and the volume is good stability.

Hongwei Chen [2] carried out an experimental study on the bending resistance of RPC cover plate, and founding the RPC has good ductility, and the components showed ductile failure when destroyed. At the same time, there were two important factors that affect the ductility of active powder concrete. Jianxin Sun [3] used two preparation methods of mixing plastic expansion agent and ordinary expansion agent respectively to produce an economically active powder concrete which could meet the design requirements. Guangjie Yan et al [4]. studied the flexural capacity of RPC200 pavement slab by means of experimental research. The results showed that, the RPC pavement slab has good ductility material performance, and the failure process showed obvious ductility under the condition of meeting the requirements of bearing capacity.

By studying the damage process and form of RPC100 foot-slabs, the construction can be effectively guided, thus reducing safety risks, and providing a scientific basis for the large-scale promotion of the material.

2. Test Design
This load test is divided into seven steps. They are Test data collection, Location arrangement of strain and deflection measuring points, Paste strain gauge, Load test, Experimental process analysis, Data processing and Interpretation of result. The specific process is shown in Figure 1.

![Test process flow chart](image)

Figure 1. Test process flow chart
RPC100 adopts domestic 42.5# ordinary Portland cement and various special mineral additives for active minerals prepared by the assembly experiment, and optimal particle size calculation independently developed by Germany Youlinsheng Limited Liability Company. Standard sand is selected for aggregate, with particle size range of 160-250 µm fine quartz sand and particle size range of 0-1250 µm, and there are three kinds of particle sizes. Steel fiber selection size as a parameter φ=0.20mm, long for 12~14mm thin round steel fiber. The water reducer by a new high-performance transparent, the liquid is dark violet and the water-reducing rate is 31%. The loading location of the board is shown in Figure 2.

![Figure 2. Loading position](image)

The model adopts 3 pieces of C-type cover plate to experiment (744 mm × 494 mm × 25 mm). Contrast test to choose 3 block length and width of the same but thickness is 90 mm ordinary reinforced concrete experiment research. It is the C30 ordinary reinforced concrete strength, four φ=12 HRB400 steel bar, the a_s= 20 mm. The calculation span of the two materials and the loading method is the same. The applicability of the two materials in practical engineering is obtained by comparing process and form of the damage under the same conditions. The test method is refer to the new national standard GB/T 23858-2009, Menhole Cover[5].

3. Results analysis and discussion

After the test, the Deflection-Load curve of ordinary reinforced concrete cover plate and RPC100 foot-slabs are obtained, as shown in Figure 3 ~ 4.

![Figure 3. The Load - Deflection curve of concrete cover slab](image)

![Figure 4. The Load - Deflection curve of the RPC cover panel](image)

In Figure 3 and Figure 4, the Load-Deflection curves of RPC100 foot-slabs and ordinary reinforced concrete in the process of failure go through three stages:

1. **Elastic stage** At this stage (A-B section), concrete and steel bar, RPC100 and steel fiber bond well, both can occur at the same time elastic deformation, and the measured load, mid-span deflection, strain is in a certain proportion. Finally reached the crack emergence of critical point B.

2. **The yield stage** At this stage (B-C section), cracks begin to produce, and develop gradually from narrow to wide. At this point, the steel and concrete, steel fiber and RPC100 still bonds well, and the tensile area is mainly composed of steel, steel fiber tension, and present a larger plastic deformation. Load-deflection curve of the rise, and tend to be gentle.

3. **Failure stage** At this stage (C-D section), the vertical crack of the plate accelerates upward
development. The mid-span deflection increases sharply, and the bearing capacity obviously decreases. The corresponding load deflection curve load cannot increase upward, tends to be flat, or even declines, and the plate loses its bearing capacity. In the end, most of the steel fibers were forced out of the RPC100 foot-slabs, and breaking the balance between the two. At this point, a vertical crack quickly ran through the upper edge of the plate, and the plate began to break. The cracks between ordinary concrete slab and RPC100 foot-slabs is shown in Figure 5 and Figure 6.

![Figure 5. Failure of ordinary concrete cover plate](image1)
![Figure 6. RPC cover panel was broken](image2)

Although there is no steel reinforcement in RPC100 foot-slabs, the failure of RPC100 foot-slabs are still ductile failure due to the mixing of a large number of steel fibers to resist bending moment. Unlike ordinary reinforced concrete cover plate, sufficient steel reinforcement is required to avoid brittle failure.

4. Conclusion
This experimental study on the component adopts single-point loading method. Through the self-made test equipment, the experiment is carried out under natural conditions. The failure mechanism of RPC100 foot-slabs and ordinary reinforced concrete cover plate, as well as the deformation analysis members during the stress process, is analyzed by comparative test.

Combined with the analysis of test results, the following conclusions can be drawn:

(1) The failure process of RPC100 foot-slabs is basically the same as that of ordinary reinforced concrete. It goes through three stages, namely, the elastic stage, the aggrandizement phase and the failure stage. It has an obvious plastic failure process, which prevents the members from causing safety risks due to sudden fracture of the cover plate in practical applications. Therefore, in practical engineering, materials with obvious plastic deformation similar to ordinary reinforced concrete and RPC100 cover plate are often used as load-bearing structures.

(2) According to the failure modes of RPC100 foot-slabs, RPC100 foot-slabs are a plastic material.

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