APPLICATION OF IMAGE ANALYZING SYSTEM TO SHEAR TESTS OF HPFRCC BEAMS

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1. INTRODUCTION

HPFRCC (High Performance Fiber Reinforced Cementitious Composites) has gained considerable attention in recent years due to its high tensile ductility and generation of fine multiple cracks. When this material is used as structural element, it is essential to evaluate both wide range of strain distribution and local scale crack behavior appropriately. Conventional measurement methods of strain on concrete, however, are not be able to obtain these two features at the same time, accurately. To solve this difficulty, image data analysis is focused and applied in this research. Shear tests of HPFRCC beams are carried out, and the overall strain distribution and the local crack opening - slipping behavior are investigaed.

2. EXPERIMENTAL PROGRAMS

2.1 Image data analyzing System

Conventional measurement methods like strain gauge or displacement meter can provide limited data which depends on location of the instruments. On the other hand, the image analysis system can measure the surface displacement in the wide region with high accuracy. Also, this system can pursue local displacement of cracks where the movement in opening and slipping direction of crack that causes a critical failure of specimen. HPFRCC beams have multiple cracks which widen in large range during the loading. Hence, the image data analysis is an appropriate method of measurement in the tests of HPFRCC.

The procedure of this system follows the research by Watanabe et al. Seals (5mm diameter) are put on the surface of specimen at space of 20mm. By using camera, locations of all these seals are captured during the loading process in pictures. Then the coordinates of center of all seals are picked up by the software HALCON, and strain of whole targeted area of specimen can be calculated based on finite element method.

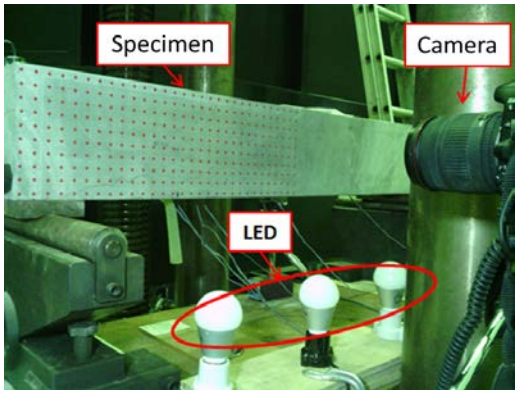

Figure 1 Test and measurement

2.2 Evaluation method

Two ways of evaluation were provided in this research. For the evaluation of shear strain distribution in wide range, contour figure is outputted. On the other hand, to evaluate the local crack behavior, a certain range of points is selected on shear failure crack and the strains against the crack opening direction are calculated. Figure 2 shows the image of this process briefly.

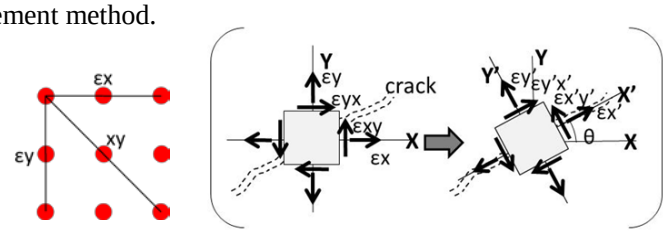

Figure 2 Investigation into local crack behavior

2.3 Specimens and loading method

In this research, shear beam tests are performed as shown in Figure 3. Seals are put on one side of the beam, and stirrups are set in the other side so that the shear failure occurs on the sealed side. Two types of materials are used: Normal HPFRCC and coarse aggregate mixed HPFRCC. It is expected that coarse aggregate contributes to the improvement of shear resistance on crack surface in HPFRCC. Here, to see the effect clearly, initial damaged is introduced with a span of 200mm to the level of nearly its failure in the shear span (Figure 3 (a)). Then, the location of loading plate is shifted to the span of 400mm as shown in Figure 3 (b).

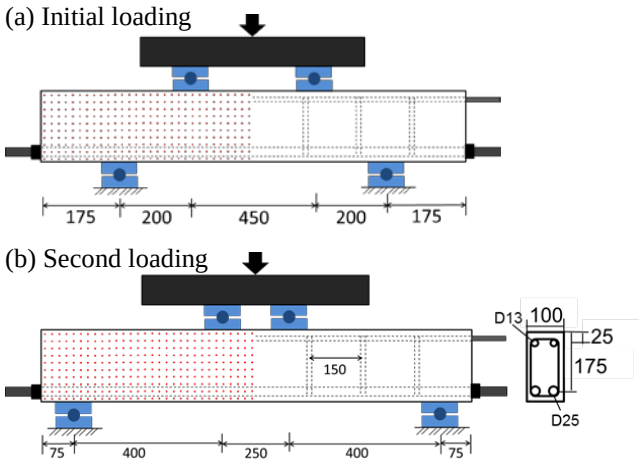

Figure 3 Shear beam test

3. RESULTS

Figure 4 shows the load-displacement response of the specimen. Figure 5 shows a changing of shear strain during the loading by contour figures.

Keywords: image data analysis, strain distribution, local crack behavior, contour figure
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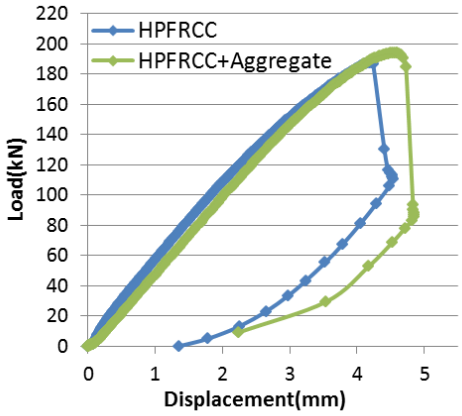

Figure 4 Load-displacement curves

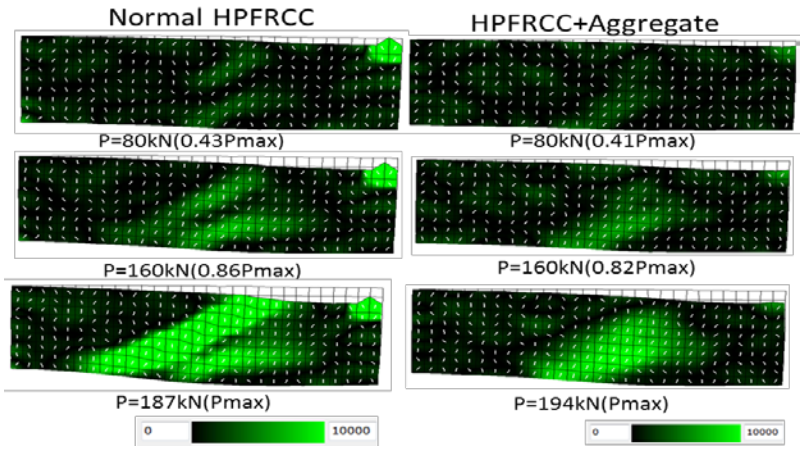

Figure 5 Shear strain contour figures

As can be seen in these figures, the maximum load is higher, and shear strain is lower in the beam with aggregate when the initial damage is introduced.

Also, Figure 6 shows the strains in crack opening and sliding directions after the crack. Red colored figures represent opening, and blue colored ones represent slipping of cracks in whole range of subjected area. The white lines indicate the angle of failure crack in each block of elements, and the length of these lines is proportional to value of strain of each local element.

Figure 7 shows opening and slipping examination at local scale. The element which has the biggest strain in the specimen is selected for the calculated area. In the beginning of the loading, there is not much difference between two materials. However, as it goes to the peak, opening and slipping of normal HPFRCC becomes higher than that of aggregate added one. As scatters can be observed in the graph, however, much higher accuracy for this investigation is required in the future.

In the light of these results, it appears to be possible that crack opening and slipping resistance of aggregate caused high shear performance and load capacity.

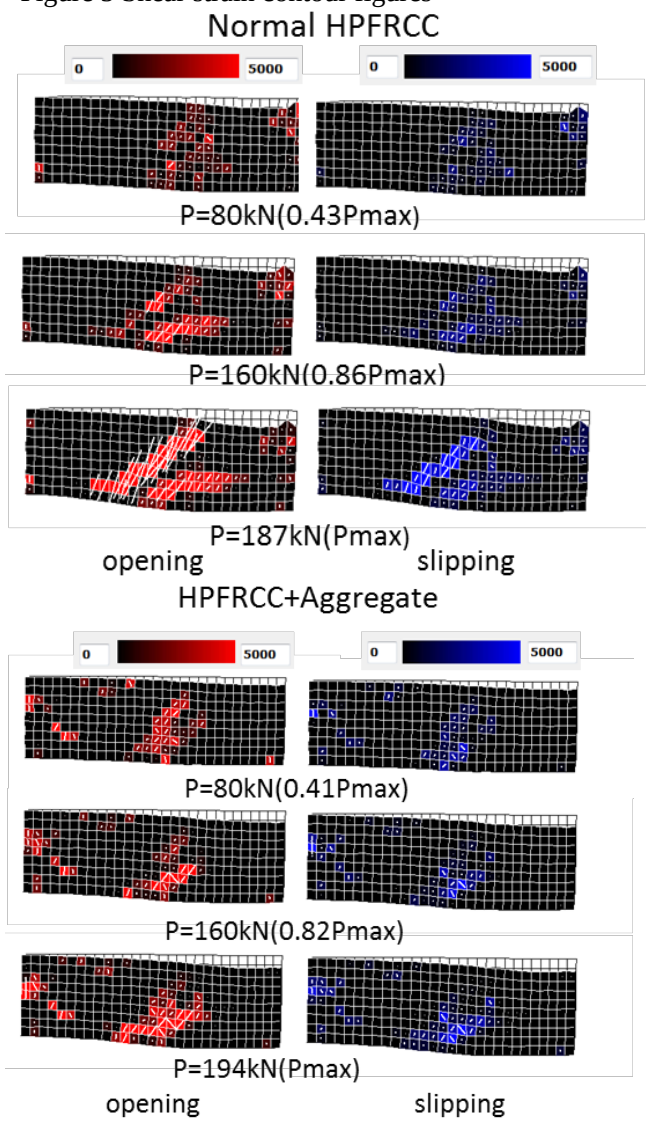

Figure 6 Opening and slipping strain contour

4. CONCLUSIONS

By using image data analysis, both wide range strain distribution and local crack behavior can be investigated in HPFRCC which performs ductile behavior due to providing of multiple cracks. Especially, investigation into shear performance and crack opening-slipping performance were conducted in this research.

REFERENCE

Watanabe, K., Higashi, H., Miki, T., and Niwa, J.:Real-Time Image Analyzing System For Loading Tests of Structural Concrete, Journal of JSCE, Vol.66, No.1, pp. 94-106 (in Japanese)

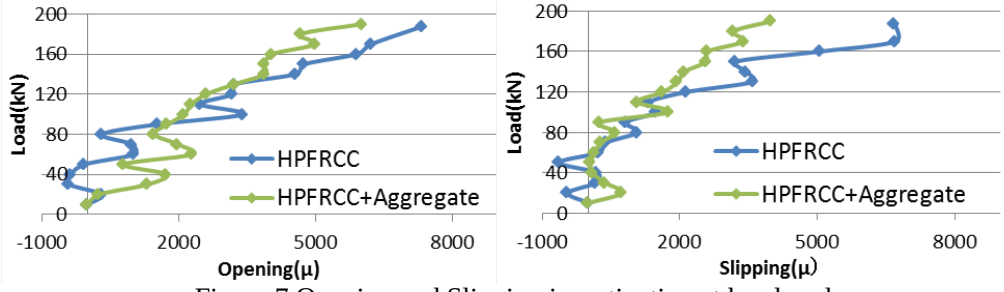

Figure 7 Opening and Slipping investigation at local scale