FAILURE PROPERTY OF UFC PANEL BONDED ON STEEL WITH ADHESIVE RESIN

Hokkaido University Student Member ○Naphon Krintrakul
Hokkaido University Professor Fellow Member Tamon Ueda
Hokkaido University Assistant Professor Regular Member Hitoshi Furuuchi
Regular member Jun Takahashi
Regular member Seiji Fujima

1. INTRODUCTION

Nowadays, many concrete structures are required for strengthening or rehabilitation. Ultra-High Strength Fiber Reinforced Concrete (UFC) is one of strengthening and repair materials which can provide better performance of strength, workability, ductility and durability when compared with normal concrete. Therefore, an understanding of the behavior of failure mode of UFC panel bonded on steel with adhesive resin is required. However, there is lack of knowledge about behavior of failure mode of UFC panel bonded on steel with adhesive resin. This study is being conducted to clarify the behavior of failure property, such as failure mode and bond strength of UFC panel bonded on steel with adhesive resin and to find appropriate testing method. The investigation results of the experimental results (Hasegawa, 2013) by FEM analysis are presented for the above objectives.

2. EXPERIMENTAL OUTLINE

This study uses the existing experimental results from the failure behavior of UFC panel bonded on steel with adhesive resin which provided by Hasegawa (2013). Hence, the simulation of the specimens by FEM (DIANA) was conducted to find failure behavior thoroughly. The FEM analysis was elastic analysis in this study.

The specimen composed of two steels plate connected by UFC panels on the top and bottom with adhesive resin**.** Dimension of UFC panel is 60mm in width, 30mm in thickness, and 150mm and 250mm in length. There are two types of specimens. First, the specimen type A is with UFC of 150mm and bonded length of 50mm in each side, and no-bonding section of 50mm as shown in Fig.1. Second, the specimen type B is with 250mm in length and bonded length of 120mm in each side, and no-bonding section of 10mm as shown in Fig.2. Both types of specimens have the adhesive layer with 2mm thickness between UFC and steel plate. Dimension of steel plate is 60mm in width, 320mm in length, and 9mm. in thickness. Furthermore, steels are SS400 and adhesive resin is acrylic resin. Both types of specimens were divided into 4 symmetry parts and analyzed as shown in Fig.3. Table 1 shows material properties of the specimens.

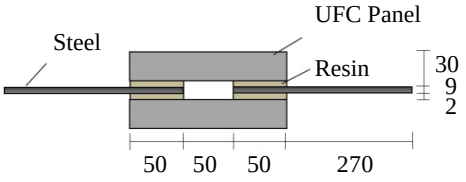

Fig. 1 Specimen type A

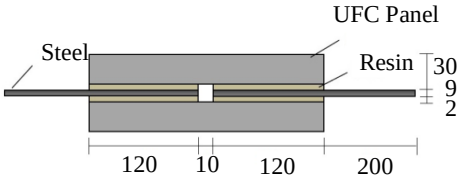

Fig. 2 Specimen type B

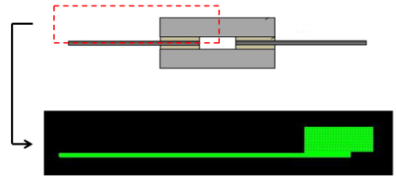
Fig. 3 Simulation of specimen

Table 1 Material properties of specimen

Material	Young Modulus(MPa)	Poisson Ratio
UFC	46,000	0.2
Acrylic resin	104.94	0.42
Steel(SS400)	200,000	0.26

3. RESULTS AND DISCUSSIONS

3.1 Normal stress

Fig. 4 shows normal stress contour line of specimen type A and Fig. 5 shows normal stress contour line of specimen type B after analyses by linear elastic analysis. Bending at UFC panel occurs during the pull-out test. The figures show bending effect occurs at UFC panel in both types of specimens but bending effect occurs in specimen type A more than type B. Bending effect at UFC panel occurs direct variation with the gap between steel plate.

Keywords: UFC panel, Adhesive resin, Failure behavior, FEM analysis
Contact address: 1-10 Kita8, Higashi2, Higashi-ku, Sapporo 060-0908, Japan, Tel: 080-8818-1200

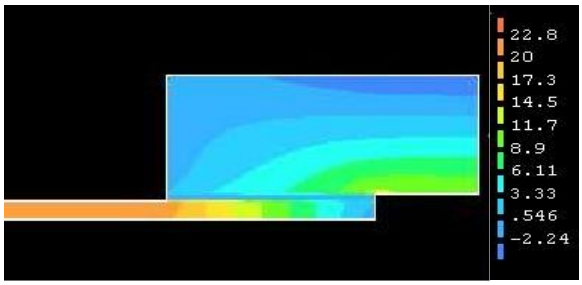

Fig. 4 Normal stress contour line of specimen typeA

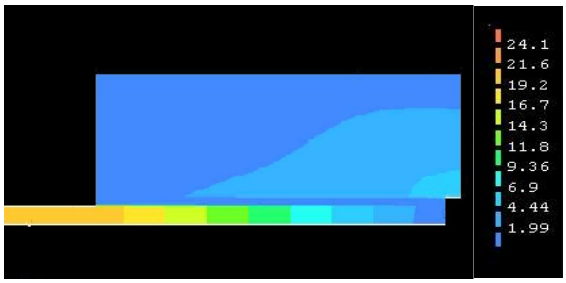

Fig. 5 Normal stress contour line of specimen typeB

3.2 Shear stress

Fig. 6 and Fig. 7 show shear stress contour line of specimen type A and B. The figures show the maximum shear stress occurring at adhesive layer, surface between steel and adhesive layer, and surface between UFC and adhesive layer in both specimens. Greater shear stress occurs in specimen type A than in specimen type B when equal load was applied because specimen type A has less bond length than specimen type B.

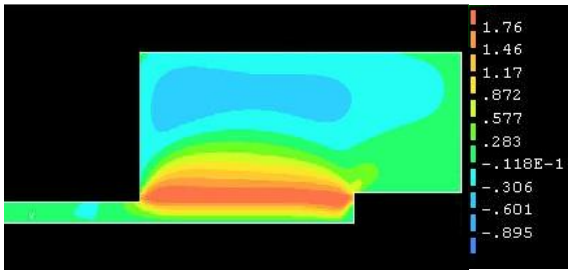

Fig. 6 Shear stress contour line of specimen typeA

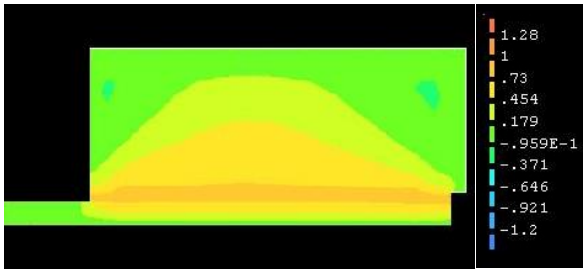

Fig. 7 Shear stress contour line of specimen typeB

3.3 Experimental and FEM analysis results comparison

Horizontal normal strain distributions of UFC panel in specimen type A and B along the interface strain have been calculated by FEM to compare with the experimental results as shown in Figs. 8 and 9. The FEM results overestimate the test results in Fig. 8, but agree well with the test results in Fig. 9. The FEM results show that the normal stress decreases quickly as the distance from the interface gets greater. The difference in location of strain between the test and FEM may be a reason of the discrepancy. FEM analysis results show bending effect occurs in the same way as the experimental results.

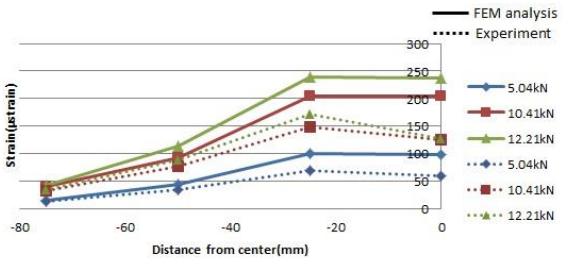

Fig. 8 Strain comparision of specimen typeA

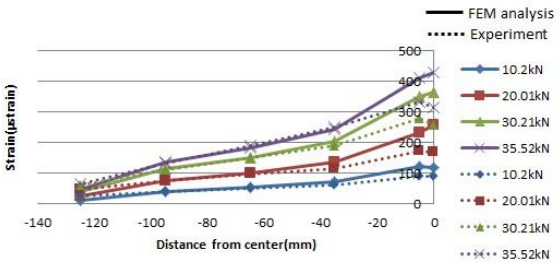

Fig. 9 Strain comparision of specimen typeB

4. CONCLUSION

The results from numerical analysis show high shear stress of specimens occur at interface between resin and UFC panel, interface between resin and steel, and Resin layer. Bending in UFC panel that occur during the tensile test will decrease when length of gap decreases. The FEM analysis in this study can help to develop an appropriate testing method for bond strength of UFC-steel interface and to clarify the failure property.

REFERENCE

Shohei Hasegawa, Fatigue Failure Property of UFC Panel Bonded on Steel with Adhesive Resin, Graduation Thesis, Hokkaido University, 2013 (in Japanese).