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CONTACT BEHAVIOR OF PREFABRICATED GFRP INFILL PANEL ON STEEL FRAME STRUCTURE

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1. INTRODUCTION

Many researchers have developed seismic retrofitting technologies and performed research and development to improve the seismic performance of buildings. Some low- and mid-rise building frame structures have infill wall systems that are built and installed as partitions after the structural frame is completed, while other infill walls are constructed as part of the structural system. Seismic reinforcement technologies have been developed based on new reinforcement materials and methods. Practical applications of FRP composite materials have been attempted in the construction field recently. One of the challenges involved in creating new practical applications using FRP composite materials are still being addressed [1,2]. In this study, GFRP panels was developed to enhance the strength of the existing walls or to replace of the existing walls in the purpose of rapid construction and emergency repair. Compression behavior of glass-fiber reinforced polymer (GFRP) infill panels to enhance the strength of existing steel frame structure when they must be strengthened or reinforced was evaluated. Compression behavior data of GFRP infill panels is very useful to propose a design procedure applicable to the design of GFRP-composite panels. So, the compression behavior of GFRP infill panels on the steel-frame structures was evaluated experimentally. Compression behavior of GFRP infill panels was checked through the distribution of compression strain.

2. GFRP INFILL PANEL

The design goal for the GFRP infill panel was to increase the performance of steel frame structures under lateral loading. The panel is consisted of GFRP plates and stiffeners with an infill of Urethane foam. The cross-section of such a GFRP panel can be designed depending on the strengthening goals for the steel frame structure. The cross-sectional shape of the GFRP infill panel was considered as a box form, which it had advantages such as a symmetric cross-section, ease of increasing its moment of inertia and so on. The main loads for the design of cross-section were in-plane and buckling loads. The thickness is controlled by in-plane load, while the buckling load determines the moment of inertia, stiffener spacing and thickness. Fig. 1 shows the designed GFRP infill panels.

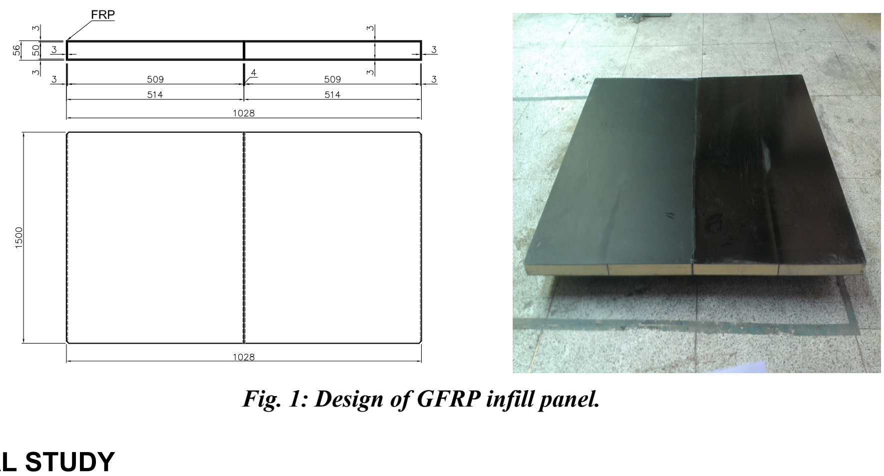

Fig. 1: Design of GFRP infill panel.

3. EXPERIMENTAL STUDY

Experimental instruments were set up to measure the performance of steel frame structure including linear variable differential transformers (LVDTs) and strain gauges. Fig. 2 presents the experimental test setup. Lateral loads were imposed on the top-loading block over the steel frame specimen using a 1,000-kN hydraulic actuator. The specimens and instruments were installed to a reaction wall and floor. The boundary conditions of the steel frame specimen were assumed to be hinges. Two LVDTs were placed on the upper and lower beams to measure lateral displacement, and inter-story drift and relative lateral displacement were calculated from the displacements measured at these two locations. The displacement load was applied through a loading arm over the specimen and was increased by 0.2 % of the drift ratio in each loading step. The steps were repeated twice for the accuracy. Through the experimental test, the compression strain distributions on GFRP infill panel were performed.

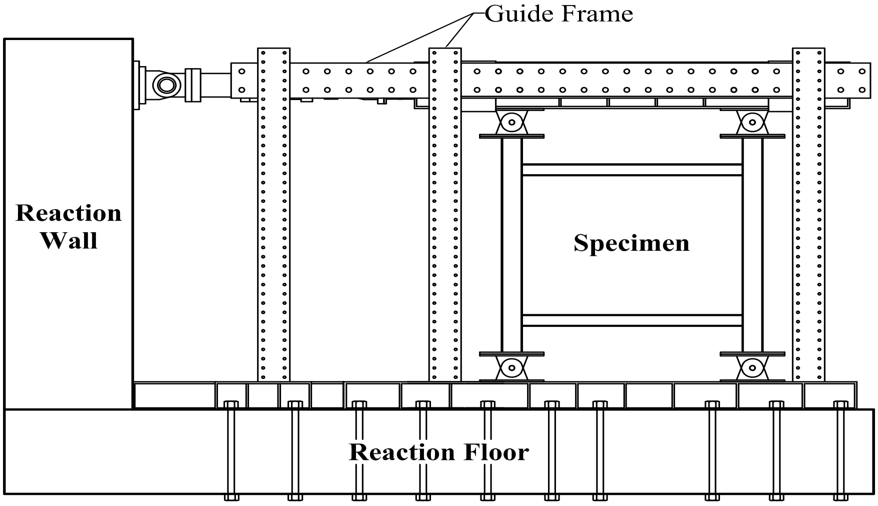

Fig. 2: Experiment test setup.

4. TEST RESULTS AND DISCUSSION

Deformed Shape

Fig. 3 shows the deformed shape of specimen (RSF2) under the final loading step. The top and bottom beam show flexural deformations. The deformation of the beam member was larger than that of the column member, and critical damage did not occur in the steel frame specimen. The RSF2 specimen was strengthened with the GFRP infill panels. Large plastic deformations were concentrated at both ends of the beam since the flexural and shear stress was much increased as the GFRP infill panel was resisted more force. The welded part of the beam section, located at the left bottom of the frame', was experienced the failure at the final loading step, and the failure of GFRP infill panel was located at the right corner.

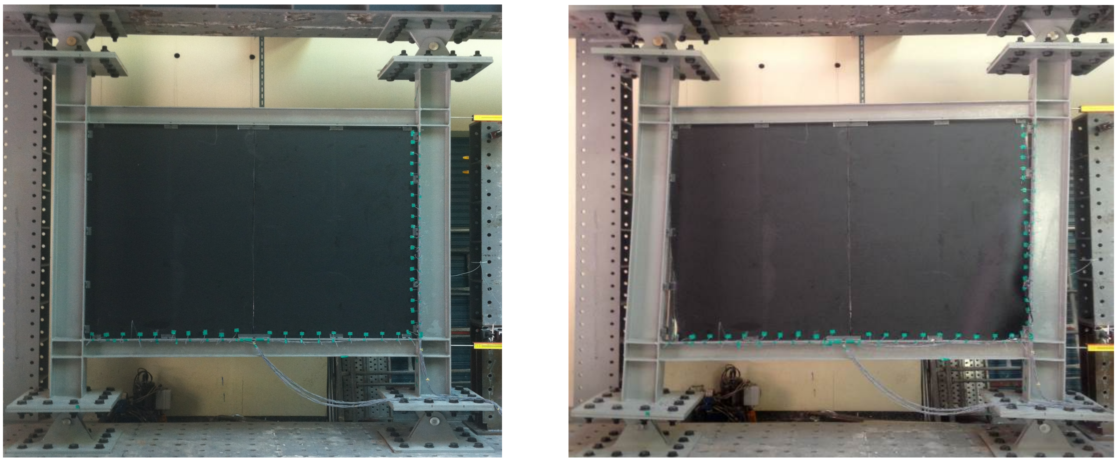

Fig. 3: Deformed shapes of specimen (RSF2).

Compression Strain of GFRP Infill Panel

Fig. 4 shows the compression strain of the GFRP infill panel at the peak of each load-step, by load direction. The compression strains at the corner of the GFRP infill panels were larger than the strains elsewhere. The compression strain distribution of GFRP infill panels reflected the diagonal compression behavior of the GFRP infill panels. Moreover, it is possible to determine indirectly the contact length between the GFRP infill panels and the steel frame, from the strain distribution of the GFRP infill panels. From the diagonal compression strain results, the effective width of the diagonal compressed struts in the GFRP infill panels was determined. In order to determine the effective width of the diagonal compressed struts, compression strain results that were greater than 0.002 were used. The effective contact-length ratio between the column and the GFRP infill panels was approximately 21.3%, and that between the beam and GFRP infill panels was approximately 2.5%. The steel-frame structures and GFRP infill panels were assumed to be in total contact in the design. However, they were not in perfect contact due to construction and manufacturing errors, and the boundary conditions of the GFRP infill panels also did not exactly match those specified in the design.

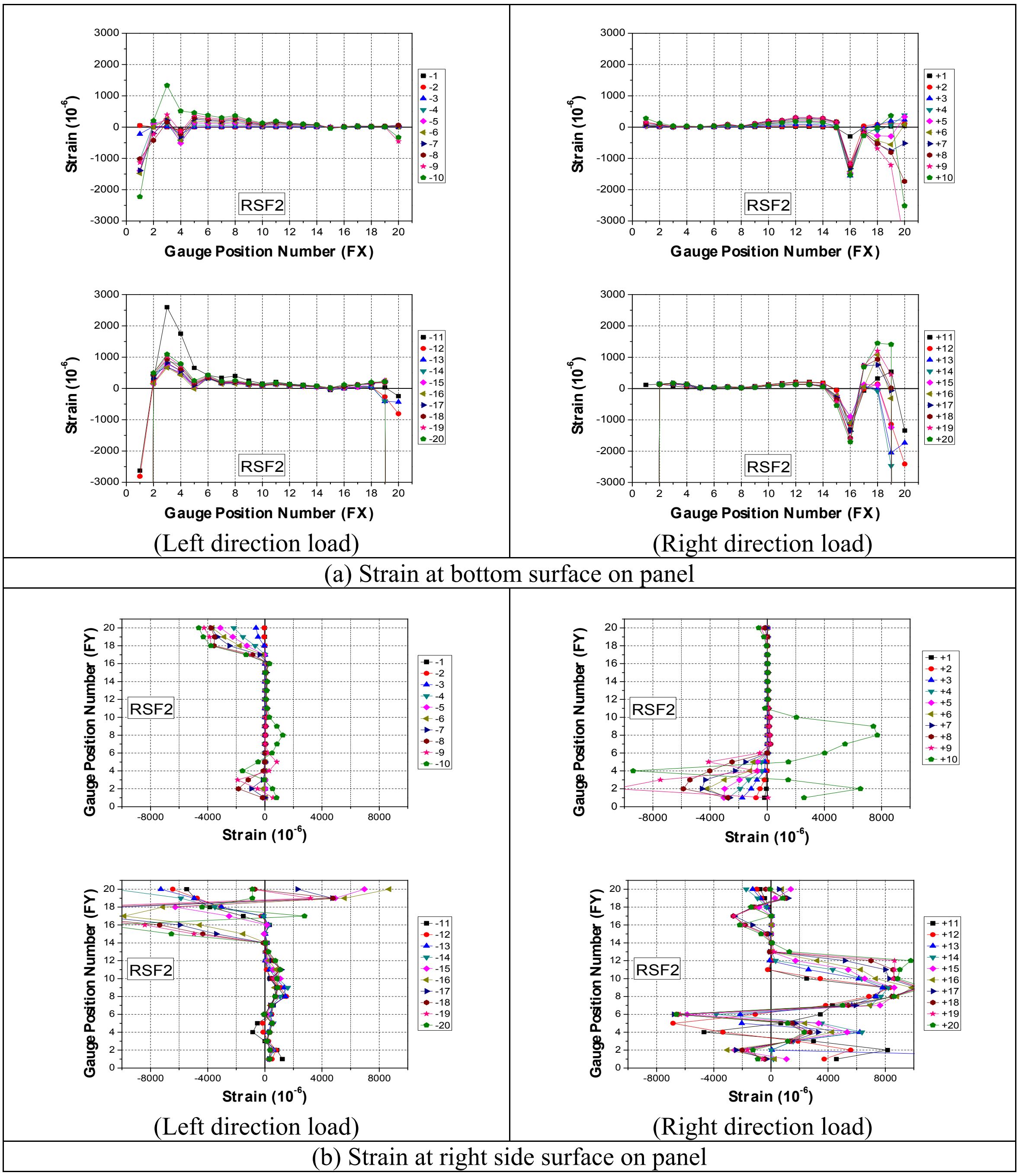

Fig. 4: Compression strains of GFRP infill panel.

5. CONCLUSIONS

In this study, the compression strain of GFRP infill panels was checked to determine the effective contact-length ratio between the GFRP infill panels and steel frame structure. Finally, it is possible to use to propose a design procedure for GFRP infill panels to apply in the construction field.

ACKNOWLEDGMENTS

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