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Performance Evaluation of Seismic Retrofit Method of Masonry Wall-infilled RC Frames Using Composite Materials

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ABSTRACT

Recently, the frequency of earthquakes in Korea has risen sharply, and measures of newer seismic retrofit are urgent. In this study, novel material reinforcement methods for concrete frames and infilled masonry walls were applied. Structural performance of test specimens with the novel retrofit was verified by a series of cyclic lateral loading tests in accordance with ACI 374.2R-13. Test results showed that the maximum load was increased due to the combined effects of strength enhancement of the concrete frame and increase of binding force between the joints of masonries. The method is expected to be effective in reducing casualties due to secondary damage, because it has the effect of preventing the masonry wall from collapse.

1. INTRODUCTION

Seismic design criteria for domestic buildings were first introduced in 1988 for buildings with 6 stories or more. Yet, 82% of the low-to-mid-rise buildings were constructed without satisfying the seismic design criteria. These old reinforced concrete frames were mostly partitioned by non-structural masonry walls. Such unreinforced masonry infill walls are vulnerable to lateral loads such as earthquakes, resulting in collapse. The collapsed infill walls would degrade the structural performance of the entire building.

In this study, glass fiber reinforced polymer panels (GFRP Panels) were attached to reinforced concrete frames in order to increase the strength of the concrete frame itself, and GFRP bars and polyurea reinforcement were applied to infill masonry walls to improve their seismic performance. Additionally, instead of applying GFRP bars, existing infill walls were replaced by glass fiber extrusion blocks. For each specimen with reinforcement, the lateral strength was analyzed and structural performance was compared.

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2. EXPERIMENT PLAN

The retrofit method summarized in Table 1 was applied to evaluate the performance of each method.

Table. 1 Retrofit method

Test	Materials used for retrofitting
Specimen #1	No retrofit
Specimen #2	Cement brick with opening, Attachment of GFRP panels on concrete frames using anchor bolts and gap-filling epoxy, Placement of GFRP bars on infill wall followed by polyurea spray
Specimen #3	Cement brick with no opening, Attachment of GFRP panels on concrete frames using anchor bolts and gap-filling epoxy, Placement of GFRP bars on infill wall followed by polyurea spray
Specimen #4	Glass fiber extrusion block with opening, Attachment of GFRP panels on concrete frames using anchor bolts and gap-filling epoxy, Polyurea spray without GFRP bars

The experiment setup used in this study is shown in Fig. 1, where only the beam-column joints at the bottom level were fixed assuming that the bottom beam represents a strap beam. Cyclic lateral loading tests were carried out in accordance with ACI 374.2R-13

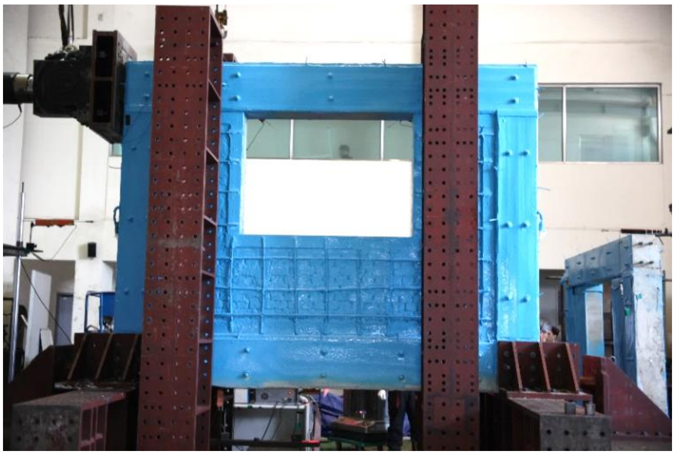

Fig. 1 Test setup of Specimen #2

3. EXPERIMENTAL RESULTS

The load and the displacement acting on the specimen were measured by the load cell and the displacement meter in the actuator. The performances are compared using load-displacement envelopes as shown in Fig 2. The force that the actuator pushes the specimen is expressed as the positive force (+) and the force pulling the specimen as the negative force (-).The maximum load obtained from Fig. 2 is shown in the following Table 2, where P_{peak} means the maximum load, and Δ_{peak} means the displacement when maximum load was reached.

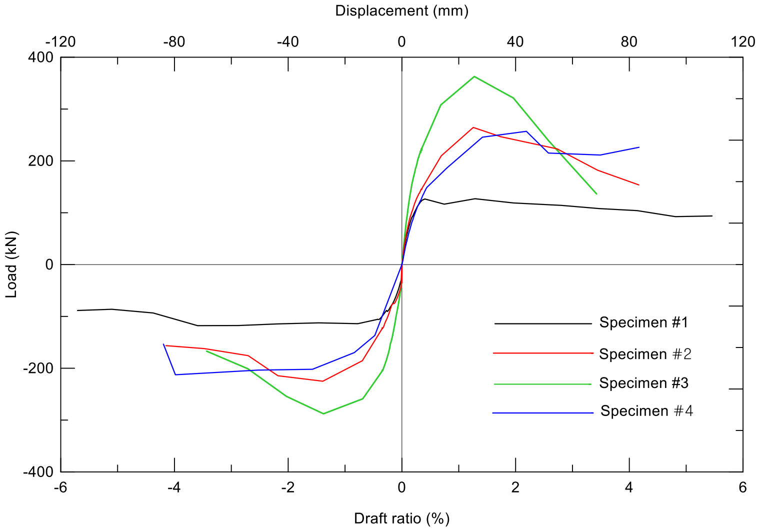

Fig. 2 Load-displacement envelope for each specimen

Table. 2 Comparison of load-displacement between specimens

Specimen	P_{peak} (kN)	Δ_{peak} (mm)	P_{peak} / P_0	$P_{0.8peak}$ (kN)	$\Delta_{0.8peak}$ (mm)
Specimen #1	**127.0**	25.7 (1.4%)	**1.0**	101.6	83.7 (4.2%)
	-116.4	-69.9 (3.5%)	**1.0**	-93.1	-88.1 (4.4%)
Specimen #2	**264.5**	25.1 (1.4%)	**2.1**	211.6	58.6 (3.0 %)
	-224.9	-27.7 (1.4%)	**1.9**	-180.0	-52.9 (2.6%)
Specimen #3	**362.8**	25.5 (1.4%)	**2.9**	290.2	43.9 (2.2%)
	-287.8	-27.6 (1.4%)	**2.5**	-230.3	-46.8 (2.3%)
Specimen #4	**257.0**	43.8 (2.1%)	**2.0**	211.3	69.8 (3.5%)
	-212.1	-78.3 (3.5%)	**1.8**	-170.1	-82.7 (4.1%)

4. CONCLUSION

The maximum load of retrofited specimens was 2.1 times, 2.9 times, and 2.0 times that of Specimen #1. The ductility decreased somewhat, but the drift ratios at failure were substantially larger than the drift levels for Life Safety of concrete frames of FEMA 365, which is 2%. It is considered that the retrofitted specimens retained more than 80% of the maximum yield strength even after reaching the displacement ratio of the Life Safety level and secured a certain level of ductility. Therefore, newer seismic retrofit method is considered to be quite effective in improving seismic performance of older reinforced concrete frames with non-structural masonry infill walls.

REFERENCES

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