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Cyclic Loading Test for Evaluating Shear Performance of RC Shear Walls Considering Voids

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1. Introduction

Reinforced concrete shear walls are widely used in many areas such as infrastructures, and nuclear power plant (NPP) structures [1, 2]. RC shear wall structures with high resistance to lateral loads such as earthquakes are widely used in NPP structures. Compared to other infrastructures, NPP structures are using thick walls and high reinforcement ratios. Also, it is difficult to predict the actual behavior of RC shear in extreme conditions. In addition, there are several concrete voids in containment building of NPP in Korea, and plants restarted after several years of repair work. Moreover, few researches on the performance evaluation of the RC shear wall considering voids have been performed. There are several cases occurred concrete voids in NPPs domestically and internationally. However, there are not performed any experiment to figure out the effects of voids on the shear performance of RC shear wall.

In this study, several cases were considered to experimentally conduct the performance of RC shear wall. The effects of concrete void on the shear performance were performed through numerical analysis and cyclic loading test. From the numerical analyses, the vulnerable factors on performance were identified. Then, several RC shear wall specimens were designed and constructed. Finally, the shear performance of each specimen was compared through cyclic loading test.

2. Numerical Analysis of RC Shear Wall

To identify the vulnerable factors, parametric studies were conducted. The considered parameters are as follows: effective area, thickness of void, and location of the void.

Effective area of void is related to the maximum shear strength according to Ogaki et al. (1981) [3]. According to the below equation, the maximum shear strength is proportional to the effective effect (A_{eff}). The maximum shear strengths were decreased according to the reduction of the effective area as indicated in Table 1. In addition, the thickness of void was also considered. However, in the case of thickness of void, the maximum shear strength does not effect on the performance of RC shear wall. Lastly, the locations of the void were considered as one of the representative failure mode of RC shear wall, diagonal shear cracking. From the numerical analyses, several factors which have significant effect on the performance of RC shear wall. From the numerical analyses, several cases were considered for conducting performance evaluation of the RC shear wall through cyclic load test. The cases of specimens were tabulated in Table 2.

Table 1. Shear Strength according to the effective area

Area (%)	Strength (kN)	Reduction (%)
0	1,857.2	0.0
5	1,662.7	10.5
10	1,531.9	17.5
20	1,419.2	23.6
30	1,264.1	31.9
40	1,080.4	41.8

Table 2. RC shear wall specimen

Area (%)	Location	Depth (mm)	Strength (kN)
-	-	-	1,857.16
5	Surface	60	1,662.98
5	Center	60	1,759.61
20	Surface	60	1,459.60
20	Center	60	1,437.37

3. Cyclic Loading Test

From the numerical analyses, cyclic loading test was performed. The loading protocol was based on ATC-24 and ACI 372.2R-13 [4, 5]. To identify the shear performance of RC shear wall exactly, in- and out-of-plane loads were considered. However, to figure out the effect of void on shear performance, in-plane load was only applied in this experiment. In addition, axial force was also applied through steel rod.

To compare the performance of RC shear wall according to the void, several sensors were deployed and compared. Load cell, strain gauges, and linear variable displacement transducers (LVDTs) were attached to measure the responses of RC shear wall. There are several LVDTs to monitor the behavior of shear wall more precisely. From the test, force-displacement, strain, and crack propagation were compared to each specimen.

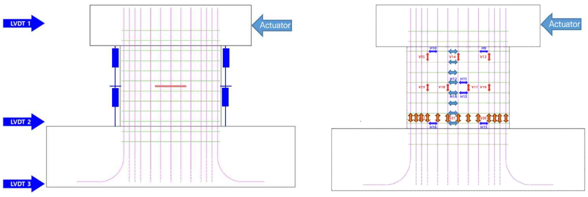

Figure 1. Sensor deployment of LVDTs and strain gauges

4. Conclusion

In this study, several factors, which are vulnerable to the performance of RC shear wall, were considered. First, numerical analyses were conducted to figure out the effect of void on the performance of RC shear wall. Then, several specimens were constructed and performed cyclic loading test. From the test, force-displacement, strain responses, and crack propagation were compared to each specimen.

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REFERENCES

[1] Gulec, C., K. (2009). Performance-based assessment and design of squat reinforced concrete shear walls. State University of New York at Buffalo.
[2] Guglec, C., K., Whittaker, A., S., & Stojadinovic, B. (2008). Shear Strength of squat rectangular reinforced concrete wall. ACI Structural Journal, 105(4), 488.
[3] Ogaki, Y., Kobayashi, M., Takeda, T., Yamaguchi, T., Yoshizaki, S., & Sugano, S. (1981). Shear strength of prestressed concrete containment vessels. In Structural Mechanics in Reactor Technology, J(a).
[4] ATC-24. (1992). Guideline for Cyclic Seismic Testing of Components of Steel Structures.
[5] ACI 374.2R-13. (2013). Guide for Testing Reinforced Concrete Structural Elements under Slowly Applied Simulated Seismic Loads, ACI Committee 374, 2013.