Study on the Effect of Opening and Loading Direction on the Strength of RC Shear Wall using Numerical Model

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1. Introduction

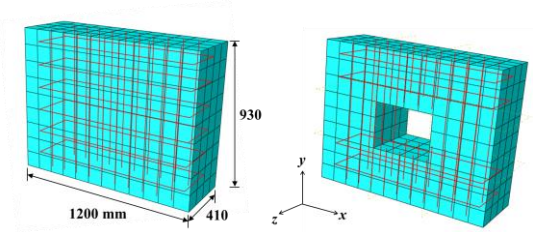
The RC shear wall is one of the major structural elements of nuclear power plants and is a very important to resist seismic loads. Despite various studies on RC shear walls [1,2], studies on the nonlinear behavior of RC shear walls are insufficient. In addition, despite the numerical models and the theoretical equations for predicting the strength of the shear wall, there are many differences from the actual experimental results. In order to resolve uncertainty of behavior and increase safety for seismic loads, studies based on experiments have been conducted.

The actual experiment has many constrains such as cost and method. On the other hand, the numerical model has many advantages because it can simulate various situations instead of actual experiments with various constraints. Therefore, it is very important to develop a validated numerical model.

In this study, the effect of various factors (loading direction, the presence of opening) on the shear strength was examined using a numerical model verified by actual experimental results.

2. Numerical Model

The numerical model used in this study was developed by Kim and Park [3]. Kim and Park [3] performed cyclic loading tests using shear wall, and the test results were compared with those of the numerical model. In this study, a parametric study was conducted using the verified numerical model. The numerical model and material properties are presented in Fig. 1 and Table I, respectively.



(a) w/o opening (b) with opening

Fig. 1. Numerical model of shear wall.

For the numerical analysis, the concrete damage plasticity (CDP) model of abaqus, a commercial program, was used. The compression damage parameter(d_c) and tension damage parameter(d_t) were used to represent the degradation of young's modulus. To determine d_c and d_t, the test results of Sinha et al. were used [4,5].

Table I: Material Property

Property	Concrete	Rebar
Elastic modulus	33 GPa	205 Gpa
Model	Concrete damage plasticity	Perfect plasticity

3. Parametric Study

In this study, instead of experiments requiring a lot of cost and constraints, a parametric study was performed using a verified numerical model. Factors used in the parametric study are loading direction, presence of opening. In Fig. 1, cyclic loading was loaded with uni-direction(*x*), and bi- direction(*x, z*). Also, the difference in shear strength was checked according to the presence of the opening. Fig. 2 shows the cyclic loading, and Table II shows the total cases used in the parametric study.

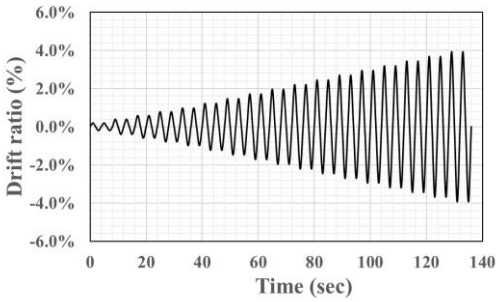


Fig. 2. Time-history of cyclic loading.

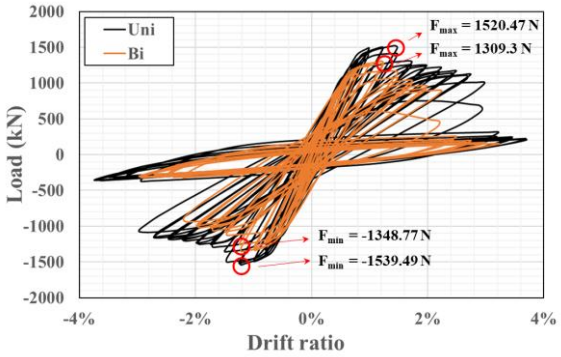
Table II: Cases for parametric study

No. of Cases	Presence of Opening		Loading direction	
	w/o	with	Uni (*x*)	Bi (*x, z*)
1	o		o	
2	o			o
3		o	o	
4		o		o

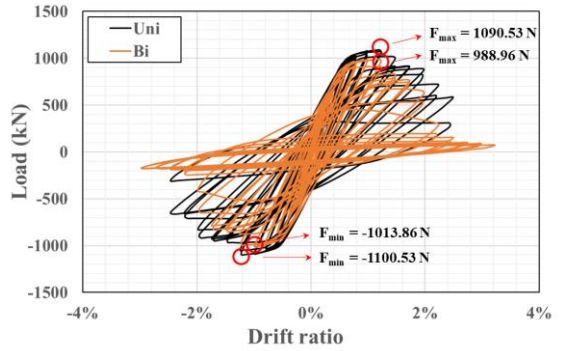
4. Results

The analysis results of cases 1-4 are presented in Fig. 3. And Fig. 4 shows the maximum and minimum shear strengths for each case. To see the effect of the loading direction in w/o opening, comparing cases 1 and 2, it can be seen that the strength in bi-direction decreased by about 13% compared to that in uni-direction. To see the

effect of the loading direction in opening, comparing cases 3 and 4, it can be seen that the strength in bi-direction decreased by about 8.59% compared to that in uni-direction.



(a) Uni-directional loading (Case 1, 2)



(b) Bi-directional loading (Case 3, 4)

Fig. 3. Load-displacement curves.

To see the effect of the opening in uni-direction loading, comparing cases 1 and 3, it can be seen that the maximum and minimum strength decreased by about 28% due to the opening. To see the effect of the opening in bi-direction loading, comparing cases 2 and 4, it can be seen that the maximum and minimum strength decreased by about 24% due to the opening.

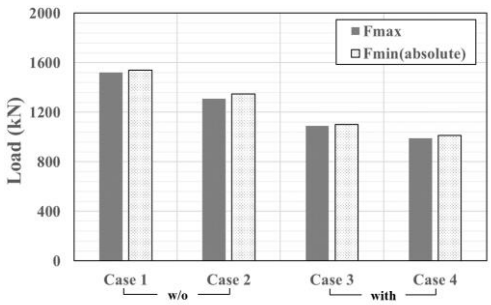


Fig. 4. Min & Max Values of Shear Strength.

It was shown that the effect of the opening has a greater effect on the shear strength than the loading direction.

5. Conclusions

In this study, using a numerical model, a parametric study was conducted on the effects of loading direction, presence of opening on shear strength. A total of 4 cases have been analyzed so far, and the remaining cases considering wall type and the location of the opening will be analyzed in the future. From the results of the parametric study, we will analyze the effects of various factors on shear strength, and consider the effects for seismic risk assessments.

ACKNOWLEDGEMENT

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