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# Compression Test for Precast Encased Composite Columns with Corrugated Steel Tube

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## ABSTRACT

The proposed column system, which embedded thin corrugated steel pipe in the center, using precast concrete cover with corner angles, indicates several advantages such as reducing the precast concrete volume only to facilitate construction with light self-weight and lowering fabrication cost. An experimental test was carried to prove structural capacity of the system to verify the axial-flexural load carry capacity. The proposed system illustrated that all 4 specimens' maximum capacity load exceeded the strengths specified in ACI design code. Its steel tube indicates that concrete filled tube(CFT) effect which increases compressive strength to confine it laterally existed. strength evaluation was carried out using the P-M interaction curve specified in ACI, which proved to be a good fit. And ultimate section (concrete infilled) shows a larger ductility.

## 1. Introduction

There are many attempts which have been made to obtain the advantages of the composite effect and economical advantage by using steel inserted in concrete. Hwang et al.[1] performed compression test of prefabricated steel reinforced concrete column. It showed that corner angle gave higher confinement effect than reinforcing bars due to the section geometry. And Lee et al.[2] carried the eccentric compression of precast column with thin steel pipe. This results illustrated that CFT effect of steel pipe. Precast encased composite columns with corrugated steel tube are developed in response to these various attempts and An angle type hollow column has a merit of making a hollow by inserting a corrugated steel pipe inside, and it could reduce preacs concrete volume and make it easy in workability. Also, angles inserted in the corner part can be assembled continuously with upper and lower floors. And they are concentrated in the corner, which has the advantage of excellent resistance to bi-moment. Since the

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corrugated steel pipe inside is very thin, there is a possibility of restricting the inner concrete a little more than the bending behavior. This study investigated the structural strength of an angular hollow column by using eccentric compression test and evaluated its strength at the time of construction and strength at permanent load.

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## 2. Test program

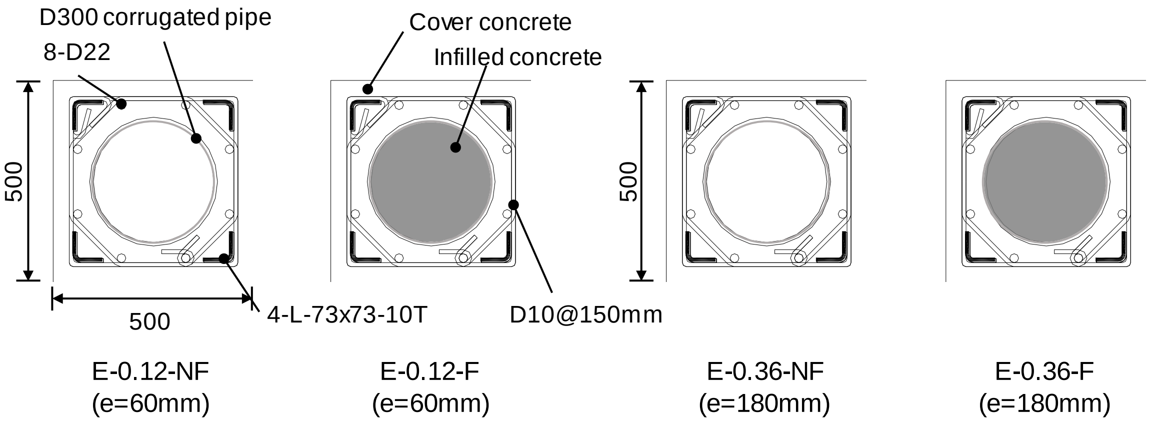


Fig. 1 Specimen section

Table 1 Test variables

| Specimen | E-0.12-NF | E-0.12-F | E-0.36-NF | E-0.36-F |
|---|---|---|---|---|
| Dimension of cross section | 500 x 500 | 500 x 500 | 500 x 500 | 500 x 500 |
| Diameter of corrugated pipe (hollow ratio) | D300 - 0.6T (28.3%) | D300 - 0.6T (28.3%) | D300 - 0.6T (28.3%) | D300 - 0.6T (28.3%) |
| Effective length (mm) | 3,020 | 3,020 | 3,020 | 3,020 |
| Precast cover | | | | |
| Concrete strength (MPa) | 36.0 | 36.0 | 38.2 | 38.2 |
| Longitudinal bar | 8-D22 | 8-D22 | 8-D22 | 8-D22 |
| Horizontal rebar | D10@150mm | D10@150mm | D10@150mm | D10@150mm |
| Steel angle | 4-L-73x73-10T | 4-L-73x73-10T | 4-L-73x73-10T | 4-L-73x73-10T |
| Hollow section | | | | |
| Concrete strength (MPa) | - | 32.6 | - | 32.6 |

Fig.1 and Table 1 illustrated the test section and variables. The eccentric compression test consists of four specimens. The experimental variables are the eccentricity and the filling of the inner corrugated tube. It is a test body that verifies the construction load of an angular hollow column when the internal corrugated pipe is empty, and a case body which evaluates the strength at the permanent load when the corrugated pipe is filled. The cross-sectional size of the test piece was set to 500 x 500 and the coating

thickness was set to 50 mm. Angle was manufactured by cold-forming the steel material of SM570, and the cross section of L-73x73-10T, which is slightly shorter than the planned length of 75mm due to manufacturing error, was used. In order to improve the bending performance, 8 pieces of D22 reinforcing bars were arranged for each side. The transverse reinforcements were placed at 150 mm intervals. In order to satisfy the ACI rebar specification, a cross tie should be placed between the reinforcing bars. However, since the cross-tie can not be arranged due to the internal corrugated steel pipe.
Fig.2 shows the test setup. The net height of the specimen is 1500mm and the total height is 2280mm. In the upper and lower parts, the rigid end was placed at 250 mm, and the section of the section was set at 100 mm. To give eccentric load, 40T plate of SS400 was attached to the top and bottom, and a 20T plate was placed in box type at the rigid ends of the specimen. During the experiment, the plates attached to the upper and lower parts were placed on a knife edge with a height of 370 mm, and an eccentric load was applied. The experiment was performed with 10MN UTM.

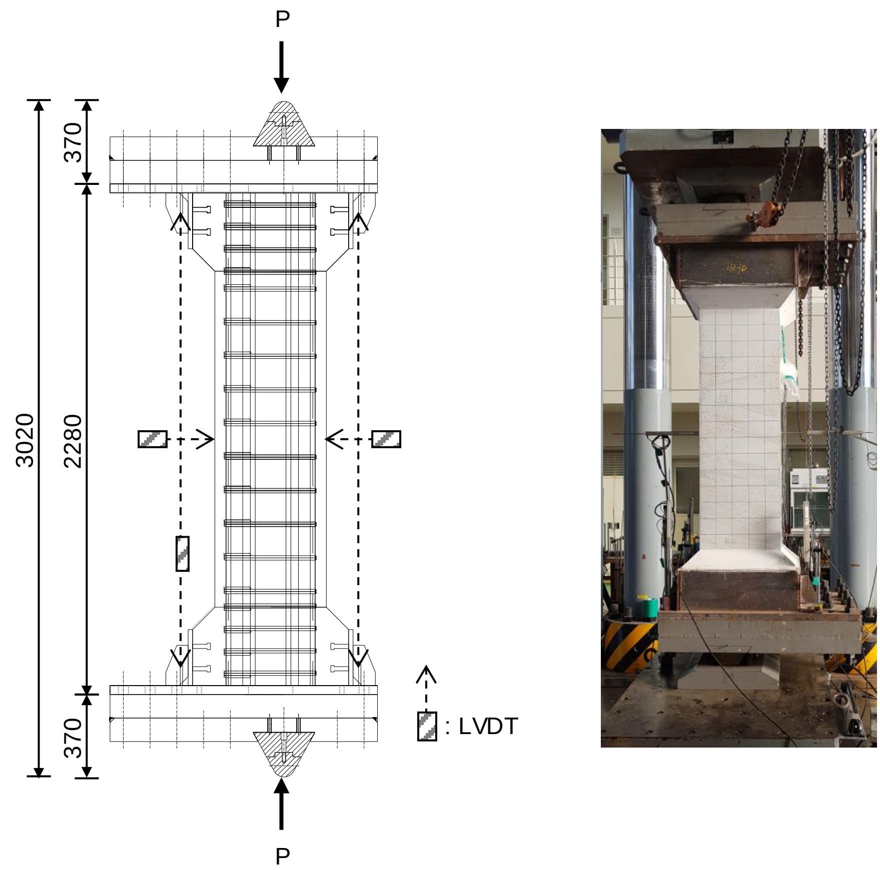


Fig. 2 Test setup of eccentric compression test

## 3. Test results

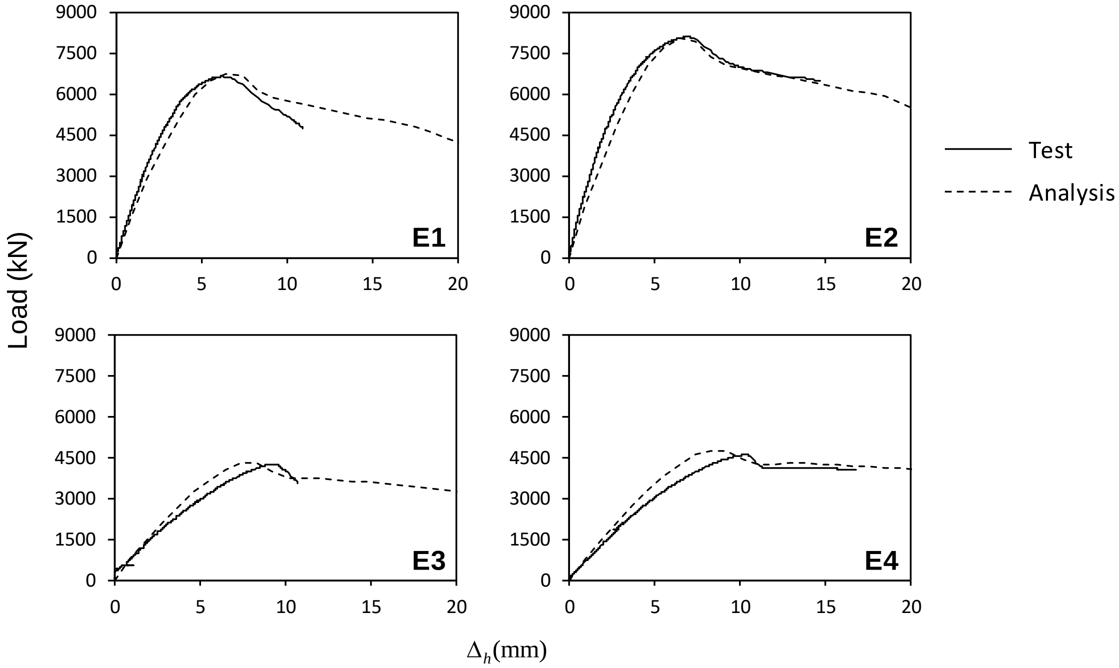


Fig. 3 Test results and nonlinear analysis

Fig. 3 shows the experimental results which is drawn with the experimental load (Y-axis) and the lateral displacement (X-axis) obtained from the LVDT of the test specimen. Basically, when the inner corrugated tube was filled, and when the eccentricity was low, the peak strength was higher. In E1 and E2 specimens with small eccentricity, tensile cracks were found after reaching maximum strength. On the contrary, in E3 and E4 specimens with large eccentricity, tensile cracks were generated before the maximum strength. Due to such tensile cracks, the initial stiffness is lowered as compared with the results of nonlinear section analysis.

## 4. Structural capacity of Precast Encased Composite Columns with Corrugated Steel Tube

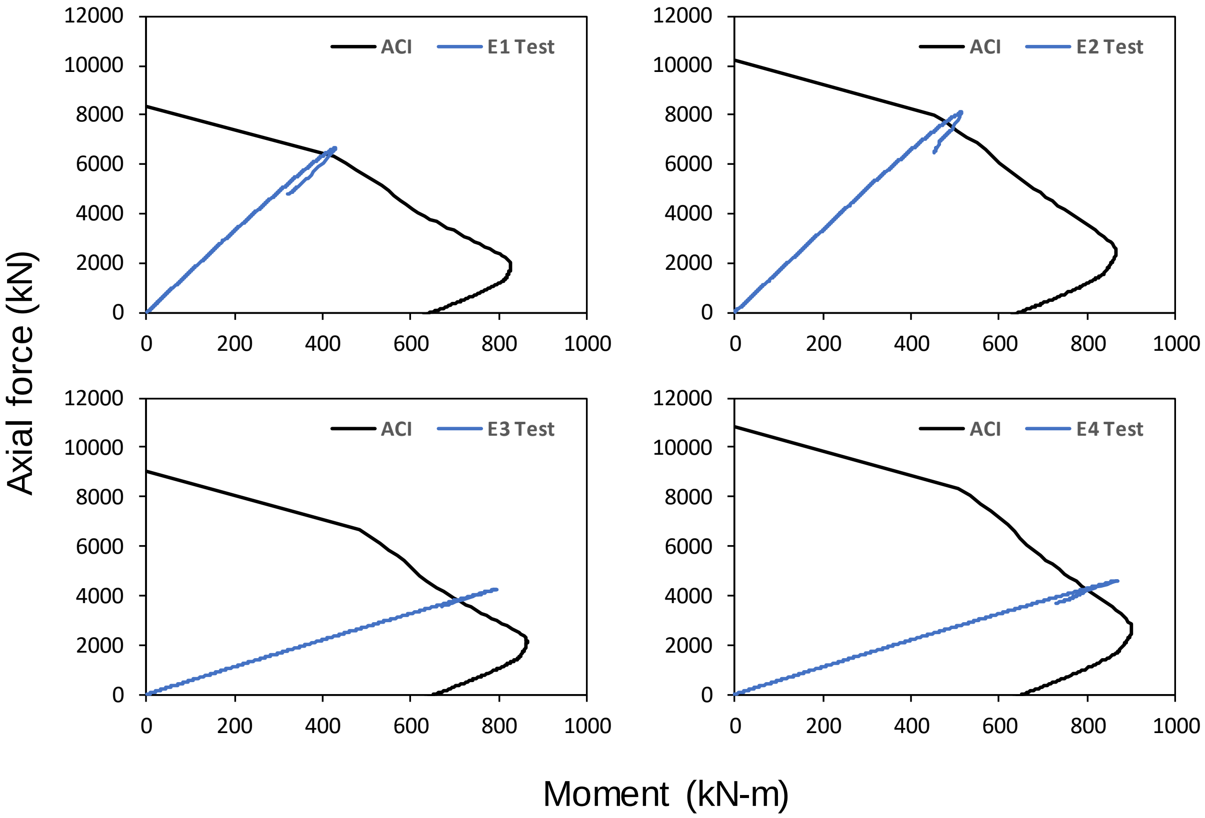


Fig. 4 Comparison test results with ACI code provision

Fig.4 illustrated that eccentric compression test results and P-M interaction curve which is defined in ACI code provision. All specimens exhibited structural performance above the values specified in the code. Especially, the higher the eccentricity ratio, the higher the performance due to the effect of corrugated steel pipe.

## 5. Conclusion

In order to verify the structural performance of the newly proposed angle type hollow column, the eccentric compression test was carried out based on whether the eccentricity and the internal pipe were filled. (1) Experimental results of all specimens are very similar to those of nonlinear section analysis assuming sine curve deformations. (2) When the eccentricity ratio is large, it is confirmed that the rigidity is lost due to the tensile crack of the convex before reaching the maximum strength. (3) the strength of the P-M interaction curve specified in the ACI code.

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