Construction Process Development of Composite Method Using Hollow-PC Column and Half-PC Beam

Jae-Yup KIM, Soo-Yeon SEO, and Byeong-Hun PARK
Dept. of Architectural Engineering, Korea National University of Transportation, Chungju, Korea
*Corresponding author

Keywords: Hollow precast concrete column, Construction process, Headed splice sleeve, Composite method.

Abstract. PC construction method minimizes field work. But it has insufficient structural integrity at joint. The purpose of this study is to develop a construction process of ‘hollow PC column and half-PC beam (HPC method)’. The construction process of HPC method was developed applying hollow-PC column and headed splice sleeve. It was possible to check the construction process indirectly through 3D modeling. In order to develop the construction method of joint, the advice of experts relating PC method was taken. A 3D model was created for the detailed construction method of column-column and column-beam joint. However, it is thought that additional studies need to be made on construction cost, construction duration, quality.

Introduction

PC members have more difficulties in securing the integrity of joint, as compared with RC method. Accordingly, studies for improving structural performance and securing integrity continue to be in progress [1]. Studies on the development of PC members and the improvement of structural performance [2], the structural performance of joint between PC members [3], and the like are actively carried out. However, most of these studies aim at the structural analysis of members, and studies in the construction aspect is not sufficiently carried out. So, it is thought that there is difficulty in being applied to construction site.

This study is intended to develop the construction process of 'composite method using hollow-PC column and half-PC beam (hereafter called HPC method)' [1], which is being developed in order to secure the integrity of PC members and in order to improve structural performance. This is a basic study for applying HPC method to construction site. And a schematic construction work process was developed by using computer simulation. The overall construction process of construction method was developed by comparatively analyzing the construction process of conventional construction method and applying elementary technology. The construction method of joint between members was developed by referring to the previously presented construction process and taking the advice of experts.

Overview of HPC Method

HPC method is a method of a structural system utilizing the advantages of RC method and PC method. And its construction method is the same as that of conventional composite PC method. However, integrity and joint performance was improved by using hollow-PC column and headed splice. The core technologies of HPC method are as follows.

Hollow-PC column

Hollow-PC column is composite HPC column using both hollow precast concrete and cast-in-place [1]. Hollow-PC column is produced by using centrifugal force after arranging reinforcing bars in a specially manufactured mold. A cavity occurs inside the column due to rotation. And PC member can
come to play a role of mold. It is possible to improve the integrity of Hollow-PC column and Half-PC beam by placing concrete in the cavity.

**Headed Splice Sleeve**

Grouted splice sleeves are used in many joints of PC method. A headed splice sleeve is a grouted splice where bond strength is increased by heading an embedded reinforcing bar [4]. Conventional splice sleeve was inferior in constructability and economic efficiency due to excessive cross section. However, the headed splice sleeve is economically efficient and shows high constructability due to an increase in bond strength. Fig. 1 and Fig. 2 is a figure showing the cross section and construction concept of headed splice sleeve.

![Headed Splice Sleeve](image1.png)

**Figure 1. Headed Splice Sleeve.**
The Construction Process Development of HPC Method

Construction Process
A construction process was developed by comparatively analyzing the construction process of RC method, All-PC method and composite method, and applying an elementary technology used in HPC method. Fig. 2 shows the 3D modeling of construction process. Construction is performed according to each story in the sequence shown in Figure 3.
Joint Construction Details

An interview was held with expert relating to PC method in order to develop joint construction method. On the basis of previously presented construction process and expert's opinion, the detailed construction method of column-column and column-beam joint was presented and 3D model was created.

Joint of Column-Column

Upper column and lower column is joined by using headed splice sleeve in a type shown in Fig. 4. A headed splice sleeve is installed at respective main bars of columns. Next, if beam and slab is installed, concrete is placed in the hollow. A vibrator should be used so that the material of concrete doesn't segregate. If concrete is cured, the head of upper column is joined to the sleeve.

Joint of Column-Beam

Figure 5 is a figure showing a joint between hollow-PC column and half-PC beam. And these are joined by placing concrete. The bottom bar of half-PC beam is anchored at the hollow part of column.
in hook type according to reinforced concrete structure code. In case of exterior column, a top bar is anchored at the joint of column like bottom bar. In case of interior column, the top bar is anchored at the column so that both of them intersect in conformance with reinforced concrete structure code.

![Joint of column-column](image1)

![Joint of column-beam](image2)

**Figure 4. Joint of column-column.**

**Figure 5. Joint of column-beam.**

**Conclusion**

Recently, many studies for improving the structural performance of PC method and the integrity of joint have been carried out. And the 'composite method using hollow-PC column and half-PC beam' is also construction method developed to make up for the weak point of PC method. However, studies on the structural analysis or performance of PC method are steadily in progress, but on the other hand, research and development in the construction aspect is scarcely carried out. This study is advance research for applying HPC method to construction site, and it was intended to develop construction process and joint construction method through 3D modeling. Important study results are as follows.

1. The construction process of HPC method was developed by comparatively analyzing the construction process of previously carried out construction method, and applying hollow-PC column and headed splice sleeve. It was possible to check the construction process indirectly through 3D modeling. Construction gets to go through the major processes of hollow-PC column installation, half-PC beam assembly, half slab installation, and concrete placement.

2. In order to develop the construction method of joint, the advice of experts relating PC method was taken. And construction method using a headed splice sleeve, core member, was developed. On the basis of experts' advice, a 3D model was created for the detailed construction method of column-column and column-beam joint.

This study developed the construction process of HPC method and the construction method of joint through an analysis of previous studies, 3D modeling and interview with experts. However, it is thought that additional studies need to be made on construction cost, construction duration, quality and the like according to the application of HPC method in order to apply to construction site.

**Acknowledgement**

This work was supported by the Human Resource Training Program for Regional Innovation and Creativity through the Ministry of Education and National Research Foundation of Korea (NRF-2015H1C1A1035953).

**References**

