

# The Development of Construction Procedure Prototype for Structural Framework of HPC Method

Jaeyup Kim, Juseong Noh, Sooyeon Seo

**Abstract**—HPC method is developed to improve the constructability and structural performance of the existing PC method. The objective of this study is to develop a prototype of structural framework and column joint of HPC method. In order to develop a prototype, the construction data of the existing half-slab method was analyzed. Analyzing design drawings and specifications of nine construction cases, a prototype of half-slab method was drawn. Applying the core technology of HPC method to the drawn prototype of half-slab method, a prototype of HPC method was developed. Regarding the prototype of HPC method, two types like ‘HPC-above’ and ‘HPC-under’ were developed. The construction procedure of the developed prototype of HPC method was comparatively analyzed with half-slab method. In the results of analysis, the structural framework procedure of HPC method had the same process of installing beam and slab with half-slab method. However, the process of ‘filling column joint with mortar’ and ‘concrete placement of hollow PC column’ was different from half-slab method. The construction procedure of column joint of HPC method showed differences in ‘joint between above/under column PC’, ‘installation of form’, and ‘filling column joint with mortar’. In order to apply HPC method to construction site, it would be necessary to have additional researches on construction specification and construction standard of HPC method.

connect between PC columns by using high strength and light weight hollow PC columns [5]. The HPC method can improve structural integrity and constructability by using lightweight columns and the head splice sleeve that improved structural performance.

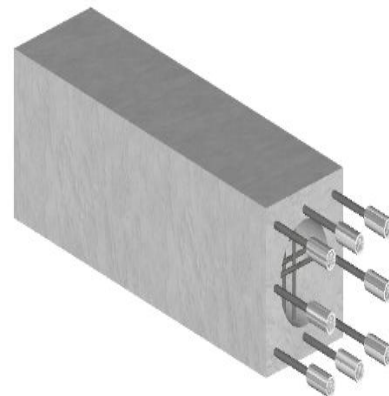
**Index Terms**—HPC method, Half-slab method, Construction procedure, Structural framework, Column joint.

## I. INTRODUCTION

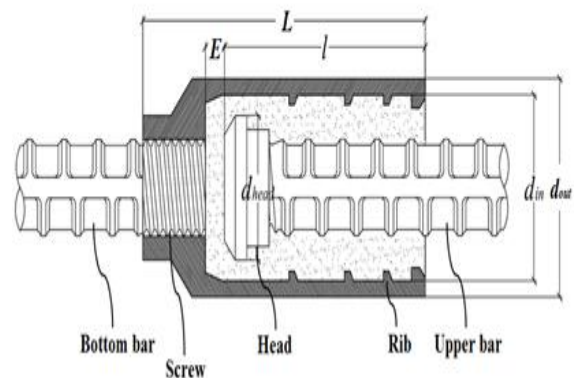
In recent years, the PC construction method is being used to shorten the construction period at large-scale constructions. However, there is a problem that the PC method is insufficient in constructability and economical efficiency due to weight increase of materials [1]. The HPC method is a method under development that combines a hollow PC column and [3], [4]-[6]. a head splice sleeve [2]-[7]. To complement the shortcomings of the existing PC method. The research method was to develop a prototype according to the position of HPC method sleeve and to compare and analyze the half-slab method and the construction procedure. The purpose of the study is to develop the prototype of construction procedures for the structural framework and column joint to apply the HPC method to the field.

## II. HPC METHOD OVERVIEW

However, due to the material weight of the PC, the PC method has problems of use of high heavy equipment, increase of transportation cost, and insufficient integrity in joints. HPC method is being developed by changing the splice sleeve to the head splice sleeve (HHS) [2]-[7]. To



(a) Hollow PC column



(b) Head splices sleeve

**Fig. 1** Core technologies of HPC method

**Table 2**Types of PC members in construction cases

Case	Location	Total area(m <sup>2</sup> )	Construction period	Types of main PC members		
				Column	Beam	Slab
A	Seoul	404,346	2012.11~2014.11	All-PC	Half-PC	Deck, DTS, RPS
B	Seoul	165,799	2014.05~2015.12	RC, All-PC	RC, Half-PC	RC, DTS
C	Yongin	57,956	2017.02~2018.12	RC, All-PC	RC, Half-PC	RC, RPS
D	Gwangju	63,660	2014.08~2014.10	All-PC	Half-PC	H/S, RPS
E	Anseong	54,953	2014.12~2016.02	All-PC	Half-PC	HCS, RPS
F	Icheon	2,806	2015.08~2015.09	RC, All-PC	RC, Half-PC	RPS
G	Yongin	10,576	2015.08~2015.11	All-PC	Half-PC	RPS
H	Hwaseong	486,048	2016.03~2018.12	All-PC	Half-PC	RPS, DTS
I	Incheon	42,212	2017.05~2018.05	All-PC	Half-PC	RPS, DTS

**TABLE 1** PROTOTYPES OF HPC

	Half-slab	HPC	References
Section size(mm)	1100×1000	<b>1100×1000</b>	Construction cases (Table1)
Height(m)	9.2	<b>9.2</b>	
Proportion of hollow(%)	-	<b>50</b>	[4]
Concrete strength(Mpa)	45	<b>45</b>	Construction cases (Table1)
Type of steel bar	UHD32	<b>UHD32</b>	
Coasting thickness(mm)	50	<b>50</b>	Standard specification of building construction

### III. DEVELOPMENT OF PROTOTYPE CONSTRUCTION PROCEDURE FOR HPC CONSTRUCTION METHOD

#### A. Case analysis of half-slab construction work

The data of nine construction works completed within the last 5 years were collected to derive the construction procedure prototype of a half-slab method. The design drawings, specifications and construction plans were also analyzed for each case. In particular, three construction sites were surveyed through on-site visits. The buildings are all logistics centers, and the construction sites are located in the metropolitan areas of Seoul, Inchoen and Gyeonggi Province. The types of columns, beams and slabs used mainly in the half-slab method were analyzed. Most of the columns were All-PC columns, and RC columns were also used in part (Table 1). For beams, half-PC beams were most commonly used, and RC beams were used in some parts. The types of slabs used heavily include rib-plus precast concrete slab (RPS) and double tee slab (DTS). In addition, half-slabs (H/S) and hollow slabs (HCS) were partially used together. Fig. 2 is general construction procedure of half-slab method.

#### B. Design Result by the Proposed Design Procedure

##### 1) Prototype of Hollow PC column

‘The prototype of a half-slab method’ was derived to develop the standard construction process for a HPC method. In order to determine ‘the prototype of the HPC method’ through the application of the core technologies for the HPC

method to the ‘prototype of the half-slab method’, prototypes for the shape and general characteristics of the hollow PC column were derived as shown in Table 2. The general types for construction work (Table 1) were applied to the cross-sectional sizes and heights of the hollow PC columns, the concrete strengths of PC members and types of rebar. A ratio of 50%, which was recommended in the previous study [4], was applied as the ratio of the hollow part of the column PC. In addition, the cover thickness was determined by referring to the standard specifications for construction work and the analysis results of construction cases as in Table 1.

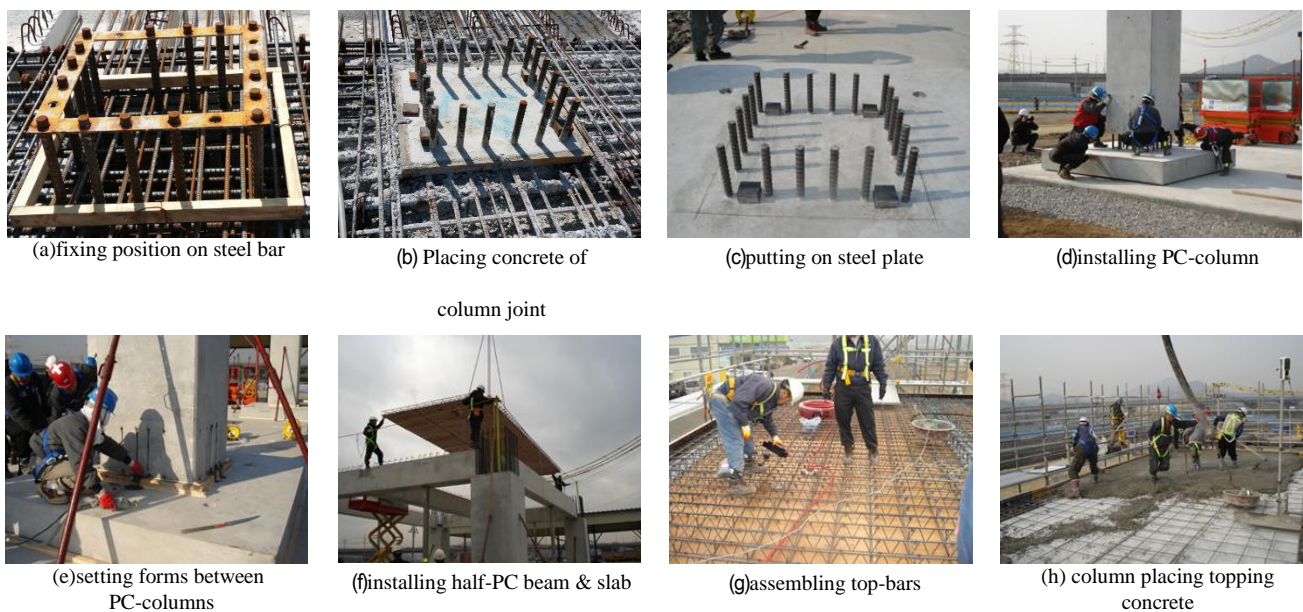
##### 1) Joint detail of HPC method

In order to determine ‘the prototype of the HPC method’, the details of column joints were derived as shown in Figure 3. Most of the joints of the half-slab method are installed on the sleeve of the upper PC column as shown in a) of Figure 3. HSS is used in the column joints of the HPC method. The joints of the HPC method were developed in two forms (HPC\_above and HPC\_under) depending on the positions of the HSS. In the case of HPC\_above, the HSS is installed on the upper column, and the position is the same as the half-slab method. Therefore, the construction producer and the shape of the joint are almost similar to each other. For HPC\_under, the HSS is installed on the lower column, and thus it can be visually confirmed that the sleeve is filled with mortar. The two construction methods were developed for selective use according to the circumstances and conditions of each construction.

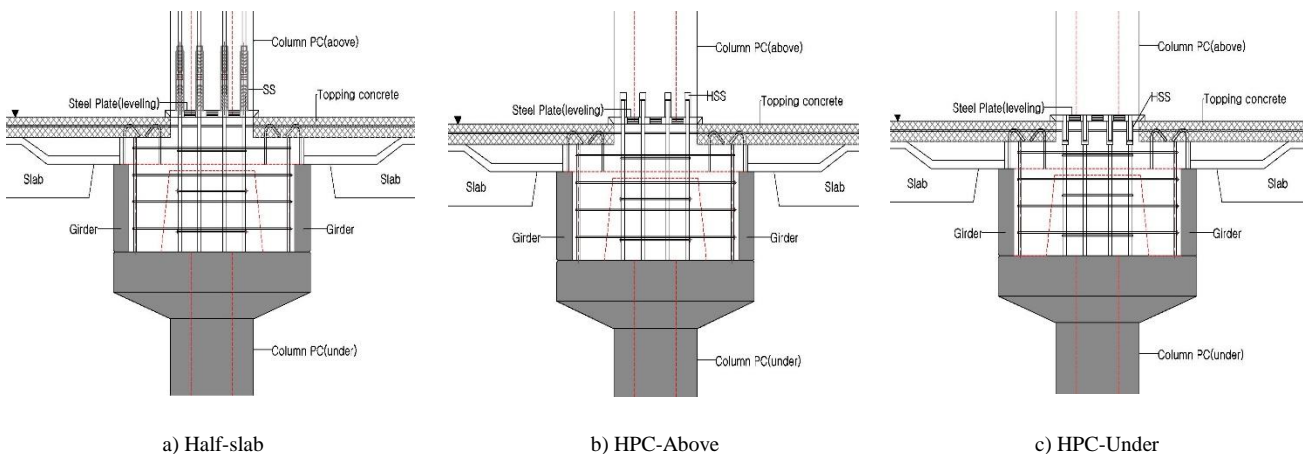
**C. The development of construction procedure prototype for HPC method**

‘The construction procedure prototype of the half-slab method’ was derived to develop the prototype of the construction process for the HPC method. In addition, ‘the prototype of HPC method’ was developed by applying the core technologies of the HPC method to ‘the prototype of the half-slab method’ (Fig. 4). The prototype of the construction process for the half-slab method’ is as follows. 1) placing concrete of column joint, 2) putting on steel plate for leveling, 3) installing PC-column, 4) holding prop-supports, 5) setting forms between PC-columns, 6) filling mortar inside form, 7) installing half-PC beam & slab, 8) assembling

top-bars of beam & slab, 9) setting forms of column joint, 10) placing topping concrete (beam, slab). ‘The construction procedure prototype of the HPC method’ is divided into HPC\_above and HPC\_under as shown in Fig. 4. The construction procedure of HPC\_above is almost the same because the sleeve position is the same as in the half-slab method. However, it was found that the types of sleeves are different, and the process of pouring concrete in the hollow part of the PC column is also different. On the other hand, HPC\_under differs from HPC\_above in that the process of ‘filling mortar inside HSS’ is added because the sleeve is located on the lower column.



**Fig. 2 general construction procedure of half-slab method**



**Fig. 3 Joint detail of half-slab and HPC method**

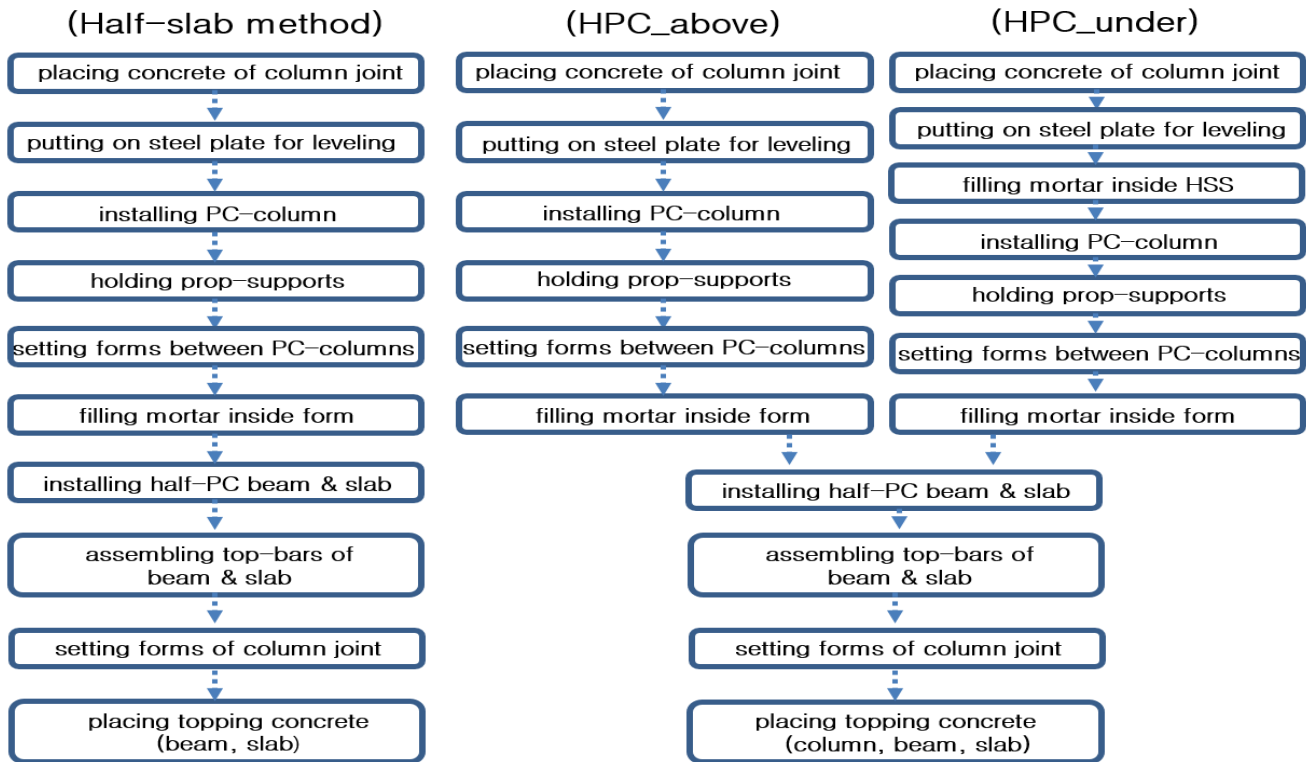


Fig. 4 Construction procedure prototype of half-slab and HPC

#### IV. CONCLUSION

The HPC method is a construction technique that is being developed to improve the structural performance and constructability of the conventional PC method. In this regard, this study aims to develop the construction procedure prototype for the structural framework of the HPC method. The important research findings are as follows.

- 1) The prototype of the HPC method was developed by applying the core technologies of the HPC method to the general configuration of the half-slab construction work. The prototype of the column joint, including the sleeve and the prototype of the hollow PC column were also derived.
- 2) The prototype of the construction process for the HPC method was developed, and the joints of the HPC method were developed into two forms (HPC\_above and HPC\_under) depending on the position of the HSS so as to ensure the proper selection according to the circumstances and conditions of each construction. The process of installing beams and slabs in the developed HPC method was the same as in the half-slab method. However, it was found that the process of placing concrete in the hollow part of the PC column was different, and the process of filling mortar inside HSS was added in HPC\_under - another difference from that of the half-slab method

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