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Research paper



Construction Period Analysis of HPC Method by PC Construction Project Cases in KOREA

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Abstract

This study was conducted as basic research for applying HPC method to building construction sites. HPC method was compared with an existing method (Half-slab method) for the analysis on a construction period. As a study method, this researcher analyzed the drawings and construction plans of the cases of the buildings constructed with Half-slab method. The analyzed seven buildings used as cases were domestically built within the last 5 years. According to the analysis, cases A and B that had columns divided for construction shortened about 16% of a construction period. The schedule of column assembly work was analyzed to be shortened much. That is judged to be because the use of a hollow PC column leads to a decrease in the number of columns. In particular, if HPC method is applied to a building construction site using large columns, it is analyzed to shorten a construction period more than the existing Half-slab method.

Keywords: *HPC method, hollow PC column, construction period, half-slab method*

1. Introduction

With the emergence of such issues as labor cost rise, lack of workers, and further demands of shortening a construction period, Precast Concrete (PC) method has actively been researched again domestically [1]. Compared to Reinforced Concrete (RC) method, the existing PC method has many difficulties securing the integrity of member joints and is vulnerable to lateral force. Heavy members cause a rise in transportation cost. The use of a high capacity tower crane impedes a reduction in construction saving [2]. To solve the problems, many new methods are developed. 'Hollow PC Column Composite Method (HPC method) was also developed to overcome the disadvantages of the PC method and continues to be researched for its commercialization. As previous works, there are studies on compressive behavior of HPC column [3], on structural performance of beam-column joint using HPC column [2], on structural performance of head splice sleeve [4], and on seismic performance of HPC column [5].

Most previous studies on HPC focused on the structural analysis of PC members in the construction structure area. There is a lack of research on construction management aspects. Therefore, the purpose of this study is to analyze a construction period of HPC method to apply it to a building construction site from the perspective of construction management.

As a study scope, this study analyzed a construction period of the HPC method being developed. As a study method, the construction period of HPC method and that of Half-slab method were calculated and compared. In other words, this study collected and analyzed the seven cases of the buildings constructed with Half-slab method within the last 5 years domestically. The construction materials of each case, such as drawings and construction plans were collected and were used for analyzing their construction period.

For the analysis on a construction period, there was an assumption that the columns of a building designed with Half-slab method are hollow PC. The construction period of each one of the two methods was calculated and compared. To calculate a construction period, this study the PC construction cases, calculated a construction quantity of each case, and analyzed a construction period of Half-slab method. The process plan of PC construction consists of design, production, and assembly. This study analyzed a construction period of a construction site which is required differently depending on an assembly schedule. A construction period of HPC composite method was calculated on the assumption that the factor technologies (hollow PC column and head splice sleeve) of HPC method were applied.

2. Overview of HPC Method

Existing PC composite method helped to improve the integrity of PC members through in-site concrete and to save transportation cost through the use of Half-PC slabs and Half-PC beams. Nevertheless, it still has low integrity of joints and faces a rise in transportation cost caused by heavy PC columns. To overcome the problems, HPC method was developed. The core technologies of HPC method are presented as follows:

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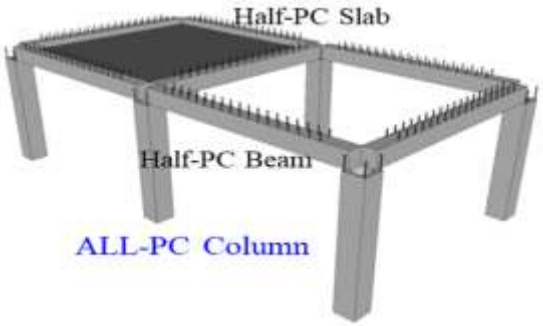


Figure 1: Half-slab method

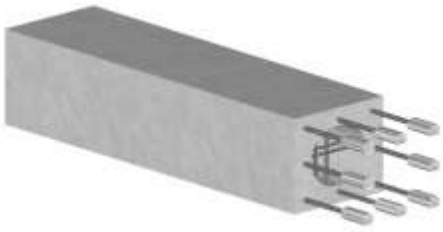


Figure 2: Hollow-PC Column

2.1 Hollow PC Column

As shown in Figure 1, a hollow PC column is made in reinforcement in a special mold and with the use of centrifugal force. Rotation makes a hollow in a column and a PC member can serve as a mold. By casting concrete in the hollow, it is possible to improve the integrity of a hollow PC column and a Half-PC beam.

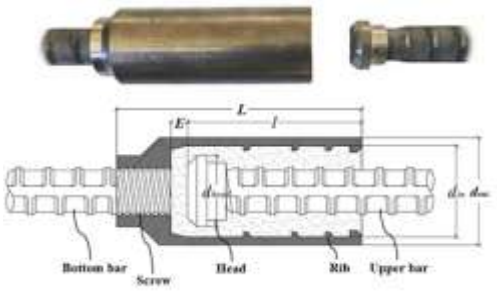


Figure 3: Head-Splice Sleeve

2.2 Head Splice Sleeve

For the joint of PC method, mortar grouted splice sleeve is used much. A head splice sleeve is a mortar grouted sleeve with increased adhesiveness by the attachment of a head to a rebar [3].

2.3 Overview of PC Construction Case

To analyze a construction period of HPC method, this researcher collected the materials of seven PC construction cases within the last five years. For the comparison between HPC method and Half-slab method, the Half-slab construction materials such as design drawings and construction plans were collected. For the analysis on a construction period, the construction period of each one of Half slab method and HPC method in each case was calculated and compared. The overview of the analyzed construction cases is presented in Table 1. The buildings were domestically constructed.

A PC column is the heaviest one among the members used for construction and has many limits in its transportation. In case of a large and heavy PC member, it is required to divide it for transportation. In case A, a column was divided in three parts and the three divided columns were assembled in construction case B was divided in two parts and the two divided columns were assembled in construction. All cases but case A and case B used n integral column. Table 1. shows a type of a PC member in each case.

Table 1: Outline of PC Construction cases

project	Construction summary		Type of critical members		
	Location	Total floor area(㎡)	Column	Beam	Slab
A	Seoul	404,346.81	All-PC (divide 2)	Half-PC	DECK, DTS, RPS
B	Seoul	165,799.32	RC, All-PC (divide 1)	RC, Half-PC	RC, DTS
C	Yongin	57,956.29	RC, All-PC	RC, Half-P	RC, RPS
D	Gwangju	63,660.00	All-PC	Half-PC	H/S, RPS
E	Icheon	54,952.97	All-PC	Half-PC	H/S, RPS
F	Icheon	2,806.65	RC, All-PC	RC, Half-PC	RPS
G	Yongin	10,576.00	All-PC	Half-PC	RPS

Table 2: Outline of PC construction cases

		Half-slab method		HPC method	
		No.of members	Working days	No.of members	Working days
A	Column(divide2)	481	33	320	18
	Beam	314	19	314	19
	Slab	585	30	585	30
	Total		82		66
B	Column(divide1)	265	18	175	9
	Beam	251	15	251	15
	Slab	451	23	451	23
	Total		55		47
C	Column	64	4	64	4
	Beam	104	7	104	7
	Slab	203	11	203	11
	Total		22		22
D	Column	88	6	88	5
	Beam	102	6	102	6
	Slab	203	11	203	11
	Total		22		22

E	Column	120	8	120	7
	Beam	148	9	148	9
	Slab	1174	59	1174	59
	Total		76		75
F	Column	23	2	23	2
	Beam	25	2	25	2
	Slab	100	5	100	5
	Total		9		9
G	Column	59	4	59	4
	Beam	74	5	74	5
	Slab	191	10	191	10
	Total		19		19

3. Analysis on the Construction Period

3.1 Assembly of PC Members

Prior to the analysis on a construction period of HPC method, the base construction period of the PC construction cases was analyzed. The process plan of PC construction consists of design, production, and assembly. This study analyzed a construction period required differently depending on an assembly schedule. Assembly in a site is comprised of PC member assembly work and topping concrete casting work. The work days of member assembly were calculated in the way of dividing a quantity of members of a base floor by the number of daily average assembled members. Through the analysis the number of daily average assembled members. Through the analysis on the construction plans of the PC construction cases and expert interviews, the number of daily average assembled members was calculated by member type. Therefore, 15 columns, 17 beams, and 20 slabs were assembled daily on average. Table 2. shows a quantity of members by member type and the work days dependent on the number of daily average assembled members in each PC construction case.

3.2 Casting of Topping Concrete

The topping concrete casting work days was calculated in the way of dividing a quantity of topping concrete of a base floor by an concrete amount of pump car. In consideration of the size of PC construction cases, a pump car was assumed to have 43m in work diameter (Table 3). The actual concrete discharge amount of the 43m pump car was 130m3/hr of actual concrete discharge, and its daily work hours were 8. HPC method requires additional concrete casting in a hollow of a hollow PC column. Therefore, it has a longer construction period than Half-slab method. After the addition of concrete in a hollow and expert advices, the topping concrete work days of HPC method were calculated.

Table 3: Working-days analysis for topping-concrete placing

case	Half-slab method		HPC method	
	Topping concrete (m3)	working days	Topping concrete (m3)	working days
A	2024.59	2	2689.40	3
B	1308.10	2	1520.86	2

3.3 Total of the Construction Period

On the basis of 25 monthly work days in accordance with Article 50 of Labor Standard Act, the assembly schedule of PC construction cases was prepared. Figures 3 and 4 show the assembly schedules of Half-slab method and HPC composite method in each PC construction case. According to the analysis on a construction period of HPC method, there was a difference between case A, case B, and case D. The

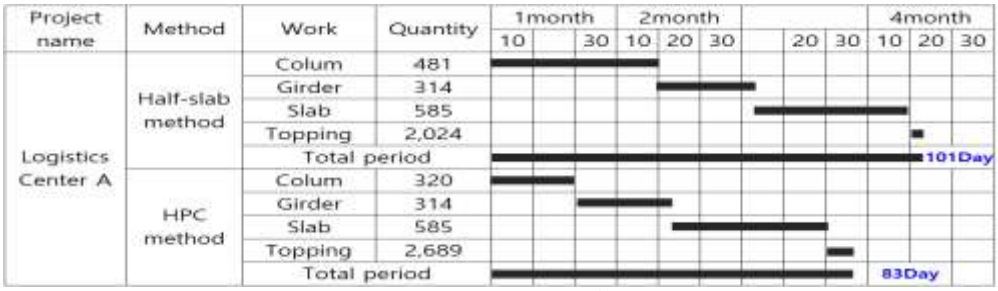


Figure 4: Construction period analysis of case A

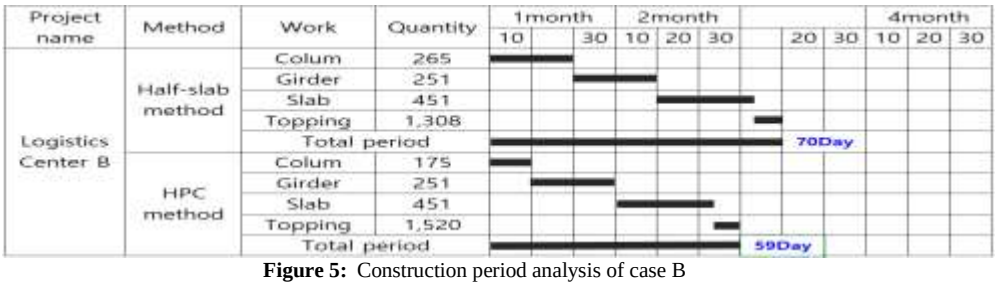


Figure 5: Construction period analysis of case B

other cases used all-in-one columns so that their column quantity was equal. Also, there was a small topping concrete quantity and consequently their construction period was not changed.

Case A and case B had 101 days and 70 days of construction period, respectively. On the assumption of HPC composite method, their construction period was shortened to 83 days and 59 days, respectively. In case A, if HPC composite method is applied, the quantity of columns reduces to 320. The period required for column assembly is 17 days. Compared to Half-slab method, it shortened about 16 days. In case B, if HPC composite method is applied, there is no division of columns and the quantity of columns reduces to 175. The column assembly period is 9 days. Compared to Half-slab method, it shortened about 9 days. Case D had a small

size of construction so that there was no big difference in a construction period. The other cases used all-in-one columns so that they had no big difference in a construction period

4. Conclusion

This is the basic research on HPC composite method from the perspective of construction management. To find that HPC composite method is applicable to a site, this study analyzed a construction period. The main results of this study are presented as follows:

The process plan of PC construction consists of design, production, and assembly. A construction period required differently was analyzed depending on an assembly schedule. According to the analysis on a construction period of HPC composite method, cases A and B which had columns divided for construction shortened a construction period. Also, in the construction procedure, only a schedule of column assembly work was shortened. That seems to be because the use of light PC columns in HPC composite method led to a reduction in the number of assembled members. In case of topping concrete casting work, its schedule was delayed but was not big different, so that it was analyzed not to be influential greatly.

To apply HPC method to a construction site, it is considered to research more the detailed construction of member joints and the development of construction guidelines.

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References

[1] S. H. An., et al., A Study on the Proposal about the Improvement of PC in Construction Industry, Journal of Korea Institute of Building Construction, 2004. 20(7): p. 33-40.

[2] D. H. Sin., Structural Capacity of the Exterior Beam-Column Joint Using Hollow Precast Concrete Column, Master's thesis Korea National University of Transportation, Korea. 2016.

[3] S. J. Lee., A Compressive Behavior of Hollow Precast Concrete Column, Master's thesis Korea National University of Transportation, Korea. 2014.

[4] B. R. Nam., Structural Capacity of Mortar-filled Head Splice Sleeve, Master's thesis Korea National University of Transportation, Korea. 2016.

[5] W. Y. Lim., et al., A Study on the Proposal about the Improvement of PC in Construction Industry, Journal of Korea Institute of Building Construction, 2014. 26(1): p. 35-46.

[6] Kimoondang., Korea Society of Architectural Hybrid System, Korea precast prestressed concrete association, Precast concrete, Korea.