An Analysis on the Productivity Improving as Use of APC in the Apartment Housing Projects

Hyunseok Lee¹,a, Yoonsun Lee²,b, Yekeun Oh³,c, and Jaejun Kim⁴,d

¹ Dept. of Sustainable Architectural Engrg., Hanyang University, Seoul, Korea, 133-791
² Dept. of Sustainable Architectural Engrg., Hanyang University, Seoul, Korea, 133-791
³ Dept. of Sustainable Architectural Engrg., Hanyang University, Seoul, Korea, 133-791
⁴ Dept. of Sustainable Architectural Engrg., Hanyang University, Seoul, Korea, 133-791

a walkloud@naver.com, b yoonsunlee@korea.com, c ohyekn@jugong.co.kr, d jjkim0205@hotmail.com

ABSTRACT

In Korea, it has recently occurred that problems of productivity and manpower shortage in the construction industry. Supply of skilled workers decreases because of evasion the building industry, so it’ll become more urgent. The productivity of construction industry and competitive construction duration in Korea are too low. If post sale system becomes effective, construction companies will strive to improve productivity. Therefore, the objective of this study is to draw up APC (Architectural Precast Concrete) as the alternative for productivity improving and analyze possibility of productivity improving by comparing with established method of construction.

KEYWORDS: APC (Architectural Precast Concrete), Productivity, Construction Duration

1. INTRODUCTION

1.1 Background and purposes

In Korea, it has recently occurred that problems of productivity and manpower shortage in the construction industry. Supply of skilled workers decreases because of evasion the building industry, so it’ll worsen. Most of companies didn’t put in operation five days per week system, but public enterprise and foreign affiliated enforced it. Many companies will carry into effect it before long. If construction companies come into operation five days per week system, shortage of labor will become worse. If five days per week system take effect by Kwon (2002), construction expenses will increase by 6.6% and construction duration will maximize by 31.5%. By National Accounts of OECD Countries, labor productivity of Korean construction industry is 50% of Japanese and Austrian, 73% of American, and 66% of French and German (Kim 2005).

When comparing with American, Korean, and Japanese construction duration by Calvert et al (2004), the average time required per one floor is 12.8 days in USA, 24.1 days in Japan, and 31.3 days in Korea. So we can know that the competitiveness of construction duration in Korea is too low. We should watch post sale system. This system is that public construction companies can raise occupants of houses when the whole construction progress reaches a certain level of that. This system goes into effect public construction companies but it will be applied private construction companies soon. So construction companies should strive to reduce construction duration because they can decrease construction expenses by reducing construction duration.

Because of these problems and construction industry environment, the productivity improving is an urgent problem in the construction industry. Therefore, the objective of this study is to draw up
APC (Architectural Precast Concrete) as the alternative for productivity improving and analyze possibility of productivity improving by comparing with established method of construction.

1.2 Methodology

From 1997 to 2006, the percentage of apartment housing construction of large scale construction projects is 76% by data of National Statistical Office. If construction companies build 4 projects for one year by this statistical data, 3 of them are apartment housing ones. Apartment housing project is given a great deal of weight on the whole construction projects like this, so this study is limited to apartment housing projects in Korea.

The step of this study is responsible for: First of all, the step of raising a question, which was emphasized to be problems of productivity in Korean construction industry and improve productivity. Next step is preliminary considerations’ one, which was examined productivity of construction industry. In the third step, the alternative of productivity improving is drawn by analysis of previous studies. Fourth, I derived verification items by interviews with construction experts, which were used to verify the alternative. Fifth, I analyzed possibility of productivity improving by comparing with established method of construction. Last, I synthesized and put in order these contents and showed the subjects for hereafter study.

2. PRELIMINARY CONSIDERATIONS

2.1 Productivity

Productivity is expressed the ratio of the result or output to an input when something is produced by some production system within a given period. There are two kinds of measurement method of productivity in the construction industry. It is the ratio of the workload classified by construction work (quantity of pouring concrete or reinforcing rod) to labor that the direct measurement method of productivity in the construction industry. It is Work Sampling and Foremen Delay Survey that the indirect method of measurement of productivity. The contents of their evaluation are the practical work time and reason of work delay.

![Diagram showing Input, Production System, and Output with Productivity = Output / Input](image)

Figure 1. Definition of Productivity

2.2 PC (Precast Concrete)

PC is a plane reinforced or prestressed concrete element cast in other than its final position in the structure. PC can be architectural or structural. The special quality of PC is responsible for: First, we can reduce construction duration. Next, it is clear that construction work might be responsible. Third, it doesn’t matter to carry out PC in all weathers. Fourth, PC has good quality and various designs because it is made in factory. Fifth, we can save form work expenses. Sixth, PC is installed easily by using standardized products. Seventh, accidents are decreased because of work decline by workers. Eighth, labor saving is possible by decrease of manpower dependence. Ninth, there are a little discarding materials, noise, and dust. Therefore, PC can be the alternative of productivity improving in the apartment housing projects.
2.3 Previous studies of PC

Previous studies of PC are divided three parts. First part was showed the alternative of PC’s revitalize and the subjects for hereafter study. Next studies are made comparative ones the examples applied PC of ones non-applied PC. Last part is studies on PC’s technical obstacles and defects. There are these studies in the next table.

Table 1. Previous Studies of PC

<table>
<thead>
<tr>
<th>Author</th>
<th>Name of study</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>An et al.</td>
<td>A study on the proposal about the improvement of PC in construction industry</td>
<td>It was emphasized in the PC industry that the political support and new method of PC (Architectural PC)</td>
</tr>
<tr>
<td>Jeong (1993)</td>
<td>Future research projects for improvement of PC technology</td>
<td>It was drawn up that 6 projects for improvement of PC technology</td>
</tr>
<tr>
<td>Kim et al.</td>
<td>Application of PC beam-column interior joint with splice type re-bar</td>
<td>PC beam-column interior joint with splice type re-bar has better than general PC in the installation time and price aspect but it is worse than reinforced concrete in the price aspect</td>
</tr>
<tr>
<td>Lee (1993)</td>
<td>Problem &amp; solution for popularization in PC housing construction</td>
<td>Solutions for popularization in PC housing construction are development a new material, new method of construction, complement system, technical development, and continuous political support</td>
</tr>
<tr>
<td>Min et al.</td>
<td>Barriers to technology innovation: A case of industrialized building technology for housing construction</td>
<td>There are economical, institutional, technical, systematic, and users’ barriers in industrialized building technology</td>
</tr>
<tr>
<td>Min et al.</td>
<td>Post occupancy evaluation of prefabricated concrete housing</td>
<td>Prefabricated concrete housing’s quality is not bad as compared with established housing</td>
</tr>
<tr>
<td>Shin et al.</td>
<td>A typological study on performance defects of PC apartment housing</td>
<td>The reasons PC defects are insufficient field management, inexperience, and problems of supply and demand of resources</td>
</tr>
</tbody>
</table>

We should focus studies by Jeong (1993) and An et al. (2004). By these studies, PC is recognized as structural PC in Korea. However, APC (Architectural PC) is widely used in USA and Europe. And it rates as high and help add to the beauty of buildings (Jeong 1993). APC plays a structural and curtain wall role, so it is helpful than reinforced concrete or steel construction in the price aspect (An et al. 2004). Therefore, we need to be interested in APC.

3. DRAW THE ALTERNATIVE OF PRODUCTIVITY IMPROVING

3.1 Construction duration in the building projects

Construction duration in the building projects is that the whole period of process from pre-construction through completion. It consists of plan, foundation work, frame work, finish work, and completion step. Some steps are placed a great deal of weight in whole steps, and some are not. If you want to reduce construction duration or improve productivity in the construction projects, you should concentrate upon steps which are placed a great deal of weight in whole steps. By Ryu et al. (2005), ground frame and finish work are placed a great deal of weight in Korean apartment housing projects. Therefore, we can maximumly reduce construction duration or improve productivity in Korean apartment housing projects if we focus ground frame and finish work.
3.2 The alternative of productivity improving

APC (Architectural Precast Concrete) is any precast concrete unit of special or occasionally standard shape that through application or finish, shape, color, or texture contributes to the architectural form and finished effect of the structure. APC may be structural or decorative, and may be conventionally reinforced or prestressed. APC has been used for many decades in the United States and Canada. Its full potential in terms of economy, versatility, appearance, structural strength, quality and permanence continues to expand as witnessed by new projects all over the continent.

APC has lots of advantages. First of all, APC has design advantages. A wide range of expressions are possible with custom-made solutions that utilize industrialized production techniques and result completely individual buildings. Components or units are produced in plants to specified quality standards. They may be inspected prior to installation. Unlimited and economical shapes and configurations are possible. Next, APC has functional advantages. Load-bearing, wall-supporting, shear walls, or units which serve as formwork to remain as an integral part of the building. It has protection from climatic conditions. Efficient and economical sound control is possible. Concrete units can be designed to provide required thermal performance by the use of special aggregates and incorporation of various insulation materials within the units (sandwich panels) or attached to them. Third, APC has construction site advantages. On-site labor time is minimized, and erection is possible in all kinds of weather. It allows easier access by finishing trades. Trade overlap problems decrease to the extent that electrical, mechanical, plumbing and HVAC sub-systems can be integrated into the precast components. Prefabrication combined with fast erection saves valuable overall construction time. Last, the economic advantages of APC are inherent in most of the above groups. They become even more apparent as design and tooling innovations increase productivity and pre-assembling of total walls help to reduce on-site labor. Decreasing site operations will assist in stabilizing the overall cost of the finished building. Financing costs will be reduced by the shorter overall construction time.
4. ALTERNATIVE VERIFICATION OF PRODUCTIVITY IMPROVING

4.1 derivation of verification item

We need verification items to analyze possibility of productivity improving by comparing with established method of construction. So, I derived verification items by interviews with construction experts and Delphi Technique, which were used to verify the alternative. The verification items of productivity improving alternative are responsible for: (1) Construction duration (2) The degree of difficulty in construction (3) An input of labor (4) An input of resources (5) occurrence of accidents (6) rise and fall of quality

4.2 Verification of productivity improving as use of APC

In established method of Apartment housing construction, it is made reinforced concrete that column, wall, slab, reveal wall, and parapet. We should focus reveal wall and parapet. In order to make reveal wall and parapet, after we make forms and reinforcing rods, we should pour concrete. If we use APC, we can omit these works. Because we can omit make reveal wall and parapet, critical path of frame work shorten. And the degree of difficulty in construction is low and an input of labor shortens. When we make reveal wall and parapet, there are many corners of form in these works. And it is hard work to install out wall’s form. If we use APC in these works, we only install APC by cranes. Because an input of labor shortens, decreased population of workers works in the construction field. Therefore, occurrence of worker’s accident can be down. An input of resources can shorten because we can omit form work of reveal wall and parapet as use of APC. Last, out wall is good of quality as use of APC. Because out wall is generally thin, it is hard that out wall has good quality. However, APC’s quality is better than reveal wall or parapet because APC is made in factory. Therefore, we can know that APC is good alternative for productivity improving by comparing with established method of construction.

5. CONCLUSIONS

In this study, after I drew up APC as the alternative for productivity improving, I analyzed possibility of productivity improving by comparing with established method of construction. In order to draw an alternative for productivity improving, I drew up APC which is a kind of PC and was verified quality by using in USA and Canada for many decades. I used the verification items in order to compare with established method of construction, which was drawn up by interviews with construction experts. The verification items of productivity improving alternative are responsible for: (1) Construction duration (2) The degree of difficulty in construction (3) An input of labor (4) An input of resources (5) occurrence of accidents (6) rise and fall of quality

When I compared established method of construction with using APC, I concentrated focus reveal wall and parapet. In USA and Canada, they understood that these were reasons of productivity reduction, so they used APC instead of them. And it increased in case of established method of construction that construction duration, the degree of difficulty in construction, and an input of labor and resources. If an input of labor increase, occurrence of accidents will increase. Because reveal wall and parapet are made generally thin and there are many corners, it is hard that they have good quality. However, APC’s quality is better than reveal wall or parapet because APC is made in factory and its installation is easy. Therefore, if we use APC instead of established method of construction in the apartment projects, we have the productivity improving and Korean construction companies have increased competitive advantages.

ACKNOWLEDGMENT

This work was supported by Sustainable Building Research Center of Hanyang University which was supported the SRC/ERC program of MOST (R11-2005-056-03001)
REFERENCES


Construction & economy research institute of Korea, 2006. “Construction management”

Jeong, H. S., 1993. “Future research projects for improvement of PC technology”


Kim, J. Y., 2005. “How will we do in the critical construction industry?” pp. 15

Kim, J. H., Jeon, B. K., Park, S. K., and Kim, G. H., 2006a. “Application of PC beam-column interior joint with splice type re-bar”


