

# STUDY ON A WAY TO ESTIMATE REASONABLE COST OF CONSTRUCTION WORKS -FOCUSED ON FORMWORKS IN KOREA-

Jin Won Kim<sup>1</sup>, Sun Young Choi<sup>1</sup>, JuHyung Kim<sup>2\*</sup>, and Jae Jun KIM<sup>2</sup>

<sup>1</sup> Master Course, Department of Sustainable Architectural Engineering Hanyang University, Korea

<sup>2</sup> Professor, School of Architectural Engineering Hanyang University, Korea

\* Corresponding author ([kcr97jkhk@hanyang.ac.kr](mailto:kcr97jkhk@hanyang.ac.kr))

**ABSTRACT:** This study was carried out being focused on formworks in order to provide a way to estimate reasonable cost of construction works in Korea. The scope of the study was set to the period after 2004 when actual cost estimating system was introduced and a survey of specialists was conducted. And execution data of specialized construction companies was collected to analyze construction costs estimated for different types and sizes of construction work. We judge that weights should be applied to different types and sizes of construction work in order to estimate reasonable costs of construction works and finally the winning price percentage should be considered.

**Keywords:** Actual Cost Estimating System, Rational Construction Cost, Formwork

## 1. INTRODUCTION

### 1.1 Background and Goals of the Study

Construction industry in Korea is showing aspects of Manhattanization, specialization and complexation due to development of new technology and new processes. Accordingly, an estimated price of a construction work is acting as a factor which increases uncertainty of future.[1] The ways to estimate construction cost can be largely divided into cost calculation method and executive budget method. Out of these, cost calculation method based on standard labor cost has been applied to cost estimation for public works since 1962. However, cost estimation based on actual record was introduced in 2004 and has been used since then in order to solve the problem of standard labor cost which does not reflect actual input cost or production cost of the market. As such actual cost estimation is prepared based on unit prices by trade of large works of which the actual costs exceed 10 billion Won, it is difficult to reflect sizes or characteristics of works, and problems such as price drop caused by low price bidding and degradation of construction quality are occurring.[2] Accordingly, in order to solve the problem of cost estimation based on actual record, it is required to improve

the way to estimate unit prices and it is essential to arrange a standard for corrective index which can reflect characteristics of works.

According to the data of Public Procurement Service which analyzed construction costs of public facility by type in 2009, structural frame works covered 20 to 22 % of direct cost. Among those, while actual cost of reinforcement and concrete work is judged to have been accumulated considering the distinct characteristics of construction site, actual costs of most of formworks are estimated by type of formwork. Accordingly, cost estimation based on actual record is showing differences from executive unit prices of private construction work for which unit prices are estimated by type of the building, member and degree of difficulty.

Accordingly, in this study, we intend to analyze actual record data focusing on formworks among frame works and present a way to estimate reasonable construction cost through a survey.

### 1.2 Scope and Contents of the Study

In this study, we limited the scope to construction works carried out after 2004 when cost estimation based on actual

record was introduced, in order to estimate reasonable costs of formworks, and the area was set to construction sites located in the capital area and over the whole country. And study was carried out for formworks among frame works which cover 20 to 22 % of direct cost.

As a method of study, we investigated problems of formwork and weights on formwork applied at the site by conducting a survey of specialist groups in design companies, general construction companies and specialized construction companies. And we investigated construction cost status of different types of building and different sizes of works by collecting contents of contracts concluded by specialized construction companies and estimated the weights. The detailed method of this study was as follows:

- (1)The basic direction and objectives were set up.
- (2)Cost data of construction sites started after 2006 was collected.
- (3)Problems of cost estimation based on actual record and matters which should be considered when estimating cost of formworks were investigated through a survey.
- (4)Weights to be reflected in accordance with characteristics of the work were investigated.
- (5)A way to estimate reasonable construction cost of a formwork was presented based on contents of construction cost data and result of the survey.

## 2. Literature Review

### 2.1 Definition and Process of Estimation

As cost management of construction work is to economically manage the cost required for the whole process of the project within the scope of predetermined budget, an estimate to predict whole cost of the project can be defined to be a process of providing information required for decision making by estimating quantity and amount of various resources such as material, labor and equipment required for execution of the construction work. A typical decision making for construction work includes material procurement, decision on the price of the construction work, decision on the contract amount and control of actual quantity through construction work management.

In conclusion, we can say that an estimate is to calculate the quantity and the cost of material, labor and equipment required for the work as well as other expenses, and the process of determining the estimated price for a public work is as shown in Figure 1.[3]

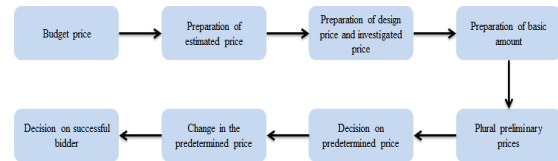


Fig.1 Process to Decide Predetermined Price of a Public work

### 2.2 Method to Estimate Cost of Construction Work

In relation to construction work cost, the process can be divided into overall estimation process, and cost management process which continuously controls executive cost in order not to allow it to exceed the estimated cost during the construction process based on the construction cost initially planned. And the construction cost including the costs of material, labor and equipment required for the work as well as various expenses is estimated in following way:

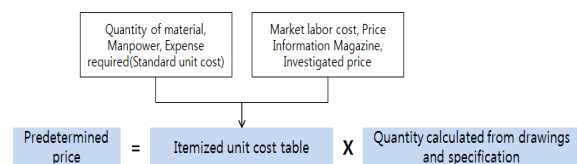


Fig.2 Estimation by Cost Calculation Method

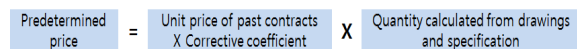


Fig.3 Cost Estimation by Actual Record Method

The cost estimation methods currently used in Korea can be divided into estimation by cost calculation method which uses standard unit cost and cost estimation by actual record method which estimates cost based on data of actual work cost record as shown in Figure 2 and 3 respectively. Estimation by cost calculation method is prepared based on standard unit cost and items such as material cost, labor cost and expenses can be calculated from unit price per item. But, it was pointed out that the cause for the drop in winning price percentage after execution of lowest price

award system was standard unit cost. Accordingly, cost estimation system based on actual record was introduced from 2004 in order to estimate reasonable costs of public construction work.

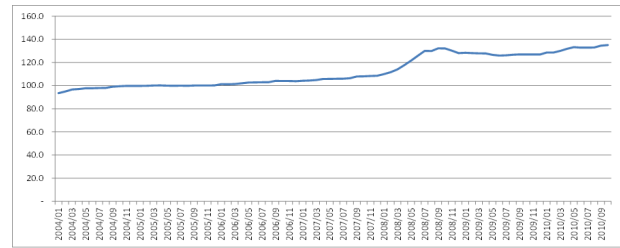
Cost estimation by actual record means the cost estimation made using the data accumulated for diverse works based on contract unit prices by trade of construction works already carried out which have been acknowledged by the head of a central government organization. In cost estimation system based on actual record, a predetermined price is estimated and bidding price is decided by the ordering organization based on data of actual work record. And construction companies come to bid their prices using the data they have built, and the contract is finalized through completion with other construction companies. We can say that actual data of construction cost is accumulated as such process is repeated.

However, the situation is that cost estimation by actual record lacks integrity of estimate, execution of work and process, and that the standard has not been established for calculation of quantity by item as, in particular, integration of design and process has not been achieved. Also, the reality is that specifications and trade classification methods of construction companies are different from each other and the needs of the time such as new technology and new processes are not fulfilled. In addition, another problem of cost estimation by actual record is that distinct characteristics and work conditions of each region cannot be reflected.

### 2.3 Method to Estimate Cost of Construction Work

Construction Cost Index is processed statistic data of direct construction costs such as material, labor, equipment and resources invested in a construction work which is prepared using Input-Output Tables and Producer Price Index of Bank of Korea and market labor cost data in construction field announced by Construction Association of Korea, and is an index which measures fluctuation in direct cost of construction works. When we look into the fluctuation in construction cost after 2004 when cost estimation system based on actual record was introduced, the trend was as shown in Figure 4.[4]

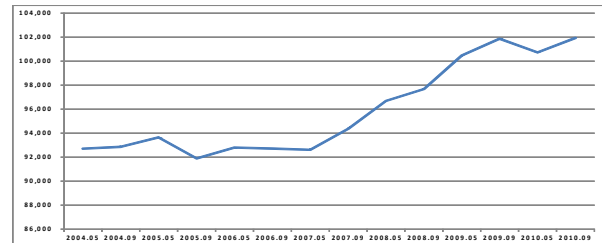
Fig.4 Fluctuation in Construction Cost Index



As shown in Figure 4, we can see that the construction cost index has been continuously increasing from the reference construction cost index 100 in 2005. Such variations imply that construction cost was increasing due to overall increase in price after 2004 and in accordance with types and characteristics of works. And the trend of change in labor cost for wooden formwork included in the status of market labor cost in construction field investigated by Construction Association of Korea twice a year is as follows:[5]

Labor cost for wooden formwork was investigated to be 92,242 Won in 2004 when cost estimation system based on actual record was introduced and was 101,932 Won in the second half of 2010 showing increase of about 10.5 %.

Fig.5 Trend of Change in Labor Cost for Wooden



Formwork

### 2.4 Actual Cost Formwork based on Record

According to the data of Korea Institute of Construction Technology, unit prices based on actual record were applied to formworks from 2006. Unit area prices of formwork with different finishing are as shown in Table 1. Unit area prices of formwork with different finishing started being established from 2007 and, the smoother the finishing is, the higher the price was set.

Table. 1 Unit area prices of Formwork with Different Finishing

Classification	1 <sup>st</sup> Half of 2007	2 <sup>nd</sup> Half of 2007	1 <sup>st</sup> Half of 2008	2 <sup>nd</sup> Half of 2008	1 <sup>st</sup> Half of 2009	2 <sup>nd</sup> Half of 2009	1 <sup>st</sup> Half of 2010	2 <sup>nd</sup> Half of 2010	Average
Smooth Finishing	24,896	25,648	26,165	28,388	29,817	29,317	23,730	24,830	26,599
Normal Finishing	19,724	19,634	19,612	20,267	22,548	19,728	16,918	16,963	19,424
Rough Finishing	14,225	14,489	14,782	14,311	14,993	14,742	13,926	14,066	14,442

### 3. Survey on Cost Estimation by Actual Record

#### 3.1 Outline of the Survey

The survey was conducted for specialists working in design-estimate companies, general construction companies and specialized construction companies for one month from Sep. 27, till Oct. 25, 2010. Total 150 copies of questionnaire, 50 copies to each field, were distributed and 32, 48 and 27 copies were collected from design-estimate company group, general construction company group and specialized company group respectively.

#### 3.2 Problem of Cost Estimation by Actual Record

The result of checking knowledge about cost estimation by actual record through survey showed that 80 % of the respondents were aware of cost estimation by actual record and 91 % responded that there is a problem in cost estimation by actual record. As to the trade of which the problem of cost estimation by actual record is most serious, the response showed that the biggest problem is in frame work.

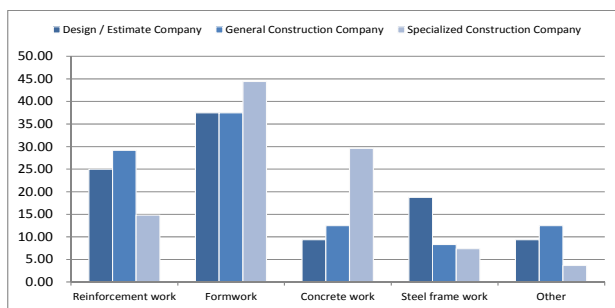


Fig.6 Trade of Which the Problem of Cost Estimation by Actual Record is Serious

#### 3.3 Matters to Consider when Estimating Cost of Formwork

In order to investigate the matters which should be most preferentially considered when estimating cost of a formwork, investigation was conducted classifying the matters into 7 items after grasping problems of cost estimation by actual record:

- (1) Preparation of design details considering contents to be executed,
- (2) Correction of design unit prices and executive unit prices
- (3) Types of work (apartment, ultra-high building, etc.)
- (4) Scale of frame work (area, number of floors, etc.)
- (5) Construction method of the formwork
- (6) Degree of difficulty of the formwork
- (7) Type of material used for the formwork

The result of the survey showed that correction for the design unit prices and executive unit prices of formwork was most important. Respondents from general construction companies answered that design details should be prepared considering the winning price percentage. And, in case of specialized construction companies, through most of the priority items were similar, the respondents answered that it is most important to consider the degree of difficulty of formwork.

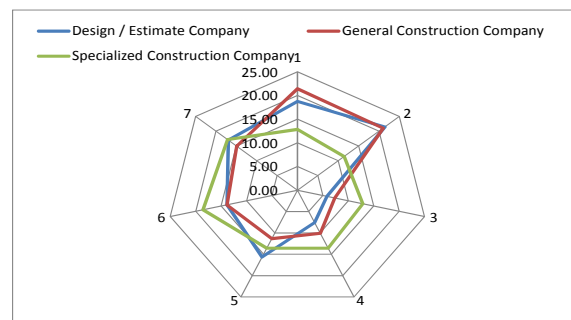


Fig.7 Matters to be Preferentially Considered When Estimating Cost of Formwork

### 3.4 Cost Estimation Considering Characteristics of Formwork

In order to estimate reasonable construction cost of formwork, weights should be applied to construction costs. Accordingly, investigation was conducted for each field. The result of classifying buildings into residential/commercial complex, general building (ordinary), general building (simple) and special building with the value for apartment which is the most general building set to 100 is as shown in Figure 8.

The result of survey showed that weights higher than an apartment by 12.61 %, 11.57 %, 6.74 % and 21.30 % are applied respectively to a residential/commercial complex, an ordinary general building, a simple general building and special building with complicated shape. Though each business type showed a difference in the weight, weights higher than the executive amount of an apartment were generally applied.

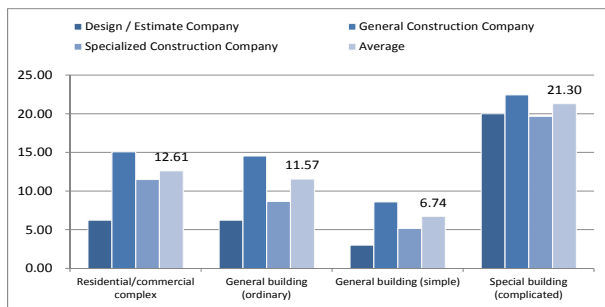


Fig.8 Weights on Cost of Different Types of Construction Work

## 4. Status Analysis on Cost of Formworks

### 4.1 Outline of the Survey

For this study, we collected contract detail data of formworks for which orders were placed with specialized construction companies all over the country excluding Jeju Island after 2006. The period of data collection was 4 weeks from Sep. 27 to Oct. 25, 2010. The analysis was carried out with total 39 samples of contract data collected which are consisted of 14 apartment sites, 9 general building sites, 11 sites of buildings attached to apartments, and 5 sites of special buildings.

### 4.2 Status of Actual Unit Prices and Contract Unit Prices of Formwork

We analyzed the status of actual unit prices and contract unit prices of formwork on the basis of the collected data in order to analyze problems of formwork. Actual unit prices are mostly prepared based on the data of general buildings excluding apartments. Accordingly, we reviewed the status of contract unit prices for different types of building and analyzed the status of contract unit prices and converted unit prices for different construction works.

For general buildings and special buildings excluding apartments of which the degree of work difficulty is low in accordance with types of building, the contract unit prices showed values higher than actually recorded unit prices of formwork in 2010 which was 16,963 Won/m<sup>2</sup>. The status of contract unit prices for different types of building showed that those of apartment were lower by about 18 % while those of general buildings and special buildings were higher by 13 % and 54 % respectively.

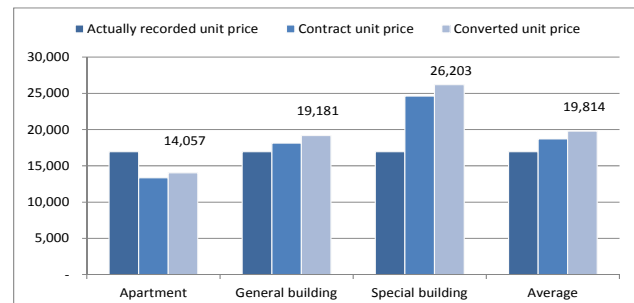


Fig. 9 Status of Contract Unit Prices for Different Types of Building

### 4.3 Weights on Construction Cost of Different Types of Building

In order to estimate reasonable costs of formwork, weights on construction cost of different types of building were estimated using contract unit prices of specialized construction companies. And, as the points in time when the contracts were made were all different, the contract unit prices were converted in reference to the actually recorded costs in 2010, and weights were estimated by analyzing contract unit prices of medium scale works for apartment and general building. However, special building was excluded as there was no data of medium scale work.

As the winning price percentage is not considered when contract unit prices of specialized construction companies are decided, it is difficult to estimate realistic weights. Accordingly, weights were estimated by adding 12 % to the each contract unit price of specialized construction companies, assuming the reasonable winning unit price percentage as 88 %. As a result, it showed that the unit prices for apartment and general building should be estimated with about 12 % and 39 % weights respectively.

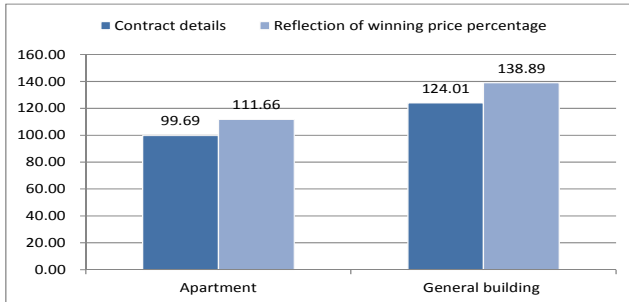


Fig.10 Status of Contract Unit Prices for Different Types of Building

#### 4.4Weights on Construction Cost for Different Scales of Work

The weights on construction cost for different scales of formwork were divided into small scale, medium scale and large scale, and the weights were estimated with apartment, general building and special building all included. The result of estimation on weights of construction cost for different scales carried out with actually recorded cost in 2010 set to 100 is as shown in Figure 11.

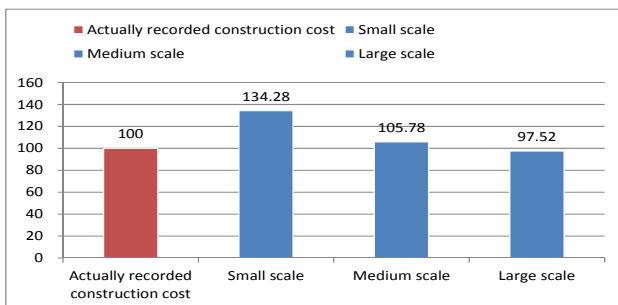


Fig.11Status of Contract Unit Prices for Different Scales of Building

The weights on construction cost of small, medium and large scale works were estimated to be about 134 %, 105 % and 97 % respectively. Excluding large scale sites, the

smaller the scale of work was, the higher the unit price of the work appeared to be. However, if we consider the fact that, the bigger the scale of work and the amount of construction work are, the lower the winning price percentage becomes, we judge that different weights should be also applied for different scales of work.

#### 5. Conclusion

Through this study, we could see that estimation of construction cost is done by applying different weights to different types of building and scales of work. However, in order to reasonably estimate construction cost, we judge that first weights should be applied to different types of building and different scales of work and second weights should be applied to works of different degree of difficulty.

#### Acknowledgment

This research was supported by a grant(code No.06 Chumdan-eunghap E01) from Virtualmighty Program by Ministry of Construction and Transportation of the Korean Government (MOEHRD) (R05-2004-000-10591-0)

#### REFERENCES

- [1] Woo-Sung Yoon, Hyun-Chul Lee, Han-Min, Lee, Seong-Seok GO, "A Study on the Presumption of Construction Cost of Public Apartment by Analyzing Actual Construction Cost", Korean Institute of Construction Engineering and Management, Vol.10(2), pp.132-144, 2009
- [2] Jae-Youl Chun, "A Study on Construction Cost Estimating Method based on Actual Cost Data", Architectural Institute of Korea, Vol.18(4), pp.121-128, 2002
- [3] Kang-Shik Kim, Chang-Taek Hyun, Tae-Hoon Hong, Seong-Min Jo, Hyun-SeokMun, "Development of an Unit Cost Modification Model for Proper Actual Cost Data in Small Building Construction Projects", The Korea Institute of Building Construction, Vol.10(1), pp.81-89, 2010
- [5] <http://www.kict.re.kr/eng>
- [6] <http://www.cak.or.kr/>