Application of WBS in Pricing Management of Prefabricated Concrete Construction Project

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Abstract. The standard of measurement and valuation is the main basis for making the bill of quantities and compiling the bidding control price and bidding quotation. In recent years, prefabricated concrete building, as a typical structural form of prefabricated building, has developed rapidly. However, in the actual operation of measuring and pricing of prefabricated concrete construction projects, the existing list system has many shortcomings. Based on this, it is necessary to optimize the measurement specifications of prefabricated concrete buildings in China. At first, this paper uses the principle of the work breakdown structure (WBS) specifications for the measurement of the current prefabricated concrete building structure is analyzed, secondly in Jinan city project as an example, to find out its branch, the branch of engineering and engineering subdivisional work on decomposition structure of the preliminary optimization, using WBS to metrological specification for the perfection of prefabricated concrete construction measurement valuation in China to provide the basis.

Keywords. WBS, Prefabricated concrete building, pricing management, measurement specification

1. Introduction
Scientific and effective valuation management is the core basis for controlling the valuation management of construction projects, and is also the necessary condition to ensure the successful promotion of the project. The pricing management of construction projects in China has developed and improved continuously in practice from the lack of unified pricing method in the early days of the People's Republic of China to the later quota pricing mode and then to the current list pricing mode [1]. The pricing management under the mode of list pricing can be divided into two parts: measurement management and quota management. In order to unify the measurement behavior of construction projects, the Ministry of housing and urban rural development has formulated relevant norms. Among them, the code for calculation of quantities of housing construction and Decoration Engineering (hereinafter referred to as "measurement specification") has undergone continuous improvement in the 03, 08 and 13 editions. Compared with the previous two versions, the scope of measurement specification is more extensive and the content is more detailed and specific, which is more conducive to the smooth progress of project measurement work. However, with the progress of construction technology and the transformation of the construction industry, there are still some gaps between the construction market and the development of social economy, which leads to the lack of refinement of some contents in the existing measurement specifications, and there are some problems to be discussed. As an important tool of project management, WBS is an indispensable part of the initial stage of a construction project. For the pricing management of a project, the project is subdivided and decomposed...
based on the determination of the pricing target, and the WBS is used. It is divided into different levels to form the corresponding work package, so that the whole valuation management of the project appears orderly, which is conducive to the orderly development of pricing work [2].

2. WBS and Pricing Management

2.1. Concept of WBS

WBS is a scientific and effective management tool [3]. It is the abbreviation of “work breakdown structures”. The definition of work breakdown structure is "according to the objectives of the project itself, the work process will be refined and decomposed into different levels within the scope of the whole project, so as to improve the management efficiency."

WBS is an important tool of project management. As a part of project management, pricing management also needs WBS as an effective tool. The principle of WBS is similar to the factorization in mathematics. We can regard the management of construction project valuation as a factor [4]. WBS is the method of factorization. Taking the total project cost as the goal, the whole process of valuation is refined and decomposed into smaller components, which simplifies the complex process and facilitates the smooth progress of project pricing activities.

2.2. Relationship between WBS and Valuation Management of Construction Project

2.2.1. The Relationship between WBS and Pricing Management. Although the pricing mode of construction projects in China is becoming more and more mature, the pricing management has a relatively complex process [5]. As a basic element of measurement management, the bill of quantities needs to be continuously developed and optimized. As a good tool, WBS plays an important role in the preparation of bill of quantities for prefabricated concrete construction.

Part e of Appendix E in the measurement specification is decomposed according to the management tool WBS [6], and the concrete and reinforced concrete works of divisional works are divided into 16 sub projects according to the construction sequence of cast-in-place and precast components, from E.1 to e.16. For example, the cast-in-place concrete foundation of the sub project is divided into 6 sub items, the cast-in-situ concrete column of the sub project is divided into 3 sub items, and the cast-in-situ concrete beam of the sub project is divided into 6 sub items, as shown in figure 1.
2.2.2. The Necessity of Combining WBS with Pricing Management. In the process of pricing management of prefabricated concrete construction project, the quality of WBS is directly related to the level of valuation [7].

(1) WBS can show the whole picture of the pricing management of prefabricated concrete construction projects [8], scientifically control the valuation range, and make clear the links of each work in the whole process from project investment estimation to completion final accounts, so as to avoid duplication and omission of work.

(2) WBS is the main tool for preparing the list of prefabricated concrete buildings [9]. When preparing the list, the items in the list are prepared according to the work contents of each stage of the construction project decomposed by WBS to prevent missing items.

(3) The effective decomposition of prefabricated concrete construction valuation management is the basis of cost control, so WBS can ensure the smooth progress of pricing management of prefabricated concrete construction engineering, and control the cost at the same time [10].

3. Case Application

3.1. Project Overview

3.1.1. Project Content. The project of this bid section is designed and constructed according to the concept and technical standards of building and housing industrialization. The prefabricated component part adopts integrated assembly technology to carry out on-site hoisting construction, and the project conforms to the green building standard.

Project Name: ronghuicheng · jinxiuli (block A14), phase I, bid section 4
Construction site: ronghuicheng project, west of 2nd Ring Road West, south of liuchangshan, Shizhong District, Jinan City.

Construction area: 26218.92 square meters
Building height: 88.90 m (30 floors)
Fortification intensity: 6 degrees
Foundation form: Pile Foundation
Structural form: shear wall structure

Main contents and material description of the project:
In this project, cast-in-place shear wall structure is adopted for the fifth floor and below of the fourth floors building. The precast concrete components are used for the components above the sixth floor. All the prefabricated components of the fourth floors building are produced in the designated factory, and then the prefabricated components are transported to the construction site for hoisting.

3.1.2. Type of Precast Elements for Six Floors. In this project, the external walls of six floors and above are prefabricated sandwich sandwich insulation wallboard, fully prefabricated air conditioning board, indoor floor is precast concrete ordinary truss laminated plate, and stairs are prefabricated stairs. Among them, the prefabricated air conditioning board is attached to the prefabricated external wall. The types of prefabricated components used in the same part of each floor above six floors are the same. Table 1 shows the WBS classification of prefabricated components on the sixth floor of the fourth building.

| Serial number | Name                               | Specification | Model number |
|---------------|------------------------------------|---------------|--------------|
| Six floors    | 1 Prefabricated sandwich wall       | YWQ           | 54 pieces    |
|               | 2 All prefabricated air conditioning board | YKTB         | 10 pieces    |
|               | 3 Prefabricated stairs              | YTB           | 8 pieces     |
In this project, all prefabricated air-conditioning panels are attached to the prefabricated external walls. Figure 2 shows the actual construction site drawings of prefabricated sandwich exterior walls and fully pre supported air-conditioning panels on the sixth floor of the fourth floor.

![Figure 2. Actual site drawing of prefabricated sandwich exterior wall.](image)

Prefabricated stairs are prefabricated in advance in the factory according to the size and specification specified in the drawings, and then transported to the construction site for hoisting. Figure 3 shows the prefabricated stairs on the construction site.

![Figure 3. Field actual drawing of prefabricated stairs.](image)

Precast ordinary composite slab refers to a floor slab with one floor under the precast floor and one floor cast-in-place on the top. Two layers are superimposed to form a complete floor slab. Figure 4 is the actual site drawing of six story precast composite slab.
3.2. Optimization of Measurement Specification for Prefabricated Concrete Buildings

Due to the lack of the content of prefabricated concrete precast components in the existing measurement specifications, there are missing items in the itemized list of prefabricated components and the imperfection of the arrangement order, the missing items in the project name, the unclear characteristics of the project and the unclear description of the work content of the prefabricated components. These all affect the smooth progress of measurement management to a certain extent. If the list of prefabricated components of No. 4 building of Jinxuili, Jinan Ronghui City (block A14) phase I is compiled according to the existing measurement specifications, the contents are shown in table 2.

**Table 2. 4 bill of quantities for prefabricated components of buildings (before optimization).**

| Serial number | Item code  | Entry name          | Project feature description                                                                 | Unit of measurement |
|---------------|------------|---------------------|------------------------------------------------------------------------------------------------|---------------------|
| 1             | 010511001  | Surface plate       | 1. Precast ordinary laminated slab (6 floors)  
2. Within 1 m³  
3. 14.64 m  
4. C30 concrete | M³       |
| 2             | 010513001  | Precast concrete stairs | 1. Prefabricated staircase (6 floors)  
2. Within 2 m³  
3. C30 concrete | M³       |

It can be seen from the above table that the list compiled according to the above measurement specifications does not have the item of precast concrete external wall. However, the prefabricated external wall exists in the actual construction. If the corresponding items in the specification are not supplemented, it is easy to cause the missing items of components, which is not conducive to the pricing management of prefabricated concrete buildings.

In addition, in the actual project, precast concrete slab includes precast laminated slab and prefabricated air-conditioning slab. However, the division of project name in the existing specification is not specific enough. For these two types of slabs, they can only be attributed to flat slab. This situation easily leads to insufficient and detailed contents of the list, which will reduce the accuracy of pricing of prefabricated components in construction projects.
According to the relationship between WBS and pricing management, the work breakdown structure of "Appendix E concrete and reinforced concrete engineering" in the measurement specification is optimized. This part is divided into "cast-in-place concrete and reinforced concrete project" and "prefabricated reinforced concrete project" [11]. Then, according to the decomposition route of the divisional, sub divisional and sub divisional works, the sub project "prefabricated reinforced concrete project" is divided into two sub projects, namely "prefabricated concrete component installation" and "post cast concrete project". Based on the current engineering quantity calculation specification and consumption quota, combined with the practical experience of measurement and pricing of prefabricated concrete buildings, the sub projects under the above two sub divisions are supplemented, and the project features and work contents of the supplementary items of sub projects are improved, so as to form a relatively complete bill of quantities system for prefabricated concrete construction, as shown in Table 3.

Table 3. 4 bill of quantities of prefabricated components on the sixth floor of Chen Lou (after optimization).

| Serial number | Item code     | Entry name                      | Project feature description                                                                                                                                                                                                                                                                                                                                 | Unit of measurement |
|---------------|---------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1             | 010511001     | Precast ordinary laminated slab | 1. 6Precast common laminated slab at bottom of layer<br>2. Within 1m³<br>3. 14.64m<br>4. C30 concrete, HRB400 main reinforcement, embedded water and electricity pipe and reserved embedded box<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Prefabricated air conditioning board for external wall<br>2. Within 1m³<br>3. 16.74m<br>4. C30 concrete, main reinforcement HRB400<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Floor precast staircase<br>2. Within 2m³;                                                                 | M³                  |
| 2             | 010511007     | Prefabricated air conditioning panel | 1. 6Precast common laminated slab at bottom of layer<br>2. Within 1m³<br>3. 14.64m<br>4. C30 concrete, HRB400 main reinforcement, embedded water and electricity pipe and reserved embedded box<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Prefabricated air conditioning board for external wall<br>2. Within 1m³<br>3. 16.74m<br>4. C30 concrete, main reinforcement HRB400<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Floor precast staircase<br>2. Within 2m³;                                                                 | M³                  |
| 3             | 010513001     | Prefabricated straight slab stairs | 1. 6Precast common laminated slab at bottom of layer<br>2. Within 1m³<br>3. 14.64m<br>4. C30 concrete, HRB400 main reinforcement, embedded water and electricity pipe and reserved embedded box<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Floor precast staircase<br>2. Within 2m³;                                                                 | M³                  |
| 4             | 010510001     | Prefabricated sandwich wall      | 1. 6Precast common laminated slab at bottom of layer<br>2. Within 1m³<br>3. 14.64m<br>4. C30 concrete, HRB400 main reinforcement, embedded water and electricity pipe and reserved embedded box<br>5. JM full grouting sleeve, reinforcement grouting material<br>6. Silicone weatherproof sealant for caulking<br>1. 6Floor precast staircase<br>2. Within 2m³;                                                                 | M³                  |
3.3. Preparation of Bill of Quantities
On the basis of the optimized measurement specifications, taking the No.4 building of Jinxiuli, Jinan Ronghui City (block A14) phase I bid section project as a case, the specific analysis of the pricing activities of its precast concrete components is shown in Table 3.

4. Conclusion
With the development of prefabricated concrete building in China, in order to meet the needs of its valuation management, prefabricated concrete building should have a reasonable pricing system. At present, China’s construction projects are priced by bill of quantities, while the prefabricated components of prefabricated concrete buildings in the current measurement specifications need to be improved. Taking Jinan Ronghui city project as an example, this paper uses WBS to preliminarily optimize the measurement specifications, which is conducive to the improvement of the measurement and pricing of prefabricated concrete buildings in China.

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