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# The Roles of Construction Management in Super High-Rise Building Projects

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## Abstract

Even though super high-rise building projects have been undertaken in Korea, there is a relatively small number of studies carried out on the projects. This study aims to demonstrate the roles of construction management in super high-rise building projects. Firstly, it describes some problems in performing super high-rise building projects in Korea. Secondly, it introduces 8 problems derived from the investigation of case projects. Lastly, it classifies the role of construction managers in super high-rise building projects into four categories; (1) design management (2) delivery strategy (3) project planning and (4) project organization. In addition, in order to prepare for the demands for super high-rise buildings which are expected to grow continuously, the construction industry, academics and researchers should be unified to establish an elaborate strategic plan to improve the categories above.

**Keywords:** super high-rise building, construction management

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## 1. Introduction

Construction of high-rise buildings had long been sought by human beings and has been actually realized. The realization and development of high-rise buildings has been possible due to the advancement of the engineering area such as the advent of steel, elevators and high-strength concrete along with the increased buying-power and human passion. The construction of high-rise buildings first began in Chicago in the early 20th century and has been led by countries like the United States and Canada. Then, many high-rise buildings have been constructed in South East Asia countries such as Hong Kong, Singapore, Malaysia and China.

Ordinary people have become more interested in high-rise buildings due to the World Trade Center disaster which happened in 2001 in New York and a considerable number of people seem to have an ambiguous anxiety about the height of high-rise buildings. Nevertheless, the trend of constructing high-rise building is expected to continue. It is because not only high-rise buildings integrate all of the state-of-the-art construction technologies, but also they tend to be seen as a national symbol or indicator of economic growth. In Korea, buildings of 50 to 60 stories have been constructed these days and they are

transforming the skylines of our cities. Some people actually live as high as the 60th floor and it will become a turning point for a new residential environment and lifestyle.

Some distinctive facts can be found in the start and development of Korea's high-rise buildings.

Firstly, the buildings began to be erected for financial earning or unclear purposes without any accumulated design and building technologies. This meant that the level of technologies required for super high-rise building projects was not fully recognized. Secondly, there was not enough social infrastructure such as related laws and regulations, disaster management system and social recognition at the time of developing super high-rise buildings. Consequently, it resulted in the loss of opportunity to construct land-mark buildings due to the lacking of faith(confidence) of concerned authorities and civil petitions. Furthermore, bureaucracy of relevant laws and regulations is still preventing the development of super high-rise buildings.

This study presents various problems which occur in the construction of high-rise buildings and some cases and studies of key construction technologies and project management methods which are integral for the construction of high rise buildings.

## 2. Problems In Executing Super High-Rise Building Projects In South Korea

Current super high-rise building projects in Korea have some problems. Projects are being performed by a few construction companies of large size due to the characteristics of the construction-centered industry.

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This discourages small-sized design firms with an unstable financial foundation, from developing key construction technologies for super high-rise buildings. Related laws and regulations adhering to partition-style are not fully reformed and deep exclusionism exists among the general contractors, specialty contractors and consultants. This has also resulted in not only the obstruction of the application of advanced construction management(CM) methods to integrate design and construction, but also the joint research and development through the partnership of the companies. Consequently, the super high-rise building era has begun without any key items such as laws and regulations, core technologies, construction management technologies, and social consensus. Each problem in the execution of super high-rise building projects in Korea is described in detail below.

### **2.1 Project management**

In order to carry out super high-rise building projects, there should be a special organization which has the integrated management capability of controlling the whole process from the planning phase to the maintenance phase based on a thorough understanding and experiences of restrictions and key construction technologies of super high-rise buildings. For a successful project, the organization has to create a smooth information flow, collect various technical data and opinions, lead the decision making process, and to have the capability of viewing and managing the whole project in each project phase and by each participant. However, this has not been activated in Korea because of the lack of owners' recognition of its importance and the backwardness of related laws and regulations to support it.

### **2.2 Design and construction technology**

Design technology is one of the core areas for constructing high-rise buildings, but it is not sufficiently developed in Korea. Therefore, the cooperation with foreign professional designers for high-rise buildings is strongly needed as a strategic approach to the acquisition of technical skills. The construction technology of Korea is more developed compared to its design technology. However, considering the competitiveness of construction costs and periods in Korea, cooperation with related foreign consultants and adoption of developed technologies from other countries is required.

### **2.3 Laws, regulations and social recognition**

Korean laws and regulations are regulation-centered. They have strictly applied a rigid floor area ratio and allowable building height governed by area or adjacent roads. In addition, partition-style regulations hinder the application of various delivery methods, adoption of the CM method and the activation of constructing high-rise buildings. It is not a rare case that a plan for super high-rise building is nullified by a civil petition

or the disbelief of authorities resulting from the lack of social recognition.

### **2.4 Feasibility Study**

A project feasibility study should be thoroughly conducted based on the profitability of the project. However, it is one of the traits of super high-rise building projects that various contradictory fields from planning to maintenance have close links with each other and each field concentrates many related key construction technologies. Therefore, successful performance of a super high-rise building project requires the establishment of clear goals, elaborate planning based on the understanding of business circumstances, selection of the best solution among alternatives and preview of the solution with the key construction technologies in each project phase. Nevertheless, the reality is that the shortage of experience and ability to perform a super high-rise building project yields a deficient feasibility study and consequently, breeds high risks like the potential encroachment on the profit.

### **2.5 Risk management**

Future status should be forecasted in each phase of the project process. Forecasted future status must include the uncertain factors on which the success of the construction project relies. Risks and uncertainty increase dramatically in constructing super high-rise building projects, but currently projects are being executed based on existing experience and intuition. In addition, systematized risk management has not been satisfactorily achieved. Focusing on the start of a project without any thorough review and verification of risks in every project phase results in frequent changes of the project plan and lead to a vicious circle of cost rise, time retardation and quality deterioration. It is vital to recognize the importance of risk management, to reflect identified risks in the project plan, and to make a positive loop.

### **2.6 Time management**

The core elements of time management include defining the characteristics of a construction project through the understanding of overall circumstances, establishing the milestone for each important item of the project and creating the master schedule timely and thoroughly. However, the variation between as-planned and reality is considerable due to the lack of understanding and experience of the environment for super high-rise building projects. The master schedule should be improved by detailed planning of each area with the feedback obtained. Also, the feasibility of every element in construction process should be considered in the master schedule. Super high-rise building projects especially require the proper tools to shorten the schedule by connecting technical elements with managerial elements in every phase and the

cooperation of project-related business parties with each other.

### **2.7 Decision making management**

Timely decision making is one of the key elements to a successful project. It is not easy to make a right and timely decision in super high-rise building projects because the decision making group has a number of various participants and professionals who have different interests in the project. The delay of decision making led by the lack of communication among the parties will result in claims, time retardation, cost rise, quality deterioration and partnership breakdown. Some cases of super high-rise building projects demonstrate that a timely decision influences greatly on the whole project and is one of the core factors determining the success of the project.

### **2.8 Design management**

In super high-rise building projects, each key construction technology such as architectural planning, structure, M&E(mechanical & electrical), materials and constructability should be integrated in an effective and systematic way. Nevertheless, Korean construction companies complete the design without a full review of cost, time, and constructability. Consequently, they cause continuous problems in a construction phase but they do not take the full responsibility for them. Also, there are so many design cases that present structural problems, lack the constructability and efficiency due to the unreasonable demand of owners, and are short of partnership among the participants.

### **3. Problems Derived From Project Cases**

Current super high-rise building projects in Korea are experiencing a lot of trial-and-errors. The reason can be extended beyond external matters such as the lack of the experience and technology. This implies that it is not simple to understand and perform exactly throughout the whole process from the planning to the maintenance.

Some local high-rise building projects were planned by large-sized construction companies of Korea and commenced after careful review and settlement of risk management in their own way, in considerable time, but they did not seem to show enough performance coinciding with original plans and goals.

Problems which have appeared up to now in most projects are summarized as below:

1) The lack of understanding of design management results in an inefficient project performance in relation to design completeness, cost control in each design phase, and project time management.

2) Adopting various options considering business profit and sale yields delays in decision makings and low constructability.

3) There is a limit in the role and the work scope of project consultants in the planning stage.

4) Decision making processes do not seem to be managed in the right time.

5) An insufficient design and delivery strategy shows up the lack of the coordination within each field of the project.

6) There is often a design change on core elements such as that of the structural system after the design development is almost finished.

7) The difference between the reality and the plan breeds the secession of the schedule cycle.

8) There can be cost rise, quality deterioration and time retardation due to above problems.

A close investigation of above problems reveals that there are many problems in managerial areas as well as in technical areas. In addition, the problems seem to produce a great amount of financial damage due to the loss of opportunities.

## **4. The Role Of Construction Manager In Super High-Rise Building Projects**

### **4.1 Design management**

One of the most important roles of CM is the design management in the early design phase where the cost, time and quality of a project are determined. In the case of super high-rise building projects, it is customary to use the fast track method in order to shorten the project period. The fast track method needs a high level of technology, but the current state in Korea is that there is not sufficient understanding and experience of management technology, and an underplayed role of professional organizations in design management. The core roles of design management for super high-rise building projects are controlling conflicting factors within architectural, structural, mechanical and electronic documents, reviewing the project cost and construction methods to shorten the project period and executing the constructability study. It is noteworthy that the successful projects of the Empire State Building, a 102-story building completed in 1931 in just 13.5 months, and the Trump World Tower, a 70-story RC building recently built in 24 months, are basically due to the advanced design technology.

#### **(1) Role and work scope of foreign designers**

Current super high-rise building projects in Korea generally use domestic design firms, except for structural design where advice of foreign consultants may be sought. It might save some construction costs but it does not seem to be an appropriate method considering Korea's poor design technology. There have been some trial-and-errors in the construction phase, which have an adverse influence on cost, time and quality. Therefore, it would be better to entrust foreign design firms to prepare the master design and part of the shop drawings until Korean designers have the capacity to design super high-rise buildings. In addition, the conceptual design phase should be understood as a planning phase to maintain the

consistency with the initial business plan and have adequate feed-backs for establishing an optimum plan relating to cost, time, and constructability, three core elements of design management. The role of each specialty consultant is very important, therefore, they should be involved in the early stage from the conceptual design phase to secure appropriate design documents and to manage time and cost properly. In the case of KLCC, the highest existing building in the world, about 60 specialty consultants participated in the project from the early design phase and the design of each area was coordinated by the CM team to produce effective design documents. Moreover, design contracts should be recognized as an essential factor to affect the quality of the design, since a standard to evaluate the level of design quality should be presented and included in them.

### **(2) Fast track management**

Fast track management is one of the essential factors for the construction of super high-rise buildings because it can shorten the project time and enables the project to respond flexibly to the changes of market and the design. A successful fast track requires the overall understanding of characteristics of planning, design, construction and maintenance of the project, the organized knowledge, and high level of management skills based on the experience in similar projects. In super high-rise building projects, the most important thing is to prepare required design documents according to each project phase based on the milestones. Also, in the course of executing the management, consistency and completeness should be ensured. Furthermore, changed facts should be applied to related fields timely and accurately. The process should be able to prevent potential errors in the information transfer.

### **(3) Core design technology for super high-rise buildings**

Among the major management items of the super high-rise building design, the displacement by wind and vibration control system is the first thing to be considered. Also, some items will be categorized as major management items. They are curtain wall system, elevators, stack effects, shortening, control of wind tunnel effect, exit and fire control system, parking and transportation system, external wall cleaning system, building maintenance, M&E related items and landscape lighting. In addition, other important items include the interior design, communication and information transmission system, noise interception and prevention system, and the right for view which aim to improve the dwelling and convenience. Specialty consultants for each item are required to understand and settle these items.

### **(4) Mock-up**

Current residential buildings in Korea usually have

their model houses to display their plans and finishing materials for sales. However, the aim of the mock-up construction is much different from that of the model house. Also there are many cases that the mock-up is made after the structure has gone up to some extent. It results from the lack of understanding of the aim of mock-up making and has no influence on decision makings in the early planning stage. Mock-up should be used as a tool for choosing designs and assessing constructability. It also should be carried out in the early design stage in order to draw the best decision. As super high-rise building projects normally adopt complex design factors, the mock-up should be made and assessed in the separate temporary facility in the early planning phase to reduce risks caused by trial-and-errors and the cost in the real construction.

## **4.2 Delivery strategy**

Despite a great amount of overseas construction experience, the construction industry in Korea still has not overcome the low level of construction production method. It hinders the nation's international competitiveness and the rearing of domestic trade contractors. Large projects in Korea, including domestic super high-rise building projects, generally adopt the delivery method where one general contractor is awarded the project in a lump sum and makes sub-contracts with trade contractors for each trade. While this delivery method has advantages such as clear responsibilities and a simple instruction system, it has disadvantages such as the likeliness of cost overrun and the chance that trade contractors will ignore the owner's intention due to the great amount of power of a general contractor. There is no reason to adopt the traditional delivery method because super high-rise building projects generally have many trades which require advice from specialty consultants, and owners' decisions also play a pivotal factor. Therefore, the development of the delivery method suitable for super high-rise building projects is greatly needed.

### **(1) Nominated sub-contractor**

Nominated sub-contractor(NSC) method is that an owner nominates a certain sub-contractor prior to the selection of a main contractor and make them work together for a project. The main contractor is paid a fee for management of the site. In South-east Asia, this delivery method is applied up to half of the total project cost in some cases. NSC method requires an elaborate contract management to clarify work scopes for each contractor and the establishment of well organized communication system. NSC can be applied to trades such as curtain wall, masonry, elevators, M&E and interior.

### **(2) Early bidding**

Early selection of NSC enables the early involvement of trade contractors into the design phase and consequently, improves the design quality and

ensures the constructability. In addition, NSC can prepare an elaborate project implementation plan with full understanding of the project. The Trump World Tower in New York is one of the cases of the early bidding of trade contractors where the first nominated trade was not excavation work but curtain wall work.

### **4.3 Project planning**

#### **(1) Logistics plan**

In a construction project, a logistic plan has a far-reaching influence on cost, time, and quality. It becomes even more important in the case of super high-rise building projects since projects are usually executed in the downtown area which causes a need for control of logistics of a large size, complex working lines, and the long haulage distances. A logistics plan must include the overall procurement plan containing long lead items as well as a site logistic plan to become the foundation of all construction plans. Especially a temporary facility plan needs to be studied connecting project duration and cost with the logistics plan. The introduction of the JIT(Just In Time) concept based on the internet is essential considering the difficulty of finding storage yards in downtown areas. Furthermore, the adaptability should also be ensured to respond immediately and flexibly to the change of site conditions and circumstances, and the force majeure.

#### **(2) Construction plan**

The most important items in the construction plan of super high-rise buildings can be the hoist plan and the structural work plan(esp. for the core). The hoist plan determines project quality and progress. The quantity, location, size, capacity, and time of installation and disassembly of hoist are linked directly to the efficiency and the productivity of a project and are also related to the logistics plan. The structural work in a super high-rise building project is executed in a fast cycle. Therefore, the core should be reflected in the design process in order to evaluate the framework cycle and reviewed in relation with the application of the form system. In case of selecting a form system, whether or not to adopt pre-fabrication of steel should be considered. In addition, the constructability should be maximized by a close investigation of fixity of a concrete placing boom(CPB). As to the review and the selection of an optimum construction method, the work environment and safety of workers should be taken into account as important factors.

#### **(3) Cycle time management**

As being performed by a crew organization, the schedule management of super high-rise building projects has to adhere to a cycle time and monitor each cycle deliberately. Some super high-rise building projects in Korea often have problem in adhering to a cycle time because of the lack of predictability and

detail in the project schedule, the difference between design documents and the schedule plan, the delay in decision makings, and the failure in timely procurement and assigning proper human resources. In order to ensure the methodical and repeatable site environment which is essential to adhere to a cycle time, the use of systematic design elements, the selection of methods which enable works to have a consistent pace, the timeliness of the procurement of human resources and materials, a systematic support team is required. In addition, the tools that minimize obstacles to the adherence to a cycle time and maximize positive factors should be applied from the early planning phase. The success of super high-rise building projects depends on how much the project duration is reduced which can be achieved by the adherence to a cycle time that leads learning effects. Therefore, a precise schedule plan should be established considering cycle times from an early project planning stage.

#### **(4) Construction implementation plan**

The construction implementation plan for a super high-rise building project aims to realize the concept formulated in the planning and design phases. Therefore, it should contain procurement and sub-contracting strategy, and plan for design development and construction to play a guideline for a successful project. It should be prepared in detail after the bench-marking of similar projects is conducted and related data are collected with the active participation of specialty consultants.

### **4.5 Project organization**

#### **(1) Design management team**

While the design management team of a super high-rise building project can be formed appropriately according to the size and scope of the project, it should play an important role in the project from an early planning phase to the substantial completion phase. Therefore, a design management team should comprise professionals of each field including specialty consultants to keep up the consistency. The basic roles of the team are project goal analysis, design review, the revision management of design documents conforming to a project schedule especially in the case of fast-track and a flexible ability to cope with design changes. Also, it should be able to find cost saving factors through the application of a life cycle cost(LCC) analysis and value engineering(VE), and develop construction methods suitable for the super high-rise building project. The importance of design in super high-rise building projects cannot be further emphasized.

#### **(2) Risk management team**

The large size, complexity and long project term of super high-rise building projects naturally result in

high potential risks. Therefore, a project organization should have an ability to identify and analyze expected risks, to establish a risk responding strategy and to follow the strategy immediately when a risk turns into a problem. Risks occur through all phases from a planning phase to a bidding phase to a construction phase. However, it is important to set up a systematic risk management plan to reflect it into cost estimation and secure a project contingency when necessary. The early involvement of specialty consultants in the project organization can reduce risks, and the risk management team can also be considered to execute feasibility study of contracts, claim management and a study on the effect of a risk upon the project schedule. In addition, political, social and environmental risks also exert direct influence on a construction project considering the current situation of the nation's construction industry and should be analyzed to achieve successful project performance.

## 5. Conclusion

This study covers the problems in executing super high-rise building projects and presents solutions for each core item. Korea lacks the technologies for super high-rise building projects because of a short of construction history of such projects, and insufficient related data and research. Nevertheless, demands on super high-rise buildings are expected to grow for the resolution of overcrowding in cities, more provision of dwellings and work environment and the efficient utilization of land. Therefore, key construction technologies should be developed covering design, structural engineering, mechanics and electronics and applied in actual work sites for the upcoming super high-rise buildings era.

Especially, a strategic approach from the long-term viewpoint is required to ensure a core design technology and key construction technologies. The industry, academics and researchers should unite to establish a master plan for the development of related technologies and each party should have clear roles. This approach should contain six steps: (1) the selection of key construction technologies to be developed for super high-rise building projects (2) the case study and assessment of Korean or foreign

projects (3) the search and the investigation of best practices (4) the examination of related regulations in Korea and other countries (5) the application to a pilot project and spread of the practice (6) the introduction of foreign advanced technologies and their proper utilization.

At the same time, the understanding of construction projects should be fundamentally turned from the conventional approach of 'operation' to the approach of 'management' as soon as possible. Super high-rise building projects concurrently involve a lot of consultants for each trade as well as owner, contractors, designers and supervisors. Therefore, for the success of super high-rise building projects, it is necessary to draw timely decisions by leading all of the participants, to build a team to coordinate each participant's interest and to reinforce a partnership to maximize the synergy effect. It explains the necessity of the introduction of the management concept into construction projects.

The government should also play an important part. It should recognize that super high-rise buildings are products of the demands of the times. It should reform related laws and regulations for the activation of super high-rise building projects, the application of management technologies, and the adoption of various delivery strategies. Policies to aid the private sector in developing key construction technologies should be established and promoted. In addition, the government should carry out the effort to reduce the nation's insecurity about super high-rise buildings by improving a national disaster prevention and management system dramatically using the World Trade Center disaster as an example. Then, the public will have a positive view on super high-rise buildings which will minimize the costs caused by lost opportunities to construct land-mark high-rise buildings in Korea.

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