

# Construction Technologies for Effective Project Schedule in High Rise Construction – A Review

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**Abstract—** One of the most crucial aspect that project managers are constantly struggling with in high rise building construction projects is time. Many research studies have experimented and concluded that construction technologies can help to manage project schedule of high rise buildings effectively. This paper attempts to highlight the issues of time and cost over-runs in the construction of high rise buildings and the significance of construction technologies in addressing these issues. This paper reviews a few of the latest construction technologies to understand its impact on the project schedule of construction projects. The paper concludes with the need for such construction technologies to improve the present status from the various research contributions.

**Keywords—**Construction Technologies, Highrise Buildings, Project Schedule

## I. INTRODUCTION

The scarcity of urban lands has paved the way for high rise buildings today, be it residential or commercial. High rise buildings has to be constructed using particular methods and techniques as various factors from the load of the building to the finishing required is quite different from other buildings. These methods and techniques have to be fast enough to complete the project on time and make it a success. Unfortunately, the methods and techniques we have been using have not been able to achieve project completion on time and one of the major problems in high rise construction is project delay which results in cost overruns.

Many factors contribute to the delay in construction projects like design finalization, contract sign off, procurement, execution and also handing over. Of all the activities in the project of development of a high rise building the execution of the building takes up the major time involving process. Today we have endless possibilities in any field because of the major technological advancements; the same can be said for execution of buildings. We have many innovative construction methods and techniques that can be applied to construction which can help in effective project schedule and completion of project without delay.

## II. NEED FOR EFFECTIVE PROJECT SCHEDULE

### A. Compressing Construction Duration[1]

An analysis of the factors that affect the construction performance having been done, leads to that instead of studying the negative aspects like delay factors, and concentrating on positive points like shortening construction time will give better results. The positive factors were obtained from previous researches and were found to be useful

for improvement in the present situation particularly reducing the time of construction.

The previous statistical models developed were found to be based on the primary variables like construction cost, gross floor area, project complexity, some management attributes like effectiveness of communications and speed of decision making to predict the construction duration.

Another construction time prediction model for Hong Kong is a set of regression models were researched based on the duration of work packages for the different standard type of public housing blocks in Hong Kong. The outcome of this model shows that 'communication management' as the significant variable to influence durations of work packages. The critical factors from this model was used across three specific building sub-sectors and surveyed.

The study consisted of opinion surveys in three independent projects – one from each sub-sector like Public housing, Public non-residential buildings and private sector buildings. The experienced-based judgements of the various types of industry practitioners like, clients, design consultants, building contractors were mainly sought through structured questionnaires surveys. Several factors of similarities and differences that was the outcome were further factor categorized and they were given ratings to convert them into indices for easier comparison. The cross comparison resulted in factors like communication and co-ordination as the similarities.

Finally a PhD research findings give the recommend strategies for shortening the construction duration, which were broadly categorized into technological strategies and managerial strategies.

### B. Impact on Time, Cost and Resource[2]

Extensive comparative evaluation of construction performance internationally have been conducted in reported in previous works by many authors. Technological improvements like prefabrication and industrialization have been identified to be the most likely approach for reducing construction time and cost and improve production performance in many countries successfully like Finland and Israel, USA in early 1960's and Hong Kong, Singapore since early 1980's there has been no research that evaluate the speed of construction methods impact on time, cost and resource requirements.

A research to study the impact of different construction methods or techniques on production performance is being done. The work study technique including activity sampling

and continuous time study is adopted in the research. Three different construction schemes are defined with respect to duration of structure, LABOR input, and costs for direct labor. Data is collected from three construction firms which occupy 1/3rd of the market and this constitutes one scheme, the other two schemes are from different contractors.

The site investigation of all the three schemes are collected and analyzed on each indicator, cycle duration, labor requirements and cost. The impact is different on each indicator, the shortening of duration is evidenced by the use of new construction technology, and however costs may increase. Such kind of comparison can help construction firms to select appropriate methods for better performance.

### C. Buildability Performance[3]

The definition developed by the UK pioneer proponent of buildability, the Construction Industry Research and Information Association (CIRIA) is, 'buildability' represents the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building. It is simply the efficient way to construction within its constraints, and the productivity is measured by it. It is noted that in Hong Kong when the industry experienced slow productivity there was increase in the building costs. CIRC report, 2001 highlight that in traditional construction, the owner engages a designer for designing and supervision, the contractors brought in later which gives poor buildability. The lack of knowledge and experience in construction of the designers, and many other similar factors are the reasons that complicate buildability.

Poor buildability will lead to time and cost over-runs hence have to be addressed and measures to improving it. The use of prefabrication and standardization has given Hong Kong the buildability required and improved productivity. The public housing department has taken initiative to apply prefabrication in their projects and the private sectors are provided with incentives for adopting them in their projects.

## III. ANALYSIS OF THE CURRENT SITUATION

### A. Current scenario in India[4]

The demand of high rise buildings in India is growing up and it is indeed a complex task. The construction of high rise buildings is highly complex, tedious and requires proper planning to successfully execute one. There are also many other factors involved when constructing a high rise structure like, safety, quality, time and cost. These four constraints make the project even more challenging. With meticulous investigation, pre-planning, pre-engineering, designing and executing of the project is considered an intense process which can be addressed only with planning to make it a success. By successful it means that that the project is completed on time, within budget and with good quality. Other factors like fire safety, environment safety and managing the waste also must be addressed as these have greater role in high rise construction compared to others.

The current technology being used for constructing high rise buildings in India are the use of reinforce cement concrete structure, with cement blocks for walls with various machines like cranes, ready concrete mixers, to aid in the execution. Some bigger construction companies are using a combination of various technologies like slip-form work, pre-fabricated

construction, dry-wall techniques, ground improvement techniques, using geo-synthetics for strengthening soils, etc.

In most of the major cities in India high rise buildings are growing rapidly due to overcrowding. The demand is growing not only for residential purposes, but also for business also. The demand can be met only if project are finished on time, and if possible faster and it can be achieved by proper planning, and adopting newer construction techniques.

### B. Time and cost over-runs in India[5]

Time and cost over runs are serious issues in the Indian scenario of high rise construction, still the factors behind them are much less researched. The various research done on time and cost over runs give us many variables that plays significant role in the poor performance, and all those variables are put into a study and surveyed with respect to Indian construction. The questionnaire survey was distributed among owners, contractors and consultants of Indian construction industry with ample experience in handling large projects. The data thus collected is put to a reliability test by using Cronbach alpha method which is widely adopted and analyzed to obtain Relative Important Index (RII).

The causes of time and cost over-runs are ranked and tabulated along with its RII. Such causes call for immediate intervention by the stakeholders for the project to be a success. The remedial measures can be taken by owners, contractors and consultants to make sure the project productivity is not affected.

## IV. CONSTRUCTION TECHNOLOGIES

Delays are inevitable is project of a large capacity which leads to non-delivery on the date agreed by the contract. The quality is compromised when there is pressure to deliver along with many other factors. Safety is another aspect and neglect of that causes delay and compensations for accidents is definitely a cost overrun, moreover the accident and fatality rates is highest in construction than in any other industry. The drawbacks in conventional construction of high rise buildings like loss of quality, safety, time and cost can be overcome with new technologies. [6]

### A. Precast Concrete Technology[7]

This technology is highly efficient in terms of speed and has gained a lot of popularity in the last two decades. Buildings from mid-rise to high-rise can be constructed with this technology. The off-site manufacturing takes care of the aspects like quality, safety, time in one package. This technology is best for high rise buildings as it can turn up huge volume and repetition. In Indonesia the precast system have been used in public housing projects to a large scale and has been considered successful, especially that it has accelerated the construction process. A study carried out of the projects done by two government institutions in Indonesia recommends precast system as it has several advantages over conventional in-situ systems.

### B. Aluminium Formwork System[8]

The light weight formwork system helps in faster construction with the ease which with it can be fixed and removed and unskilled workers can even handle it. This is well suited in repetitive construction process as the formwork is modular made in factory, with a trial set up done in the factory. The formwork components are high strength aluminum panels welded to an aluminum sheet and

manufactured for specific design. The various components are explained in detail and the procedure of setting up the formwork and taking it down is also discussed with a case study. However, the speed of construction of this formwork is its main advantage along with its superior finish and less work on plastering thereby minimizing time.

#### C. Pre-Engineered Building[9]

The improvement in technology has given us PEB i.e. Pre-Engineered Buildings, which is completely steel frames structure with steel for walls, doors, windows, floors and roof. The building is completely fabricated in factory and installed at site with nuts and bolts, thus reducing the construction time drastically. Apart from being SUPER-FAST this technology is sustainable. All the analysis of the building is done by using Staad Pro software and the load calculations are compared to conventional frames found to be less by 25%, the weight of PEB are lighter than conventional, provide more clear longer spans and are also cost less.

#### D. Modular Construction[10]

Also called volumetric construction this technology is considered modern method of construction and Malaysian Construction Industry is evolving towards it. The advantages like quality construction, speed of installation, sustainability and others make it the most effective of the new techniques is discussed in detail and also its contribution to Malaysia. The characteristics of modular construction makes it to be produced off-site in huge volume will also cost lesser. This technology needs more research to enhance the process, create awareness of the technology and its implementation in construction and expedite the construction.

#### E. Top-Down Construction Technique[11]

This is an emerging technology where there is simultaneous execution of sub-structure and super structure. The schedule can be compressed as the building can be worked both above and below the ground at the same time, and also there is no waiting time for the high rise to come up till the basement is finished. Many other issues like dewatering, wall and soil movements are minimized. The installation of the technique is explained in detail, and the emphasis is on the diaphragm wall.

The methods on installation of the diaphragm wall, the different materials for the wall are studied in detail. Two case studies are investigated where this technique is applied in different ways and there are many more ways. This is innovative technology that has to be researched and applied in Indian context to greater extent.

## V. CONCLUSION

All the summary of the papers presented above lead us to one point that construction techniques can reduce the construction time which is a priority in high rise building constructions and also give quality, safety and are cost effective. The fear of the unknown is what that has kept these technologies at bay from the Indian Construction Industry, hence to bring about an awareness of these techniques and its advantage techniques over schedule compression is the main aim of this study. Further research is required to compare the techniques against each other so as to understand the most efficient of them, which will give a clear understanding in its application in the industry.

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