



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 7, July 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118



9940 572 462



6381 907 438



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Time and Cost Comparison of Monolithic Construction over Conventional Construction Method in Housing Projects Using Primavera Software

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ABSTRACT: The Monolithic Construction system is well-known technology though it was developed many years ago its implementation is slowly catching up with 30% growth year on year. This study focuses on the comparison of monolithic technology using aluminium formwork and conventional technology using traditional formwork. The construction cost estimation of three storied building was done by both conventional construction and monolithic construction technology. Primavera p6 is used for planning and scheduling construction activities. The Comparison of cost between both methods is presented here. The time required for the construction of 1136 dwelling units using both methods is also presented in this paper.

KEYWORDS: Time and cost, Monolithic technology, Scheduling, Primavera p6.

I. INTRODUCTION

Houses serve more than merely as shelters. Since housing is one of the most essential human needs, they are the key to leading a fulfilling life. The population in a country like India is rapidly increasing, resulting in a housing shortage in the country. Many people in India live in slums, on the ground, in huts, on illegal property, and temporary shelters. The future will present significant and difficult challenges for the traditional housing construction method, labour availability, and labour cost. It's vital to have a low labour dependency, innovative technology with mechanization, so that a house can be built quickly, qualitatively, and affordably. India requires the greatest number of houses requirements at the lowest possible cost and in the shortest possible timeframe. Monolithic Concrete Technology with aluminium formwork is an upcoming technology that is enabling mass housing projects to be built cost-effectively and rapidly. Formwork systems play a very important role in project time, cost and recurring maintenance expenditure. Various Form work systems and methodologies are available world-wide whereas intricate and in-depth analysis of suitability of the form work system for the project centric approach is very much sought before adoption of any such systems.

Construction projects are becoming progressively larger and more complex in terms of physical size and cost, hence the risks and potential for losses require better control. Project management has evolved mainly because of the need to control costs and schedule. One of the major elements that affect and contribute to a project's success or failure is project scheduling. Without proper planning, scheduling, and resource allocation, the construction industry does not profit from the project. Proper software and techniques must be used for this purpose. Project management tool Primavera P6 is primarily used for this study. The primary goal of this study is to use Primavera software to compare the costs and duration of monolithic construction to traditional construction methods in housing projects.

II. LITERATURE REVIEW

J.Vijaylaxmi et al. (2022) [1]: The goal of this research is to look into the time and cost performance of construction projects in India. After identifying factors associated with time and cost overruns in earlier studies, this empirical study uses a structured questionnaire. An assortment of construction industry participants, including owners, consultants, contractors, and project managers, are surveyed for data. The results of this study show that external factors like lengthy dispute resolution, permits from relevant authorities, market conditions, and contractor-related factors like financial difficulties by contractors, ineffective planning and scheduling, poor site management by contractors, client-related factors like late payments by clients, frequent change orders during construction, and material and machinery-related factors like poor procurement planning all have an impact on the construction process.

KwadwoOti-Sarpong et al. (2021) [2]: The paper offers complementary understanding of what transpires in a project-based attempt to transfer technology by concentrating on nature of technology, roles actors play, social artefacts, and larger context through lens of social construction technology. The analysis, which focuses on the creation of new monolithic formwork technology on a mass housing project in Ghana, shows how adopting new technology can have significant effects on project management by influencing project routines, production methods and end products. According to findings, it is necessary to take into account more flexible project planning and management procedures. MF is made up of thin aluminium panels and extras like connectors, struts, tie rods, bolts, flushers, etc. that are made specifically for the project. The technology enables the simultaneous concreting of structural elements like walls, slabs, beams, columns, and stairs by utilizing monolithic construction techniques. Although MF's design principles are standardized, each project's requirements are met by custom-made components.

MullapudiDurgaSruthi et al. (2020) [3]: The main goal of this paper is to use earned value management to analyze the cost and schedule for a residential building. A case study is used for this project to determine the performance and progress of the project in terms of time, cost, and resources. Earned Value Management (EVM) is one of the best methods for tracking construction project progress. It evaluates effectiveness and estimates completion time and costs by taking time and cost factors into account. This technique can be used to detect and control delays as well as serious time and cost issues. In comparison to manual calculation, Primavera is an efficient tool for calculating Earned Value Analysis for projects.

Hindu Odugu et al. (2020) [4]: This research compares monolithic technology with aluminium formwork to precast technology. Both monolithic construction and precast construction technology were used to estimate the construction costs of an eleven-story building. Primavera p6 is used for construction activity scheduling and tracking. Project's total cost and duration have been determined. The cost comparison revealed that there is a cost difference, with precast construction being significantly more expensive than monolithic construction. The precast construction method is simple to use and reduces project duration. Precast construction takes less time than monolithic construction methods. Precast construction is highly productive and produces little waste. Construction using the precast method has a lower dependence on labor.

Mohan Sai Gaddam et al. (2020) [5]: This paper compares existing formwork technology to newly emerging formwork systems such as aluminium formwork and jump formwork systems, which are not commonly used in India, and recommends which method is best for the project under consideration. Formwork is an important architectural feature that accounts for 20-25% of total construction costs. When compared to traditional methods, it is possible to cast larger elements faster using the most recent formwork methods, eliminating the need for time and labour. Conventional methods take 20% longer than aluminium formwork systems and 65% longer than jump formwork systems. Aluminium formwork and jump formwork systems cost 25% less than conventional formwork systems. The project's cost and duration can be reduced by using this newly emerging type of formwork system. Using these newly emerging technologies, projects can be completed effectively, quickly, and affordably. Because construction takes less time, it can indirectly save money on construction costs.

Sreenath.V et al. (2018) [6]: This thesis provides a concise definition of the demand for modular aluminium formwork in the Indian building sector. The analysis of the viability of customizable aluminium formwork system in a framed building takes into account the quality, speed, labour requirements, cost and other pertinent factors. For comparison, same average floor plan is also created in full Mivan design. The cost estimates of each floor for three constructions were created using the three possible formworks. Given the number of formwork repetitions conceivable, it appeared that the building employing Mivan technology would be the most cost-effective overall. When only the initial expenditures were taken into account, it was discovered that using modular aluminium formwork is expensive. However, the technique is more cost-effective than conventional technology because of the quality produced by using modular aluminium formwork, the stability provided by monolithic construction, the larger carpet area, and the speed of construction.

S.M.B.Jaswanth et al. (2018) [7]: This study focuses on how planning and scheduling can be optimized, and how much time can be saved. Construction industry is lagging due to inappropriate planning and scheduling, but with the help of P6 software it can achieve the appropriate planning and scheduling. There are still many construction companies that are following the traditional way of planning only few companies are using P6 software. In olden days planning was more time consuming; now with the help of P6 software, time can be minimized during the initial stages of planning. Primavera software is user-friendly, allowing users to do any task. The cost of any individual work break- down in a structure can be determined, as well as the duration. The result shows that in comparison to the original schedule, 6% of it has been modified with the help of Primavera software. The cost variation after cost optimization is 2.9 % as compared to the originally projected budget.

III. OBJECTIVES

1. To study the monolithic and conventional construction method.
2. To prepare the Architectural drawings and BOQ for the Housing Project.
 - To prepare the housing plan and its bill of quantities.
3. To prepare the Programme of Works using Primavera software - Using Critical Path Method.
 - To define the list of activities and estimate the duration of each activity.
 - To provide the relationship between the activities.
 - To define the resource pool and assign appropriate resources to the activities.
 - To develop scheduling for both the construction method.
4. To compare Time & Cost of Monolithic Construction over Conventional Construction in the Housing Project.

IV. METHODOLOGY

The process of Time and Cost comparison of Monolithic Construction over Conventional construction method in housing projects with the help of primavera software consist of a series of steps. The basic steps for executing the present work are given below.

1. Literature survey
2. Site visit
3. Estimating quantities of Monolithic and conventional construction
4. Analysis of cost
5. Scheduling using primavera p6
6. Results and discussions
7. Conclusion

Data's regarding the monolithic construction technology is collected from visiting the site. Using AutoCAD; a plan for both monolithic and conventional structure was created based on the information gathered and with the case study as a reference. In case of Monolithic construction, the basic house is designed so that each flat is intended to have a total area of 281 sqft . Living space, a bedroom, a kitchen, and a bathroom have all been separated from one another. Houses in G+ 3 configurations: Living space - 84 sq.ft, Bed room - 70sq.ft, Kitchen - 35 sq.ft, Bath - 33 sq.ft.

Identified activities involved in both the construction of monolithic and conventional structure and prepared the bill of quantities. The rate of the activities is calculated using Analysis of rates-Delhi volume 1 &2, 2018.

The activities are then classified as work breakdown structure for scheduling using Primavera P6 which includes: Phase I – 8 blocks, Phase II – 9 blocks, Phase III – 30 blocks, Phase IV - 24 blocks. Each block consists of 16 houses (4 houses in each floor)

V. RESULTS AND DISCUSSION

Analysis is done in Primavera Web as per the available data and the results are generated. The schedule for the two types of configuration is done using the Primavera Software. The various activities involved in the two types of structures are planned out, and starting and ending dates are assigned to each activity. Based on these activities the schedule is prepared for the monolithic and conventional structure. The approximate cost estimation is done for both of the structure and the comparison is made based on the schedule and the budget for monolithic and conventional technology. The ideal system is chosen based on these factors.

Comparison of Monolithic and Conventional Construction

The comparison of monolithic construction and conventional construction is conducted with reference to -

1. Cost of construction
2. Time taken for construction
3. Maximizing Usable area
4. Dependability on Labors

Cost estimation for conventional and monolithic construction methods

Sl No.	Description	Conventional method, Total cost (Rs)	Monolithic technology, Total cost (Rs)
1	Substructure (excavation, sand piling/filling, foundation, plinth)	6,13,81,147	5,58,62,062
2	Superstructure	224,72,93,488	23,59,46,836
3	Finishes	34,37,065	NIL

Table 5.1: Total cost of monolithic & conventional construction method

The same floor plans for 1136 dwelling units were used to estimate the building quantities for both construction systems, including the earthwork, PCC, reinforcement for the superstructure and substructure, RCC works, etc. The comparison does not include activities like flooring, roofing, wood works, sanitary fixtures, etc. The cost required for both types of construction, is shown in Tables 5.1. After calculating all the quantities, the total cost for the monolithic housing project is Rs. 29, 18, 08,898 and the total cost for the conventional housing project is Rs.31, 21, 11,700.

When compared to conventional construction, monolithic construction results in a 6.5 % reduction in construction costs. The cost-benefit analysis presented above does not account for additional costs and benefits like increased carpet area costs (5-6%), early occupational costs (4-5 months), savings on interest costs, reduced resource holding costs (4-5 months), etc. that would be associated with conventional construction. Material wastage on site, no one kept track of it (3-5 percent). The scrap value of aluminium forms after 100 repetitions was also not taken into account. Considering above details, approximately 10-15% of overall cost shall be saved. The Analysis of rates-Delhi volume 1 & 2, 2018 is used to determine the rate for each activity.

Traditional formwork- Initial cost is less (Rs 4200/sqm) but finish is not good & life cycle cost is high due to less repetition 70-80. Cost of shuttering is Rs 400-500/sqm.

Aluminium formwork- Initial cost is high (Rs 7500/sqm) but finish is very smooth & life cost is low due to large no. of repetitions 170-250. Cost of shuttering is 175-200/sqm.

Scheduling for Monolithic and Conventional Structure

From the schedule given in Fig 5.1 and Fig 5.2 we can see that the time required for the completion of the Monolithic housing project is 263 days and that for the conventional structure is 353 days. When compared to conventional construction, monolithic construction results in a 25% time savings during the building process. As the time required for sub structure work is same for the both structures, the time required for the construction of the super structure takes more time. Since, in monolithic construction all the building components are cast together.

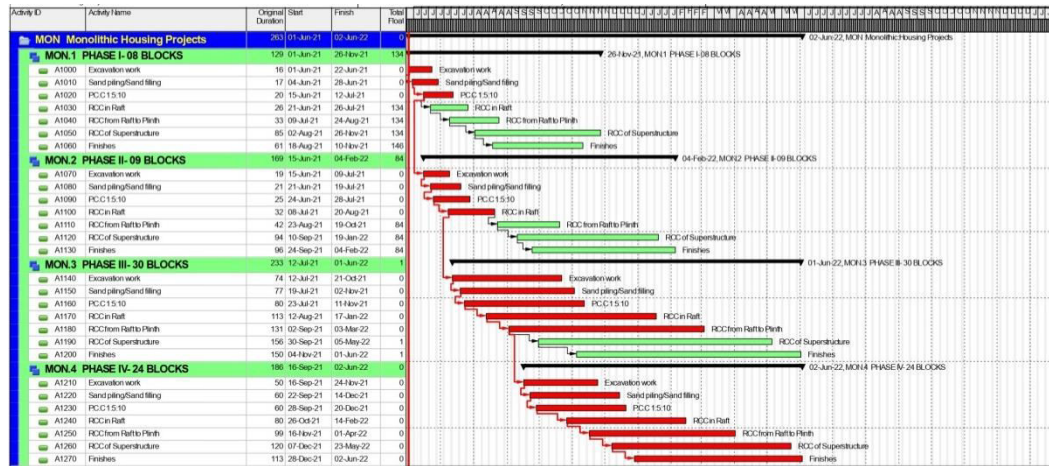


Fig 5.1 Schedule for Monolithic housing projects

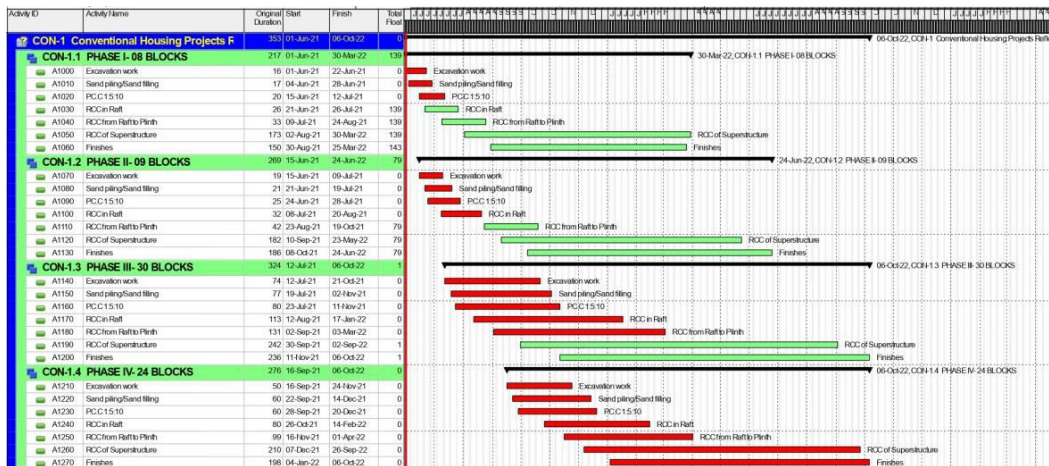
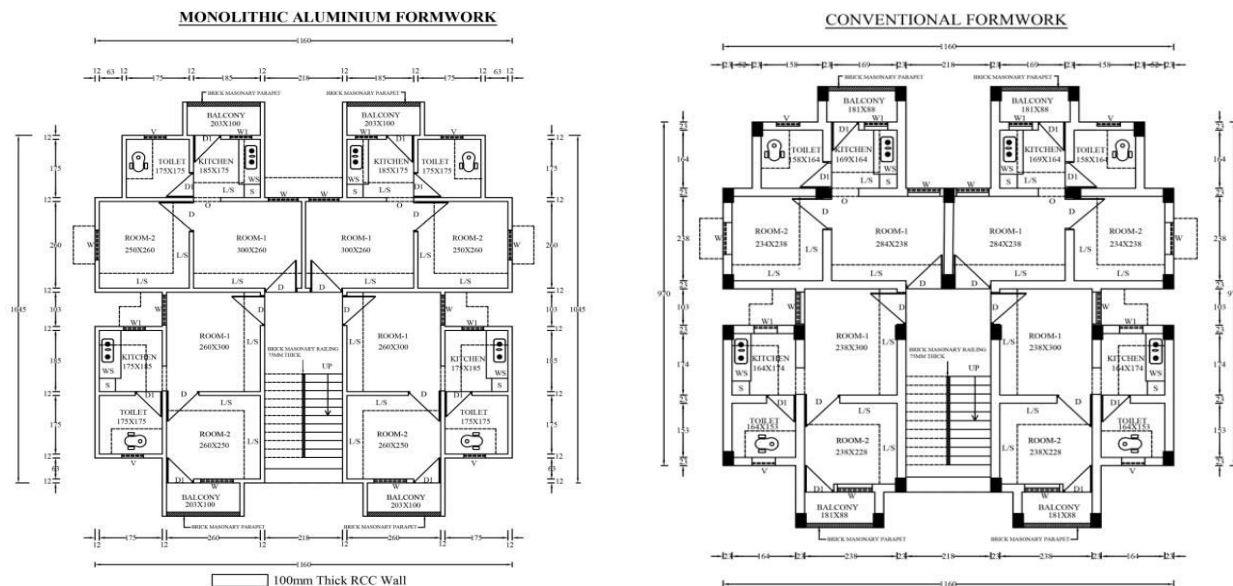


Fig 5.2 Schedule for Conventional housing projects

Comparison of Usable Area



Sl. No	Description	Aluminium formwork	Conventional formwork
1	Total Plinth area	116.76 sqm	116.76 sqm
2	Usable area	101.89 sqm	90.31 sqm
3	Percentage of usable area	87.26 %	77.34%

Dependability on Labors

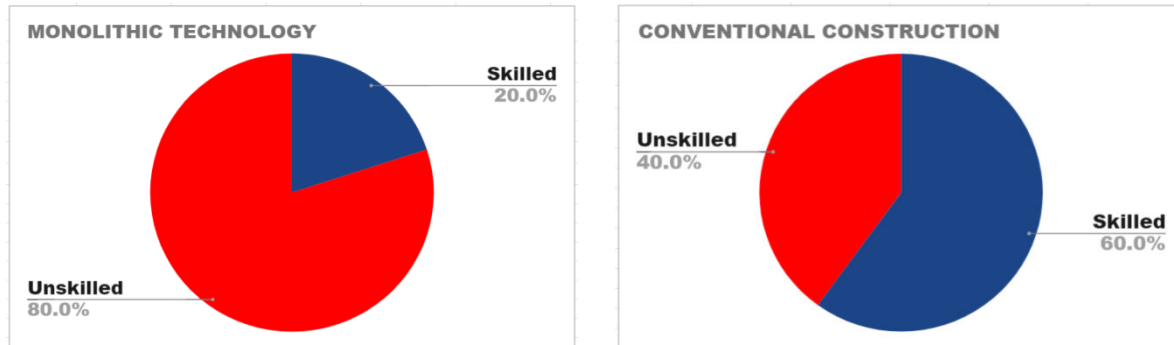


Fig 5.3: Reliance of the work force on conventional and monolithic technology

The fact that there is comparatively less manual labour makes it easy for construction workers to work with. Only pumping concrete into the form work is done, avoiding lifting of bricks, stones, sand, etc. The work becomes simple once the formwork is laid out. In monolithic construction, the need for skilled labour is reduced, and labor-intensive tasks like masonry and rendering are entirely eliminated. Unskilled labourers can erect aluminium formwork systems without the aid of hoisting cranes. The largest panel can be handled by one person because the largest one weighs no more than 25 kg.

VI. CONCLUSION

In this project an effort is made to compare the suitability of the two systems of the Housing projects in terms of construction time and cost. The structural configurations selected for the study are Monolithic structure and Conventional structure. To know the construction time required the schedule is prepared in Primavera and the schedule are compared for both the Monolithic and conventional technology. The cost comparison also made for the same. From the study, the following conclusions could be made.

- Primavera is an effective tool for creating Gantt charts for the schedule of conventional and monolithic housing projects. It efficiently connects all the project-related activities and establishes the overall time needed to complete each of the project's various construction phases.
- The project's overall cost and duration have been determined. The cost comparison revealed that there is a difference, with the cost of the conventional construction method being significantly higher than that of the monolithic construction technology.
- Monolithic construction costs Rs 29,18,08,898 to build 1136 homes, while conventional construction costs Rs 31,21,11,700. Therefore, we can conclude that the cost difference is substantial (6.5%), or Rs. 2,03,02,801.
- Thinner wall sections giving higher usable area. The usable area is found to be increased by about 10% by adopting shear wall system.
- Monolithic construction technology is a faster mode of construction with 25% savings in time comparing to conventional construction.
- Monolithic construction has a high rate of productivity and minimal waste. Less reliance on the labour force is required when using the monolithic construction method.
- As a modular pre-designed formwork system, it functions as an assembly line and enables quick construction of multiple/mass scale of repetitive type units. As India needs a lot of rapid dwelling units to provide affordable housing to its rising population, this technology is one of the solutions to the overgrowing problem.

From this study it can be concluded that the monolithic construction technology is the best system for mass construction as compared to the conventional construction method.

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