OPTIMIZATION OF PRECAST COMPONENTS IN BUILDING CONSTRUCTION

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Abstract - *In this study, the development and use of on-site and precast construction techniques vary significantly across different countries. Traditionally, cast-in-situ construction has been the primary method for building structures. However, prefabricated systems have emerged as an advancing technology that facilitates rapid construction and helps minimize project delays. This approach enhances product quality, as structural components are produced under controlled conditions in manufacturing plants where high-performance materials can be used. Moreover, prefabrication contributes to improved workplace safety by reducing on-site activities, especially those performed at height or near traffic zones, during high-rise construction. Prefabricated construction methods are applicable not only to new projects but also to the rehabilitation of existing buildings. Their use results in faster project completion and minimized interruptions throughout the construction process. Fast-track construction techniques often incorporate prefabricated components to expedite the erection of structures. For instance, in traditional house construction, raw materials such as bricks, timber, cement, sand, steel, and aggregates are transported to the site, and the building is assembled entirely on-site. In contrast, prefabricated construction involves casting only the foundation on-site, while structural elements such as columns, beams, staircases, lintels, chajjas, floors, and roofs are manufactured in a factory, transported to the location, and assembled using cranes.*

Key Words: Precast Construction, Prefabrication, Cost Optimization, Time Efficiency, Modular Components, Sustainable Building, etc.

1. INTRODUCTION

The development and use of on-site and precast construction techniques differ considerably across countries. Traditionally, cast-in-place construction has been the dominant method for building structures. In recent years, prefabricated systems have emerged as a modern technology that facilitates faster construction and helps minimize project delays. This method also enhances the overall quality of construction, as structural components are produced under controlled factory conditions where high-performance materials can be used during casting. Additionally, prefabrication improves safety on construction sites by reducing the amount of on-site work required, particularly at high elevations or in areas with heavy traffic, such as during high-rise construction. Prefabricated construction techniques are applicable to both new developments and the rehabilitation of existing buildings. Their adoption leads to faster project completion and fewer interruptions throughout the construction process. Fast-track construction methods often rely on prefabricated components to accelerate structural assembly. For example, in traditional house construction, materials such as bricks, timber, cement, sand, steel, and aggregates are delivered to the site, and the entire structure is built there. In contrast, prefabricated construction involves casting only the foundation on-site, while elements such as columns, beams, staircases, lintels, chajjas, floors, and roofs are manufactured in a factory, transported to the site, and assembled using cranes.

1.1 Aim & Objective

The aim of this project is to compare the cost and construction time of prefabricated buildings with conventional methods to evaluate the efficiency and economic benefits of prefabrication.

1) To study the conventional & prefabricated building construction.
2) To Analyze the time and cost required for various building components.
3) To compare the conventional and prefabricated building construction with respect to time and cost.
4) To optimize blend of conventional and prefabrication techniques in construction. Above objectives will be achieved by taking a case study.

2. Literature Review

Haron et al. (2005) [1] stated that conventional construction practices depend largely on on-site operations such as the installation of timber or plywood formwork, placement of steel reinforcement, and casting of concrete at the site. These methods commonly employ reinforced concrete frames using traditional wooden formwork. Their study revealed that such practices lead to increased project costs due to higher labour demands, excessive material consumption, and transportation requirements, along with slower construction progress. The research further indicated that traditional construction approaches are less efficient and more resource-intensive compared to modern prefabrication methods, ultimately reducing productivity and cost-effectiveness in construction projects.

Haron et al. (2005) [2] stated that prefabricated construction methods involve manufacturing structural components such as floor slabs, staircases, columns, beams, lintels, and chajjas off-site, which are later assembled at the construction location. This technique considerably reduces the dependence on on-site labour and enhances the overall productivity of the construction industry. Their study highlighted that the adoption of precast building systems results in shorter project durations due to higher efficiency and precision in execution. Furthermore, the integration of advanced machinery, equipment, and modern construction technologies in prefabricated systems improves both the quality of construction and the speed of project completion, making it an effective alternative to overcome the drawbacks of conventional construction methods.

Dr. N. B. Chaphalkar and Ms. Sayali S. Sandbhor [3] stated that their study focuses on the development of a calculation model for current construction products, analyzing building materials included in the product basket, fluctuations in their wholesale prices, and the resulting impact on promotional success. The authors provided an overview of the Indian financial system and discussed the role of institutions contributing to it. They emphasized that inventories and products marketed in the financial sector are influenced by various government-established indicators, which affect market trends, sales, and production costs. According to their findings, the Indian market relies on the Stock Market Index—compiled at the national level—as a key measure of retail price variations. The study also highlighted that development remains one of the most significant and debated aspects within the construction industry, and that Indian business regulations permit the use of stock market capitalization for calculating capital gains on materials and supplies.

Azman et al. (2012) [4] stated that the global construction industry is undergoing a significant transformation with the increasing adoption of prefabrication techniques as a strategic shift from conventional construction methods. Their study examined the challenges involved in integrating prefabricated systems with traditional practices and provided a comparative analysis of implementation strategies in the United Kingdom, Australia, and Malaysia. In the Malaysian context, the Industrialized Building System (IBS) was identified as a major initiative wherein structural components are prefabricated either on-site or off-site and then assembled with minimal labour requirements. In the United Kingdom, such practices are categorized under Modern Methods of Construction (MMC), representing various innovative approaches to building development. Similarly, both the UK and Australian construction industries frequently use the term Offsite Manufacturing (OSM) to describe these processes. The research also highlighted the increasing use of precast concrete systems across all three regions and emphasized the crucial role of government bodies and academic institutions in enhancing awareness, providing training, and fostering the modernization, efficiency, and sustainability of the construction industry.

Baldwin et al. (2009) [5] stated that their study compared the cost and productivity aspects of conventional construction methods with those of prefabrication techniques. The analysis considered several cost factors, including material procurement, manufacturing, off-site and on-site inspections, and the installation of prefabricated elements. The findings revealed that although the initial cost of prefabrication is approximately 25% to 35% higher than that of traditional construction, it delivers significant productivity improvements. Prefabrication enhances production efficiency by about 30%, mainly due to reduced on-site labour requirements and material savings resulting from limited formwork usage. Furthermore, the study reported that prefabricated floor slabs provide around 28% cost savings, while precast pre-stressed concrete components achieve up to 60% savings, thereby illustrating the long-term economic and operational benefits of implementing prefabrication in the construction industry.

Dabhade et al. (2009) [6] stated that their study examined the time and cost feasibility of different construction techniques within the framework of India's urban development, where vertical expansion is increasingly adopted due to limited horizontal space in metropolitan areas. The researchers emphasized that in a rapidly growing economy—where rising costs pose major challenges—reducing construction time can play a crucial role in minimizing overall expenses. A case study of a 10-storey multilevel car parking structure was undertaken, featuring post-tensioned composite steel beams spanning 16 meters. Using identical plan dimensions, floor-to-floor heights, and loading conditions, the building was analyzed under two alternative systems: (1) a precast concrete frame with a precast concrete floor, and (2) a steel frame with a precast concrete floor. For the precast concrete frame system, an additional interior column was introduced to satisfy structural requirements over the 16-meter span. Time scheduling for each method was conducted using Microsoft Project 2003, focusing on material and construction costs of structural components. The findings indicated that the steel frame with a composite deck floor demonstrated the greatest time efficiency, reducing construction duration by 55.3% compared to the precast concrete frame and by 14.3% relative to the steel frame with a precast floor. However, this system incurred 23.10% higher direct costs and 12.99% higher net costs than the precast frame system, with only minor variations of 0.52% (direct cost) and -2.34% (net cost) compared to the steel frame with a precast floor. The study concluded that although advanced composite steel structures offer substantial time savings, they involve a moderate increase in initial costs, reflecting a key trade-off between efficiency and expenditure.

Haas et al. (2000) [7] stated that their research analyzed the trends and impacts of prefabrication and preassembly within the construction industry, with particular emphasis on their influence on the workforce. The study reported that from 1984 to 1999, the adoption of prefabrication and preassembly techniques increased by nearly 86%, demonstrating a substantial transformation in construction practices over that 15-year span. Survey data collected during the study indicated that these methods contribute to enhanced productivity and improved safety conditions at construction sites, while the required worker skill levels remain relatively consistent with those of traditional methods. Furthermore, the study observed that wage levels are generally lower in projects utilizing prefabrication approaches. The researchers also identified both the advantages and limitations of these systems, underscoring their overall impact on project efficiency, labour structure, and evolving industry standards.

Girmscheid and Krocher (2007) [8] stated that their study investigated the application of prefabrication methods and their influence on construction efficiency, cost, and market potential. The research highlighted that prefabrication reduces on-site construction time by enabling simultaneous activities at different locations, in contrast to the sequential workflow typical of conventional methods. Their findings indicated a 5% increase in construction speed and a 10% reduction in total project costs due to time savings on-site. The study also analyzed the market for prefabricated concrete elements in Switzerland, identifying key challenges faced by companies in the precast industry. Through comparative analysis with other construction segments and international benchmarks, the research identified growth opportunities within this market. Based on prior studies and empirical observations, the authors proposed strategies to increase the adoption of prefabricated components, including the creation of an industry-wide knowledge platform to centralize and disseminate technical and commercial information to architects and engineers. This platform was designed to address barriers to market adoption while promoting factors that facilitate the use of precast elements, drawing on best practices from other construction sectors and incorporating the interests of relevant stakeholders to support wider implementation of prefabrication in Switzer.

Haron et al. (2005) [9] stated that their study analyzed the transitional phase of the Malaysian construction industry as it moved from conventional building methods to a more systematic and mechanized approach, known as the Industrialized Building System (IBS). The research emphasized that IBS improves productivity and construction quality through the use of advanced machinery, equipment, high-quality materials, and detailed pre-project planning. Noting the absence of organized data on cost comparisons between conventional construction and IBS methods in Malaysia, the study specifically examined the differences in building costs between traditional systems and the formwork system within the IBS framework. Data were collected through questionnaire surveys and case studies of institutional buildings, and statistical analysis using the t-test was employed to determine significant cost variations. The findings revealed a notable cost difference favoring the conventional system over the formwork system, providing useful insights for stakeholders assessing cost-effectiveness in Malaysia's evolving construction sector.

Huanga et al. (2004) [10] stated that their study investigated the reduction of erection time for reinforced concrete (RCC) formwork, showing that modular formwork systems can decrease overall project construction time by up to 15% compared to conventional methods. The research highlighted that cost optimization is achieved through the reuse of formwork within the same project or across multiple projects, thereby minimizing material waste. Recognizing that traditional concrete formwork is labor-intensive and time-consuming, the study analyzed various modular formwork systems aimed at enhancing productivity and cost-effectiveness. Effective implementation was shown to require careful planning during both design and construction phases, including resource allocation for modular form sets, cranes, and labor. Using computer process simulation techniques, five distinct form reuse schemes were identified and modeled with the CYCLONE methodology. Micro-CYCLONE simulations and sensitivity analyses were conducted, varying the number of form sets, cranes, and labor crews within a real-world case study. The findings provided valuable insights into the productivity and cost implications of different form reuse strategies, enabling more efficient planning and facilitating gang-form construction in building projects through modular formwork systems.

Yadav and Shah (2013) [11] stated that their study examined precast technology as an initial step toward promoting sustainable development in construction. The research emphasized that erecting precast units is a complex mechanized process involving continuous assembly and installation of prefabricated components. Precast construction provides advantages over conventional methods by fabricating structural members—such as panels, walls, beams, and columns—at predetermined sizes in a factory before transporting them to the construction site for final installation. The authors highlighted that this approach not only accelerates construction but also ensures higher quality, making it an effective method to meet the growing demand for sustainable housing, particularly in developing countries. The study also discussed various types of precast systems, detailing their key characteristics, the equipment required for assembly, and the installation procedures for different components.

3. METHODOLOGY

3.1 General

This chapter outlines the research methodology employed for the study titled **"Optimization of Precast Components in Building Construction."** The methodology is structured to achieve the study's objective of comparing precast and conventional construction methods in terms of cost and time, with the goal of optimizing the application of precast techniques in building projects. A combination of qualitative and quantitative data, field observations, and case studies has been used to provide a thorough and well-rounded analysis. Traditional construction methods, including load-bearing walls and RCC-framed structures with masonry infill, often encounter challenges such as inconsistent quality, weather-related delays, and high labor demands, which can significantly impact large-scale or time-sensitive projects. Conversely, precast construction offers benefits such as consistent quality, reduced labor requirements, faster construction timelines, enhanced durability, and production that is less affected by weather conditions. This study evaluates both construction approaches to determine the most effective use of precast components for achieving cost and time efficiencies.

3.2 Research Flow:

Figure 3.1: Flowchart

3.3 Site adaptation

Following steps involved in site adaptation for prefabricated construction method.

- ✓ **Selection of site**

Maharashtra state police housing and welfare corp. ltd. constructed site of 7512Sq.M. area which was required to complete as early as possible to built up speedy construction B.G. Shirke Construction Technology Private Limited i.e. contractor adopted precast construction method. The site consisting of 132, 2-BHK flats which has to complete in 12 months of short period. Considering this short period the contractor along with footing work they installed another team for molding, casting and placing various precast members on site. Adopting this method till the plinth level completed the all components of building are ready to use and place.

- ✓ **Site visits**

Along that the precast data will available from site by interviewing site engineer and various times site visit; After that it will be possible to do respective site as if it will be constructed by conventional method to estimate for comparison with precast method. All design drawings are collected form site also observation work during construction work. Rent for particular transporting each component the erection cost is calculated. The erection cost consisting the cost required for each components for one cycle where to pick up components, to place or erect it and come back to pick up another precast member. Considering this each precast members erection cost is estimated during site visit by analyzing cycle time of rented Cranes and Trailers.

- ✓ **Safety on Site**

B.G. Shirke (Contractor) having above 500 Workers on site where heavy equipments and machinery used. Also site contains the heavy Precast column, Beam, Lintel, slab Panels and Chajja which are transporting and placing work is there; So the use of 15 Kg bearing helmet and safety shoes is compulsory. If the transportation of component work executed in that section the all work will be on hold only placing work will done and only respective workers allowed in that section.

- ✓ **Optimizing Conventional and prefabricated techniques**

Optimizing Conventional and prefabricated techniques in case study following points taken in to consideration.

- ✓ **Identification of problem**

In the past decade construction is done with the help of traditional method. Traditional method means the use of form work and require more labour etc. Today's the need of fast-track construction. So the most of companies will go for the readymade components and construct the building within a stipulated timing. Using this fast-track construction saves the duration of project and automatically saves the cost. Thus the need is to be study of various precast building components which required less time for construction and get final results and to optimize the building components to conventional construction so that in conventional method we will reduce the project time as well as project duration.

- ✓ **Literature review**

Once the problem is identified, survey was carried out with the help of various journals, books, taking case studies to have a deep knowledge about the problem, understand the concepts of problem. With the help of data get the idea to examine the site situation, how the optimization to be done using estimating the cost of different components of building in precast and conventional types.

- ✓ **Collection of data**

The primary data was collected from the internet sources from which we know that the what is mean be precast construction, how they construct and gives the deep knowledge about that construction, how to prepare a planning. Also I have taken a one case study for detailed study on Karad site and collecting all data required for project work. Such as precast column, beam, lintel, chajja, slab panels types which are to be used for construction. Collected data contains the cost and the time requires placing the components by using such equipments.

- ✓ **Analysis of Data**

The main execution part is to analysis data using case study which includes calculating estimating cost and analyze time. Estimated cost involves the type of estimate and basic consideration for evaluating the problem.

- ✓ **Estimating Cost**

For analyzing the data for prefabrication method compared to conventional method by using Divisional schedule rate 2015-2016.

The concrete quantity estimated by,

$Q = L*B*H*N$ (Unit- M3)

Where,

L= Length

B=Breadth

H= Height

N=Numbers of column components

After calculating the quantity of concrete, the steel quantity is estimated after taking the help of bar bending schedule. The bar bending schedule consisting the numbers of tor Steel bars with their size and length.

Steel Quantity Estimated by,

$Q = N*(L*D*D)*162$ (Unit- Kg)

L= Length of Bar

D = Diameter of Bar

N = Number of Steel Bars

a) Estimating column by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of column casted by connectional method and prefabricated method.

b) Estimating beam by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of beam casted by connectional method and prefabricated method.

c) Estimating Lintel-chajja by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of Lintel-chajja casted by connectional method and prefabricated method.

d) Estimating Slab by using collected data require steel, concrete quantity calculated, using them the cost analyzed by comparing it the cost of slab casted by connectional method and prefabricated method.

The rate taken from DSR 2015-2016 with following specifications are there;

- **M-20 Concrete Columns (3Abi/5 BDF5)-** Providing & casting in situ cement concrete M-20 of trap / granite /quartzite/ gneiss metal for R.C.C. Column as per detailed designs & drawings or as directed including centering, formwork, cover blocks compaction & roughening the surface if special finish is to be provided & curing complete. (Excluding reinforcement) With fully automatic microprocessor based PLC with SCADA enabled reversible drum type concrete mixer with natural sand. (Spec. No.: Bd.F.5 Page No. 300 and B.7, Page No.38)
- **M-20 Concrete Beam and Lintel (3Ab i / 5 BDF 6) -** Providing & casting in situ cement concrete M-20 of trap / granite /quartzite/ gneiss metal for R.C.C. beam and Lintel as per detailed designs & drawings or as directed including centering, formwork, cover blocks compaction & roughening the surface if special finish is to be provided & curing complete. (Excluding reinforcement) With fully automatic microprocessor-based PLC with SCADA enabled reversible drum type concrete mixer with natural sand. (Spec. No.: Bd.F.6 Page No. 300 and B.7, Page No.38)
- **M-25 Concrete Slab (4A a i / 5 BDF 8) -** Providing and casting in situ cement concrete M-25 of trap/ granite / quartzite/ gneiss metal for R.C.C. slabs and landings canopy, waist slab with steps as per detailed designs and drawings including centering, formwork, cover blocks compacting and roughening the surface if special finish is to be provided and curing complete. (Excluding reinforcement).With fully automatic microprocessor-based PLC with SCADA enabled reversible drum type concrete mixer with natural sand. (Spec. No.: Bd.F.8 Page No. 302 and B.7, Page.No.38)

- **M-20 Concrete Chajja (5A a i / 5 BDF 8)-** Providing & casting in situ cement concrete M-20 of trap/ granite/ quartzite/ gneiss metal for R.C.C. chajja as per detailed design & drawings including centering, formwork, cover blocks compacting & roughening the surface if special finish is to be provided & curing complete. (Excluding reinforcement).With fully automatic microprocessor-based PLC with SCADA enabled reversible drum type concrete mixer with natural sand. (Spec. No.: Bd.F.9 Page No. 303 and B.7, Page.No.38)

- **Tor Steel (32 / 24 BR 35A) -** Providing, cutting, bending, hooking, tieing in position and laying TMT FE 500 steel bar for reinforcement as per detailed drawings for all R.C.C. works. (Spec. No.: BR.35 Page No. 134)

The cost includes transportation, erection and labor cost for casting and placing.

✓ **Estimating Time**

During casting, erecting and placing each component of precast member the time is calculated for precast and also cycle time calculated if building is constructed by conventional method excluding foundation work. Considering the fact that plinth level is completed before cycle time is calculated for each component.

The following site activities are considered for precast construction method-

- **Transportation -** Transportation of precast components done by using heavy trailers having double-Triple axel with 50MT Weighing capacity. Generally such vehicle having speed of 5-10Km/Hr in working area and on Highway it is restricted upto 60Km/Hr. The rent for such vehicles about Rs.5000-8000 Per day excluding diesel and diver allowance on 8 Hrs working basis.

- **Erection-** For this activity the heavy Cranes are to be used which are available on hourly basis of Rent Rs. 1200-1500 per Hour including diesel and driver allowance. The capacity of such cranes is 20MT to 70 MT. They will be used as per site condition.

- **Level Work-** where each component is to be placed; it should be level by using level tube with greater accuracy and for that work more time required, so it should be calculated during estimating time.

The software that is Microsoft project 2007 for planning of both precast and conventional construction is used to calculate actual period.

3.5 plan consider analysis:

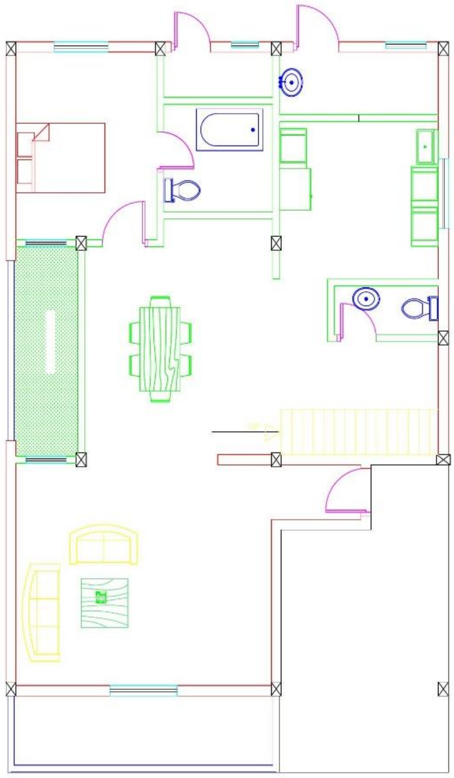


Figure 3.2 Ground Floor

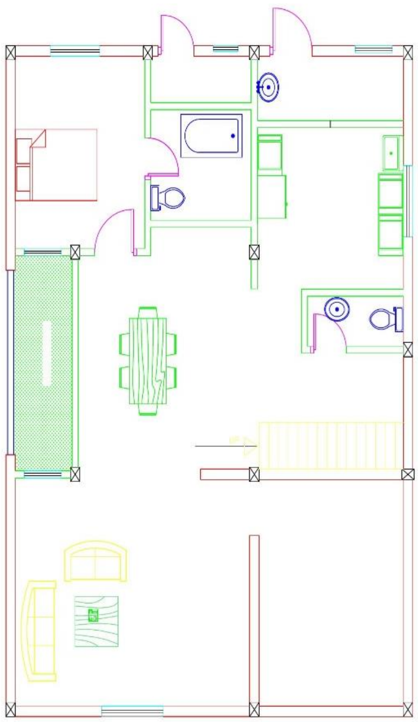


Figure 3.3 First Floor

Room Name	Dimensions
Living Room	13'11" x 16'9"
Dining Room	12'0" x 15'7"
Kitchen	12'6" x 12'4"
Guest Bedroom	11'2" x 14'0"
Toilet	5'8" x 9'3"
Toilet	5'8" x 2'9"
Toilet	8'5" x 3'6"
Foyer	7'0" x 4'8"
Utility	12'6" x 5'0"
Deck	3'8" wide
Parking	18'8" x 17'7"
Courtyard	5'3" x 15'4"

Table No. 3.1 Schedules of Ground Floor

Room Name	Dimensions
Family	15'7" x 11'10"
Master Bedroom	20'0" x 13'1"
W.I.R	10'6" x 5'7"
Children's Room	12'5" x 12'4"
W.I.R	4'8" x 5'3"
Bedroom 2	11'1" x 17'7"
W.I.R	5'4" x 7'3"
Toilet 1	7'3" x 5'0"
Toilet 2	5'10" x 8'7"
Balcony 1	5'10" x 8'7"
Balcony 2	9'7" x 18'0"
Family	15'7" x 11'10"

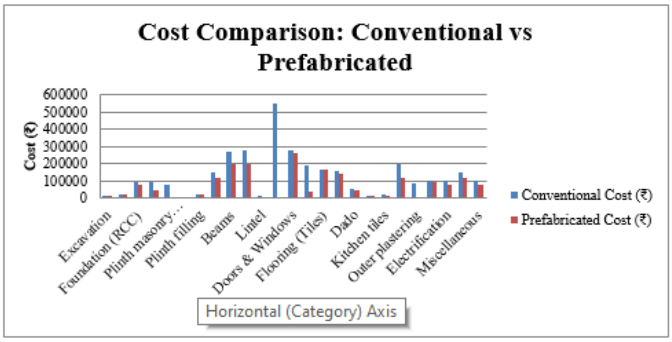
Table No. 3.3 Schedules of First Floor

4. RESULTS AND ANALYSIS

4.1 General:

The prefabricated construction is significantly more cost-effective and time-efficient compared to conventional methods. Major savings are observed in structural works, internal finishes, and building services due to factory production, reduced labor, and minimized material waste. While groundwork and minor finishes show minimal differences, the overall project cost is notably lower with prefabrication. In terms of time, prefabricated methods drastically shorten construction durations—especially in plastering, painting, and structural components—thanks to faster assembly and parallel workflows. Overall, prefabrication offers faster project delivery and reduced costs, making it a highly efficient alternative for modern construction projects.

4.2 Cost Comparison: Conventional vs Prefabricated Construction – Detailed Observations



Graph No. 1- Cost Comparison: Conventional vs Prefabricated

[1] Overall Cost Efficiency of Prefabricated Construction

Analysis of project costs shows that prefabricated construction is generally more economical than conventional methods. This advantage stems from the industrialized production process, lower labor requirements, reduced material wastage, and shorter construction timelines.

[2] Significant Savings in Superstructure Works (BBM)

A notable cost reduction is observed in the Brick Bat Masonry (BBM) of the superstructure. Conventional construction for this activity often exceeds ₹5.5 lakhs, while prefabricated construction achieves considerably lower costs. Prefabrication reduces labor-intensive expenses by utilizing factory-made components that are easier and faster to assemble on-site.

[3] Lower Costs in Internal Finishing Activities

Internal plastering, flooring, and painting demonstrate substantial cost savings in prefabricated construction. Pre-finished panels require minimal on-site finishing, and tasks can be standardized in a factory environment. For example, painting costs are almost halved compared to conventional construction, reflecting significant time and labor efficiency.

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[4] Cost-Effective Installation of Doors and Windows

Installing doors and windows is less expensive in prefabricated construction because frames are often integrated during the manufacturing stage. This reduces the need for on-site adjustments, enhances precision, and minimizes errors, contributing to overall cost savings.

[5] Structural Components Benefit from Modular Design

Prefabricated columns, beams, and slabs show clear cost reductions. Produced in standard sizes and shapes off-site, these elements allow for efficient material use and quicker assembly. This approach also reduces site congestion, equipment requirements, and labor effort, lowering both direct and indirect costs.

[6] Minimal Differences in Preliminary Site Activities

Early-stage site activities, such as excavation, PCC below foundation, and plinth filling, show negligible cost differences between prefabricated and conventional methods. These tasks largely depend on on-site conditions and require similar treatment regardless of construction type.

[7] Limited Cost Variation in Minor Finishing Items

Activities such as DPC (Damp Proof Course), kitchen tiles, kitchen otta, and skirting have nearly identical costs in both methods. These smaller tasks are performed on-site and thus do not significantly benefit from prefabrication.

[8] Moderate Savings in Building Services

Services like plumbing, electrification, and terrace waterproofing show moderate cost reductions in prefabricated construction. Early integration of conduits and plumbing lines into prefabricated units simplifies on-site installation and minimizes rework, reducing both labor and material expenses.

[9] Painting Offers Clear Cost Advantage

Painting, a labor-intensive finishing process, is more cost-efficient in prefabricated buildings. Factory-finished panels provide smooth surfaces that require less preparation and fewer coats, saving both time and paint.

[10] Consistent Reduction in Total Construction Cost

When the cumulative cost of all activities is considered, prefabricated construction consistently shows a reduction in overall project expenditure. This not only benefits the client's budget but also enables better time management, reduced labor dependence, and greater predictability in execution.

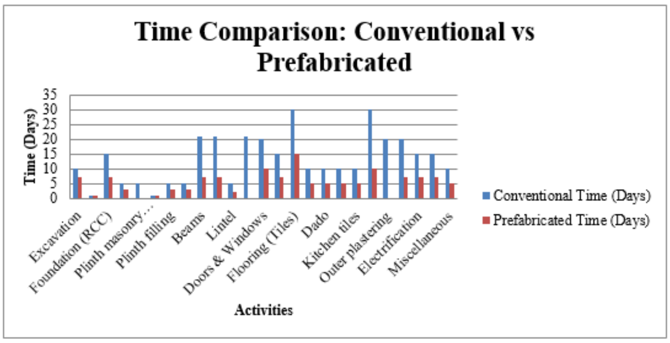
[11] Material Optimization and Waste Minimization

Prefabrication improves material efficiency and reduces waste. Conventional construction often encounters higher material loss due to breakage, over-ordering, and inefficiencies, which are minimized in a controlled factory environment.

[12] Conclusion on Cost Trends

Overall, while certain construction activities remain cost-neutral between the two methods, most structural and finishing tasks exhibit significant cost advantages when prefabricated methods are used. This supports the growing preference for prefabrication in residential and commercial projects where cost efficiency, speed, and quality are key considerations.

4.3 Activity and duration Comparison: Conventional vs Prefabricated Construction – Detailed Observations:



Graph No. 2- Time Comparison: Conventional vs Prefabricated

1] General Trend: Faster Construction with Prefabrication:

The graph clearly shows that prefabricated construction methods consistently require less time than conventional methods across almost all construction activities. This validates the claim that prefabrication not only saves cost but also significantly shortens the project timeline, which is crucial for time-sensitive developments.

2] Substantial Time Savings in Finishing Works:

The most noticeable time difference is seen in internal plastering, painting, and flooring (tiles). In the conventional method, these activities take up to 30 days, whereas the prefabricated approach reduces them to nearly half or even less. This is due to the smoother surfaces and more uniform finishes provided by factory-made components, which require minimal on-site touch-ups.

3] Shorter Duration for Structural Elements:

Activities like **columns**, **beams**, and **slabs** show a significant reduction in time using prefabrication. In conventional construction, each of these takes around 21 days, while prefabricated components reduce this to roughly 7 to 10 days. This can be attributed to the fact that prefabricated structural members are manufactured off-site and simply need to be assembled, eliminating the time-consuming formwork, curing, and scaffolding processes.

4] BBM (Superstructure) Time Efficiency:

The Brick Bat Masonry (BBM) superstructure, which is time-intensive in conventional construction (about 21 days), takes much less time in prefabricated construction (approximately 6–7 days). This showcases how modular walls or panels reduce not just labor but also drying and setting periods.

5] Time Reduction in Doors & Windows Installation:

Installing doors and windows takes around 20 days in traditional methods, whereas prefabrication reduces this to nearly 8 days. This is possible because prefabricated elements often include pre-cut openings and frames, simplifying the installation process significantly.

6] Early-stage Activities Show Modest Gains:

Activities such as excavation, PCC below foundation, and foundation (RCC) show smaller yet notable time reductions. Since these are groundwork activities that happen on-site regardless of the building method, the time advantage of prefabrication is less dramatic, though still beneficial (e.g., 15 days down to 8 days in PCC).

7] Finishing Items Like Skirting, Dado, and Kitchen Tiles:

These minor works also exhibit reduced durations in the prefabricated method. While they typically take 10–15 days conventionally, prefabrication shortens them to 5–7 days, indicating better preplanning and reduced manual intervention.

8] Faster Execution of Building Services:

Service-related activities such as electrification, plumbing, and terrace waterproofing also show moderate time savings. For example, electrification drops from 15 days to 7 days, largely due to the integration of service conduits within prefabricated panels, eliminating the need for chases and hacking during installation.

9] Reduction in Overall Project Duration:

When evaluating the cumulative time across all activities, prefabrication consistently results in significant total time savings. The reduction in construction time can lead to earlier project handovers, lower interest on project financing, and faster revenue generation in commercial or residential developments.

10] Less Downtime Between Activities:

In prefabricated construction, tasks are more sequentially aligned due to precise coordination and minimal dependency on curing or drying periods. This results in less idle time between construction phases, unlike conventional methods where delays are common due to overlapping labor schedules and material dependencies.

11] Enhanced Project Scheduling and Predictability:

Due to the controlled nature of prefabrication, timeline predictability is significantly higher. Prefabricated elements can be manufactured while site preparation is ongoing, thereby overlapping activities that would otherwise occur in sequence in conventional construction.

12] Conclusion: Time Efficiency Validated:

The time comparison validates that prefabrication is a time-saving construction technique, especially beneficial in projects where early completion is a priority. These time savings not only improve productivity but also reduce overhead costs related to labor, equipment rental, and site maintenance

Activity	Conventional Cost (₹ Lakhs)	Prefabricated Cost (₹ Lakhs)	Cost Savings (%)	Conventional Time (Days)	Prefabricated Time (Days)	Time Savings (%)
Excavation & PCC	1.5	1.4	6.7	15	8	46.7
Plinth Filling	1.2	1.1	8.3	12	7	41.7
DPC	0.8	0.8	0.0	10	8	20.0
BBM (Superstructure)	5.5	2.0	63.6	21	7	66.7
Columns/Beams/Slabs	4.5	2.5	44.4	21	9	57.1
Internal Plastering	3.0	1.5	50.0	30	12	60.0
Flooring (Tiles)	2.5	1.3	48.0	25	10	60.0
Painting	2.0	1.0	50.0	30	12	60.0

Doors & Windows	1.8	0.9	50.0	20	8	60.0
Kitchen Tiles/Otta/Skirting	1.0	1.0	0.0	12	6	50.0
Plumbing	2.5	2.0	20.0	15	7	53.3
Electrification	2.8	1.8	35.7	15	7	53.3
Terrace Waterproofing	2.2	1.5	31.8	18	9	50.0

Table No. 4.1 - Cost and Time Comparison between Conventional and Prefabricated Construction

4.4 Combined Summary: Cost and Time Comparison – Conventional vs Prefabricated:

The comparative analysis of conventional and prefabricated construction methods demonstrates a clear and consistent advantage for prefabrication in both cost and time efficiency. Economically, prefabricated construction substantially lowers expenses in critical structural and finishing activities, including BBM (superstructure), internal plastering, painting, and doors/windows installation. These savings are primarily driven by optimized material utilization, factory-controlled production processes, and reduced on-site labor requirements. Although some groundwork and minor finishing tasks show comparable costs across both methods, the overall financial benefit of prefabrication is significant. From a time perspective, prefabricated construction considerably shortens project timelines for nearly all activities. Notable reductions occur in structural works, plastering, painting, flooring, and building services such as electrification and plumbing. On average, tasks that would typically take 15–30 days with conventional methods are completed in less than half the time through prefabrication. This improvement is largely due to parallel processing manufacturing components off-site while site preparation proceeds shorter curing periods, and minimal delays between consecutive tasks. In summary, prefabricated construction provides the dual advantage of reduced costs and faster execution, making it an attractive solution for modern construction projects where efficiency, budget control, and timely delivery are essential. Its adoption enhances project planning, optimizes resource allocation, and improves return on investment, particularly in large-scale or repetitive developments.

5. CONCLUSIONS

The analysis clearly indicates that prefabricated construction outperforms conventional methods in both cost and time efficiency. Significant cost reductions are achieved in structural works such as BBM, columns, beams, and slabs, as well as in internal finishes like plastering, flooring, and painting, and building services including plumbing and electrification. These savings result from industrialized, factory-controlled production, which optimizes material use, minimizes on-site labor, and ensures consistent quality.

In terms of time, prefabrication allows simultaneous off-site component manufacturing and on-site preparation, reducing durations for structural assembly, finishing, and installation tasks to less than half of conventional timelines. Reduced formwork, curing time, and improved task sequencing further accelerate project delivery. Minor groundwork and finishing activities show modest benefits, but the overall timeline is substantially shortened.

The combined effect of reduced cost and faster construction results in earlier project handovers, lower overheads, improved resource utilization, and enhanced project predictability. Prefabrication is therefore particularly advantageous for large-scale, repetitive, or time-sensitive projects, offering an effective solution for modern construction challenges where efficiency, quality, and cost control are critical.

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