# THE USE OF MODULAR PRECAST CONSTRUCTION IN REDUCING CONSTRUCTION TIME IN CASE OF AFFORDABLE MASS HOUSING PROJECTS.

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**ABSTRACT:** *This paper focuses on the use of modular precast construction in speeding up the construction time in case of affordable mass housing projects. The construction industry is growing in construction techniques day by day at an impressive rate Modular precast building blocks are a developing technology in the construction sector that allows quickly and time saving construction. Modular precast components are becoming more and more popular as a result of their ability to meet the need for urban development, which is only going up, much faster, and this modular precast technology will act as a best alternative construction technology while implementing mass housing projects instead of using the conventional technique. This paper focuses on the overview in practicing the use of modular precast technology in the mass housing projects, with specific focus on mass housing projects in reducing the construction time.*

**KEYWORDS** : ***Precast , Modular ,Precast technology, Mass housing projects , Speeding construction time , alternative –construction technology .***

**INTRODUCTION** : Modular Precast concrete construction is a time tested and well accepted technology throughout . It is seen that most of structures in developed countries are constructed of steel, precast concrete, or a combination of both. Precast concrete is a building material created by pouring concrete into a form that can be used again and again. Foundations, columns, beams, slabs, and exterior and internal walls are all constructed using precast technology. The precast concrete is given the opportunity to fully cure and be continuously monitored by plant staff for improved quality by being produced in a controlled setting (usually referred to as a precast plant).For at least the next 8 years, the country must build 30 to 35 thousand housing units each day to meet the increasing demand for housing. Housing is the main concern that every human being must have. The building industry believes that a more dependable, quicker, and sustainable form of construction is required due to the constantly expanding population and to meet the above housing need. Even though the idea of "building it fast" in the most cost-effective manner has not changed since the beginning, new technologies have been created to accommodate modern construction. Precast concrete construction technology is one such solution. Precast construction technologies enable builders and contractors complete their projects faster and more affordably while also minimising construction waste.

Due to the rapid growth in housing demand in India over the past 15 years and the evolving real estate industry, there has been a tremendous need for residential building construction. Currently, it is usual for huge projects to include townships, mass housing, commercial malls, IT parks, SEZs, etc. The majority of these projects are still being built utilising traditional methods .This makes it impossible to fully utilise the unique benefits these projects have now in terms of repetition and large scale turnover. Also, it makes project management difficult in terms of the quality and speed of construction. The economy is expanding swiftly, thus building must be completed promptly, economically, and to a high standard. To accommodate the rising demand, some builders tried to innovate and switch from the conventional cast-in-situ (CIS) building to modular precast construction.

**AIM :** This paper aims to analyse the topic under discussion in order to fully understand how Off-site Modular Precast Construction can be used to achieve productivity increase minimise construction time , reduce site workforce, , and reduce site work hours in order to improve Construction in case of large affordable mass housing projects.

**OBJECTIVE :** 1)To speed up the construction time

2) To lower the labor cost .

3) To allow less wastage of materials than cast - in- situ built up construction.

4) Comparison between cast in situ and modular precast technology

**HYPOTHESIS :** Modular Precast concrete construction technology in spite of having number of advantages and less time duration is not accepted by private sector in case of mass housing residential construction and that the modular construction is the only construction technique best efficient in reducing construction time in case of Mass Housing projects .

**SCOPE :** Modular Precast Structures can be the best fit for Reducing construction time . People look for it when they are in need of quick built structures. With benefits like faster construction, environmental benefits, flexibility to design the house interiors completely to suit one's taste in aesthetics, less maintenance .

**LIMITATIONS** : Modular Precast construction technique of building components has some cons as compared to conventional construction techniques. The transportation potential of the materials produced at the factory is restricted by the availability of roadway width, height under bridges, and pavement strength. Project delays might be caused by city traffic. Additional expenses include the cost of lifting equipment, temporary bracings during shipment, and specialist framework to support precast components on site. High levels of precision, planning, and coordination are necessary. A major risk can arise from a design flaw in large production.

**LITERATURE REVIEW** : A thorough investigation into numerous facets of housing design was done with the goal of "affordable housing for all." The following is a summary of the main points and analyses. The purpose of the study is to provide a framework for design and to get insight into the various elements of the "dream home."

**N. Dineshkumar , P. Kathirvel Comparative Study on Prefabrication Construction with Cast In-Situ Construction of Residential Buildings -** The main purpose of the study report is to study the present state of India's precast construction industry. Author's analysis on the cost-effectiveness of precast concrete construction for mass housing residential buildings gained importance for areas of infrastructure. For a single double-story residential building, prefab construction costs 13% more than traditional construction.

When compared to conventional construction, prefab construction is simple to use and shortens project length by 63 days for projects of comparable size. It's the primary benefit of prefab building, and it also helps when there is a labour shortage. According to the author's survey, prefab structures are more advantageous and are more frequently used in industrialised, large-scale infrastructures.

**Vaishali Turai ,Ashish Waghmare A Study of Cost comparison of precast concrete vs. Cast-in-Place -** With a case study, the author looked into the precast method used in India. Precast concrete and cast-in-place concrete are compared in terms of time and costs for the purpose of this article. Any construction's cost directly varies with how long it takes to complete.

Precast is produced in factories (i.e., under regulated conditions) and can be mixed and cured in adequate amounts. Precast concrete is produced in factories and delivered to the construction site. Less labour is needed for precast building; workers are simply needed to join precast members.This involves indirect labour cost savings.

Compared to cast-in-place concrete, there is very little material waste in precast concrete construction. Because members are cured in the factory before assembly, there is no requirement for curing on site following the arrangement of members.

**B. Raghavendra, Siddhant Anant .time, Cost, Productivity and Quality analysis of Precast Concrete System -** The purpose of this article is to compare the precast system to the conventional by reviewing and analyzing the precast system's time, cost, quality, and productivity factors. Construction is extremely productive, and waste is at a minimum.

Because there are many unskilled workers in the county, operating heavy equipment without experience can be challenging, and the cost of transporting structural components from the factory to different locations can vary. India currently only has 2% of skilled labour. This percentage needs to be raised in order to meet India's enormous housing demand using precast, which would need its widespread implementation. Author shared his opinion on the website .

**Akash Lanke Design, Cost & Time analysis of Precast & RCC building -** The author of this research article used one structure as an example and designed it as both a precast building and a traditional cast in-situ construction. The author has conducted a cost analysis and a feasibility study based on time and cost.

According to the author's analysis, precast buildings are much less expensive and take much less time to build than conventional methods. The precast concrete system is more cost-effective and has less duration than the traditional cast-in-place method, according to all of the research, but there are still some considerations when using precast, such as the volume of construction, the site's relatively close to the manufacturing facility, the type of building, etc.

**Krish R. Villaitramani ,Hirani Prefabricated Construction for Mass Housing in Mumbai** - In this study, the article analyzes the feasibility of mass prefabricated housing in Mumbai. Prefabrication, a technologies that were either the construction process and allows mass production of cheap residences, has the potential to quickly address environmental and sustainability concerns. In the instance of Mumbai, the city with the highest concentration of slum dwellers in the world, prefabrication is discussed as a possible solution for the housing shortage. In this academic paper, the study analyzes the planning, analysis, and design of a residential building in Mumbai that uses prefabricated techniques while also considering the cost of overall construction. The planning of the building is done in such a way that the building's maximum area utilisation is achieved for the least amount of space and money.

**Mohak Patel,. Erection of Building Construction Easy To Made** – The constructing of precast components has been particularly studied in this research article as well as other implementation phases of precast elements. The efficiency of a building is the amount to which it can be manufactured, transported, and erected with the least amount of material, labour, and other resource usage.

Effective erection is being able to get one with the least amount of effort, time, and other resources. The quick which was before of structures, the roughly equal weights of erection units, the high level of prefabrication and manufacture correctness, and last but not least the ease of butt joints and the availability of fastening mechanisms are all characteristics of effective erection.

A component is placed in its example through a sequence of steps called an erection cycle.

**Ram Kumar, Manoj Patterson et. A Case Study On Use Of Precast Technology For Construction Of High-Rise** - Manoj Patterson, Ram Kumar, et al.

A Case Study On The Use Of Precast Technology For Mass housing Construction - A case study of precast operation in has been analyzed by the author constructing and gave his perspective of it.

The achievement of "Housing for all" by the year 2022 depends on precast.

The case study of using precast technology to build high-rise buildings quickly, sustainably, and affordably in an Indian scenario is highlighted in this paper. Greater Noida (West), in Delhi NCR, India, is the location of the case study for the Dream Valley initiative.

A residential township, it contains 379 villas, 47 high-rise residential towers, commercial and institutional buildings, as well as other constructions. More than 10 million square feet of the project's total built-up area have been.

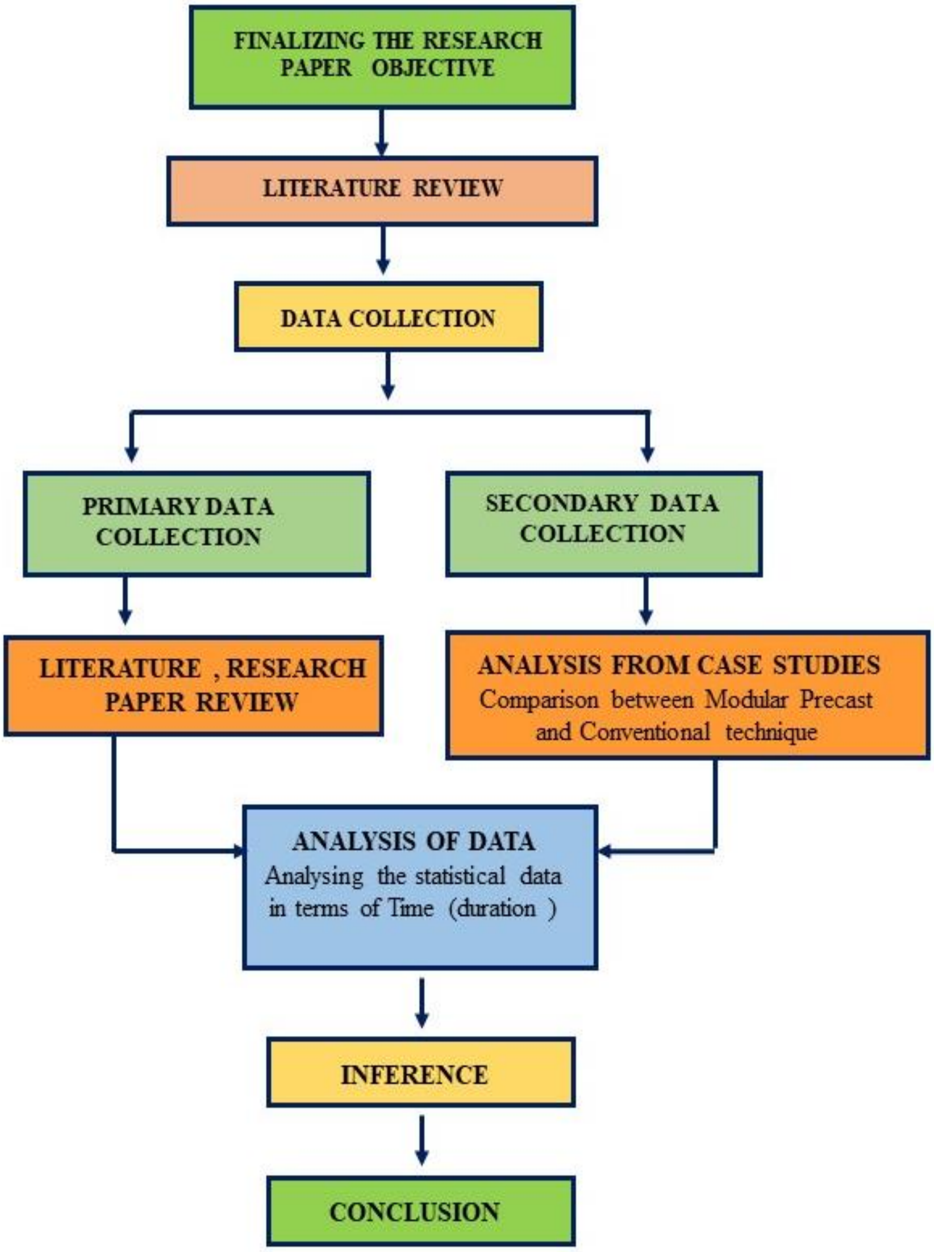



**Figure 1 : Methodology Flow Chart**

**METHODOLOGY :**

The primary data will be collected from Literature Reviews. All data analysis and reporting will be done on the basis of data obtained from Literature Reviews .The net case study for modular precast concrete construction was considered for analytical comparison. scale project of its kind in India called the Light House project in Ranchi and the Xrbia Lohegaon project in Pune .The first phase begins with a detailed assessment of the literature

outlining modular construction, its

advantages, cost analyses, comparisons, and a fundamental knowledge of the cost-beneficial elements. The second phase will involve after having gained a good understanding of the modular construction idea, its various varieties, and its advantages and how it can reduce the time in case of mass housing projects and the comparison between Modular precast and conventional technique. Capital costs, equipment costs, duration and are taken into account during cost analysis. The study was conducted using net case studies that changed the cost on-site for the cast-in-place method and the modular construction method for the first level. In this analysis, only one unit was taken into account. And lastly the third phase begins with the end of data collection, and at this stage we analyse the received data, and compile it in a meaningful manner.

## DATA COLLECTION

## MODULAR CONSTRUCTION AND TRADITIONAL CONSTRUCTION METHODS

### What Is Modular Construction?

### Comparison Between Modular Construction And Traditional Construction Methods

When a building is put together from a number of volumetric steel modules that are connected to form a whole structure, the process is referred to as modular construction. The modules are created and finished off-site in a factory setting before being transported and lifted onto ready-made foundations at the construction site.

After that, the building is connected to services and has cladding and roofing added to its exterior. Because less foundations are needed for installation and erection of modules than for traditional approaches, and because foundations and modules can be prepared at the same time to speed up construction, modular construction is more environmentally friendly than traditional procedures. Importantly, because modules are created in a factory setting, it is possible to better maintain quality control and reduce the risk of mistakes.

A very affordable construction technique is modular building. Concurrent construction enables work to start earlier and concurrently with site preparation, which results in initial cost reductions.

Construction of modular buildings takes less days to complete than traditional ones. There is reduced material waste since precision manufacture enables design replication. Manufacturing in centralised factories uses less energy and costs less to create and operate.

## DESIGN ELEMENTS FOR MODULAR PRECAST

Engineering and software advancements have immensely benefited the modular sector. Design and customisation tasks that were previously exceedingly challenging to complete have gotten a lot simpler. A developer can build nearly any structure using a combination of modular and panelized or site-built construction methods.

The structural restrictions of a modular box and transportation laws are the fundamental design restraints. It is more challenging to design rooms with large open spaces because of the 16 feet width restriction. Combining two modules and opening their walls to one another is the only practical technique to achieve this.

**TIMEFRAME**

**For Modular Construction In Case Of Mass Housing**

It usually takes 8 to 14 weeks. Construction can start in the factory while your foundation is being built on your site, which results in some time savings. The schedule hardly ever changes because of the weather.

**TIMEFRAME**

**For Conventional Construction In Case Of Mass Housing**

It usually takes 6 to 12 months. Work projects cannot begin until the prior project is finished since all building is done on site.

**Building Process For Modular**

Assembly-line construction is the constructing process. in a factory where things are made. When compared to conventional dwellings, this more effective method lowers the expense and time .

**Building Process For Conventional**

The most expensive building method that calls for practically the entire house to be built from scratch. Since they don't work on the same kind of house every day, it will take more time and demand more workers.

The risk of damaged construction materials, such as bent wood from weather exposure, is highest during this process.

**Floor Plans/Design In Case Of Modular Construction**

Most builders can provide 100's of sample plans to help guide the home selection . Modular Homes are normally highly customized in the interior and exterior appearances. Full custom modular builders , while rare , offer the ability to design from scratch or accept private architects rendering for conversion by the factory to modular .

**Floor Plans/Design In Case Of Conventional Construction**

Most custom builders can provide sample plans they have built , offer design services , or direct you to plans on the internet in either case , full customization is standard .

## DATA COLLECTION

### CASE STUDY 1 - Light House project in Ranchi and the Xrbia Lohegaon project in Pune

### Case Study & Analysis From Statistical Data For Conventional Technique

**Table 1 Duration for Construction of One Unit for Cast In Situ**

| Particular | Total Manpower | Avg. Daily Salary | Duration (Days) | Amount (Rs.) |
|---|---|---|---|---|
| Supervisor | 2 | 800 | 40 | 64000 |
| Steel Fixer Foreman | 1 | 600 | 29 | 17400 |
| Concreting In-Charge | 1 | 600 | 26 | 15600 |
| Welder | 0 | 600 | 0 | 0 |
| Carpenter & Carpenter Labor | 15 | 400 | 14 | 84000 |
| Mason & Mason Labor | 12 | 600 | 8 | 57600 |
| Steel fixer | 18 | 700 | 40 | 504000 |
| Electrician | 1 | 700 | 26 | 18200 |
| Labor (mazdoor) | 9 | 750 | 12 | 81000 |
| Siling Operator | 1 | 650 | 18 | 11700 |
| QC Inspector | 1 | 700 | 25 | 17500 |
| **Total Amount (Direct Labor Cost)** ` | | | 238 | **871000** |

**(Source - International Journal of Trend in Scientific Research and Development)**

**Table 2 Equipment & Machinery Charges for Construction of One Unit for Cast in Situ**

| Description | Qty | Rent/Day or Hour | Work in (Days) | Amount (`) |
|---|---|---|---|---|
| Concrete mixture machine | 1 | 1000/ Day | Approximately | 15000 |
| Lift for lifting the concrete | 1 | 1200 /Day | 40 | 48000 |
| Concrete Boom Placer | 1 | 1800/ Hour | 15 | 15000 |
| Other expenses | app. | | | 10000 |
| | (Total Amount ) | | 55 | 88,000 |

**(Source - International Journal of Trend in Scientific Research and Development)**

**Table 3 Duration for Construction of One Unit for Modular Construction**

| Particular | Total Manpower | Avg. Daily Salary | Duration (Days) | Amount ( ` ) |
|---|---|---|---|---|
| Supervisor | 2 | 1200 | 6 | 14400 |
| Steel Fixer Foreman | 1 | 800 | 6 | 4800 |
| Concreting In-Charge | 0 | 800 | 4 | 0 |
| Welder | 1 | 600 | 2 | 1200 |
| Carpenter & Carpenter Labor | 6 | 600 | 4 | 14400 |
| Mason & Mason Labor | 2 | 700 | 6 | 8400 |
| Steel fixer | 6 | 1 200 | 6 | 43200 |
| Electrician | 2 | 800 | 6 | 9600 |
| Labor (mazdoor) | 5 | 750 | 6 | 22500 |
| Siling Operator | 6 | 800 | 6 | 28800 |
| QC Inspector | 2 | 800 | 6 | 9600 |
| **Total Amount (Direct Labor Cost) `** | | | 58 | **156900** |

**(Source - International Journal of Trend in Scientific Research and Development)**

**Table 4 Equipment & Machinery Charges for Construction of One Unit for Modular Construction**

| Description | Qty | Rent/day | Work in days | Amount |
|---|---|---|---|---|
| 40 T heavy mobile crane | 2 | 10000 | 8 | 160000 |
| 4-5 T mobile crane | 1 | 3050 | 8 | 24400 |
| Miscellaneous | Approx. | | Lump sum | 5000 |
| Total Amount (`) | | | 16 | 189400 |

**(Source - International Journal of Trend in Scientific Research and Development)**

**CASE STUDY 2**

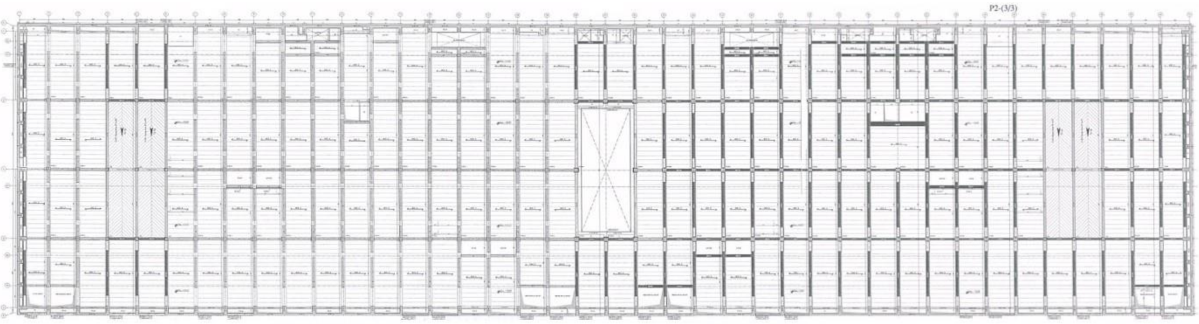
**Comparing The Construction Time Duration For Modular And Cast In Situ :**

**Time Process In Case Of Modular Precast :**

The Perlite construction company provided all the information needed for this analysis. This study focuses on the IRANMALL project's southern parking lot. Parking was chosen as a case study due to its distinctive schedule and structure; over 70% of the parking building was constructed using precast components, which included hollow-core concrete beams, columns, and hollow-core columns that were first implemented in Iran.

This project can help us develop a practical strategy for implementing various precast components. The car parking was constructed over a 24,000 square metre space with seven underground stories, as shown in Figure 1. Data sheets and MSP scheduling software were also utilised in this study.

**Figure 2: Parking Plan**



**(Source :Time comparison between precast and conventional construction)**

**CYCLE OF A PROJECT**

The execution activities of the building phase are split into on-site and off-site operations , as illustrated in Figure 3, which is one of the key differences between the conventional method and the prefabrication one.

Site construction activities and off-site activities are carried out simultaneously, so by manufacturing precast components, transporting them to the construction site, and installing them there simultaneously, the construction period would be noticeably shorter than it would be for a conventional one. However, the typical approach requires on-site construction for the majority of the tasks, which results in longer operations.

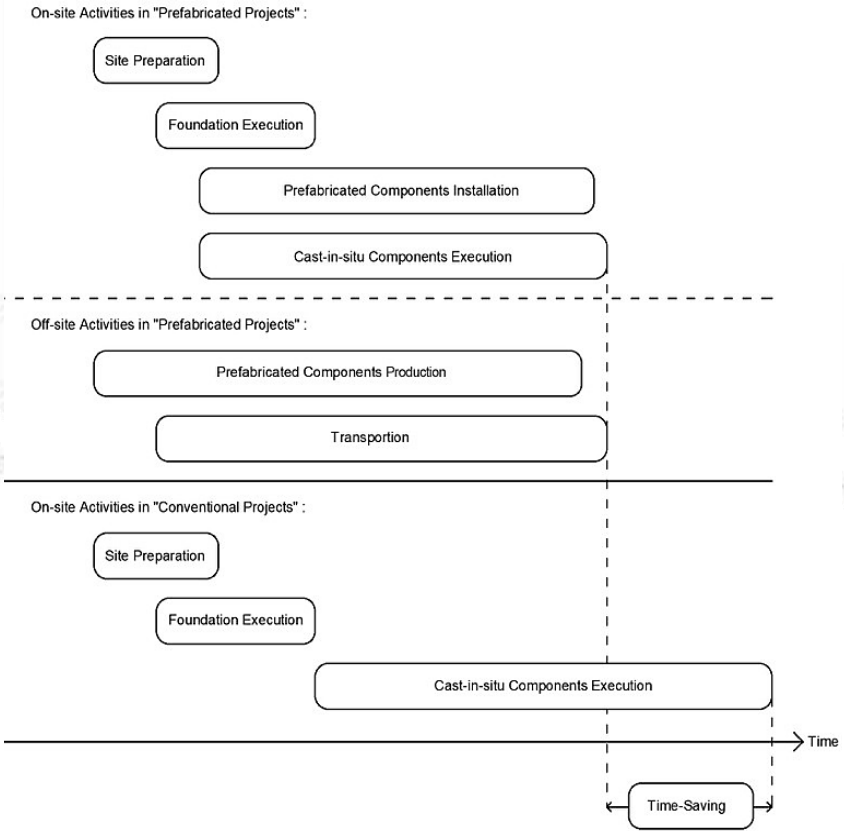



**Figure 3 - Construction phase of prefabricated vs conventional**
**(Source- Time comparison between precast and conventional )**

## PRECAST PRODUCTION PROCESS

Precast component production is scheduled in various stages. And , the majority of manufacturing procedures involve nine phases ; each step, known as a job, required a specified amount of time to complete as part of precast production .

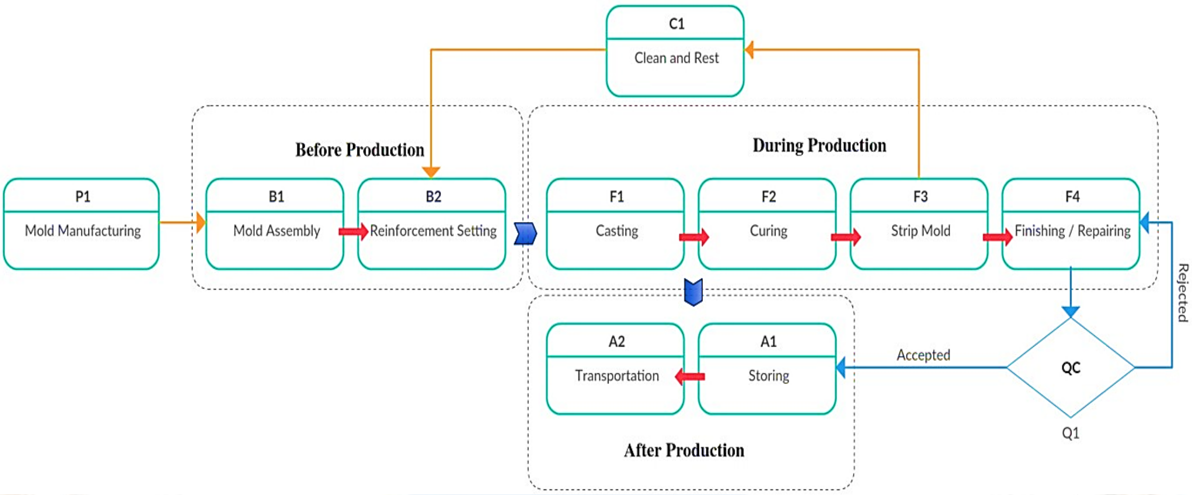



**Figure 4: Production process of precast components**

**(Source- Time comparison between precast and conventional construction)**

Figure 4 illustrates the 11 phases that go into the production of precast columns, beams, and panels. Additionally, the manufacturing of hollow-core required hollow-core production lines and was automated and mechanised. The majority of these calculations are performed by provided software simulations and genetic algorithms for arranging the production of precast components. By analysing the required time for each activity and the overall time of off-site manufacturing, the time of each activity, the number of moulds, and the number of production lines are taken into consideration.

## OFF-SITE CONSTRUCTION - PRECAST COMPONENTS

The precast concrete primary beams, secondary beams, U-shell beams, columns, panels, and hollow-cores that are made and erected in precast structures.

**BEAM** -3101 prefabricated beams were created and placed for the project. There were a total of 443 beams in total, with 161 primary beams, 162 subsidiary beams, and 120 U-shell beams on each floor. When the concrete acquired its 13 Mpa compression strength, the moulds were removed after the beams had been cast. Starting with covering the components, the curing procedure, as shown in Figure 5, involved heating the cycling water to 60 degrees Celsius

**Figure 5: Curing process of concrete beams**

**(Source- Time comparison between precast and conventional construction)**

For 2 hours, maintaining that temperature for 8 hours, and then cooling it from 60 to 25 degrees Celsius for 2 hours.

In comparison to the current method, this type of curing would significantly save the time required for mould removal, curing, and the number of people needed on site. It took five months to create all of the precast beams required for the project, with a daily production rate of 20 total beams.

**COLUMN**

The prefabricated columns were 1.2 × 1.2 metres wide and 4.8 metres high. To connect and fix with earlier and later columns, each column had 24 couplers at the bottom and 24 bars at the top. A total of ten columns were created each day using five production lines, each of which generates two columns every 24 hours. Prefabricated columns were created in steel moulds the same way as beams were. This is depicted in Figure 6.

**Figure 6: Column production line**

**(Source- Time comparison between precast and conventional construction)**

**HOLLOW-CORE**

The pre-stressed form of ceiling utilised in the project is hollow core components. They can be used for spans up to 14 metres due to their unique structural features, such as their low weight and usage of pre-stressed concrete. These ceiling types were produced using hollow core production lines. According to Figure 7, each line of hollow cores generated hollow cores that were 7, 12, and 16 metres long and 250, 400 mm thick. The bulk of these hollow cores were employed in projects with lengths of 7 metres. A hollow core with ten lines was prepared to produce 52000 square metres each month.

**TRANSPORTATION**

Prefabrication construction heavily depends on transportation, which is affected by the number of trucks and the distance between the production site and the building site . The production location was situated 4.3 kilometres from the construction site in the parking lot. It took 8 minutes for trucks to arrive and transport prefabricated parts due to the low volume of traffic in the region. Additionally, concrete and precast components were transported using 25 trucks and mixers.

**ON-SITE ASSEMBLY**

Grout was injected to strengthen the joints after fitting downstairs column bars into next level column couplers, as shown in Figure 8. It took around 30 minutes to assemble the prefabricated columns, which included 10 minutes for positioning and 20 minutes for preparing and injecting grout into the couplers. Additionally, grout has a service life of 40 to 60 minutes, and mixing grout and water took 8 to 10 minutes.

**BEAM**

As shown in Figure 7, middle beams were erected on the backrests of two u-shell beams when columns were put together. Joined beams, however, did not require u-shell beams and were placed directly on columns. U-shell beams and secondary beams took about 20 to 30 minutes to put together, while middle and linked beams took about 40 to 50 minutes.

**Figure 7: Assembly of a joined beam**

**(Source- Time comparison between precast and conventional construction)**

**PANEL**

Each panel in the parking area took five to ten minutes to set, and each 6.6-meter frame in the Project required 16 panels to be fitted.

Each team of six workers placed eight panels over a five-hour shift.

As shown in figure 8 , after one row of panels has been adjusted, the retaining wall armatures should be connected with panel bars, and concreting should then begin.

**OVERALL CONSTRUCTION COMPLETION PERIOD FOR PRECAST**

For each floor was executed between 16 to 20 days.

**Figure 8: Assembly of panels**

**(Source- Time comparison between precast and conventional construction)**

**TIME PROCESS IN CASE OF MODULAR PRECAST :**

**ON-SITE CONSTRUCTION**

**REINFORCING WALL**

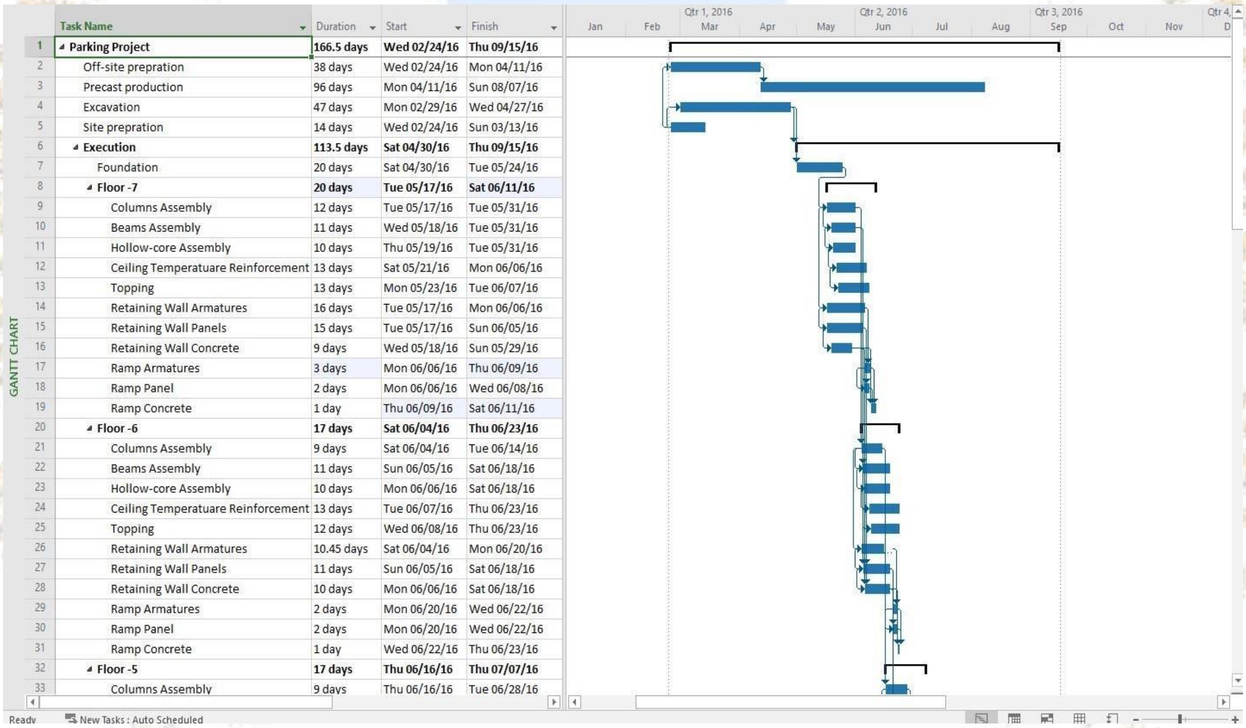
The project was enclosed by a 60-centimeter wide retaining wall with covered panels to resist against lateral soil pressures and tensions since parking was built underground. Before the retaining wall was built, the soil was hammered and covered with geotextiles.

## TOPPING

When assembling all of the hollow core components, temperature reinforcements were carried out four centimetres above the hollow core surfaces, longitudinal and latitudinal armatures were put 15 centimetres apart, and concrete pouring only began after the temperature reinforcement was complete.

## COLUMN

At the junction with the retaining wall and the parking, the columns were built on-site. Taking into account the breadth of the retaining wall, each column was 2.6 metres long, 90 centimetres broad, and two metres in length overall. The site manager, supervising engineers, and control project office provided the data for this study. After gathering project activity time sheets, MSP software was used to schedule the tasks, and the output data was examined. Every floor required between 16 and 20 days to complete, and the parking phase's activities were completed in six months, as shown in Figure 9. (167 days). As illustrated in Figure 10, the parking was predicted to take 753 days to complete using the conventional method, which resulted in a 78% time savings based on MSP scheduling and data gathered during the design phase of the Iranian mall parking.



| | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | Parking Project | 166.5 days | Wed 02/24/16 | Thu 09/15/16 |
| 2 | Off-site prepration | 38 days | Wed 02/24/16 | Mon 04/11/16 |
| 3 | Precast production | 96 days | Mon 04/11/16 | Sun 08/07/16 |
| 4 | Excavation | 47 days | Mon 02/29/16 | Wed 04/27/16 |
| 5 | Site prepration | 14 days | Wed 02/24/16 | Sun 03/13/16 |
| 6 | Execution | 113.5 days | Sat 04/30/16 | Thu 09/15/16 |
| 7 | Foundation | 20 days | Sat 04/30/16 | Tue 05/24/16 |
| 8 | Floor -7 | 20 days | Tue 05/17/16 | Sat 06/11/16 |
| 9 | Columns Assembly | 12 days | Tue 05/17/16 | Tue 05/31/16 |
| 10 | Beams Assembly | 11 days | Wed 05/18/16 | Tue 05/31/16 |
| 11 | Hollow-core Assembly | 10 days | Thu 05/19/16 | Tue 05/31/16 |
| 12 | Ceiling Temperatuare Reinforcement | 13 days | Sat 05/21/16 | Mon 06/06/16 |
| 13 | Topping | 13 days | Mon 05/23/16 | Tue 06/07/16 |
| 14 | Retaining Wall Armatures | 16 days | Tue 05/17/16 | Mon 06/06/16 |
| 15 | Retaining Wall Panels | 15 days | Tue 05/17/16 | Sun 06/05/16 |
| 16 | Retaining Wall Concrete | 9 days | Wed 05/18/16 | Sun 05/29/16 |
| 17 | Ramp Armatures | 3 days | Mon 06/06/16 | Thu 06/09/16 |
| 18 | Ramp Panel | 2 days | Mon 06/06/16 | Wed 06/08/16 |
| 19 | Ramp Concrete | 1 day | Thu 06/09/16 | Sat 06/11/16 |
| 20 | Floor -6 | 17 days | Sat 06/04/16 | Thu 06/23/16 |
| 21 | Columns Assembly | 9 days | Sat 06/04/16 | Tue 06/14/16 |
| 22 | Beams Assembly | 11 days | Sun 06/05/16 | Sat 06/18/16 |
| 23 | Hollow-core Assembly | 10 days | Mon 06/06/16 | Sat 06/18/16 |
| 24 | Ceiling Temperatuare Reinforcement | 13 days | Tue 06/07/16 | Thu 06/23/16 |
| 25 | Topping | 12 days | Wed 06/08/16 | Thu 06/23/16 |
| 26 | Retaining Wall Armatures | 10.45 days | Sat 06/04/16 | Mon 06/20/16 |
| 27 | Retaining Wall Panels | 11 days | Sun 06/05/16 | Sat 06/18/16 |
| 28 | Retaining Wall Concrete | 10 days | Mon 06/06/16 | Sat 06/18/16 |
| 29 | Ramp Armatures | 2 days | Mon 06/20/16 | Wed 06/22/16 |
| 30 | Ramp Panel | 2 days | Mon 06/20/16 | Wed 06/22/16 |
| 31 | Ramp Concrete | 1 day | Wed 06/22/16 | Thu 06/23/16 |
| 32 | Floor -5 | 17 days | Thu 06/16/16 | Thu 07/07/16 |
| 33 | Columns Assembly | 9 days | Thu 06/16/16 | Tue 06/28/16 |



**Figure 9: Parking execution scheduling program**

**(Source- Time comparison between precast and conventional construction)**

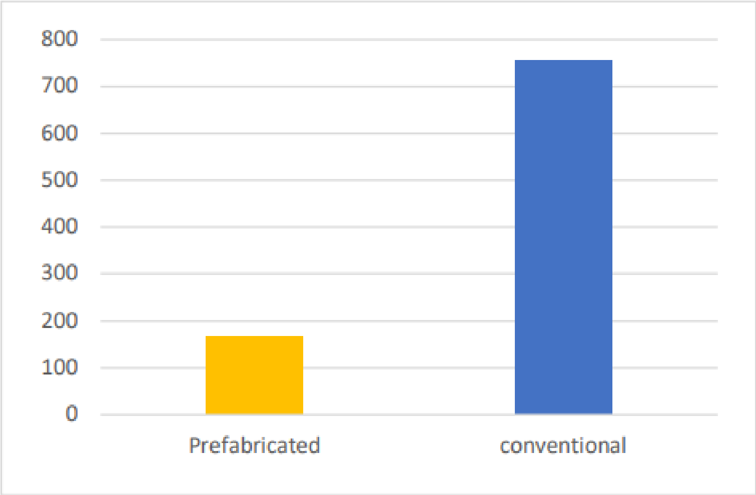



**Figure 10: Modular vs conventional execution time (in days)**

**(Source- Time comparison between precast and conventional construction)**

## DATA ANALYSIS ON CASE STUDIES

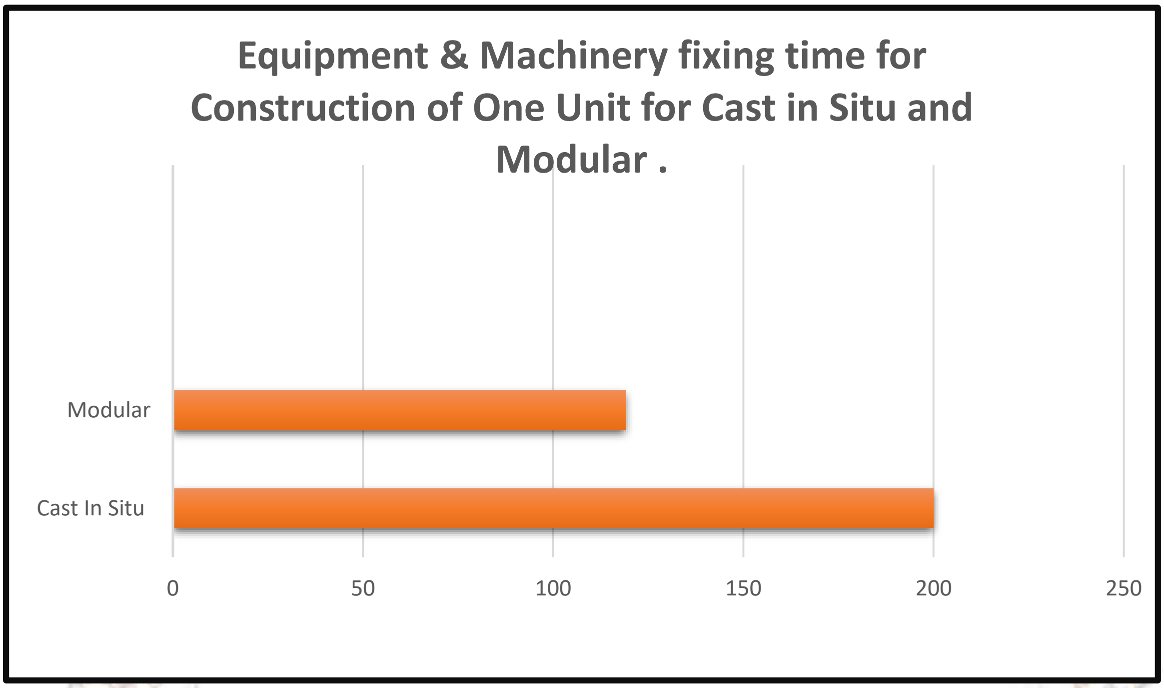
As we saw in the above shown case studies analysis ,

**For Case Study 1**

It is seen that the time duration required for modular construction is comparatively less than the cast in situ construction with duration of 238 days for Cast in situ and 58 days for modular

Construction. As seen previously the case study has only compared these parameters for only one unit of area , they have compared the labour required which in case of modular is very less , as it does not involve any curing works or other masonry works as such. The case study also says that it usually takes 8 to 14 weeks. Construction can start in the factory while your foundation is being built on your site, which results in some time savings.

The schedule hardly ever changes because of the weather. And in case of conventional construction technology it usually takes 6 to 12 months. And also the work projects cannot begin until the prior project is finished since all building is done on site. The weather has an impact on the work schedule . Also talking about the Building process for modular Assembly-line construction is the constructing process in a factory where things are made.



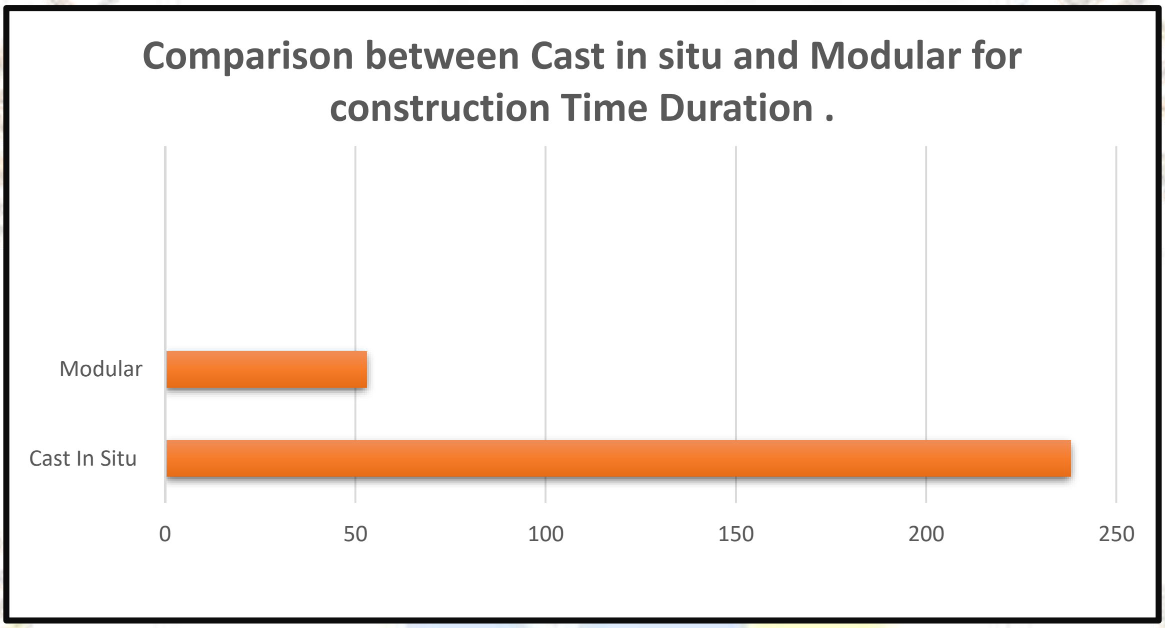




**Figure 11: Equipment Modular vs conventional execution time (in days)**

Weather-related delays are removed. When compared to conventional dwellings, this more effective method lowers the expense and time and in case of conventional method it can be said that it is most expensive building method that calls for practically the entire house to be built from scratch. Since they don't work on the same kind of house every day, it will take more time and demand more workers . In case of Mass Housing Projects the floor plans are generally repeated to avoid delay in construction and use of modular precast construction can be best proven for this cause . Additionally, it is subject to weather-related delays .

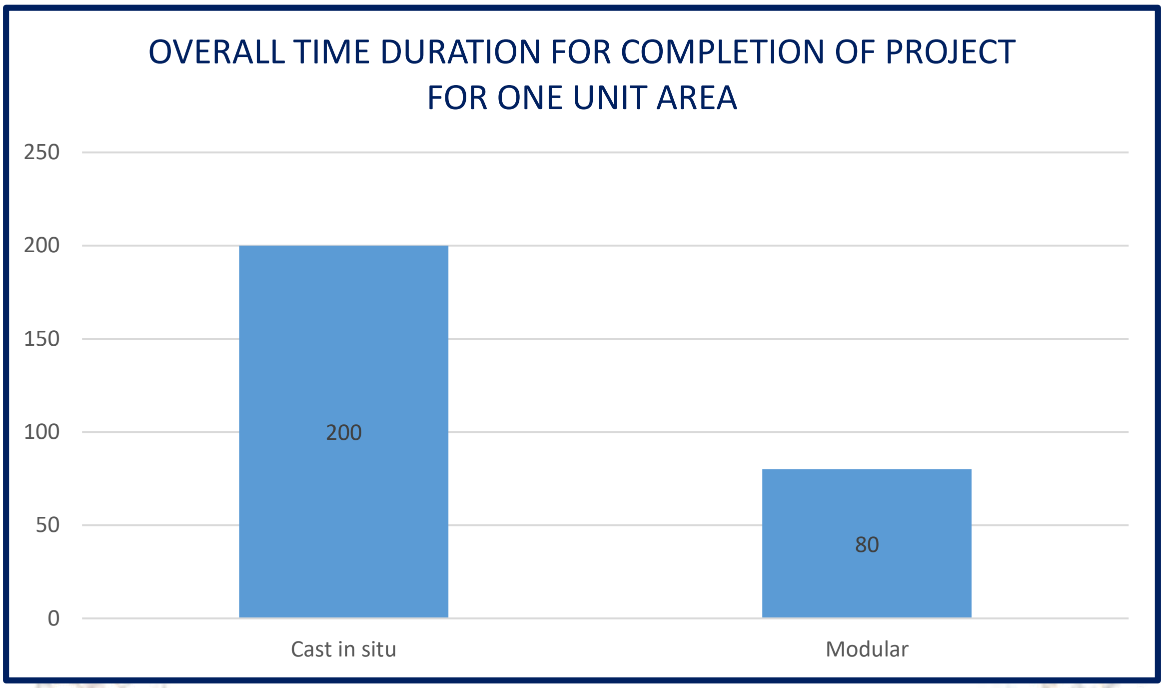



**Figure 12: Overall time Duration for completion**

Reduced construction time by Modular

**FOR CASE STUDY 2**

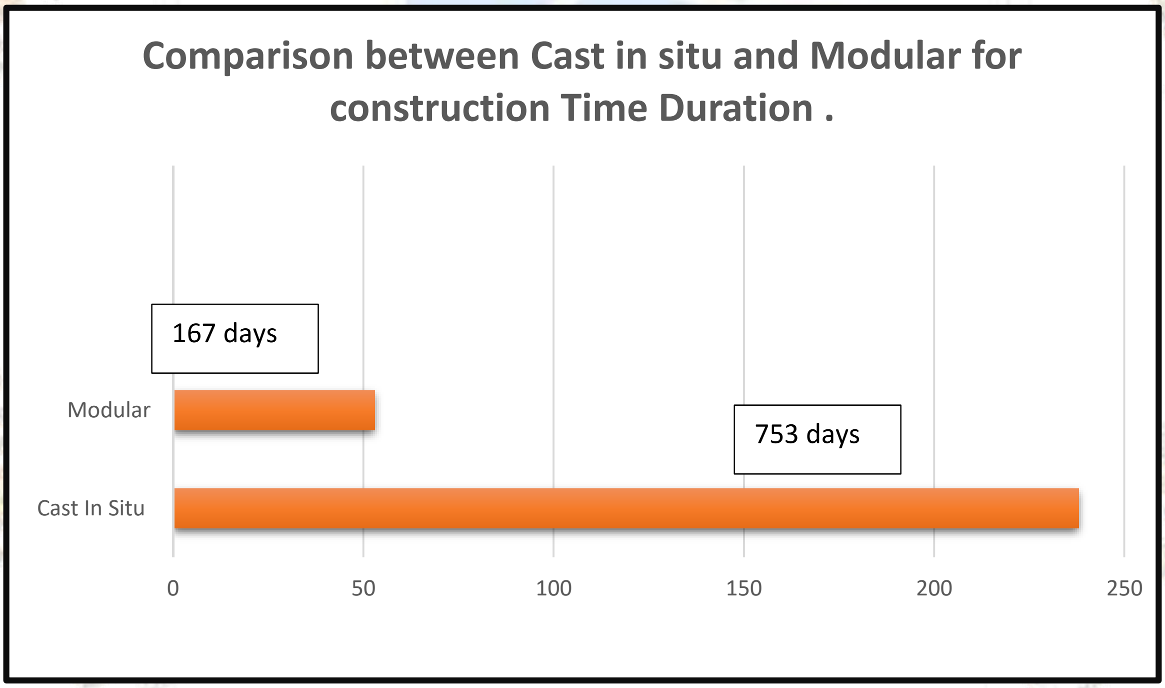



**Figure 13: Overall time Duration for completion**

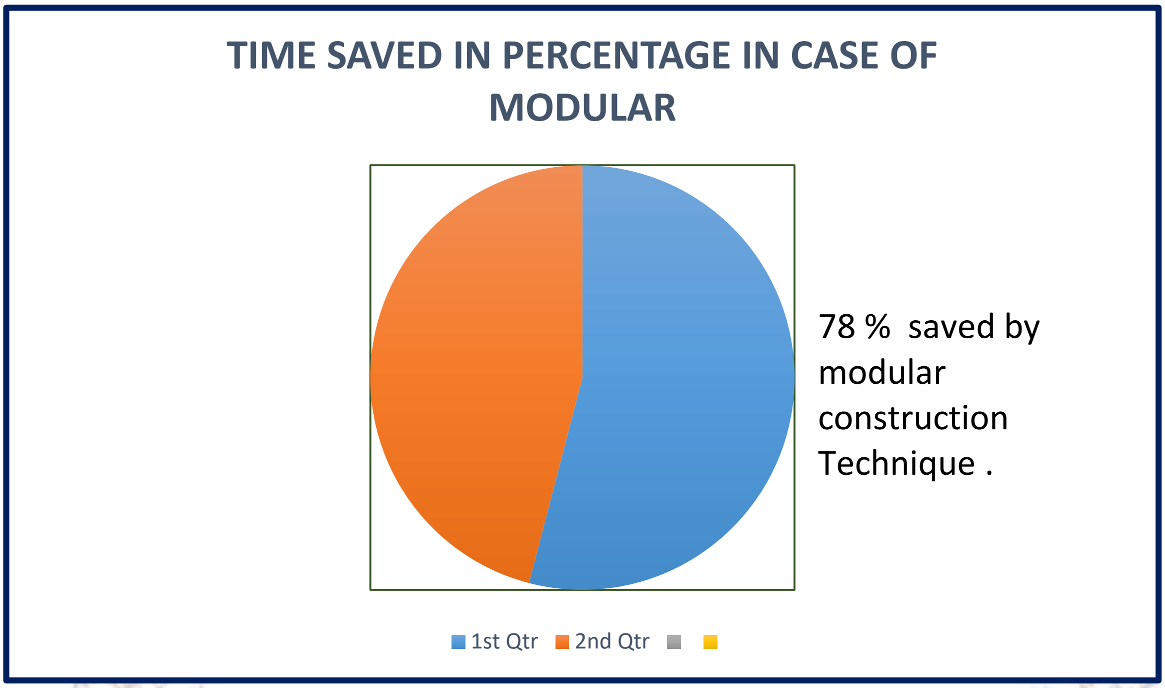



**Figure 14: Time saved in percentage**

**TABLE 5 -Comparison To Traditional Method**

| | **Modular construction** | **Traditional methods of construction** |
|---|---|---|
| **Cost** | significantly cheaper than conventional techniques | High cost indeed |
| **Speed** | Method of Fast construction | Slow in comparison with the modular |
| **Wastage** | Green construction methods and a controlled atmosphere result in less material waste. | High waste as a result of on-site building techniques |
| **Flexibility** | Less flexibility as a result of unit standardisation | More flexible it is |
| **Quality** | Increased quality control as a result of controlled production conditions | Practices for in-situ construction are susceptible to weather fluctuations. They might result in subpar building work. |
| **Labour** | Because of computer-integrated manufacturing, it is less labor-intensive (CIM) | Labor and skilled personnel are needed. |

**INFERENCE :** As we can see from the preceding section, the case study only evaluated these parameters for one unit of area. They also compared the labour needed, which in the case of modular construction is relatively low because it doesn't require any curing or other masonry work specifically.

**CONCLUSION :** The importance of alternative construction technology must be taken into account by the stakeholders in order to improve the health and safety of both users and the construction industries given the current crisis in the housing sector. Precast has the potential to influence the Indian construction sector in terms of the economy, society, and environment. The potential benefits of this breakthrough must be revealed in order for the necessary development to proceed.

Due to large-scale projects, the requirement for high-quality construction that is completed quickly, and the necessity for less labour, precast concrete technology has already reached India. Careful planning and designing can maximise the use of all these benefits. This case study seeks to impart practical knowledge and educate readers about the possibilities that precast offers. The following lessons from this case study could be : From the mentioned case study statistics chart , that it can be inferred that precast construction with 78 percent of reduced construction time has a significant potential to meet new market demands if developed and carried out with careful planning in case of mass housing projects . Comparison between CIS and conventional definitely proves that modular construction technology can be best suited for large mass housing projects .

Wherever necessary, using a mix of factory-made precast modules offers more advantages in terms of time, cost, and quality than the conventional "all precast or no precast" strategy. From the analysis done from various literatures it has been found that . It has good quality control. The speed of construction can be increased with precast construction if we implement this technology in mass housing projects . The labor requirement in precast construction is very less. The installation and connection of precast construction is also very easy and takes less time . Due to its broad application, the total system is increasingly being chosen by many developed nations in mass housing projects . Modular construction is currently the most turning construction method available in India and around the world. and it should be used for large mass affordable housing projects .

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