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To Analysis the Meritorious Advantages of Precast Structure over Cast In Situ Building Construction In Allied With Time And Cost At Mumbai Region

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Abstract - Most construction projects use cast-in-place concrete, in which the wet mixture is poured and formed directly at the construction site. Since this often takes place on a construction site, the term "site cast concrete" has become the standard. An analogy is drawn to the usage of precast concrete, in which pieces are cast off-site and then transported to the construction site. Concrete for on-site casting is often delivered using the iconic revolving-barrel concrete mixer trucks. In a centralized batching plant, where stricter quality control over the components may be maintained, the mixture is prepared. At every stage of the process—from transport to the site to proper mixing in the truck to unloading and depositing in the forms and handling for placement, finishing, and curing—the level of responsibility and competence exercised by the people involved is vital. Extreme steps may need to be taken to ensure close monitoring of each stage of production if accessibility and weather at the work site have a major influence on the quality of the work. While the focus here is not on construction management or procedures, a basic understanding of these topics would aid in the creation of workable designs for concrete buildings. Cast-in-place concrete and precast concrete are two competing construction techniques supplied by various contractors for the structural elements, and a breakeven formula is established to help evaluate and pick the best solution. The criteria for selection is the one that will have the least financial impact. The quantity of works, in this case concrete, is taken into account apart from other factors. Finding that the transportation and shifting cost of Precast components significantly impacted the entire cost of construction, this research aims to help decision-makers and engineers analyze both concrete building approaches early in the construction planning stage.

Keywords - Cast in Situ Constriction, Cost, Precast Construction, Time.

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INTRODUCTION

Precast (or "prefabricated") buildings have standardizing and manufacturing its primary structural components at a different location, then sent to the construction site. These components are manufactured utilizing industrial procedures based on mass production to allow for the speedy and cost-effective construction of several buildings.

The following are some of the defining features of this construction technique:

- Workforce fragmentation and specialization
- Manufacturing using standardized, interchangeable components using tools, machines, and other equipment, often in an automated setting.

To streamline and quicken the building process, designers and builders must work together more closely throughout the design phase and the production planning stage. Buildings with a consistent layout in plan and height are an essential first step in reaching that goal.

Such high-rise apartment complexes might have anything from five to 10 levels. As the global urban population grew in the second half of the 20th century, several nations turned to precast construction methods. After World War II, their popularity skyrocketed in the nations of Eastern Europe and the states that had been part of the Soviet Union. When referring to prefabricated construction systems, Russians use the term "Seria," whereas Romanians use the term "Secţiunea."

Precast Concrete Structures:

A precast concrete structure is an assembly of precast parts that, if properly joined, create a three-dimensional framework that can withstand the forces of gravity, wind, and earthquakes. The framework works best for commercial structures like offices, stores, parking garages, schools, and stadiums, which need flexible, adaptable floor plans. Less than 4% of the total volume of a precast framework is comprised of concrete, the vast majority of which is used for the flooring. The columns, beams, floor slabs, stairways, and diagonal bracing are all precast concrete components.

Cast-In-Place Concrete

Most construction projects use cast-in-place concrete, in which the wet mixture is poured and formed directly at the construction site. Since this often takes place on a construction site, the term "site cast concrete" has become the standard. An analogy is drawn to the usage of precast concrete, in which pieces are cast off-site and then transported to the construction site. Concrete for on-site casting is often delivered using the iconic revolving-barrel concrete mixer trucks. In a centralized batching plant, where stricter quality control over the components may be maintained, the mixture is prepared. At every stage of the process—from transport to the site to proper mixing in the truck to unloading and depositing in the forms and handling for placement, finishing, and curing—the level of responsibility and competence exercised by the people involved is vital. Extreme steps may need to be taken to ensure close monitoring of each stage of production if accessibility and weather at the work site have a major influence on the quality of the work. While the focus of this study is not on construction processes or their management, an understanding of the challenges and constraints inherent in this field will aid in the creation of practical plans for constructing concrete buildings. Documented in Raina, Frederick (2001).

Significance: Precast concrete has been used for as long as there has been concrete, all the way back to the Romans. Information on precast concrete's benefits may be found on the website of the National Precast Concrete Association (NPCA). The benefits they list are more general advantages of concrete than exclusive to precast, however there are several advantages of precast over site-cast :

- It's simpler to regulate the ingredients, the positioning, and the curing of precast since it's made in a CCE.
- Controlling and monitoring quality is simplified.
- A precaster might save money by purchasing materials in bulk for many jobs.
- You can refine your mixtures and techniques without worrying about the weather, since you can cast regardless of the conditions.
- Less skilled workers are sufficient since fewer of them are needed.
- Installing precast on-site is fast and easy due to its modular design and the fact that it doesn't need time to harden before use.
- There is a high potential for profit with a single mold and initial setup since precast products are easily duplicated.
- Heating the precast pieces accelerates curing, which results in a significant improvement in strength gain and a shorter period between casting and service.
- Extremely long-lasting concrete may be produced by carefully managing the ingredients, mixing, and curing stages of the process.

LITERATURE REVIEW

Low Sui Pheng And Choong Joo Chuan The authors have shed light on some of the issues that have kept precast suppliers from using just-in-time 'JIT! Equipment shipping and delivery. Reporting that precasters and contractors are skeptical that JIT delivery can be implemented owing to variables including site preparedness and unpredictable deliveries, they conclude that the responsibility for resolving this distrust falls on the site contractors themselves. Better contracting and stricter adherence to the site contractor's timetable is what they recommend to fix the problem. Using the JIT method, precast concrete pieces are delivered to the construction site just in time for installation. The transit time of precast members between the factory and the building site may be shortened with the help of JIT.

Vu Nam Nguyen Business is rising in the precast sector. It presently accounts for 20% of global concrete production because to benefits like shortened construction times, more product variety, higher quality at approved performance standards, reduced costs, etc. SCC is increasingly replacing traditional concrete in the precast sector because to its various advantages, such as reducing noise pollution in cities, pouring in congested reinforced areas, or dealing with Complex geometry.

Anchorage, Alaska According to the authors, using cast-in-place columns in bridge building necessitates a significant amount of time and manpower on the job site. Congestion caused by cast-in-place construction may be very inconvenient. Precast bridge components may reduce on-site construction time, field labor requirements, and traffic delays. The girders of bridges often benefit from this method. Full bridges may be prefabricated and transported off-site, although often just the columns are precast. In seismically active regions, it

might be difficult to have a strong connection between a precast column and footing, and especially between a column and a drilled shaft.

M.J. Ameli1, J.E. Parks Recent innovations in bridge building, the author argues, have included novel approaches that facilitate construction and speed up the total time to deliver the project. No matter whether you're building a brand new bridge or replacing an old one, prefabricating key components of the bridge beforehand can make your life easier. Some of the most important parts of a bridge built using rapid bridge building are the connections between the precast concrete bridge segments that make up the substructure. Scientists are now looking at the viability of different connection topologies in places with moderate to high seismic activity. Acceptance criteria for connections in seismic zones include special emphasis on their load bearing capability, ductility, and ability to be repaired.

H.N. Nurjaman, B.H. The research and uses of precast concrete structural systems are geared on the rapid construction of one thousand low-cost residential skyscrapers throughout major cities in Indonesia. Precast concrete structural solutions have seen tremendous growth in popularity during the last two decades, notably in Indonesia. This is because precast structural systems are superior than monolithic ones in a number of ways, including in terms of quality control, speed of construction, and applicability to conventional modular designs. The government of Indonesia began constructing a thousand low-cost housing complexes around the country in the middle of 2006.

OBJECTIVES

- Comparative Analysis of Cast-In-Place Construction, Prefabricated Buildings, and Precast Structures
- Researching how Precast and Prefabricated Buildings Affect Project Completion Times

METHODOLOGY

We compared the time and money needed for both precast and cast-in-situ construction by making estimates and using the Berakeven Analysis and Payback period approach.

Think about some of the ways in which precast concrete is more useful in building. Books, articles, technical papers, theses, research papers, reports, etc., are all fair game for a literature review.

DATA COLLECTION

CASE STUDY: SAMPLE I - Precast India Pvt.Ltd

Sr. No.	PARTICULARS	DETAILS
1	Name of Company	Precast India Pvt.Ltd
2	Name of Project	Gayatri Phase-II
3	Address	Wadebolhai
4	Name of Client	Mr.Bhate
5	Name of Project Manager	Mr. S.Jadhav
6	Name of Construction Manager	Mr.Ajit Dhumal
7	Name of Contractor	Precast India Pvt.Ltd
8	Name of Consultant	Precast India Pvt.Ltd
9	Plot Area	59,670 Sqm
10	Area Under Open Space & Road	20,228 Sqm
11	Net/Plot Area of Project	39,442 Sqm
12	Duration (Day's)	
13	Precast Concrete	240(Day's)
14	Cast-In-Place Concrete	320(Day's)

DATA ANALYSIS

Building multi-story homes in Wadebolhai, Pune, as quickly as possible is a top priority for Precast India Pvt. Ltd. The proposal called for the construction of six 8-story buildings with a total of 168 apartments occupying an area of about 1,200,000 square feet. The ground level of each structure is raised on stilts, making it 16.5 m in length, 16.6 m in width, and 24 m in height. It was constructed with prestressed floor beams, hollow core slabs, and precast columns. In order to make informed decisions on the most economical structural system, owners often turn to designers and engineers for guidance that goes beyond the broad strokes afforded by generalizations, price estimates, and past projects. Therefore, it is best to employ a quantitative method of comparing the two choices in terms of their construction costs in the early stages of architectural and structural design, when picking between a CIP concrete structure and a PC concrete structure for a certain project.

The following cost function provides a convenient expression for this relationship.

A) Breakeven Analysis:

$$\sum \text{TC Cost} = \sum \text{DC} \times \text{Qi} + \sum \text{IC} \times \text{Ti} \qquad \textbf{Eq.1}$$

While the following symbols stand in for the ones used in the preceding sentence:

TC Cost (in Rs) : Sum of Indian Rupees spent on concrete for both CIP and PC.

DC (in Rs/Cu Meter) : Expenses that are directly related to the amount of CIP or PC concrete placed in place.

Qi (in Cu Meter) : CIP or PC concrete volume expressed in cubic meters.

IC (in Rs/day) : The percentage-based indirect expenses of constructing a concrete structure.

Ti (in Days) : Time Required for Concrete Construction (includes PC Concrete Production)

The following equations show a straightforward relationship between the volume of concrete, in cubic meters, and the overall cost of concrete works (pouring and erection included).

BREAKEVEN ANALYSIS

Two related projects that have used both the CIP and PC structural systems provide the necessary input data for this analysis. Unit pricing and concrete amounts for important structural components in CIP and PC systems are shown in Table 6.1. These data are derived from two separate construction projects. Both initiatives seem to be of comparable scope, cost, and quality based on their shared criteria. According to the contractor's timetable, 320 days will be spent on CIP concrete activities, whereas only 240 days would be spent on PC concrete activities (including design, production, and construction)..

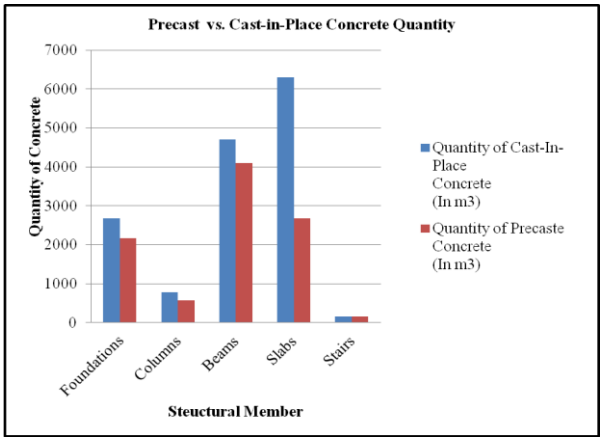
Table 1: Quantities of Concrete Works by Structural Members

	Project A			Project B		
Type of Structure	Cast In Place Concrete			Precast Concrete		
Structural Member	Quantity of Concrete (In m^3)	Unit Cost (In Rs/ m^3)	Total Cost for Individual Structural Element (In Rs)	Quantity of Concrete (In m^3)	Unit Cost (In Rs/ m^3)	Total Cost for Individual Structural Element (In Rs)
Foundations	2675	12285	32,862,375	2174*	11407	24,798,818
Columns	772	14040	10,838,880	564	22676	12,789,264
Beams	4702	14040	66,016,080	4100	26676	109,371,600
Slabs	6295	14040	88,381,800	2278**	12285	27,985,230
Stairs	161	15795	2,542,995	161	43875	7,063,875
	Cumulative Costs		200,642,130	Cumulative Costs		182,009,084

Notation:

* The PC structure's underground footings and slab are made of CIP concrete.

** Since the PC slab is hollow and just 0.3 meters thick, its volume is much less than that of the CIP slab.



Graph 1– Precast concrete vs. Cast-In-Place concrete Cost

FORMULA DERIVATION

Cast-In-Place Concrete (CIP) Structure Costs:

All structural sections other than the foundation and the stairs (which are the same for all choices) need a total of 11,769 cubic meters of CIP concrete, which must be completed in 320 days (depending on the project schedule) at an average cost of 14040 Rs/m3;

Total cost = 11769 * 14040 =165,236,760 Rs.

Assuming all concrete works are on the critical route and there is an inverse linear connection between the cost of concrete and the time it takes to install it,

Cost of 10000 m^3 CIP concrete = 140,040,000 Rs **Eq 2**

It takes 272 days to complete 10 000 m^3 of concrete if it takes 320 days to build 11 769 m^3 of concrete.

Assuming that the overall cost is 140.04 million and the profit margin is 25% (or 35,100,000 Rs), the indirect cost is 35,100,000 Rs.

A breakdown of indirect expenses and profits / day = 35,100,000/272 = 129,044 Rs /Day **Eq. 4**

Thus, the direct cost for 10,000 m^3 of CIP concrete is

Direct cost = Total cost – Total Indirect cost

= 140,040,000 - 35,100,000 **(Eq 2 - Eq. 4)**

= 105,300,000Rs

i.e. Direct Cost = 10,530 Rs/ m^3 **Eq. 5**

DC1: Direct cost = 10,530 Rs/ m³

T1: Time for finish 10,000 m³ = 272 days

IC1: Indirect cost & profit margin = 129,045 Rs/Day

If we plug those numbers into Eq.1, we get the following:

Total Costs (in Rs) of CIP concrete = DC1*Qi + IC1*Ti

= 10,530 * Qi + 129,045 *272

= 35,100,240 + 10,530 * Qi **Eq. 6**

Precast Concrete (PC) Structure Costs:

According to Table 6.1, all structural parts (apart from the foundations and stairs) would need a total of 12699 m^3 of PC concrete, which will be constructed in 240 days (based on the project timetable) at an average price of 18603 Rs/m^3,

Total cost of PC concrete = 12699* 18603 = 236,239,497 Rs.

Since all concrete works are on the critical route, it is possible to extrapolate the time and money required to install the concrete by using this fact.

Cost of 10,000 m³ PC concrete = 186,030,000 Rs **Eq. 7**

Additionally, if 240 days are required to build 12699 m^3 of concrete, then 189 days are required to complete 10,000 m^3 of concrete.

Let's suppose, for the sake of argument, that the PC contractor's indirect costs and profit margin are the same as those of the CIP contractor.

IC2 = IC1 = 129,045 Rs/Day **Eq. 8**

Total Indirect Cost for PC concrete = 129,045 Rs /Day * 189 Days

= 24,389,505 Rs **Eq. 9**

Thus, the direct cost for 10000 m³ of PC concrete

Direct cost = Total cost – Total Indirect cost

= 186,030,000 Rs– 24,389,505 Rs **(Eq7 - Eq. 9)**

= 161,640,495 Rs, or

= 16,164 Rs/ m³ **Eq. 10**

DC2: Direct cost = 16,164 Rs/ m³

T2: Time for erecting 10,000 m³ of PC concrete = 272 days

IC2: indirect cost & profit margin = 129,045 Rs

Substituting the above variables in Eq.1, then it can be written as follows:

Total Costs (in SR) of CIP concrete = DC2*Qi + IC2*Ti

= 16164 * Qi + 129,045 *189

= 24,389,505 + 16164 * Qi **Eq. 11**

FINDING THE BREAKEVEN POINT

After developing the linear equations Eq. 6 and Eq.11 for the link between the amount of CIP and PC concrete and the overall costs of installation, we can find the breakeven point by equating the two sets of equations as follows:

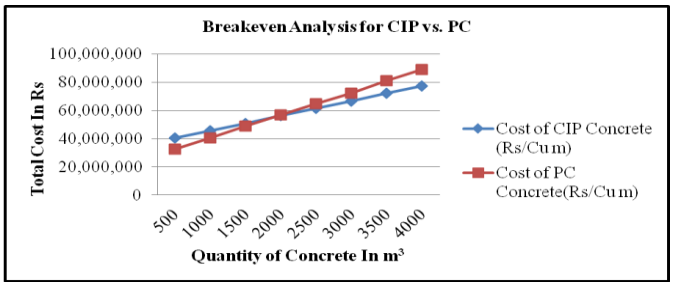
TC1 = TC2, i.e., 35,100,240 + 10,530* Qi= 24,389,505 + 16164 * Qi, and thus

Qi = (35,100,240 - 24,389,505)/ (16164 – 10,530) = 1901.08 m³ of concrete.

Table 6.2 lists the prices per cubic meter of CIP and PC concrete for increasing volumes of concrete in m^3. Breakeven occurs at Qi = 1901.08 m^3 and a total cost of 56,160,333 Rs when plotting the two preceding variables in the XY plane as shown in graph no. 6.2. The figure shows that using PC concrete is more cost-effective and preferable when the total amount of concrete needed is less than 1901 m^3, while using CIP concrete is more cost-effective and preferable when the amount of concrete needed is greater than 1901 m^3.

Table 2: Data of the Concrete Quantities vs. CIP/PC Costs

Sr. No.	Quantity of Concrete (m^3)	Cost of CIP Concrete (Rs/ m^3)	Cost of PC Concrete (Rs/ m^3)
1	500	40,365,280	32,471,308
2	1000	45,630,280	40,553,083
3	1500	50,895,280	48,634,858
4	2000	56,160,280	56,716,633
5	2500	61,425,280	64,798,408
6	3000	66,690,280	72,186,958
7	3500	71,955,280	80,961,958
8	4000	77,220,280	89,043,733



Graph 2– Breakeven Point of CIP vs. PC

CONCLUSION

Cast-in-place concrete and precast concrete are two competing construction techniques supplied by various contractors for the structural elements, and a breakeven formula is established to help evaluate and pick the best solution. The criteria for selection is the one that will have the least financial impact. The quantity of works, in this case concrete, is taken into account apart from other factors. This research indicated that the transportation and shifting cost of precast components had a substantial influence on the entire cost of construction, and this knowledge might help decision makers and engineers analyze both concrete building systems early in the construction planning stage. Using the Payback Period approach, we determined that the Precast Concrete System had a shorter time to recoup the initial investment compared to the Cast-In-Place Concrete System (4.8 years vs. 2.5 years, respectively). Case study findings indicate that constructing using cast-in-place materials is more expensive than using precast concrete. The current research, however, disproved the previously held beliefs.

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