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# **Advancements in Precast Technology: A Comprehensive Study of its Evolution in the Indian Construction Landscape**

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## **ABSTRACT**

This research paper delves into the evolution of precast construction technology in India, a country that holds a significant position on the global stage, comprising about 18% of the total world population and ranking first in population among countries. Recognizing the pressing need for innovative construction methods in India, the study explores the historical timeline of precast technology adoption in the country.

Analyzing the challenges and opportunities faced during the implementation of precast construction, the paper sheds light on the growing demand for efficient and sustainable building practices in country. By tracing the chronological development of precast technology in India, from its inception to the present, the research aims to provide insights into the factors influencing its trajectory.

Furthermore, the study examines the future prospects of precast construction in India, considering its potential to address the demands of a rapidly growing population and urbanization. Through a comprehensive analysis of past trends and current advancements, this research contributes to a deeper understanding of the evolution of precast technology in India and its role in shaping the future of the construction industry.

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**Keywords:** Precast Concrete, Construction Technology, Construction Industry

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## **1. INTRODUCTION**

In the United States and many European countries, precast construction has become a common and effective strategy. However, in India, the use of precast concrete is a relatively recent phenomenon, gaining traction over the past five years. This shift is particularly noticeable in response to the increasing demand for housing due to rapid urbanization.

The construction industry, contributing about 10% to the country's Gross Domestic Product (GDP) with an annual growth target of 9%, faces the immense challenge of providing 30 to 35 thousand houses daily for the next eight years to meet housing demands. With a growing population and the urgency to fulfill housing needs under "Housing for All" is an initiative by Government of India in which affordable housing will be provided to the urban poor with a target of building 20 million affordable houses. There is a pressing need for a reliable, speedy, and cost-effective construction approach.

Traditional construction methods, reliant on manual labor, are no longer sustainable to meet these demands. Precast concrete construction emerges as a solution, offering the capability to build faster, more efficiently, and with reduced waste. It aligns with modern trends in construction and can contribute to creating high-quality, energy-efficient structures that bring long-term benefits.

While precast construction holds significant advantages, proper planning, design, and skilled implementation are crucial for realizing its full potential. Mechanization and new construction technologies, like precast concrete construction (PCC), can be a viable solution if implemented correctly. However, deploying PCC without proper planning and by inexperienced workers may lead to missed benefits and misconceptions about the technology.

Despite its numerous benefits, precast construction project managers must address potential challenges. The focus should extend beyond merely assembling precast components and include factors such as module design, production, transportation, and installation. This research aims to explore the evolution of precast technology in India, considering its benefits, challenges, and the need for improved management to fully harness its potential.

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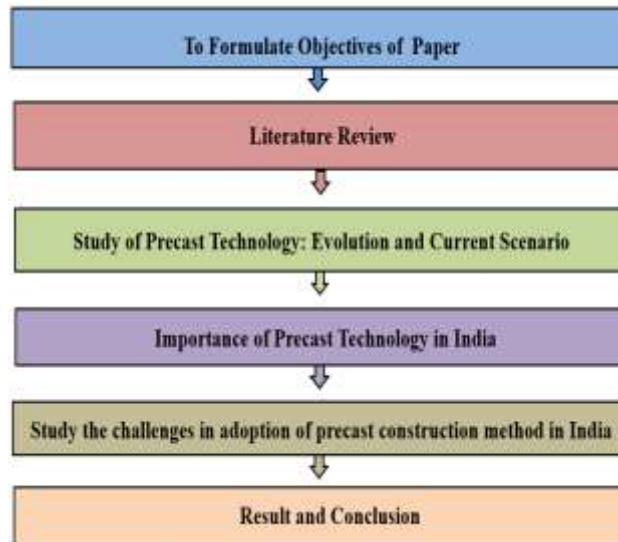
## **2. Study Objective**

The purpose of this review paper is to briefly review recent progress in a particular topic. Overall, the paper summarizes the current state of knowledge of the following objectives

- 1) study the comprehensive historical timeline of the evolution and adoption of precast construction technology in India.
- 2) Examine the development and progress of precast construction technology in India over the years.

### 3. Methodology

The study's methodology is delineated through a systematic flow diagram, illustrating the structured sequence of steps undertaken to conduct the research. This diagram provides a clear and organized representation of the methodological framework employed in this paper, guiding the systematic exploration of the evolution of precast construction in India.



### 4. Literature Review

**Dinesh Kumar et al. (April 2018)** conducted a study to examine the current situation of the precast industry in India. Two main factors are considered in their study, namely cost and time. For this research purpose, data is collected in the form of a questionnaire and the current state and scope of precast technology is known from this survey. A residential building is used and compared as a case study. The comparison showed that there is a huge cost difference between the methods, which is very high for this type of single-family home compared to conventional manufactured homes. The prefabricated construction method for individual two-story residential buildings costs 13% more than conventional construction. This is the main disadvantage of prefabricated construction, which in this case is not economical to build. At the same time, prefabricated construction is easy to process and shortens the project duration by 63 days compared to conventional. In this phase, conventional construction is economical and convenient compared to prefabricated construction.

**Siva Priya et al. (May 2019)** carried out this research as the construction industry replaced its method of implementing conventional methods with various innovations in the construction process and in the selection of materials. Prefab construction can increase productivity and quality of work through the use of better construction machinery, equipment and materials and extensive pre-project planning. This study is essential since there is no organized body. In this research work, the precast construction method and the conventional construction method are compared and it is found that the total costs for the construction of the building in precast concrete construction are reduced by 20% compared to the conventional construction method.

**Akash Lanke et al., (June 2019)** made a dissertation on the analysis of the design, costs and times of prefabricated buildings and RCC. Apart from these factors, several other minor factors are also considered for the analysis, such as construction speed, quality control, environmental conditions, labour resources, durability, connection, size, shape, etc. Cost and duration are compared as essential factors. A building is selected as a case study and the design is carried out on site for the same building as a prefab building and a traditional cast building. From this analysis it is notable that the prefabricated construction costs are significantly reduced and the construction time is also much shorter than with the conventional method. From all this study we can conclude that the precast concrete system is cheaper than the conventional method of pouring in situ, but still there are some conditions that we must take into account when using precast, namely the amount of construction, the distance from the site of the production unit, type of building, etc.

**Ragavendra Holla et al. (May 2021)** reviewed and summarized the role of time, costs, quality and productivity of the precast system to compare it with the conventional one. Precast concrete construction is considered more productive and reduces completion time, costs, and dependency on labour. Compared to the Cast in situ process, the precast process is less time consuming as materials and prepared items are delivered just in time and placed on site, reducing unnecessary handling and equipment use. The process of casting concrete in place is time consuming, as it takes at least 28 days for concrete to reach a strength of 99% of its total strength.

In this work it was pointed out that the construction methodology has a direct influence on the strength and quality of the structure. The precast design has been found to provide better productivity, reduce project duration and costs, and reduce dependency on labor. Precast parts are a construction method that saves time and money and guarantees concrete quality to the highest degree. Construction productivity is high and waste is minimal. While it is very inexpensive, it has its own disadvantage as the precast system is not yet fully implemented in India and there is less awareness of this process in the Indian construction sector.

**Kulabi Ahmed (2022)** has shown through his research that the only way to save time and money on a project is to improve the properties of normal weight concrete. In this research it was found that time and cost savings can be achieved by improving the three properties of precast parts, such as heat resistance, fire resistance and heat capacity.

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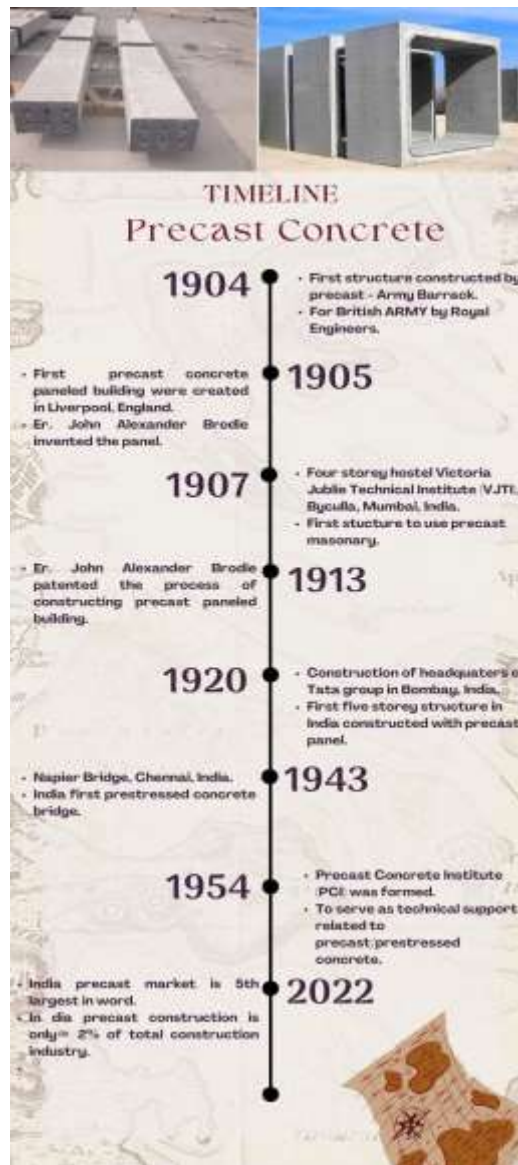
## 5. Timeline of Precast Construction Technology

Precast concrete, tracing its roots back to approximately 1300 BC, has a historical significance as enduring as the material itself. Early applications were observed in the Middle East, where builders devised a hard cement-like coating by covering clay structures with burned limestone—an early manifestation of modern cement.

Advancements in concrete technology took shape centuries later during the Roman era. Romans incorporated crushed limestone and other soft rocks with sand and water to form an early version of concrete. This mixture was strategically poured into molds or wooden forms, facilitating the construction of intricate aqueduct systems and catacombs, demanding precision and durability.

The capability to pre-mold concrete and install multiple slabs concurrently, regardless of adverse weather conditions, played a pivotal role in the construction of extensive underground tunnels by the ancient Romans. The early iterations of precast concrete thus became instrumental in driving the expansion of major cities in Europe and Asia, showcasing the material's enduring significance in urban development.

This historical narrative not only underscores the ingenious application of precast technology in the past but also serves as a testament to the enduring durability of concrete as a foundational building material, influencing the growth and resilience of structures throughout history.



## 6. Barriers To Precast Construction In India

There are various barriers for using precast technology in India based on literature study which are as follows

### 1. Investment

The initial investments are very high for setting up a precast construction plant near or at site. This method of construction requires big players of construction industry to participate and encourage the application of precast construction technology. As this construction technology requires a high initial investment therefore it's difficult to apply this method to smaller scale project. The government should provide additional benefits for setting up a precast construction yard.

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### 3. Taxation

The taxation system in Indian applies 18% GST to the rate which further increases the overall cost of construction. The transportation of precast components from other state requires to pay an additional tax, which increase the overall cost of project. The government can provide an additional subsidy to encourage the application of this method.

#### 4. Transportation

The sizes of individual precast components depend on availability of transportation vehicles. The components must reach on its scheduled time and also without getting any damage. The damage may affect the strength of structure or the process of assembling.

#### 5. Infrastructure

Maximum load-carrying capacity of bridges and pavements also affect the module size of the precast components. The vertical and horizontal clearance of roads, bridges and underpass are also required to be checked before finalization of the components.

#### 6. Standardization

There is a lack of standardization, codes, and certification by BIS to check the quality of manufacturing. The erection of precast elements also needs to be verified with some standards to ensure the quality of construction.

#### 7. Joints & Connections

The issues with joints and connections lead to the problem of leakage, seepage. This is because the IS codes and standards on precast concrete does not have sufficient guidelines to improve the water tightness of structure at the junctions.

#### 8. Perception

The negative and mixed perception of Indian stakeholders of the construction industry resists the adoption of precast construction system. The major cause for this perception is because of the initial investments and the less understanding of precast concrete technology.

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### 7. Conclusion

In conclusion, the trajectory of precast concrete construction has traversed a rich historical landscape, from its early applications in ancient civilizations to becoming a pivotal force shaping contemporary construction practices. The evolution of this technology underscores its enduring importance, driven by the need for efficient, rapid, and sustainable construction solutions.

In contemporary India, the imperative for mass construction has led to the adoption of precast concrete as a key technological solution. The decision by the Indian government to select precast construction as one of the six technologies for the Light House projects is a strategic move that aligns with the demand for scalable, time-efficient, and cost-effective construction methods. This choice not only reflects the acknowledgment of precast technology as the need of the time but also signifies a commitment to modernizing the construction industry in alignment with global trends.

As we look ahead, the integration of precast concrete construction is poised to play a pivotal role in meeting the escalating demands for housing and infrastructure development in India. The ongoing efforts and initiatives, both historical and contemporary, position precast technology as a cornerstone for achieving sustainable urbanization and fostering economic growth. With the government's endorsement and a growing recognition of its benefits, precast concrete construction stands as a beacon for the future of the construction industry in India, addressing the imperative needs of our time.

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