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A Review Paper on Precast Concrete

Prashant Attri[1], Karthikeyan Murugesan[2]

[1]PG Student, Department of Civil Engineering, Galgotias University, Gr. Noida, Uttar Pradesh
[2]Assistant Professor, Department of Civil Engineering, Galgotias University, Gr. Noida, Uttar Pradesh.

Abstract - *Rapid population growth leads to huge demand for basic services and resources like housing, infrastructure, resources, etc. Various technical studies show that the use of precast technology accounts for about 2% of the total Indian construction industry. Currently, the adaptation of precast concrete construction (PCC) technology is limited to infrastructure projects such as metro, monorail, bridges, etc.*

Researchers suggest that the use of PCC technology is a sustainable method to achieve high quality with lower consumption of resources such as cost and time during construction.

Today, conventional construction pales in comparison to prefab construction. Precast concrete is a smart way to construct any type of building safely and economically. It guarantees fast construction times, high economic efficiency and excellent quality. Precast concrete elements are an industrialized form of construction. It means moving work from sites to factories. This improves productivity and quality and shortens the construction time of a building. In short, precast concrete elements significantly reduce overall construction costs. This article is about precast technology research and its advantages over conventional construction.

***Key Words*: precast, cast in situ, construction, review, comparison of concrete.**

1.INTRODUCTION

Ready-mixed concrete is a construction product that is manufactured by pouring concrete into a reusable mold or form, which is then cured in a controlled environment, transported to the construction site, and installed there. Large Indian real estate companies rely on precast technology when building their latest projects. The main advantages of precast technology are quality, speed of construction and good value for money. In order to avoid labor shortages and delays, and to deliver quality products, developers and builders now rely on precast technology. Using such technology helps up to 64% of the time it takes for similar projects that use normal designs and technologies. In other words, if the normal brick and mortar method takes a year to complete a project, the precast method takes about four months. Precast technology has proven its worth in Europe and the Middle East by saving construction time. The best part about the technology is that it not only speeds up construction, but also increases the quality of the end result.

1.1 History of Precast Technology

Ancient Roman builders used concrete and soon poured the material into molds to build their complex network of aqueducts, sewers, and tunnels. Modern applications of precast technology cover a large number of architectural and static applications, from individual parts to complete building systems.

In the modern world, prefab panel buildings were introduced in 1905 in Liverpool, England. The process was invented by municipal engineer John Alexander Brodie, a creative genius who also came up with the idea for the soccer goal. In 1906 they followed the Walton tram stops in Liverpool. The idea was not widely accepted in the UK. However, it has become popular all over the world, especially in Eastern Europe and Scandinavia.

In the US, precast concrete has developed as two sub-industries, each represented by a large association.

The precast concrete industry focuses on utility, underground, and other non-prestressed products and is represented primarily by the National Precast Concrete Association (NPCA). The precast concrete industry focuses on prestressed concrete elements and other precast concrete elements used in above-ground structures such as buildings, parking lots and bridges. This industry is represented primarily by the Precast / Prestressed Concrete Institute (PCI).

2. LITERATURE REVIEW

2.1 F. Givssani et al. (August 2006) research deals with precast and on-site concrete roof systems for residential buildings. There are two other types of panels of interest, the first using composite trusses and the second based on a casting process that behaves like a two-sided thin panel supported on solid supports. The concrete slabs of the place are illuminated with terracotta bricks. The limit states of crack formation and deformation must be carefully considered in this study.

2.2 Souma Alhaj et al. (2009) wrote an article on increasing the productivity of precast concrete parts. Therefore, the production process is examined with the production lag model. The data from 40 cycles is used in the analysis. Comparative impact and severity are measured by five causes of delays, namely: labor, environment, management, equipment, and materials on overall system productivity.

When analyzing the delay in production, it was found that material, followed by equipment availability and then labor, was the main cause of the system delay. On the other hand, a statistical analysis of the assembly cycle time of three types of precast elements is carried out to ensure that the delay observed in the first step is due to the variation of the precast elements. From this it was concluded that in the future a decision model should be developed with which production and site managers can improve production in the plant and on the site.

2. 3 Tanut Waroonkun (2011) presented an article on the analysis of a conceptual model that takes into account the multiple factors that affect the efficiency of the adoption process. For this, the main influencing factors for the use of precast concrete systems are determined by statistical evaluations among 160 experts in the construction industry. To do this, a simple regression analysis is performed and the results are obtained.

2.4 NG Ban Kiong et al. (November 2012) discussed precast concrete systems for building maintenance. This article looks at the factors that lead to maintenance problems in precast concrete system construction. These factors are factors that must be considered when planning, fabricating and designing precast concrete systems. Finally, recommendations are suggested for use by designers, contractors, fabricators and researchers involved in precast concrete systems. Precast concrete parts are produced to the specified dimensions and transported to the construction site. Without proper planning, building maintenance problems can arise. Various factors are taken into account, such as: Architectural design phase, structural design phase, construction services design phase, production phase, construction phase, etc.

2.5 VC Castilho et al., (2012) conducted a study to determine the cost of continuous and single-support roofs consisting of uniaveolar beams and prestressed beams using genetic algorithms (GA). A comparative analysis of the final cost of these two precast elements was carried out. Although the prestressed beam is more economical, the single-cell beam comes on the market to compete with the rest of prefabricated products for roofs. The Genetic Algorithm (GA) is a search and optimization method that uses concepts from genetics and is based on the mechanisms of population evolution. One type of plate called a unialveolar plate is prefabricated. These panels have a hollow core which makes the panels lighter. In this plate, the depth of the plate increases with increasing light. The results conclude that prefabricated roofs are cheaper. In this study, the use of GA was examined in order to find the most economical solution for post-tensioned beam and single-sided beam ceilings.

2.6 Muhammad Abedi et al. (2013) directed their research to investigate the potential of cloud computing technology as construction collaboration tools for supply chain management of prefabs. Poor integrations and lack of collaboration are the biggest obstacles in precast construction projects. An effective communication system and access to up-to-date information are required to improve cooperation between actors in the precast supply chain in the various phases of precast construction. Results show poor planning and scheduling, high precast costs, poor design, lack of architectural creativity, poor production time, large and heavy precast, incorrect deliveries, on-site coordination and collaboration, poor on-site, contactors poor specialized skills, and the lack of good communication between the parties is the main obstacle in the supply chain of finished parts. These barriers in the precast supply chain stages can negatively affect the delivery performance of precast projects. Therefore, cloud computing technology has enormous potential to provide efficient collaboration systems in precast construction. Therefore, cloud computing technology has proven to be an efficient collaborative system in managing the finished parts supply chain. Cloud computing as an important collaboration tool will improve the integration, communication and cooperation of parties and stakeholders in precast construction.

2.7 M.J. Gopinath et al., (November 2013) wrote a thesis on a two-dimensional precast frame with 3-bays, G + 5 floors under lateral loadings. The connections in the beam-to-column connection and the connections in the beam-to-beam connection were reinforced with specially designed long steel bolts by welding and bolting. The frame was subjected to cyclical transverse loads until its failure. The results are compared with the ANSYS model. The efficiency and performance of joist connections and beam connections were examined, and the performance of precast frames compared to monolithic frames was examined. In this study, joints in beam-to-column joints and joints in beam-to-beam joints were investigated experimentally. It is concluded that the predesigned model works more efficiently than the conventional one.

2.8 N. Rossley et al., (2014) described the connections of precast elements under shear load in their dissertation. A study is being carried out on the connection between external and internal precast concrete elements. The connection between the walls is called a loop bar connection. A cross bar is inserted between the loop bars to ensure that all the loop bars are connected. This connection creates a space between the walls, which is then filled in with concrete to create a rigid connection. The main objective of these experimental investigations is to determine the behavior of the loop bars under transverse load. The connection exhibits ductile behavior as it creates few cracks in the pipe and has a large deflection to warn of errors. This ductility is within the acceptable ductility of a structure. Therefore, the construction industry is recommended to use this type of connecting construction, which can be used for medium-high precast elements.

2.9 Mar Dewi Jamal et al., (2014) carried out a study to verify the ductility of precast elements under cyclical load

and then compare them with conventional elements. The test was carried out using a gradual type displacement control. The study shows that precast concrete elements have higher ductility compared to monolithic concrete. Ductility of precast concrete elements, μ = 4.379, while for monolithic concrete, μ = 2.333. After testing, it was found that the ductility properties of the precast elements are higher than those of the monolithic structure. But the crack patterns are almost the same for both types.

2.10 Prakash Rao et al. (2014) examined the perception of building owners and contractors towards precast construction technology. In our country, the perception of prefabricated pieces is not the strongest. This can be attributed to reasons inherent to human acceptance traits and a lack of skills in the fabrication of precast concrete parts. This perception is based on the respondent's name, experience, precast knowledge, etc. through a questionnaire survey with high-ranking clients. Workers consider precast elements to be unsafe. Repeating mass units is the best option. Some point out that research is needed in the field of precast concrete research.

2.11 Dinesh Kumar et al. (April 2015) 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 prefab 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.

2.12 Siva Priya et al. (May 2016) 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.

2.13 Akash Lanke et al., (June 2016) 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, labor 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.

2.14 Ragavendra Holla et al. (May 2016) 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 labor. 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.

2.15 B. Anvari et al., (August 2016) advised that a multi-goal Genetic Algorithm-primarily based totally (GA-primarily based totally) looking approach is proposed to resolve unified useful resource scheduling problems (that are equal to prolonged Flexible Job Shop Scheduling Problems). To the high-quality of the authors` knowledge, that is the primary time that a GA-primarily based totally optimization method is implemented to a holistic trouble with the purpose of minimizing time and price whilst maximizing safety. The version is evaluated and in comparison to different specific and non-specific fashions the usage of times from the literature and eventualities stimulated from actual precast constructions.

2.16 A L Kulabi Ahmed (2016) 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.

2.17 Kyuman Cho et al., (July 2017) addresses in their dissertation the comparison of a traditional roof system with a semi-finished concrete slab system. A system of half precast concrete slab system (HPCSS) is reported to have excellent structural performance compared to conventional panel systems. However, there is a lack of research on the design issues of an HPCSS. The results show that (i) the productivity of the construction of HPCSS is 1.7 times higher than that of a conventional panel system, (ii) the cost per unit of productivity of HPCSS exceeds that of a conventional panel system. The results of this study suggest that it is possible to develop an optimal plan of a construction site in which an HPCSS is installed and that the HPCSS can be actively used in the future.

3. ADVANTAGES OF PRECAST CONCRETE

• Quality is more assured in the construction of precast elements.

• Dependence on labor is lower in precast concrete construction.

• Build speed is faster. Total construction time can be saved up to a minimum of 20% compared to conventional construction.

• Fewer workers are needed and these workers may be less skilled.

• The ductility of precast concrete elements is higher than that of monolithic concrete.

• The precast concrete part has low weight and superior thermal insulation properties.

• Precast cover plate improves cracking moment.

• Because precast parts are manufactured in a controlled casting environment, it is easier to control mixing, placing, and curing.

• Since a precast operator can purchase material for multiple projects, quality discounts can reduce costs.

• Quality is much easier to control and monitor for precast concrete.

4. DISADVANTAGES OF PRECAST CONCRETE

• The precast construction method is not economical for small residential buildings.

• Transporting finished parts over long distances can cause damage.

• The pattern of cracks in precast and conventional construction is almost the same.

• Poor integration and lack of cooperation between stakeholders.

• If the planning is not correct, this can lead to maintenance problems at a later time.

• The cost is higher compared to the conventional method.

5. CONCLUSIONS

The use of precast concrete support systems for the construction of low-cost apartments has advanced enormously all over the world. This is because precast concrete systems have several advantages over the conventional in-situ concrete system:

• It was found that, in general, a profitability of the structure of around 5-10% was achieved by replacing the conventional structure with precast concrete pieces.

• Although prefab construction offers many advantages, but it still opted for the conventional construction method and consider it safe, as the costs of precast elements are slightly higher than the conventional construction method.

• The precast part is used throughout the world and has many properties, such as it can withstands seismic loads, cyclic loads, etc.

• The assembly and connection of prefabricated buildings is also very easy.

• Precast parts have lower lifetime costs than any other construction solution.

• It was also shown that construction speed could be significantly increased in line with the achievement of higher quality works and greener construction projects.

• The need for personnel in precast construction is very low.

• Precast parts minimize the need for maintenance over the years.

• The use of precast concrete parts as load-bearing components will definitely increase in the future.

Construction speed can be increased with precast construction.

• Precast concrete technology has already reached India due to large-scale projects, the need for high-quality construction at high speed, and reduced manpower.

All of these benefits can be used optimally through careful planning and design.

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