

# Precast Construction Technique: A Sustainable Approach for Smart Cities

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**Abstract** - India is considered as the fastest developing nation in the world. Globalization, Industrialization and Urbanization is going on a very faster rate and thus attracting people from all over the world into the country. Increasing economy lead to the betterment of living standard, Infrastructure, Healthcare facilities etc. which is also a major cause of attraction for people towards the major urban centers of the country. Simultaneously cities are facing numerous problems of increasing urban population, pollution levels, scarcity of potable water etc. Here evolves the concept of the smart cities and also smart technology for their construction, that compliments the environment, its resources, and people. In the present time where resources are limited and population is increasing constantly, smart cities can serve the purpose of preserving the environment by efficient use of our natural resources. For transition of these cities all over the country, construction activities must be required on a very large scale which can cause a lots of pollution, so a sustainable way to carry out this task is the need of the time, and precast construction technology is one of them. This research analysis the need of precast technology over conventional method and its benefits. In this paper an attempt is made to identify the sustainable approach of this technique towards the environment by controlling pollution level, saving time, money and energy. This study will help in analyzing the different ecofriendly ways that must be adopted for future cities and also justify the transition of technology from conventional to precast.

**Key Words:** Sustainability, Precast construction, Smart cities, Pollution control, Economical construction.

## 1. INTRODUCTION

### 1.1 General

Today in the twenty first century when urbanization is on its peak and India is heading towards the development with full force and has a constantly increasing economy, it faces the biggest problem of being a construction zone for several more years in the future. It is necessary to fulfil one of the basic necessity of human life i.e. shelter. As the development is going on with the time, numerous new technologies have been introduced in the field of transport, food production, construction equipment's and the most important one is construction techniques.

Precast is one of those techniques which are used nowadays extensively for the construction purposes of residential,

commercial and other typologies of the buildings [1]. In this technique the concrete prepared with full specification and proper maintained ratio of the aggregates is poured into the reusable molds, that has been prepared earlier according to the desired requirements and dimensions and then cured further just like the conventional method but in a totally controlled environment. These structural elements like beams, slabs, walls, columns, stairs etc. are then transported to the actual construction sites and erected into their desired place [2].

### 1.2 History

Precast is considered as the new technology, generally in India it's not so common as compared to the other parts of the world. Romans were considered as the pioneer in the construction field and the first user of precast technology. They construct their tunnel system and aqueducts by using the molds for casting [3].

Precast or Prefabrication are the two almost similar technologies that began in India under the company Hindustan housing factory, which was developed by Pandit Jawahar Lal Nehru. Then also it came into existence for the purpose of delivering the faster construction rate for mitigating the huge housing demands for the refugees coming from west Pakistan in 1950. Here also precast technology were used as a tool to accelerate the construction speed in order to accommodate the people in least possible time. It constructed pre-stressed railway sleepers to exchange the conventional ones made up of wood. This manufacturing unit is presently located in Delhi with the name of Hindustan Prefab limited [4].

### 1.3 Present scenario

Today all the trends, requirements, needs, techniques are changed to a superior level. Population is regularly increasing and hence demanding the resources on a higher note. Trend of overuse or wastage of our natural or man-made resources is another challenge to cope with. In these situations when the strong need of using precast technology is felt, India is lagging behind the other developed countries in its use, simultaneously India is leading ahead in terms of population growth, which creates an adverse situations in the country today.

## 2. OBJECTIVE

The prime objective of this research is to justify the precast technology as a better solution for the construction of smart cities. Moreover it also reveals the various advantages of this technique for the environment.

- To prove precast technology as environment friendly technique as compared to the cast in situ by analyzing them on various parameters like Pollution, Deforestation, Use of Energy and Resources.
- To prove it as an appropriate time saving option for faster construction of smart cities.
- To divert the attention of various Policy makers, Builders and Developers towards the huge environment friendly benefits of precast technology.

## 3. METHODOLOGY

### 3.1 literature review

- Research papers from various international journals, related to the topic has been studied.
- Articles and Reports has been reviewed from selective and authentic sources.

## 4. CONVENTIONAL CONSTRUCTION METHODS

India is going through a huge transition phase from developing towards a developed nation, and to achieve this goal a massive need of construction is felt. The construction industry in India alone stands for about 10% of the total Gross Domestic Production. Cast in situ (CIS) technology that is being followed in India on a large scale is generally a major source of pollution, as all the reinforced concrete structures are erected on that particular open site without providing much more controlled environment as compared to the precast technology [3]. Certain activities like batching, concreting, open storage of aggregates, excavation, sand filling, movement of large construction equipment's etc. that has been performed on the CIS construction sites, are the major contributors of a pollutant named  $PM_{10}$  which includes tiny particles of smoke, dust, dirt etc.[5]. Another pollutant is  $PM_{2.5}$  which is emitted mainly from the road dust and vehicular emissions, which is again can be easily seen on the CIS construction sites [6]. People living in the vicinity of these sites are highly affected by above mentioned pollutants and more vulnerable to the life threatening cardiovascular, asthma, bronchitis diseases and even lead to premature death [5]. Due to all these reasons CIS method of construction is not considered as human and environment friendly.

Another technology that has been used in India is structural steel in which large column free spaces are provided by using trusses, space frames. In this all the structural

members like beams, columns, roofing etc. are of steel and the use of concrete and other materials mainly responsible for pollution are used in small proportions. This technology are generally used for the industrial purpose instead of housing and commercial which are much more in size and need. On comparing both, CIS technique is capturing about 70% of the market leaving behind the 30% for later one [3]. But this technology is also a part of CIS, as the base and foundation are erected in the same manner on the site itself. Therefore both the technologies are not providing a satisfactory and sustainable solution for the future of construction where a lots of work needs to be done keeping in mind the environment, resources and human health on the priority.

## 5. CONCEPT OF SMART CITIES IN INDIA

Globalization makes this whole world easily reachable for the masses of any particular country or a city. People are travelling across the borders for seeking better life standards, Job opportunities, Education, Healthcare facilities etc. This lead to the polarization of population in most developed and developing nations. India being one of the fastest developing country of the world is also going through the same situation. Increasing Urbanization in India is the effect of a rapid growth in Globalization and Industrialization which in turns lead to the significant increase of the urban population in India.

**Table -1: Year wise urban population growth in India.**

Urban population (%)	year
27.8	2001
31.2	2011
40	2030
50	2050

This huge and rapid growth of urban population in India presents the great challenge of infrastructure development and providing better services to the mankind keeping in mind the regular deterioration of the environment and extinction of various natural resources that needs to be controlled effectively along with the new possibilities of development.

Here comes the smart cities in picture. As the name suggests these cities are considered to be smart and clever enough to respond the above mentioned issues efficiently in a protective manner and also expected to deliver simultaneously the high quality of living standards, pollution free environment and effective use of our natural resources. In India it is initiated through a mission of Ministry of Urban Development named as Smart Cities Mission (SCM) under which 100 smart cities are proposed to develop throughout

the country. Ministry defines the smart city as “building and promoting cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment, and the application of smart solutions.” In the implementation of smart cities, SCM is considered as a significant step also aiming towards the betterment of Indian economy and thus enhancing the standard of life of the people, boosting their financial stability [7].

**5.1 Need of smart cities**

Lots of urbanization taking place in the country has placed various needful things and services together being accessible to the users in their daily lives but simultaneously considered as a major factor responsible for the climate change, emission of greenhouse gases which lead to global warming. A series of major problems are associated with this, starting from melting of glaciers to the change in micro climate of the cities, all is needed is a smart solution to control these factors.

The expansion of towns and cities on higher level is another concern to deal with. Along with the increase in urban population there is an increment noticed in shifting the typology of towns from lower to higher category in terms of population size shown in the table below.

**Table -2: Changing typology of Indian cities and towns on the basis of urban population growth.**

Typology (Based on population size)	No. in Year (2001)	No. in Year (2011)	Increment (no.)
Towns (< 1 lakh)	5161	7935	2774
Cities (1-10 lakh)	441	468	27
Metro cities (> 10 lakhs)	35	53	18

Above table presents a clear picture of speed of transition phase taking place in India. Smart cities may prove to be the better solution for future and therefore they are considered as the future cities which can transform the whole scenario and contributes a lot towards the healthy and ecofriendly lifestyle. But it is just like to be a sweet dream that cannot become true without the active involvement of each and every person including from the policy makers to the end users in conserving the energy, resources and using them efficiently complying it with the implementation of the new and latest technologies [8].

**5.2 Challenges for smart cities that can be controlled by precast technology.**

**Rising water crisis.** Water is a very crucial natural resource and considered as one of the basic necessity of human life, and potable water has the significant role in enhancing the healthy lifestyle. Regular construction activities on a large scale are the major consumers of water and plays an important role in depleting the water table throughout the country. Use of water in the construction process depends upon the type of construction going on. Cast in situ construction demands more water than the steel-glass and precast construction. Water and energy are supposed to be the main pillars for supporting the human life during the whole life cycle of the building [9].

Due to the inefficient use of the water, many areas of the country are facing its scarcity. Reduction in the water level and interrupted supply of municipal water with low pressure compels the common residents to use their own powerful electric motors to store the water in overhead tanks. Water purifiers have been used on the large scale to maintain the purity of water, these initiatives consumes a lots of energy and increase the load on power supply and thus contributing to the rise in carbon footprint [10]. However, the quality of water is also significant factor for the construction purpose. Concrete has both the elements i.e. water and cement which reacts with each other. If impure water is used for preparing the concrete the impurities may react differently to the constituents of the cement and may affect its setting time. It may also affects the durability and strength of the concrete which may prove to be dangerous regarding the structural stability of the building [11].

**Deforestation.** Development demands the space and most of the time this space is extracted by deteriorating the green areas mainly the forests and the agricultural lands. India is going through a heavy urbanism phase and urban sprawl of its major cities has significantly destroyed the green cover to a great extent. Being in this situation planning of 100 more smart cities is a huge challenge in front of the Government, Policy makers, Planners and the Developers to achieve that benchmark causing minimum harm to our biodiversity. Although various steps has been taken till now including the National Forest Policy of India according to which forest and other green areas must combined to cover about one-third of the total land area of the country, but still proves to be insufficient [12].

**6. PRECAST TECHNOLOGY AS A SUSTAINABLE SOLUTION**

Construction is one of the major cause of deforestation but also essential for future developments, therefore it must be done using various environment friendly materials and construction techniques that supports the idea of sustainability and proves to be perfect for the upcoming projects of smart cities. Precast construction technology is considered one of them which can be a better option for

designing our future cities. It can serve the purpose in numerous ways:

### 6.1 Controlling Deforestation

Use of timber can be seen extensively in the construction industry especially in the traditional methods of cast in situ construction. It is used to fulfil the demands for timber molds, wooden logs for shuttering and also for scaffolding at various places [4, 13]. Not all but a reasonable amount of wooden products are used in constructing a building. Ply boards are used for formwork to support the load of freshly prepared concrete is also a by-product of timber industry. Due to having a large scale CIS based construction industry in India, as discussed earlier, the burden on the timber industry is high. Also these wooden products are not water proof and remain in the open environment exposed to the weather on the site therefore they got damaged especially during the rainy season. Ply-boards can be used for two or three times maximum and got vandalized after that. Then again the new demand for these products rises for continuing the construction works further, which is again got completed by sacrificing more trees for the purpose. All these factors doesn't exist in precast technology as all the construction are done in a factory under fully controlled environment, thus it reduces the load from timber industry and plays a vital role in controlling pollution levels. It also reduces the waste generating on the site, which makes this technology more sustainable [14].

### 6.2 Controlling Pollution

As discussed earlier in this paper Cast in situ is a conventional construction technique which is done on open site and considered as major source of pollution, while on the other hand in precast technology, various structural members i.e. beams, columns, slabs, staircases all are constructed in a covered and controlled environment. Pollution caused by the dust particles, blowing of aggregates like sand and coarse sand on the site and other activities are all eliminated here. It also single handedly controls the pollution of numerous sites working on the concept of precast technology by transporting the readymade product to the original site location for its assembly [15]. It also helps in finishing the role of various machineries used for construction and hence controlling their carbon emission from getting mixed into, and deteriorating the environment.

### 6.3 Time Saving

According to a research the total time is calculated of a project by using both techniques of construction i.e. Precast and Cast in situ, in which the results shows the former one faster than the later one. Where conventional technique took about 705 days on the other hand precast technique completed the project in just 598 days. Findings reveals that the precast technology completes the project 15% faster saving 107 days [16]. This is another way to control the

pollution by reducing huge no. of construction days. This faster rate of construction in precast technology is due to various reasons like:

- Precast structural members don't need to be plastered due to their initial finished surfaces.
- They don't need to be cured on the site.
- All the shuttering, scaffolding and formwork used to be erected at the site in conventional method is completely eradicated in precast technology, hence saving a lots of time.
- Time taken for reinforcement of various structural members are also saved.

### 6.4 Water Efficient

Precast technology is contributing and strengthening the efforts of saving water in following ways:

- Precast technology uses 20% less concrete as compared to conventional method [17]. The water used to prepare and cure that concrete is all saved.
- Water used on site for curing the whole structure is saved as these precast blocks had already gone through that stage in a very controlled conditions, where water is efficiently used for their curing in the factory.
- No plastering is required therefore Water used for plastering and its curing is all saved.
- Water used for suppressing the aggregates and loose soil on the site is saved to a great extent.

### 6.5 Economical

It proves to be economical for large scale projects where a mass production of structural members are needed i.e. housing projects where typical floors are need to be erected and similar types of structural members are to be used. However, for small scale projects the investments will be more as compared to the conventional one, but in the long run the building will get benefits of structural stability [17]. Some other reasons which makes it an economical solution are:

- Less concrete, Steel, and manpower is required. All the factors are money driven and limiting them can save lots of money of the investors.
- Less consumption of water and electricity save the expenditure need to be done on them.
- Shorter time period of the project saves the money spent on hiring the various heavy construction machineries on per day rental basis.
- Precast concrete is generally light in weight and has high thermal property, which can help in keeping the building cool and thus saving the money and energy by reducing the cooling loads [1].

## 6.6 Saving fossil fuels

- Fossil fuel like coal that is majorly used in various thermal power plants to produce electricity can be saved in the long run, as precast technology saves electricity by limited and controlled use of heavy electronic machineries.

Petroleum products like diesel can be saved by reducing the construction days for which various construction equipment's used.

## 7. CONCLUSION

Today India is going through a great transition phase. In this journey country needs to go through the intense construction activities which is considered as the one of the major source for pollution. At the same time, the whole world is already fighting with the severe causes of pollutions in the form of Greenhouse emissions, Global warming, Ozone depletion, Water crises etc. Thus the path of development is full of challenges to achieve the desired goal without further harming the nature. Lots of studies, conferences, researches and policies have been framed till now to save the environment against this unavoidable problem. This study concluded that Pre-cast construction technology is found to be far better than the conventional one. It will help in controlling the Pollution, saving the resources like Water, Energy, Money, Forests etc. It is a great sustainable technique which proves to be the best for our future cities and also its speed of construction will help in getting the results faster. However, just the technology cant react better alone, a combined effort of each and every person related to the industry is required. The support is needed at every level from the Government via Policy makers to the Planners and Developers who must adopt this challenging task of shifting their work from conventional to the precast system, and hence contributing in the sustainable development of the nation.

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