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June' 2019 Vol.21 No.6 ₹ 130/-

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Precast Concrete Technology – Case Study



# Nuvoco – A Leading Partner for Precast Concrete



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Precast concrete is today one of the most versatile and dynamic products in the construction industry, owing to the countless benefits it offers. The key element that sets it apart from conventional site cast concrete is that precast concrete is usually produced by casting the concrete mix off site, then cured in a precisely controlled environment, usually at Precast plant, and then the finished concrete elements are transported to the site, lifted, and positioned in place, using cranes and cables to complete the structure.

### Market Size

A report by HNY Research states that the global demand for precast concrete is expected to grow at a CAGR of 6.5% every year, achieving a market size of USD 185.35 billion by 2023. This rapid and powerful growth has been a result of the increasing focus on housing and infrastructure development in the country.

### Emergence in Construction Market

Using precast concrete is not only faster and safer, but it also makes the construction process significantly more affordable compared to using Cast in-situ concrete. This makes it a unique product that can help meet the growing need to reduce construction costs and time required, besides facilitating offsite construction

projects. Precast concrete also improves the durability and load bearing capacity of structures, especially when the concrete is pre-stressed with cable reinforcement. It also offers a greater volume turnover, owing to which, it has today become widely popular among builders and contractors.

### Challenges Addressed

In light of these factors, precast concrete is able to effectively address several challenges faced by cast in-situ concrete. Site wastage and the associated environmental impact is also reduced greatly while using precast concrete, as the modules are designed in the plant, specific to the precise requirements, and can be stored at the factory yard until the construction site is ready.

Due to the factory-controlled prefabrication environment where it is produced, precast concrete offers the choice of a wide variety and combination of colours, textures, sizes, and shapes, along with higher density and crack control, weather and sound insulation, and more. Owing to this, precast concrete is widely used in Mass Rapid Transit systems, in India. However, large-scale projects like these are accompanied by the major challenge of supplying huge volumes of concrete, designed to adhere to specific standards and requirements. Two of the largest projects in recent times include the Mumbai Metro, and the

Noida Metro, for which, Nuvoco Vistas Corp. Ltd was the construction materials partner. The Indian construction industry giant was responsible for providing a wide range of specialised precast concrete products and solutions, for which, it set up multiple captive plants so that the required quantity of High Performance Concrete could be produced and supplied efficiently.

### Mumbai Metro Project

The Mumbai Metro Line – 3, an ongoing project, is the first underground metro line in Mumbai, connecting Cuffe Parade to SEEPZ, with 26 underground stations and one at-grade station. The concrete was required for package 4, which will comprise the three underground stations of Siddhi Vinayak, Dadar, and Shitladevi. Nuvoco set up a dedicated captive plant at the site, for the production and supply of 2,48,000 m<sup>3</sup> of concrete which include High Early Strength as well as standard concrete. The project required the construction of 6082 m twin bored tunnels with an internal finished diameter of 5.80 m. The underground tunnel sections needed to be 1.4 m long, 1 m wide, and 275 mm in height, with a volume of 1.4 m<sup>3</sup>, and required the use of precast concrete tunnel segments or rings, to provide a protective lining and reinforcement to the structure. However, the segment also had to be strong enough to withstand the





heavy load and durable enough to stand the test of time. The precast concrete further needed to possess sufficient plasticity during casting so that it could be moulded into the required shape and set properly.

The primary challenge was supplying high early strength concrete of 14 Mpa at 16 hrs without steam curing for de-shuttering. The project also needed to ensure extremely low Chloride ion penetration and migration to offer a service life of 125 years, along with controlled shrinkage, and a customised aesthetic finish. Nuvoco has been able to address these needs by using a combination of two of its products, Instante and Robuste, of M50 Grade. The specific process for the construction required the placement of the reinforcement cage inside the segment casting mould. So, rapid setting M-50 grade Robuste concrete was produced at Nuvoco's captive batching plant, and transported to the location by transit mixers. The concrete was also designed to gain strength of 14 Mpa in 16 Hours, with a slump of 100 mm to 140 mm, following the approved mix design for the project.

The concrete was then placed into the moulds by using a concrete bucket over crane in the precast yard, after which, it was vibrated using three vibrators fitted to the bottom of the mould. During the concrete placement, the steel reinforcement also had to be checked to ensure that it stayed

fixed in place, with sufficient structural support. After the leveling was done and the top surface of the segment was finished, it was covered with plastic and canvas sheets to prevent water loss, until the concrete achieved the early strength required for de-moulding. A total number of 7835 permanent precast rings were required for the package, out of which 5978 have already been casted with as many as 16 rings with 8 sets of moulds being casted in a day. Not only has this helped ensure high early strength for enhanced productivity, it also provided ease in placement of concrete in the thin structural moulds, besides ensuring a significantly faster production cycle.

#### Noida Metro Project

Nuvoco was also responsible for supplying 243,700 m<sup>3</sup> of concrete for Noida Metro, for its NC 01 - elevated viaduct and 8 elevated stations, and NC 02 - elevated viaduct and 7 elevated stations. It set up three dedicated captive plants for the project, to achieve a concrete output of 250 m<sup>3</sup>/hr, with one plant being used as a pre-cast yard for the casting of pre-stressed U girders for the elevated viaduct. The main challenges encountered included ensuring the productivity of the casting yard, as well as the early strength required for the de-shuttering and lifting of the precast modules, along with controlling the temperature and shrinkage, and offering the required aesthetic finish. Each of the girders also had to be 5 m wide and 27 m long, with a height of 1.8 m, a thickness of 150 - 200mm, and a volume of 50 - 60 m<sup>3</sup>. They also needed to be pre-stressed, using 52 to 109 cables as per the specified design.

Nuvoco used its high performance early strength concrete, Robuste, of M55 Grade, for the project, ensuring the U Girders achieved a strength of 12 - 14 Mpa at 12

hrs for early de-shuttering. As a result, it was successfully able to erect 200 U-shaped girders in May 2016, which earned the project a place in the Limca Book of Records, as it was the most number of girders erected in a month on a single metro line project. The achievement was possible majorly due to the excellence in quality, product, and service, provided by Nuvoco, and allowed 2.7 km of the twin track viaduct being ready for use within a month.

#### Structural Lightweight Concrete - Xlite

Similar to Robuste and Instante, yet another specialized product of Nuvoco is structural Xlite, a lightweight concrete that is rapidly gaining in popularity over regular concrete in the precast sector. Not only does it have similar strength as regular site-cast concrete, it is also roughly 25% to 50% lighter, which makes it easier to handle at the precast unit, transport to the construction site, and position correctly. This is because it is produced using processed aggregates such as expanded or sintered clays, shale, slates, fly ash, and slag, or using naturally occurring lightweight rocks like pumice and scoria. As a result, it also has a density that ranges from 1,000 - 1,800 kg/m<sup>3</sup> and a strength ranging from 10 - 40 MPa. In fact, the American Concrete Institute (ACI) also reaffirms that structural lightweight aggregate concretes have a 28-day compressive strength estimated at 17 MPa and higher, while weighing under 1,850 kg/m<sup>3</sup>.

Owing to this, structural lightweight concrete offers 50% load reduction compared to conventional concrete, which made Xlite perfect for use in one of Nuvoco's projects in Surat. Nuvoco was responsible for producing and supplying 1,200 kg/m<sup>3</sup> density M10 Grade structural lightweight concrete, used to construct precast structural elements for toilet blocks, which had to be transported to Mumbai by road, over a distance of 300 km. The lightweight product made transportation easier, along with facilitating its use on a table tilting type precast formwork. Possessing high early strength for early de shuttering, it was able to improve factory output by 30%, while its self-curing properties also reduced water requirement during curing. As a result, it enabled a significant reduction in trucking and placement costs, thereby reducing the cost of the project as a whole. ■

