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Technology Trends in Building Construction

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Conventional building construction industry is on the cusp of mainstreaming a few new technologies to address stringent timelines, diminishing skill levels, and depleting human resources. In Recent times, the successful adoption of precast technology, 3D Concrete Printing and hybrid construction techniques are visible signs of change in industry's willingness to embrace unconventional technologies. New technologies generally offer opportunities to split construction into on-site and off-site activities to optimize timelines.

Though many of these technologies have been tried and tested elsewhere in building constructions the biggest challenge is to convince the implementing agencies and approving authorities on the engineering parameters satisfying the requirements of seismic zones and accommodating end user concerns on the serviceability and functionality of the buildings. Having understood the requirements and the benefits offered by these technologies, many of the technology providers and industries have independently opted to conduct various tests in collaboration with academicians and are relentlessly working towards validating the engineering assumptions.

The Success of these new technologies may be considered a small step, but it is a quantum leap for the conservative construction industry waiting to unleash itself, mirror the economic growth and to set international benchmarks. A Few technologies that have grabbed the attention of stakeholders and fired the imagination of engineers across the globe are explained below.

Precast Technology

Europe, Southeast Asia, and the Middle East are the prime beneficiaries of precast technology. Most of their affordable and mass housing needs were taken care of by this technology. Though the Indian construction industry mainstreamed this technology for infrastructure projects, its penetration into the housing sector has been negligible.

Technology Initiatives like Global Housing Technology Challenge (GHTC) and implementation of light house projects in various States by the Ministry of Housing and Urban Affairs will certainly boost the confidence level and awareness among the academicians, real estate developers, and end users.

Precast Large Concrete Panel (PLCP) system has been widely adopted in India and has inherent benefits of factory produced quality products, mechanized construction, widely used locally available materials as resource and potential to bridge demand and supply gap. Though it offers many benefits, it also has a few disadvantages such as extensive logistics and lack of a well-established supply chain.

MISSION 96 - G+12 (BUA-64,000 sq ft) for CIDCO, Navi Mumbai in 96 Days

The Mission 96 initiative by Larsen and Toubro (L&T) using precast large concrete panel which resulted in completing ninety-six flats in 96 days gave confidence to the realty sector and many developers started to adopt this technology for mass scale affordable and EWS housing projects.

The Main objective of Mission 96 was to Build 96 flats of a G+12 Storey residential apartment in 96 days including MEP and finishes using PLCP technology. PLCP consists primarily of 2D precast wall panels, complemented with 3D panels and volumetric units of weights varying from 2-9 Tons.

The emulative design philosophy ensures adequate structural performance in terms of strength and serviceability. The precise structural detailing ensures that the requisite ductility and toughness are achieved in response to lateral seismic and wind loads as per the prevailing building codes. Meticulous precast planning of the number of discreet elements per flat coupled with constructable joint details ensured structural cycle time of 3 days/floor and 12 floors in 36 days, which is the fastest ever.

All the precast elements were produced in a strategically located precast production facility. An onsite temporary factory setup requires extensive planning such as the number of moulds, grade of concrete, early strength to demould, curing methods, lifting embedments based on handling stresses, stockyard planning based on demand and supply, repair stations, and dispatch clearance stations to ensure seamless flow of precast elements to the erection site.

Plant and Machineries for the production as well as erection played a crucial role to ensure timely completion. Selection of erection equipment based on the lifting capacity and limiting the element weight based on the crane population ensured success. Well planned coordination, road network, first in first out storing facility and just in time element shifting are crucial to achieve the cycle time.

Organization structures like a shutdown job with well laid out responsibility matrix and a plan B for all the activities are essential for success. Well experienced engineers and supervisors at the frontline with daily planning executed the project meticulously. Last but not the least, BIM modelling helped the design and execution teams to mitigate many construction risks, ensured constructability and helped in monitoring day-to-day progress.

3D Printing

Of late this technology is becoming a showstopper as complicated shapes of buildings are being printed with minimal setup and resources.

Growing demand and the resulting supply gap, especially in villas, affordable and EWS housing will boost the adoption of this technology in a big way and at the same time its usage is being explored in office buildings and other complex shaped buildings as well.

India's first 3D-concrete printed post office building executed by L&T is a testament that the industry is no more limited by status quo. This project was executed on a design & build model with scope encompassing from foundation to finishing.

IIT Madras Validated the Emulative Structural Design Concept and Approved for Construction

L&T's Architectural team conceived a dynamic curvilinear building form, by leveraging the design flexibility offered by 3D concrete printing technology. During finishes scope finalization and execution, due care has been given to demonstrate the rich legacy of India Post and to retain the architectural intent of 3D printed textured surface. The building was constructed using a 180 mm solid wall design concept, adhering to approved emulative structural design and in compliance with Indian codes. The wall thickness was divided into three parts: an external wall portion of 60 mm, an inside wall portion of 60 mm, and a void of 60 mm. While printing, horizontal reinforcement mesh was seamlessly integrated into the 60mm thick external and internal walls. Once the printing

3D Concrete Printed Post Office Building, Bengaluru

reached the full height, vertical reinforcement bars were inserted through the central void created earlier. Subsequently, the entire void space was filled with 3D printable concrete, ensuring a robust and reinforced structure.

By adopting this methodology, Engineers successfully integrated both vertical reinforcement bars and horizontal distributors into the 3D printing process.

3D printable concrete was produced at the job site, using locally available raw materials and aggregates up to 5 mm in size. Since we have printed in an open-to-sky construction environment and 3D printable concrete is sensitive to atmospheric variables like temperature, wind, humidity, etc., we have continuously monitored these variables and accordingly, the concrete was finetuned on a real-time basis.

A State of-the-art in-situ 3D Concrete printer was deployed to print the entire building structure without any vertical joints. The printer was operated at a speed of 150 to 250 mm / sec with a layer thickness of 25 mm. The 3D model (Revit) drawings were directly fed to the printer, to ensure seamless digital flow of drawing from drawing board to actual construction. The entire printing work was completed within 12 days including the time required for lintel support.

To expedite the work, slab segments have been cast using Precast Technology and erected at the job site. Wherever MEP

Model Flat, L&T Realty Chennai

conduit provisions were required, the necessary notches were pre-programmed in the 3D model drawings and printed accordingly, to avoid MEP chasing works.

Hybrid Construction

Hybrid technology combines two or more technologies to achieve speed, efficiency, and mechanization. Technologies such as precast, Prefabricated Prefinished Volumetric Construction (PPVC) and pre-engineered structural steel offers modularity in construction and is well suited for Hybrid construction. Singapore has been successfully using Hybrid technologies such as Precast and PPVC for building construction and have demonstrated its benefits. Hybrid technology construction leverages the best of each technology to achieve cost efficiency and speed without compromising on the aesthetics and functionality.

Use of Digitalization such as BIM, IoT and Robotics at the offsite controlled environment helps to reduce wastage typically witnessed at conventional construction sites. It helps industrialize the entire construction process. Though it offers many advantages, this technology must battle a strong headwind due to insufficient infrastructure and inflationary trends of construction materials such as fossil fuel and steel.

Mission 45 - 7 Storey (BUA-1,30,000sq ft) for DRDO in 45 Days.

A challenging timeline of 45 days was agreed upon the identification of suitable technology. Daily planning of 45 days' work schedule in the form of drawings and gang charts helped the site team to visualize the quantum of work and plan resources well in advance.

The unique engineering concept developed by DRDO for their state-of-the-art Flight Control System (FCS) Integration Facility in bengaluru was detailed by a team of enthusiastic L&T engineers teaming up with likeminded dedicated vendors. The behavior of the hybrid system was evaluated by a team of engineers simulating construction stages.

Cast in-situ foundation was carried out in advance and the prefabricated structural steel frames were erected using tower cranes of 12MT capacity. Prefabricated MEP cradles were assembled at the yard which were within the reach of the tower cranes. Before installing the precast slab elements (15 m span), the cradles were shifted and installed. A Screed of 70 mm thickness was laid over the slab of precast elements which integrated all the precast elements to act as diaphragm.

Prefinished Prefabricated volumetric toilet pods and volumetric lift shafts were shifted on trailers from the offsite production facility to the job site and installed using 250MT & 500MT tyre mounted cranes as each one weighed approximately 30MT. While lift shafts were designed as load bearing elements, the toilet pods were designed as non-load bearing units. Preplanned MEP and Finishes helped the execution team to progress as planned along with the structural works.

All the above discussed technologies with digital push, will help transform the Indian construction industry to become the trend setters. Adding to this, initiatives like modular MEP, green construction, sustainable buildings and building information systems for efficient building management will surely help the industry to focus on innovative methods of construction to enhance operational efficiency. ■