gleeds

The Next Wave

Digital and Modular Construction

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Introduction

Change is the only constant that humankind has endured and evolved to adapt with. The Construction industry has adopted many changes resetting itself to fit in with the evolving world. The industry across the years has faced many hurdles to its smooth growth such as World War I and II, financial nose dives such as the Great Depression and the Great Recession and pandemics such as the Asian Flu, SARS and H1N1, all of which have affected the thinking, industry opportunities and pushed for change to meet the requirements of the given time and changed the world in general but the industry has still risen above and stood tall and resilient over it all.

The COVID-19 is yet another 'hurdle' encountered where the industry has been forced to deal with the hold of construction during the lockdown and the slow progress following the relaxation of the rules, the shortage of labour, new operating procedures, strict health and hygiene and credit crunches affecting cash flow.

It is inevitable for the industry to rethink its methods and strategy to overcome the root shock of the present challenge and demonstrate efficiency, sustainability and resilience. With re-design and the addition of precautionary health and safety measures, comes the challenge of execution following on from the disrupted supply chain, labour shortage and the current programme timelines steering the industry towards faster and efficient methods of construction and adoption of new technologies.

It is a well-noted fact that the construction industry has been very slow to adapt to new methods of construction or technology, and hence the productivity and the efficiency of the industry has been set back. This thought paper looks at modular construction, a modern method of construction, mitigating to a large extent the risk of labour shortage and delayed project delivery, and digital technologies such as Building Information Modelling (BIM), Virtual Reality (VR) and Augmented Reality (AR) aids design, management and execution of projects efficiently. The use of technologies such as 3D scanners, drones, IoT devices enhances project monitoring and data collection activities, making the process less human intensive, is also highlighted.

The Next Wave - Digital and Modular Construction

The Present Challenges in Construction

The industry is foreseen to face the challenges noted below in lieu of the circumstances:

- Shortage of labour for onsite works
- Increase in the cost of preliminaries
- Loss of information due to project complexity
- Requirements of health and hygiene on work sites
- Increased supervision/remote supervision
- Increased facility management
- Extended project durations
- Poor planning and briefing
- Work schedule changes
- Site safety measures implementation
- Meeting project completion timelines
- Supply chain disruptions
- Pressure on priofitablity
- Reduced productivity

Labour productivity, the global picture

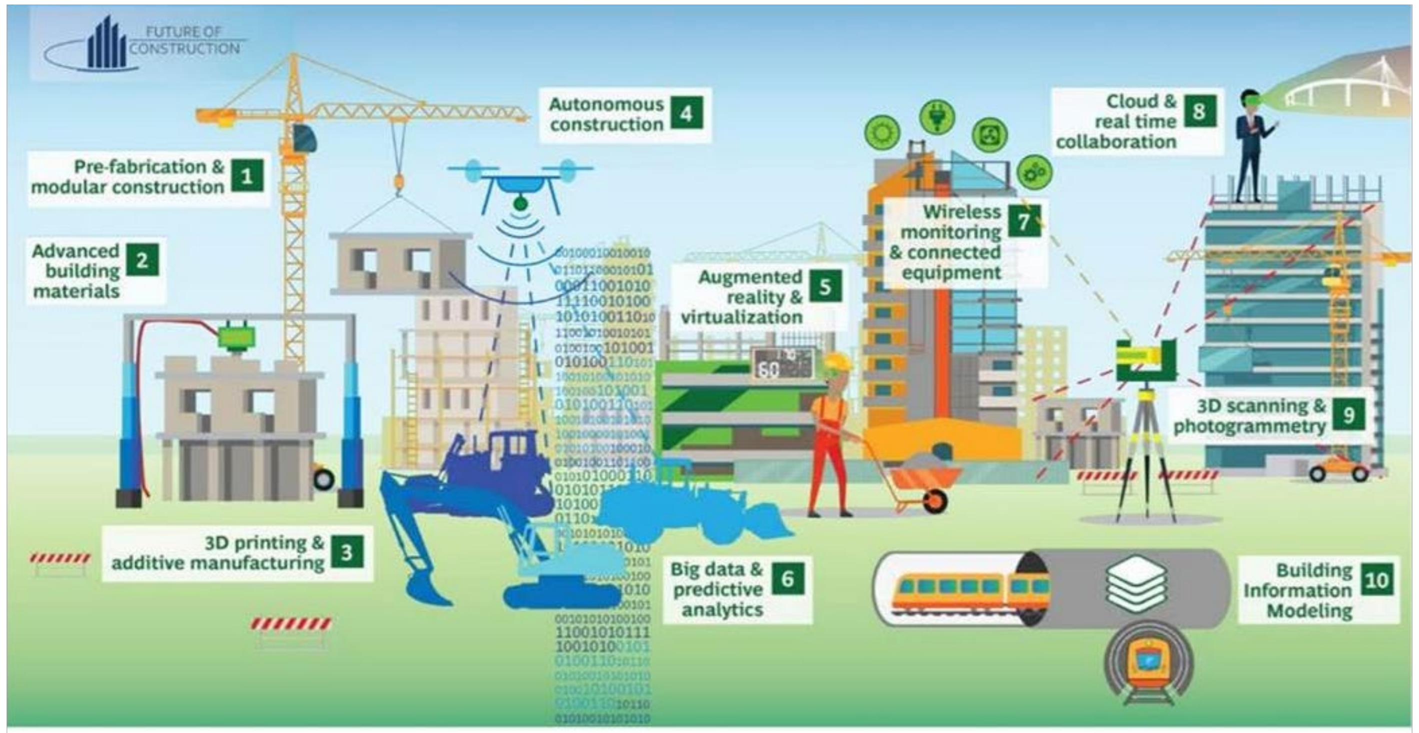
Source: OECD; Monitor Deloitte analysis

The Future of Construction

What then is the future of construction likely to be?

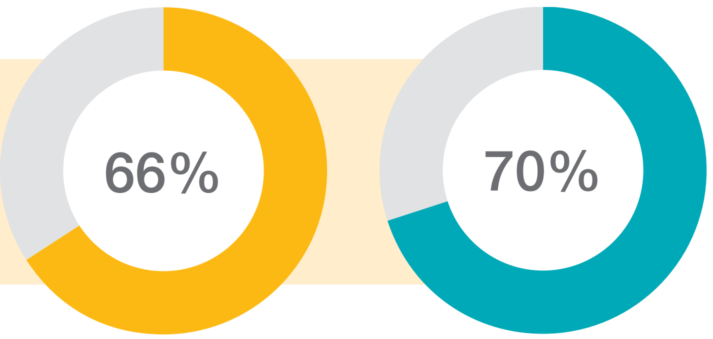
As we know it,the world has been progressing towards technology rapidly whilst the construction industry has lagged behind. This industry is one of the world economy's largest sector and employs about 7% of the world's working population as reported by McKinsey, however the industry still showcased a gap of at least 2% of the global economy in productivity. Therefore,the industry must focus on improvement on the betterment of the productivity equation (productivity = quality+ cost +time).

The opportunity to bring about big change is necessary in the present where the impact of COIVD-19 is driving everyone towards innovative solutions to address the challenges faced by the industry, with a 'more for less' attitude.



Source: World Economic Forum, The Boston Consulting Group

In July 2020, IDC reported that for 66% of construction companies in India digital transformation is a priority to drive much needed changes to their processes, business models and/ or ecosystems, while 70% have commenced their digital journey already.



With virtual design taking over, visualising and executing projects have become easier than before. The use of BIM is predicted to bring in a potential cost savings of upto 20% (Source: NITI Aayog, The Government of India). It is efficient and can assist in monitoring the project from the very beginning until completion, and later on in facility management. IoT, AR, VR assists site progress and management, aiding the site personnel as well as the stakeholders. With the efficiency and productivity that technology offers the industry will eventually, be capable of churning out projects must faster and in turn, contributing to the failed economy.

Use of faster methods of offsite construction, such as prefabrication and modular construction,is another very useful method of construction. It can speed up construction bringing about a faster return of investment. Whilst at the start the cost of the building may be about 10% higher with the use of a compositor modular versus conventional the speed of construction and the dependency of labour reduces bringing about a program savings of upto 50% (Source: McKinsey Report).Use of composite structures also increases the carpet area resulting in the generation of additional revenue, thus bringing about a return of investment. These changes are perceived to turn the industry around, bringing about a quicker return of investment.

Technology Aided Construction

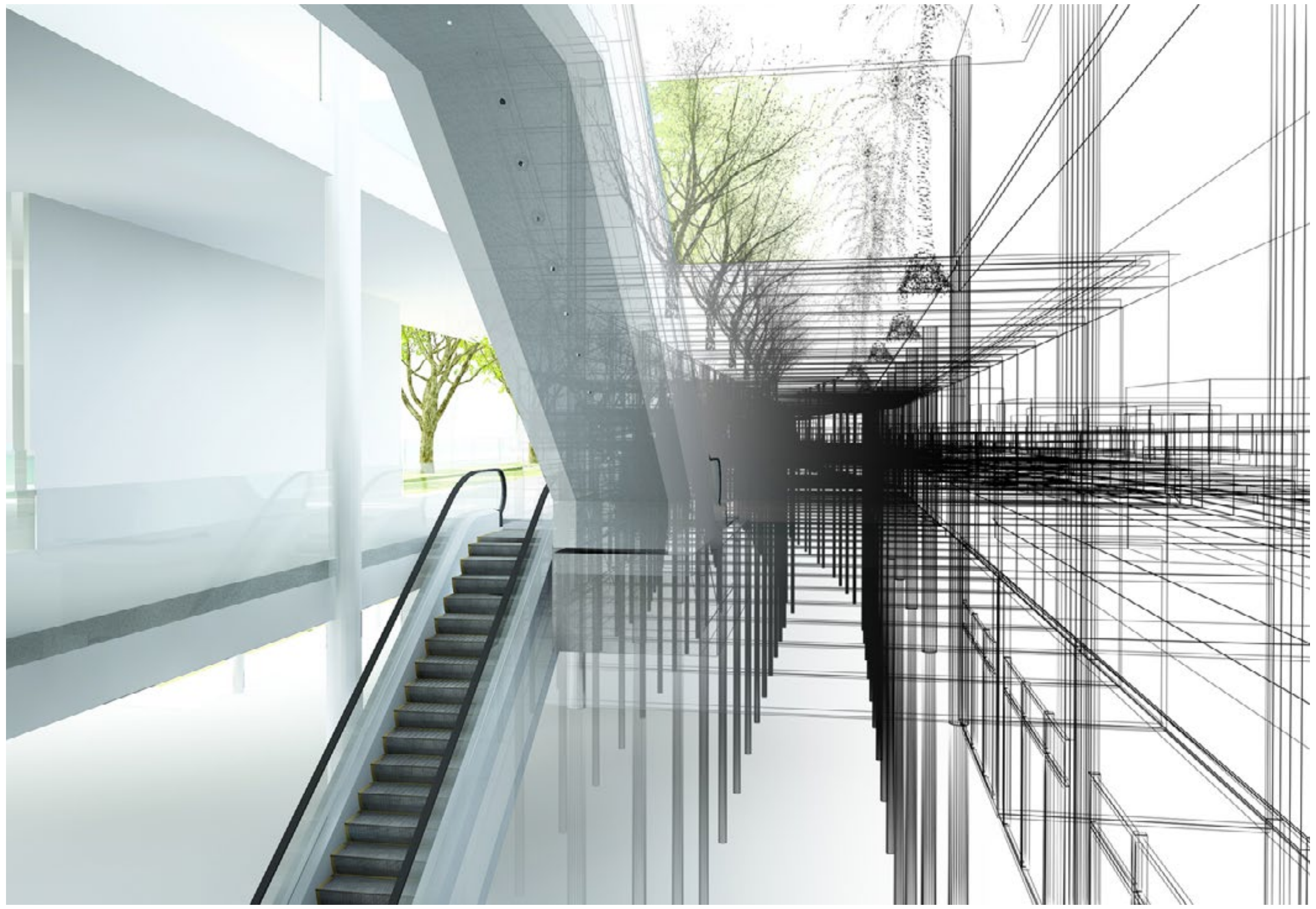
Virtual Design and Construction

Building Information Modelling (BIM) is a process that uses virtual models that include, both graphical and non-graphical data, to deliver projects. The process of managing data on a BIM platform is also referred to as Virtual Design and Construction (VDC). Ideally, the BIM platform provides access to a central server, commonly called as Common Data Environment to manage, and collaborate information between the stakeholders. However, the industry is yet to achieve the maximum utilisation of an integrated BIM workflow throughout the process.

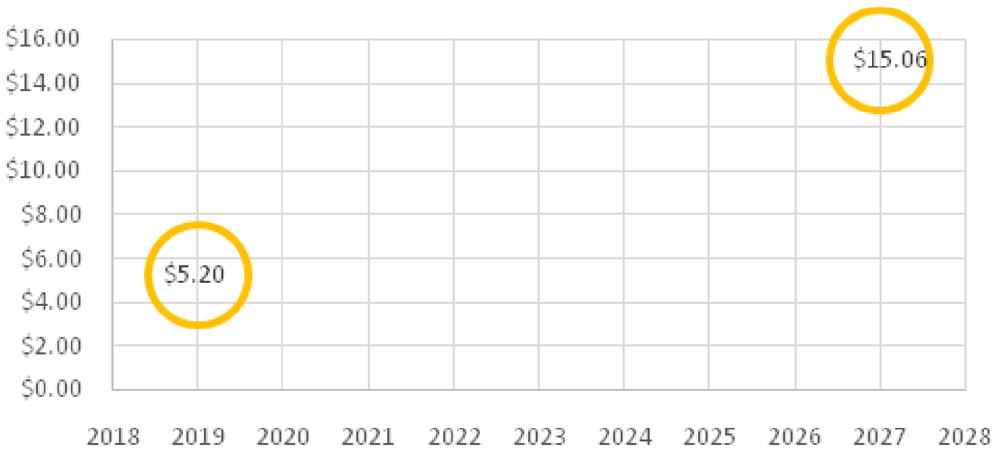
The benefit of combining both, graphical and non-graphical data such as, specification or characteristics of a material, the time required for execution, cost, location etc., on a single platform enhances the functionality of the model for performing various analysis. The integration and analysis of the data mitigates unforeseen design and constructability risk that might have adverse impact on the project.

The primary advantage of using BIM as a tool and as a process are:

- Better control of information/data throughout the life-cycle of the project, minimizing loss of data
- Enhanced visualization with data provides better understanding, thereby, reducing change in design/ requirements
- Improves planning and constructability analysis
- Better monitoring techniques
- An integrated workflow provides accurate data to production/fabrication units



Overall, BIM acts as powerful communication and collaboration tool for all stakeholders. As reported by the Ministry of Statistics and Programme Implementation (MoSPi) at the end of December 2019, 355 projects have had a project cost overrun of INR 3.88 lakh crore and 552 projects have faced escalation. The Government is hence encouraging the use of BIM to speed up construction and optimise the cost of construction by an estimated 20%, therefore achieving the housing for all initiative. It is also encouraging the use in infrastructure projects.



The global building information modeling market size was valued at $5.20 billion in 2019, and is projected to reach $15.06 billion by 2027, growing at a CAGR of 14.3% from 2020 to 2027 which is an immense growth

Source: Allied Market Research. Value noted above in Billion USD.

BIM models come with different level of details (LOD) as demonstrated below from which information can be extracted:

Depending on the nature of data embedded or attributed to the models, BIM can be used for planning and simulation activities with the attribution of 'time' which is commonly known as 4D BIM use and the use of BIM for quantification and cost management related activities is known as 5D.

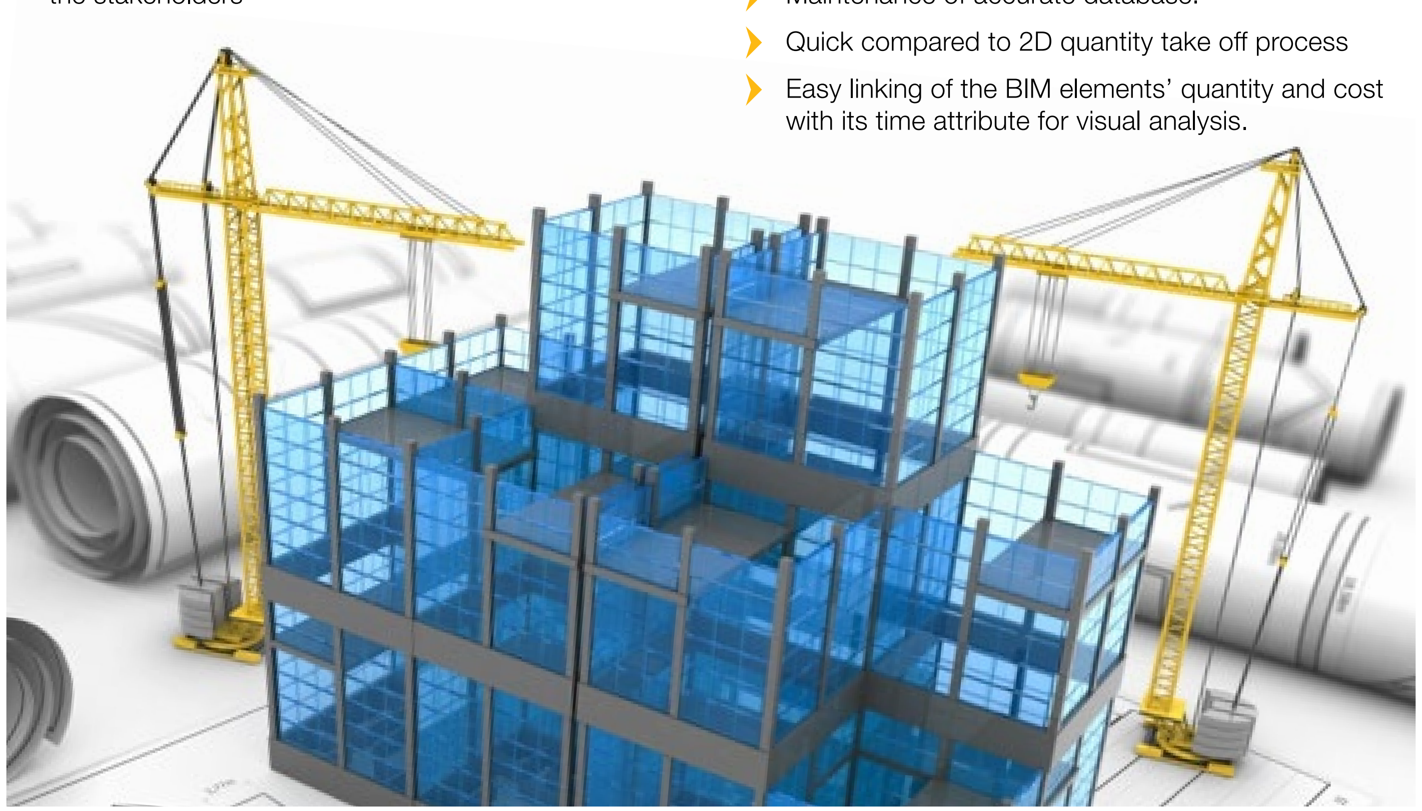
The Next Dimension

BIM with time- the 4th dimension

- Aids in visualizing site logistics and logistic planning Including temporary equipment and structures
- Enhanced sequence analysis to identify best construction practices and unsafe scenarios.
- Provides 4D simulation that helps in communicating better to all stakeholders.
- Tracking in 4D provides accurate project status to the stakeholders

BIM for cost- the 5th dimension

- A well detailed (LOD) model provides necessary information for quantification and cost management
- Provides accurate data and information on which costs are built.
- Costs reflecting change in design can be analyzed, with the change in model, efficiency in making design decisions.
- Maintenance of accurate database.
- Quick compared to 2D quantity take off process
- Easy linking of the BIM elements' quantity and cost with its time attribute for visual analysis.



Generative Design (GD)

Design is a long drawn out process right from the start to the finish, from concept to good for construction. Most decisions made in the design stage, impact costs, the environment, aesthetics and other client's requirements resulting in the loss of precious project time. The quick timelines and the limited thought into the impact of each change or decision has increased the push towards Generative Design (GD).

What is Generative Design?

Generative design leverages machine learning to mimic nature's evolutionary approach to design. Designers or engineers input design parameters (such as materials, size, weight, strength, manufacturing methods, and cost constraints) into generative design software and the software explores all the possible combinations of a solution, quickly generating hundreds or even thousands of design options. From there, the designers or engineers can filter and select the outcomes to best meet their needs.

Examples of the use of generative design:

- Pedestrian bridge, printed with 3D steel in the Netherlands used GD, to remove excess material by mixing structural calculations with geometric manipulation, teaching the algorithm to recognize which parts of the bridge were least crucial
- A research project, classrooms and the circulation of people in a hypothetical school were generated through a genetic algorithm programmed to minimize walking time, use of corridors, and other parameters
- Design of Autodesk office in Toronto, created office spaces taking into consideration the opinions of employees and managers about workstyles and location preferences, which was transformed to data and then eventually fed into GD with other parameters to pull out floor layouts

There are quite a few advantages in the use of generative design (GD). It:

- Creates various options to choose from
- Considers parameters more precisely
- Can do more in the same amount of time for a normal design
- Has less human errors
- Generates less wastage

Though generative design is a fairly new concept it is being used across many sectors from aerospace to sporting goods. Its most common use apart from just aesthetic design is for structural material use optimization, where algorithms help create areas of minimal material yet meeting the structural requirements of strength, stiffness and fatigue. This could optimize the material requirement and in turn bring down costs. Whilst, the prospects are great, the longevity and the long-term benefits for the construction industry by investing in generative design are yet to be fully understood. The extend of breath taking design born off the creative human mind is yet to be replicated by GD.

The Adoption of AR and VR

Virtual reality (VR) technology is widely being used at the construction site with the help of handheld devices to visualize a room or an area in its entirety showcasing the planned activities. This helps the site team to understand the sequence of work to be carried out and mitigate any constructability risk well in advance. It is also being used to mimic hazardous scenarios and train the workforce to be prepared for any real-life situations.

VR has further evolved into an augmented reality due to the active participation of technology giants such as Google, Microsoft, Hewlett and Packard etc. and has proven to be the future of visualization. Using an Augmented Reality (AR) provides more dynamic and interactive virtual experience that helps designers to gain insights on the product.

The industry has witnessed a growth in the usage of VR and AR devices, enabling designers and end-users to experience the project and mitigate design flaws at an initial stage. It allows the site team to understand the coordination of services and identify constructability issues prior execution.

In the field of marketing, better experience of the assets by the realtors and developers to their prospective clients is provided. Also, facility and asset managers are being trained using VR and AR in special projects such as nuclear power plants, oil rigs, thermal power plants and others., thereby, reducing the risk in operation and shortening the overall time required for the operation of the asset.

It's uses in the industry:

- Aids in project visualization in great detail, which can be done at an initial design stage.
- Aids in measures, like the Microsoft Halolens and DAQRI's smart glasses, can measure the physical dimensions.
- Jio Glass a cheaper alternative for the Indian market, for conferencing calls, viewing presentations and hold discussions.
- Aids in on-site revisions, by showcasing how the revisions will fit on-site.
- Aids users to view building information in layers, from the location of walls to the project progress.
- Assists in team collaboration, by sharing of videos and photos to remote team members.
- Devices, like AugView that can see through the underground can be helpful for safe underground works.
- AR headset that aid construction workers in training.

There is undoubtedly a great potential in the use of AR and VR and are tools that contribute tremendously in planning the project from start to finish, ensuring accuracy, preventing rework and saving building costs. It is also a great tool for collaboration onsite, offsite making the process of decision making faster and easier. However, despite the benefits, the momentum for the tools is yet to pick up. Use of the equipment for prolonged hours and adverse climate may prove uncomfortable for the users. Therefore, a certain amount of planning and reserved use may be required.

Technology to Aid Site Progress

Remote monitoring of construction sites with the use of drones, radio-frequency identification (RFID), mobile devices, sensors and other IoT devices in the present times is a more efficient method. This eliminates the physical requirement of personnel at the site to monitor and report site progress and still provides real-time insight to all stakeholders.

Drones and Laser scanners

Field of unmanned aviation vehicles (UAV) has witnessed a significant growth in its application in various industries, including construction. The use of UAVs such as drones help in providing real-time data of the conditions at the site from birds eye perspective.

- Drones provide excellent aerial coverage.
- Laser scanners and high definition cameras provide clear visuals.
- Data and visual captured used to develop work in progress.
- 3D laser surveys provide accurate details of site conditions feeding into the development of as built drawings.

Drones in India has been recognised by both the Government and private sectors and is expected to grow at 18% CAGR in the next couple of years. The wide application of drones has initiated the government to regularise the technology in the coming years.

National Highway Authority of India (NHAI) has taken the initiative of using drones to monitor highway and infrastructure projects of nearly 14,800 Kilometres. Drones are also being used by the real estate industry to conduct survey of vast lands enhancing the quality of information gathered for development.

High-profile projects such as airports, power plants, irrigation projects etc, are beginning to realise the potential of drones. Bangalore International Airports Limited (BIAL) has also implemented drones in the new terminals that are being constructed.

For existing old buildings, a high definition 3D terrestrial laser scan is produced using 3D laser scanners and high dynamic range 360 TrueView images with HDR cameras, the raw data is then processed to point cloud files and 3D models of LOD 300 level have been produced.

Project: Eastman Dental Hospital

Gleeds India has worked on several projects for the UK and across the globe, in recreating 3D models of LOD 300 from point cloud data and is a part of the Gleeds Digital Services provided.

Internet of Things (IoT)

IoT devices or connected devices are being leveraged to analyse the site conditions in real-time. For example, the temperature monitoring device, workforce monitoring, material, and equipment logistics, etc. generates sufficient data and can be used to monitor and analyse the trend, which can be further be used to mitigate risk.

These devices are being widely used in monitoring the following activities during construction:

- Fleet management and monitoring supply chain
- Wearable devices to track workforce behaviour and mitigate safety hazards
- Real-time data of materials installed such as setting of concrete, thermal behaviour of structural elements amongst others
- Deploying automated machineries to perform repetitive tasks

The data generated by the installed IoT devices help the stakeholders to identify the factors that influence the site or resource performance and improve it accordingly. Also, the data is used for performing behavioural analysis sometimes with simulation to predict risk in the projects.

Further, the industry can maximise the usage of the immense data by using artificial intelligence and machine learning to develop predictive tools and automate repetitive tasks while managing projects. Identification of best design practices, efficient use of resources, optimised scheduling etc, are some of the few activities that are being made automatic using these tools.

The field of applying IoT during construction is growing rapidly and is creating a new ecosystem of start-ups and tech giants working towards solving the industry's problems. However, the ability to use such technology in construction sites is slowly catching up due to the prerequisite skills and resources that is required to set up an end to end infrastructure that attracts additional cost and time. Nevertheless, the tangible and intangible benefits of these technologies have driven some of the companies to use IoT for its projects as a user case study to understand its feasibility including the return on investments.

There are various uses of IoT on an ongoing job site. Concrete Sensors enables contractors and engineers to monitor hardening slabs' and structures' temperature, relative humidity and strength. Combined with a mobile app, the Internet of Things-styled devices supply numbers and measurements needed to make critical decisions with a high degree of accuracy. Upon completion of pours, sensors are automatically activated to immediately analyze the concrete, ensure quality, and foster schedule efficiency. Job sensors can also measure the surrounding atmospheric conditions, detect airborne pollutants, gas emissions levels and noise. Track certification and maintenance dates to stay on top of routine inspection and repair schedules.

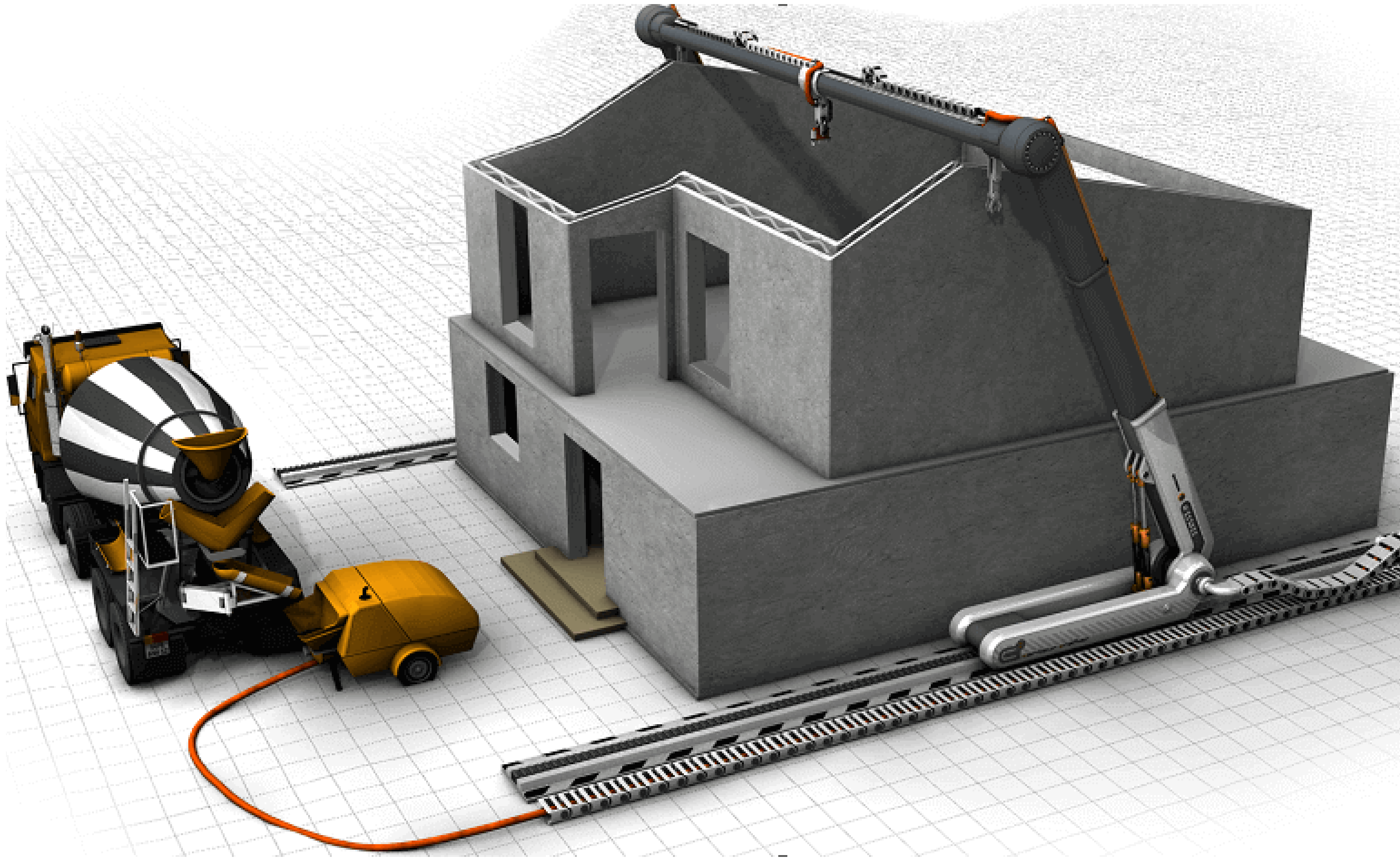
Most construction is repetitive and has been done before, with the available data, the industry can use analysed data to:

- Improve site progress
- Improve productivity
- Increase safety by reducing risks
- Smart bid
- Use predictive analytics during the project distribution

3D Printing

3D printing which first developed for product prototyping now has emerged as quite an advanced technology. 3D printing in the construction industry is also known as 'building printing' or 'contour crafting' and has slowly progressed over the years. 3D printing can be used to create construction components or to 'print' entire buildings. Construction is well-suited to 3D printing, as most of the information necessary to create an item will exist as a result of the design process, and the industry is already experienced in computer aided manufacturing. Building information modelling (BIM) in particular may facilitate greater use of 3D printing. 3D printing is a significantly faster method of construction and is perceived to bring up to a 60%-time savings on a jobsite, there is also very minimal construction wastage and a reduction in human error.

In Spain, the first pedestrian bridge printed in 3D in the world (3DBRIDGE) was inaugurated on 14 December 2016 in the urban park of Castilla-La Mancha in Alcobendas, Madrid. The bridge has a total length of 12m and a width of 1.75m and is printed in micro-reinforced concrete. The 3D printed bridge reflects the complexities of nature's forms and was developed through parametric design and computational design, which allows optimising the distribution of materials and maximising the structural performance, being able to dispose the material only where it is needed, with total freedom of forms. The 3D-printed footbridge of Alcobendas represented a milestone for the construction sector at international level. 3D houses like the mini castle a 15 sqm castle in Minnesota, USA or the Lewis Grand Hotel Extension of 130 sqm in North of Manila, Philippinesare all reflections of the good use of 3D printing. However, while 3D printing may prove costly with the investment needed for equipment and intellect, it reduces time, promotes material recycling and reduces pollution proving to be a sustainable solution to the present infrastructure requirement.



Technology Aided Facility Management

BIM and IoT

The level of information embedded in a model defines the extent to which it can be used in a project's life cycle. A project that intends to use BIM for managing its assets during the operational phase, requires the designers, contractors, and manufacturers to attribute relevant data. This application of BIM for asset management is referred to as its 7th dimension.

The incorporation of data such as specifications, users' manual and other operational information in a BIM model (as built) during the handover stage of the project mitigates any loss of information between the stakeholders. The BMS is linked with sensors or IoT devices that are installed in the facilities or assets which provide real-time inputs to the BIM linked platform. The embedded information in the model is further integrated with Building Management Systems (BMS) that supports the management of the facilities enhancing the effectiveness on the whole process.

IoT devices enable an efficient way of transmitting data through a centralised server (cloud storage) that is conveniently accessed by the facility manager through a BMS. The devices are managed through a central command system and automated thereby reducing human intervention. The use of IoT devices and its supporting applications has witnessed a surge over the last few years due to enhanced connectivity and better compatibility with equipment.

Projects ranging from hospitality to infrastructure and commercial to residential have begun to embrace the benefits of these technologies to minimise their operational cost. Major service providers like IBM, WIPRO, Schneider, Honeywell, Panasonic, etc. have harnessed this trend. This sector has also witnessed collaboration to solve deficiencies in the built environment and we are also witnessing new applications to minimise human interactions in a building.

Digital Twining

Digital twining is another upcoming trend in the industry. Digital twining is the mapping of a physical aspect to a digital platform. Creating a digital twin can replicate accurately the behaviour and process of the building which can aid in the construction projects by accelerating and automating traditional design, production and operational process using real time data collected by sensors creating predictive simulations. It uses data from sensors on the physical asset to analyse its efficiency, condition and real-time status. Up to 85 per cent of internet of things platforms will contain some form of this by 2020, according to Orbis Research. Digital twins can be used for long term assest management and is likely to reduce running costs of infrastructure to provide substantial savings over the life cycle of the building.

Crossrail in the UK is said to have a digital twin model for the entire network. Digital twins are also used in NASA to explore next generation vehicles and aircraft. The city of Singapore also has a digital twin.

Digital Twining has many benefits such as:

- Improves operations
- Reduces risks, costs and time by integrating systems
- Improved approval management
- Improves performance management.

The Next Wave - Digital and Modular Construction

Blockchain

Blockchain is the technology which has the ability and power to record, enable and secure whole numbers. In the construction industry blockchain can be used to automate the contractual processes and paperwork. This could easily save money, free up valuable resources, and speed up project delivery.

The advantages of using this system is it provides:

- Timely information
- Unambiguous communication
- Less mistakes.
- Precise information

It is also understood that most of the construction information is lost with the first owner of a property, however with the blockchain technology, all minute information could be blockchain encoded and passed on to future owners.

Some Prominent Examples of Projects using BIM in India

The following projects have used/ are using BIM technology for:

- **Planning, designing and construction in**
  - Personal Rapid Transit in Amritsar
  - The Bangalore Airport, Terminal 2
  - Delhi IGI Airport
  - Delhi Metro Rail
  - TRIL IT City, Gurgaon
- **Costing in**
  - The Nagpur Metro Rail Corporation, Nagpur
- **Generating the BIM Model, Performing Clash Detection, GFC and as Built Drawings and generating Bill of Quantities in**
  - Proposed residential project, Kolkata in 2.77 acres

Modular Construction- A Modern Method of Construction

Modular construction is a process in which a building is constructed off-site, under controlled plant conditions, using the same materials and designing to the same codes and standards as conventionally built facilities – but in about half the time. Buildings are produced in "modules" that when put together on site, reflect the identical design intent and specifications of the most sophisticated site-built facility – without compromise.

This method particularly,achieved its traction post-war boom in the 1940s-1950s when there was a high demand for housing in a short time frame. The popularity has been fluctuating in countries like the USA and UK, but countries like Japan, have adopted it well resulting in premium prices for modular houses, factoring the quality standard and earthquake resistance they are designed for.

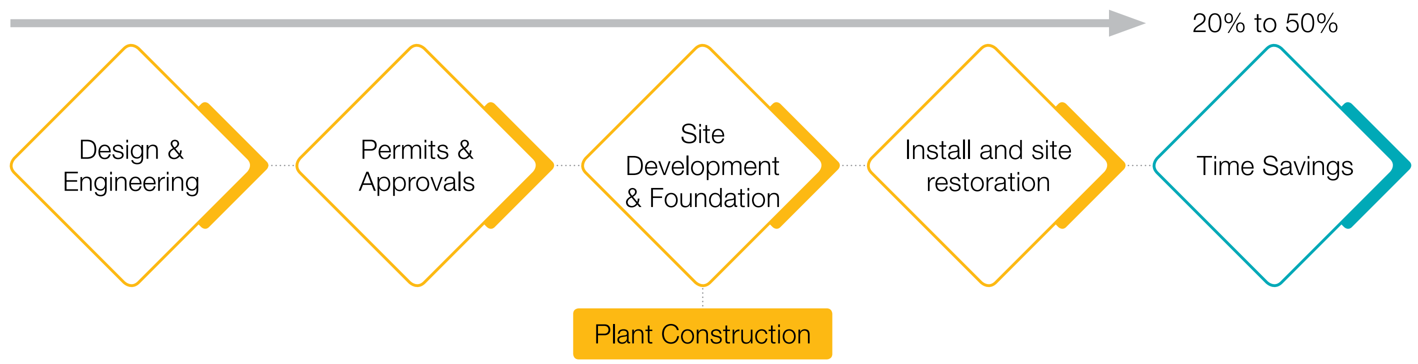
The use of modular prefabricated units in construction efficiency, has been well showcased in the building of the Huoshenshan Hospital in Wuhan, China the epicenter of the pandemic. This 645,000sqft, 2 floor building was completed in a record of 10 days, highlighting how efficient and time effective modular construction can be.

The Grange University Hospital in Wales which involved Gleeds UK as the QS, delivered a fast track 350 bed hospital in a 137-week duration with modular construction as against the 197-week duration for a traditional build resulting in a 23% program saving. The design incorporated a ward block with bed being placed one above the other on all floors, simplifying engineering and constructability.

Green Park Village Primary School in Reading UK, is a two storey, steel framed volumetric school building, including double storey height main hall and feature reception area, with faceted link buildings and complex external wall treatment. Using off-site volumetric construction and SMART building technology, Reds10 (D&B contractor) were able to demonstrate how this type of building (even with its non-standard shape) can be delivered well within the budget, in a significantly reduced period of time on site, to a quality that complements the exceptional standards of Berkeley Homes and operated to the lowest cost and carbon footprint.

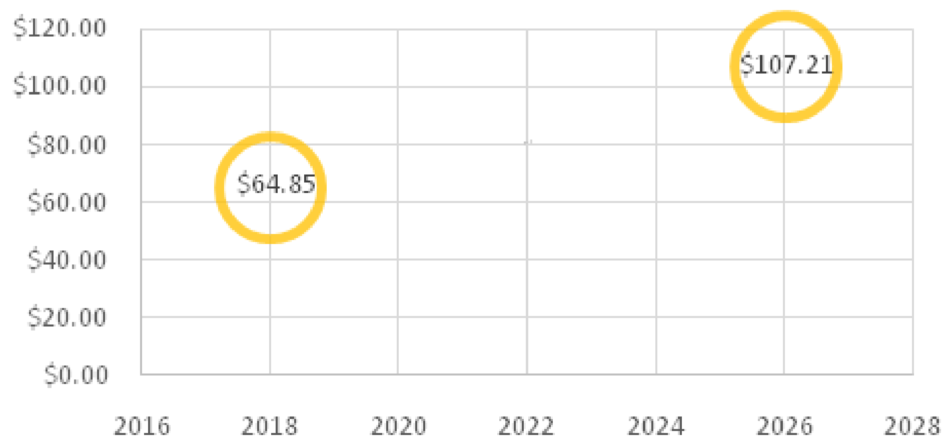
The Next Wave - Digital and Modular Construction

MODULAR CONSTRUCTION SCHEDULE



SITE-BUILT CONSTRUCTION SCHEDULE

Source: Modular Building Institute.



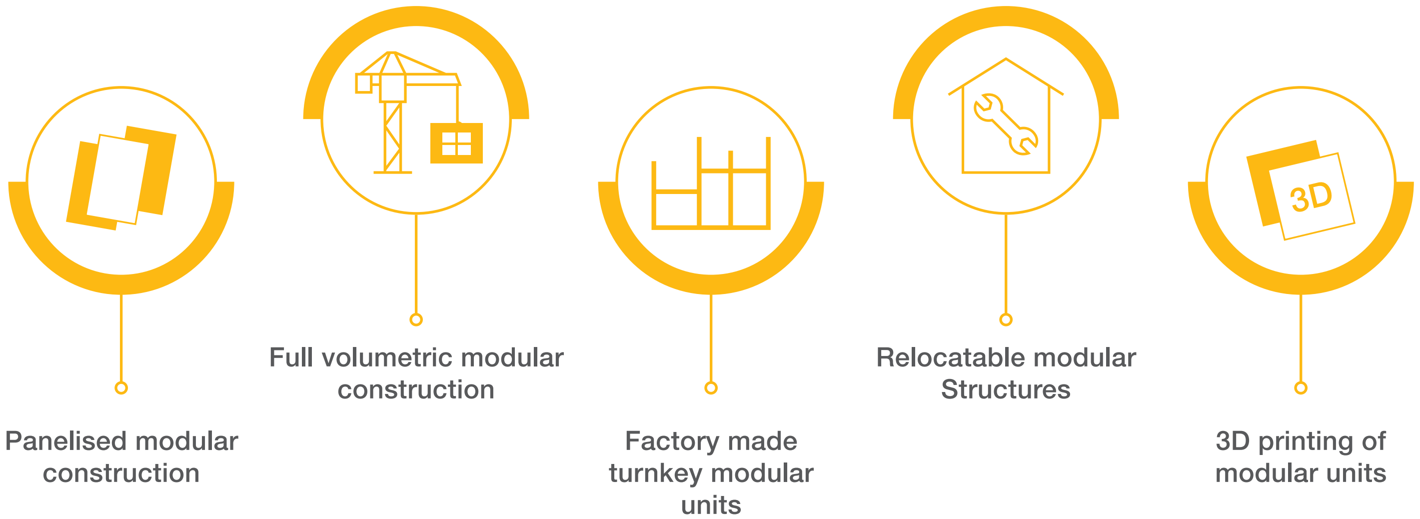
The global modular construction market size is expected to reach USD 107.21 Billion by 2026, exhibiting a CAGR of 6.5% during the forecast period.

Source: Fortune Business Insights

The Advantages of Modular Construction

- They achieve improved productivity.
- Programme savings as against a traditional construction.
- Improves cost predictability.
- Reduced waste.
- Increased client satisfaction.
- High quality identical modular, room size and volumetric units.
- Promotes sustainability.
- Faster project delivery.
- Flexibility and reusability.
- Better coordination and cooperation.
- On- site safety conditions.
- Workmanship and productivity.
- Less scope for errors.

Modular Construction Trends



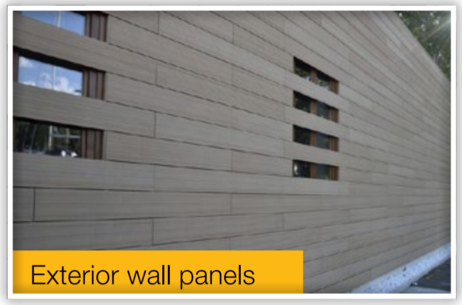

Green Park Village Primary School, UK

Picture courtesy: Reds10 UK

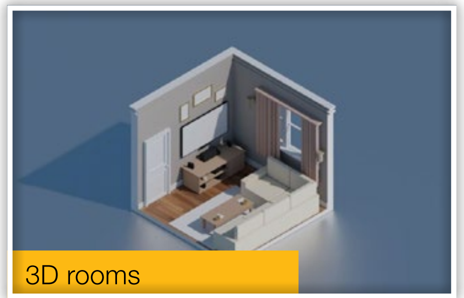
Off-site and Modular Construction Products

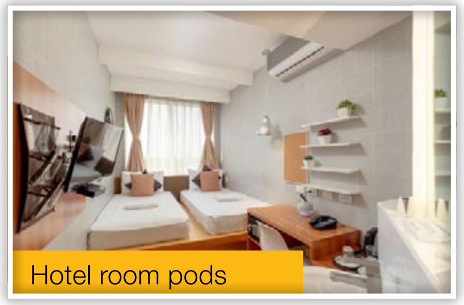
Whilst, prefabricated steel and precast concrete are widely used in India and is a form of offsite construction, there are many other products that modular form of construction can offer, resulting in a more efficient form of construction for structure as well as the architectural and interior works. Modular construction components usage varies across various sectors. Commercial and retail buildings largely use composite prefabricated steel structures, and internally use components such are internal wall panels, glazing panels, modular furniture and floor panels, whilst the residential sector use doors, windows and kitchen units. Hospitality and residential sectors are also leaning towards the use of bathroom pods.


Facades and glazing


Exterior wall panels


Bathroom pods


3D rooms

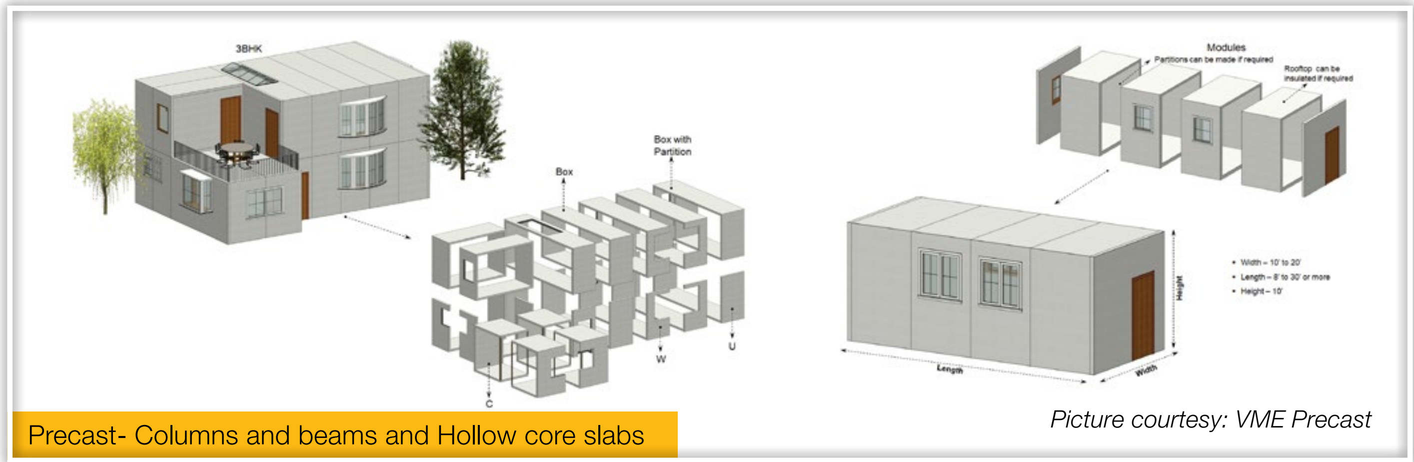

Hotel room pods


Prefabricated steel structures


Volumetric modules


Modular MEP


Modular data centre


Precast- Columns and beams and Hollow core slabs

Picture courtesy: VME Precast

Modular Construction for Data Centres

The demand for data centres has risen, following the forced work from home situations giving rise to huge data generation. Clients and providers are now looking for quick constructability options to house the data generated, giving rise to the use of pre-fabricated data centres are pre-engineered buildings, pre-assembled, integrated and tested in the factory environment before it is brought and installed at site. The three major modules that form the data centre which are the power module that is designed to provide bulk power data, cooling module which is cooling architecture to support the IT and the IT module which is the space that houses the IT equipment are all prefabricated and assembled off-site. The structure, size and shape of the data centre differs and will impact transportability of the data centre modules and is a design consideration. Fully fabricated data centres are best suited for temporary needs such as a sporting or military service, mobility of the data centre is key, remote site requires one, located in a harsh environment and required for disaster recovery.

Prefabricated and Modular Construction - Project Examples

Office Buildings

- **Embassy 3A** in Bengaluru of 1.6 million sqft where offsite manufactured precast concrete
- **Sattva Knowledge Park** in Hyderabad of 4.67 million sqft BUA, is a composite steel structure
- **Marathon Furturex Office**, an IT and finance business centre in Mumbai, was built with a prefabricated long span roof

Retail

- **Lulu Mall** in Lucknow of 2 million sqft is using precast concrete, aluminium glazing, joinery and pods
- **IKEA Store** Bengaluru, 550,000 sqft, being built with a composite steel structure

Heath care and hospitals

- **KMCH Hospital** of 1 million sqft. Is an expansion of the current including a hospital wing, teaching block and residential apartments is using precast concrete, aluminium glazing, joinery and pods
- **National Cancer Institute**, Nagpur, of 700,000sqft BUA with a prefabricated steel structure

Residential

- **Yenapoya Apartments** in Mangalore is a 3-block residential project of 100,000sqft which was fully completed using completely offsite manufactured precast concrete
- **Earth classic**, residential building n Mumbai of 100,000sqft, prefabricated steel structure

Industrial

- **Phoenix Medical System**, Factory Building, Chennai, is a 60,000sqft factory building which used elements such as hollow core slabs, internal and external precast walls, precast lift core, staircase, columns and beams

Mixed-Use

- BCH shopping complex and residential building in Kerala, 900,000sqft being constructed as a prefabricated steel structure

Grange University Hospital, Wales

The Challenges and Possible Mitigation Measures

Project planning

It requires intensive pre-project planning and engineering. Also, along with the complexity of modules' design, further considerations and planning are needed when incorporating different components within a module, and when modules are lifted, transported to the final project site, placed on the foundation, and joined to form the building.

Mitigation: Upskilling oneself and learning from experience from other projects, from a common data base. Also the use of BIM and other planning tools to make the job more efficient.

Limitations in experience

Modular construction is a relatively new form of construction in India. The lack of experience and or knowledgeable and experienced experts, such as designers and engineers is a limitation. Finding off-site construction consultants, suppliers, and contractors is another significant difficulty.

Mitigation: With virtual platforms and most companies having global partners, training, data collection, analysis and information sharing is faster and more efficient. As the industry has showcased in the past, it is ever changing and will eventually adopt to new ideas, more so in the present situation as the entire industry is resetting.

High initial cost and site constraints

A massive amount of initial capital is required to set up appropriate machinery to run a modular manufacturing plant. Since there is no groundwork on the site, clients maybe hesitant to invest initially on something that is not visible as site progress. For the use of high- rise buildings, the erection of cranes may prove difficult, with the space constraints on site.

Mitigation: Demonstration of program savings with the adoption of this method maybe more convincing to clients especially if the same can be visually demonstrated on a virtual platform. Options of erection of cranes, timelines, space constraints can all be visually analysed and solutions can be formed around it .

Reduced adaptability to design changes

Once the design has been approved, other interdependent activities are also undertaken simultaneously, therefore, the design must not change, hence indecisive clients can suffer big losses for change in design.

Mitigation: Use of BIM at the concept stage, could give clients a better perspective view of what they are likely to get as a final product and changes can be visualised and informed decisions could be made.

Transportation constraints

It can be difficult to transport the modules long distances. Time delays can occur due to late transmit permits for oversized components. The current travel restrictions could cause delays if not planned well.

Mitigation: This ideally maybe a hinderance initially however with more use of modular components and expansions of manufacturers pan India, these delays in transportation could be mitigated. Options of having manufacturers set up near sites where there is land availability for larger projects could be considered.

Client Risk

As works for modular construction is done offsite, manufactured, and assembled, clients will be paying for the works done, though has not reflected on actual progress on site. Therefore, the risk lies on the client as offsite works is completed and paid for whilst the actual installation on the construction site will be done later.

Mitigation: A good insurance and payment to contractor against a vesting certificate will be the ways of mitigating the risk on the Client.

Number of Joints

Modular construction is created in panels and numerous sections which result in a large number of joints that are prone to maintenance. Though they can be designed for large spans, transportation to site can prove to be a challenge resulting in the smaller module construction

Mitigation: There may be no clear solution, apart from designing to the most optimum solution for the project. For manufacturing locations that are closer to site, design of larger spans can be explored.

Limited variety

Modular construction proves cost efficient only with optimum use of moulds resulting in mass production with little variety. As the past trend in India has always been to be unique in terms of aesthetics, this option may be difficult to sell to clients.

Mitigation: Whilst the repetition can remain, planning to create similar modules across various projects across the country for the same client could be a possible solution. As the modules are factory made, they can be stored and delivered, where required at the given time in case, the projects do not run in parallel. This can be maintained and tracked using RFID.

It is Time for Digital and Modular Construction

Given the current crisis, though there is a slowdown in the economy, the crisis will eventually be tackled, and the industry will bounce back. The main focus is undoubtedly on increasing the productivity and efficiency on construction sites, mitigating complexities of design and execution and aiming for a faster return of investment.

Fulfils growing demands

With the growing needs of the infrastructure of the country and the likely shift of development to smaller towns and cities, demand in construction of office, affordable housing, affordable hotels, pharmaceutical industries, warehouses and educational buildings are likely to increase. To meet the increase in demand, clients will have to look at quicker options of construction, with efficient timelines of completion, which would be sufficed by modular construction and aided with technology.

Better quality

Quality is well kept in modular, with less room for error and low rate of wastage, being both energy and cost efficient and hence more sustainable.

Economy of scale: A client can use the standardised off-site products across various construction, proving to be a cost-efficient option. Use of the economy of scale by standardisation and offsite manufacturing can reduce costs significantly.

Plugs labour shortage gap

In the present scenario, noted that the labour is a shortage. The labour-intensive on-site construction can now be replaced with skilled personnel who will do the job in an efficient time scale.

Time efficient

Time saved for a modular construction is noted to be about 20% to 50%, as delays due to procurement or labour on site is eliminated. Standardisation and installation are a faster method of construction and results in sometimes, projects being completed ahead of time. Integrating components in a building project is a lucrative strategy that is contributing to a rapid completion time. Usually, large, complex structures were hard to correlate but creating these advantages reach out to many commercial projects. IoT has provided solutions over this.

Reduces whole-life costs

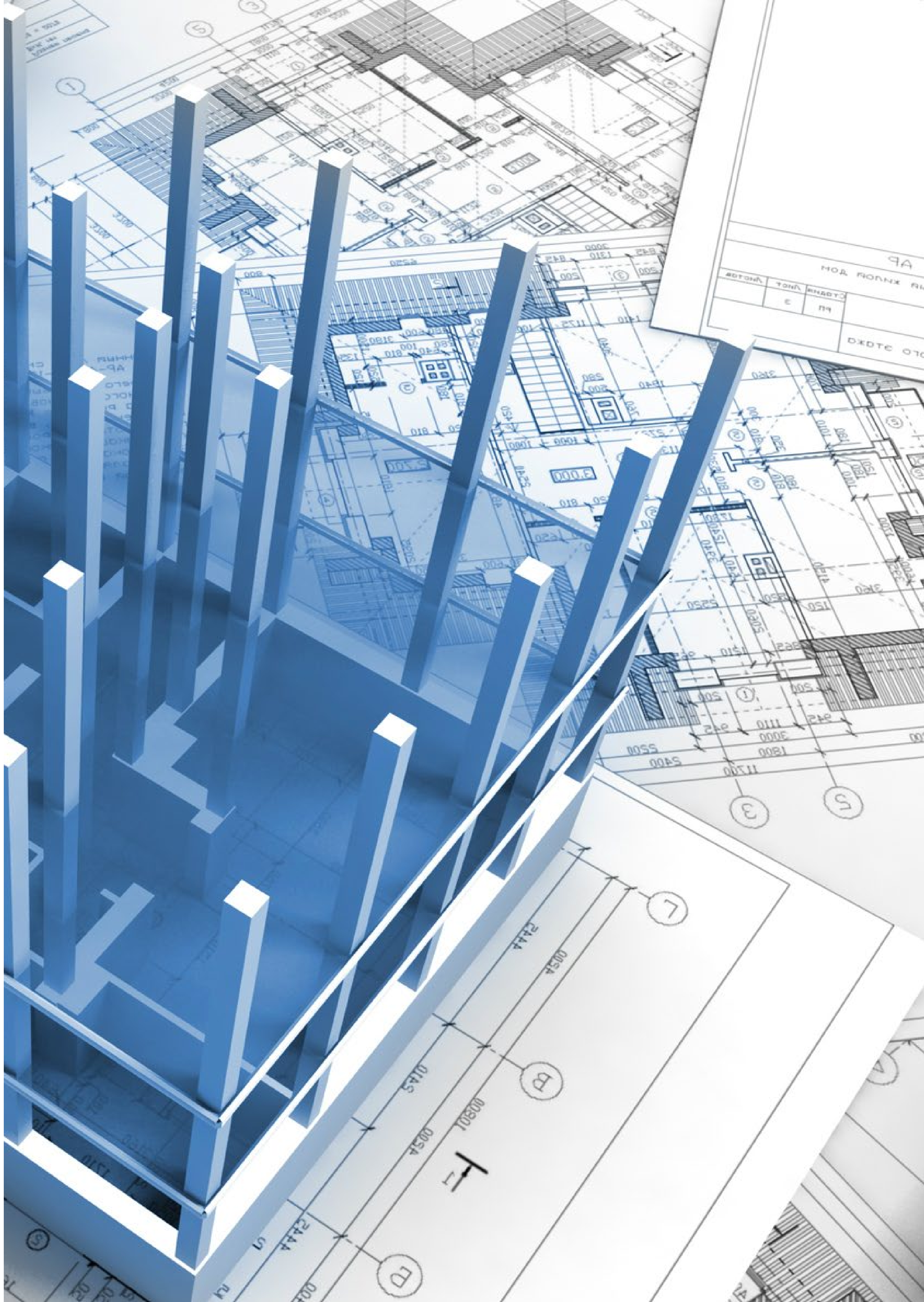
The offsite manufacturing is an enhanced quality factory product which is key in whole-life costs savings, as the better quality will reduce operational costs.

Better site progress review

With BIM and drone technology, the progress review on site can be considered by all stakeholders and transparency is achieved. Additionally, RFID sensors make it possible to record components through every step of the supply chain. This makes it logistically possible to correlate a complete structure despite of size and scope of a project. Intelligent modules reduces job site delays and allows greater project control with real-time possibility for design adaptation at any phase of a building project

Client Satisfaction

As technology makes all stakeholders more efficient in their services to the client and the in time, efficient completion of projects, results in total client satisfaction, which is every project delivery's ultimate goal.



Conclusion

In the present, whilst the world is recovering from the ongoing COVID-19 crisis, the demand for the construction industry remains. It is set out to face a demand for new infrastructure, as a possible aftermath of the vacuum created in the span of half a year of delay and stoppage of works on site. There is also now a more dire requirement for constructing 'more for less' following on from the cash crunch, disrupted supply chain, labour and workman crisis and all the health and safety requirements and social distancing norms required to run a construction site, thus giving rise to the inevitable rethinking and re-strategizing of the current construction model with a good workable productivity equation.

The construction industry has always been slow to adopt innovation and change, however, this might be the right opportunity for the industry to leapfrog into a digital era and adopt with it modern methods of construction like modular. With technology ruling the world and being a big part of a day to day life, construction by no means can be left behind. There is also set to be a revolution in design, now primarily focussing on COVID-19 and any other future pathogens prevention measures. Investing now in the digital side of construction such as BIM technology, augmented reality and big data can bring about change like none other resulting in less human error, higher productivity and better quality output. Collection and streamlining of data can assist in IoT based management and design. Automated production of construction components is showcasing good time savings and can be used invariably in all projects as required. Planning and production of the same can be aided by BIM technology. This new model of working optimising both assets and manpower can prove to be the next normal of the industry and also contribute to the health and wellbeing of site-based personnel by reducing their chances of injuries and site-related health issues improving quality of living for a workman.

Therefore, modular construction with a digital platform, brings about a better performing and a high-quality product, modern and resilient, meeting the rising customer and client expectations which can be the holistic solution to the future of construction for an urban world.

Gleeds India have very actively been involved in various projects using pre-fabricated steel structures, precast concrete and various modular construction such as modular furniture, wall panels, bathroom pods, glazing, doors and windows and hotel pods. Gleeds UK has also delivered many fully modular buildings such as the Grange University Hospital and school projects such and Green Park Village.

Digitization in construction is the revolutionary method of working to improve the delivery, operation and renovation of built environment using digital tools and processes. Gleeds India offers its services as Gleeds Digital Services and is involved in converting 2D to 3D, 4D sequencing, clash detection and 5D cost modelling, capabilities that are the new prerequisites to support the construction industry in the immediate future.

We are actively involved and assisted in local and international projects with its reality capture (point cloud services) successfully converting point cloud data in any given point cloud format submitted by the building services team to 2D, 3D revit models which include detail architectural and structural models to LOD 100, 200, 300, 400, thereby assisting the design and clients to read the existing buildings digitally.

References

1. Modular Building Institute [www.modular.org]
2. Affordable Sustainable Housing accelerators in India [ghtc-india.gov.in]
3. Modern Method of Construction [nhbcfoundation]
4. Modular Construction: From Project to products [Mckinsey report]
5. Modular Construction Market [Fortune Business Insights]
6. Digital Transformation the Future of Connected Construction March 2020 [An IDC InfoBrief]
7. Digital Transformation the Future of Connected Construction in India July 2020 [An IDC InfoBrief]
8. Point of view of digital constructions [Deliotte]

Blogs and publications

- Constrofacilitator
- Building.co.uk
- ESubConstruction Software
- Active wizards
- Viewpoint
- BCG
- Analytics Vidya
- Build off-site
- Constructiontimes
- Constructionworld
- Autodesk
- Raconteur
- Archdaily

Projects sourced from

- Katerra
- Modular Concepts
- Eversendai
- Kirby Building Systems
- Voltagreens
- JSSL
- Gleeds India and UK
- VME precast
- Reds10

Other media reports

Register with Gleeds- our cloud based integrated registration database for design professionals, contractors, suppliers and product manufacturers, recently launched to allow us to reach out to you quicker for our upcoming project opportunities.

Click on https://tinyurl.com/gleedsregister or scan the QR code using your camera to complete the registration.

For queries regarding the registration, please write to us at register@gleeds.in

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