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PRINTING ARCHITECTURE

FUTURE IMPLEMENTATION IN INDIA

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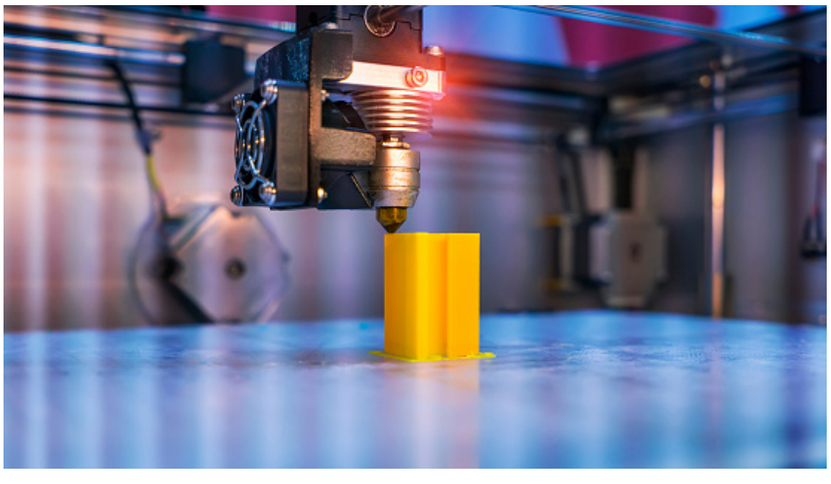
Introduction :

Architecture and Design thrive on innovation and ideas, both in terms of material and technology & process and implementation.



A couple of months back the first ever 3D printed school in Africa was inaugurated and it is interesting to note the implications of this advancement in the field of construction as well as the use of this technology in India.

Why 3D printed schools?

Pandemic or not, there is a shocking shortage in educational infrastructure, globally ; but especially in Africa and Asia.

Since the outbreak of the COVID-19 pandemic, more than 1.5 billion students across the world have not attended school. Schools will eventually reopen, and educational infrastructure is still needed by over 290 million students, especially in countries where online alternatives are unavailable.

But even before the COVID-19 pandemic, students in countries like Malawi faced challenges to attend school daily. Adifu Maulana quit school in 2014 to escape the punishment she often received for arriving late. She had to walk 7 kilometres to attend classes held under a tree because of Malawi's shortage of classrooms.

Like Malawi, there are numerous countries in Africa and Asia that do not have the infrastructure to provide adequate education to their population. UNICEF estimates a shortage of 36,000 classrooms in Malawi which would take 70 years to build using conventional methods.

The first 3D printed school in the world in Malawi :

The world's first 3D-printed school in Malawi (in the Shalima District) welcomed its first students on June 21, 2021.

This was made possible thanks to the aid project of 14Trees which a joint venture between Swiss cement is maker LafargeHolcim and the United Kingdom's development finance institution, the CDC Group. They aim to use fast construction of computer-built schools could help alleviate a shortage of classrooms in countries like Malawi and students like Maulana can resumed learning.

The walls for the schools were printed in just 18 hours (as opposed to several days) and with a 50% smaller carbon footprint that a regular brick and mortar methods. This method of 3D printing schools will help to address Malawi's 70-year schools' backlog within just 10 years, while also significantly reducing the time and cost of building houses and schools in the region.

Another key advantage is that the quantity of material required is reduced drastically while printing, and this influences affordability; meaning that the building becomes more affordable.

Having completed the world's first 3D-printed school in Malawi, 14Trees now hopes to carry out similar projects in Kenya and Zimbabwe. Another 3D-printed school is scheduled to be built in Madagascar in the coming months.

What is 14Trees?

14Trees, a LafargeHolcim joint venture with CDC Group, the UK's publicly owned impact investor, is deploying 3D printing technology at scale to build affordable and low-carbon housing and schools in Africa, starting in Malawi. With its record speed of construction and optimized material use, this technology reduces the carbon footprint for building new homes by up to 70%. Pioneering this technology in schools for the first time, 14Trees aims to address the country's chronic infrastructure shortage while creating skilled local jobs.

Madagascar following in the footsteps of Malawi :

The Non-profit organisation Thinking Huts has partnered with architectural design agency Studio Mortazavi to create a 3D-printed school on the campus of a university in Fianarantsoa, Madagascar. It aims to tackle the shortage of educational infrastructure which in many countries contributes to fewer children getting a good education.

Thinking Huts considered seven countries for their first 3D printed school. Madagascar will be the pilot's location based upon the need for education infrastructure, stable political outlook in an emerging economy, opportunity for growth, as well as renewable energy potential.

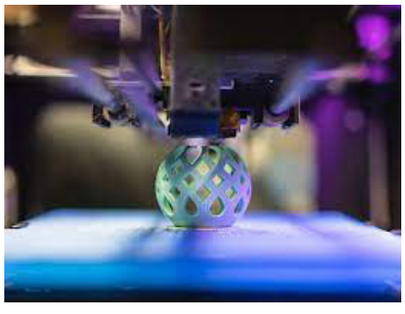
Using technology developed by Finnish company Hyperion Robotics, the school will be built using 3D printed walls and locally-sourced materials for the doors, roof and windows. Members of the local community will then be taught how to replicate the process to build schools for the future.

In this way, a new school can be built in under a week, and with less of an environmental cost than traditional concrete-based construction. The 3D printed buildings use less concrete than other methods and the 3D cement mixture also emits less carbon dioxide compared to traditional concrete, Thinking Huts claims.

The modular design allows for individual pods to be joined together in a beehive-like

structure and means schools can be easily expanded. The Madagascan pilot project also features vertical farms in the walls, and solar panels. An absence of buildings to deliver education from is a significant hurdle in many countries, particularly in areas lacking skilled labour and resources for building. By using the technology to build schools, Thinking Huts is seeking to widen access to education - something which will become particularly important post-pandemic. UNICEF and other organisations have warned of a learning crisis exacerbated by the virus, with 1.6 billion children across the world at danger of falling behind because of school closures aimed at containing the spread of COVID-19. So, getting children back in the classroom as soon as is safely possible will be vital to continuing their education, particularly for those with limited access to the internet and personal learning devices.

So, what is 3D Printing?



3D printing, or additive manufacturing, is the construction of a three-dimensional object from a CAD model or a digital 3D model. The term "3D printing" can refer to a variety of processes in which material is deposited, joined or solidified under computer control to create a three-dimensional object, with material being added together (such as plastics, liquids or powder grains being fused together), typically layer by layer.

3D printing encompasses many forms of technologies and materials as 3D printing is being used in almost all industries you could think of. It's important to see it as a cluster of diverse industries with a myriad of different applications.

A few examples:

Consumer products (eye wear, footwear, design, furniture)

Industrial products (manufacturing tools, prototypes, functional end-use parts)

Dental products

Prosthetics

Architectural scale models

Reconstructing evidence in forensic pathology

When it comes to using this technology in the construction industry, concrete is generally squeezed out of a nozzle and it is attached to an automated robotics arm which is either stationed or moving along the rails, in a successive fashion, one layer upon another to build the desired building or structure. As per recent studies, it has been estimated that the 3D printed construction market will be worth 40 billion dollars by 2027.

As illustrated above, the use of 3D printing technology in architecture and the construction industry is vast. And the advantages of using this technology are obvious. The growing popularity of Building Information Modelling (BIM), will facilitate better use of 3D printing technology, enabling architects, designers and engineers with design detailing.

3D Printed schools in India :

A stepping stone to the education crisis in the country?

UNICEF is working closely with the Government of India, state governments in 17 states, civil society, academic institutions and the private sector. While primary engagement will be with the Ministry of Education and the Ministry of Women and Child Development, more involvement with ministries of Tribal, Minority and Social Justice Departments, Disaster Management Authorities will be essential especially in terms of ensuring the delivery of quality education to the most marginalized children which forms the centre of our work. To achieve the outcome girls and boys, particularly the most disadvantaged, participate in quality education with learning outcomes at grade appropriate levels by 2022.

The following intermediate outcomes have been identified:

1. A recent report has found significant shortfalls in budgetary funding and utilization in education. This has resulted in critical infrastructure gaps, according to a parliamentary panel on education.

2. For instance, the School Education department proposed to allocate INR82570 crores. But only INR59845 crores were allocated.

3. Only 56% of schools have electricity, with the lowest rates in Manipur and Madhya Pradesh.

4. Less than 57% of schools have playgrounds according to the UDISE 2017-18 survey. Almost three out of four government schools in Odhisa did not have a playground as of 2018.

5. Almost 40% of schools did not have a boundary wall A total of 2613 projects were sanctioned in 2019-20. But only three had been completed in the first nine months of the financial year.

6. Only three laboratories had been built one each for physics, chemistry and biology, despite sanctioned funds for 1,343 labs.

7. 135 libraries and 74 art/craft/culture rooms had been sanctioned. But none had been built with just three months left in the financial year.

8. At secondary schools, less than 5% of the facilities aimed at disabled students like ramps and special toilets had been completed.

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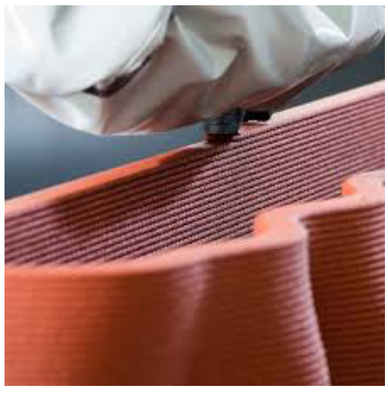

Advantages of 3D Printing, especially in India :

Following are key aspects that will help to further the use of 3D printing, especially in India.

1. Reduced time for project completion :

Time taken to complete a project is reduced from months and weeks to hours and days. This aspect plays a key role in the use of 3D printing for disaster relief and emergency housing. This is not the case with 3D printing. At a construction rate of about 20 seconds per square foot of wall (three minutes per square meter), a modest-sized 2,500-square-foot home could be constructed in about 18 or 19 hours with a workforce of about four people.

2. Reduced project costs :

Conventional methods of construction cost four times more than this method of construction. Bad weather conditions also affect labour at sites and drive up costs due to work stoppages; which will not be a hindrance to 3D printing machines. Since the entire process is highly dependent on technology and machines, it helps to lower the cost of labour on site, by reducing the man-hours required.

3. High levels of design detail & accuracy :

Being a technologically intensive process, high levels of accuracy, detail and complexity can be achieved with ease. (Completely eliminating the aspect of human error). Flexibility The process allows architects to design freely with complex geometries and does not inhibit them.

4. Precise material quantity calculation :

The use of BIM will facilitate the ease of calculation of precise quantities of materials required for construction, reducing material wastage and in turn keeping costs in check.

5. Safety on site :

3D Printing will help to increase the safety on site during the construction process, by eliminating construction hazards to humans since most of the construction work will be done by the machines.

6. New possibilities :

Opens the possibility of construction in places with difficult access by humans, e.g. space.

Keeping the above factors in mind it is obvious to see why India should work towards adopting 3D printing in the mainstream construction industry, especially for emergency relief as well as quick and cost effective construction of schools.