

3D printing building technology – the game changing future technology

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Abstract. 3D printing is basically, constructing an object or structure based on a computer aided design, depositing the material layer by layer using a Robotic Printer. The major advantages of 3D Printing are: Time saving, Design flexibility, Environment friendly and it is suitable for constructions in hazardous & dangerous areas, where human force can not be deployed. 3D Printing technology makes the construction quicker and the buildings can be designed with intricate architectural details, and the technology allows for greater flexibility in customizing the design to meet specific needs, as the 3D Printer can execute whatever design it is fed continuously, and it also avoids waste of materials that happens during construction in a conventional way. Having multifarious advantages, 3D Printing is going to be the game changing technology and no doubt, this will be the future technology in construction sector across the globe towards a sustainable development.

1 Introduction

Shelter is one of the fundamental necessities of individual and giving them satisfactory housing is a social obligation. Innovation is an incorporated part and basic contribution for the development of reasonable houses to the majority and financially savvy innovation is an assortment of strategies or systems that utilizes innovative materials and technologies to build at a cost less than that of the conventional method for development. Utilizing materials effectively and diminishing waste and carbon foot prints is a top notch method for guaranteeing a naturally cognizant structure project.

Building a structure or construction using a computer aided design, depositing the material layer by layer utilizing a Robotic Printer is called 3 D Printing. There are basically 3 stages in 3 D printing viz, Data Processing, Material Processing and Robotic Printing. The major advantages of 3 D Printing are: 1. Time saving 2. Design flexibility 3. Environment friendly 4. Suitable for Hazardous & Dangerous area. 3D Printing technology makes the construction quicker and the buildings can be designed with intricate architectural details, and the technology allows for greater flexibility in customizing the design to meet specific needs, as the machine can execute whatever design it is fed continuously, and it also avoids waste of materials that happens during construction in a conventional way.

As per the latest studies conducted by *Indian council for research on International economic relations*, there will be a shortage of about 38 million houses in 2030 in the urban India and there is no other technology available to address this issue. Therefore, 3D Printing is going to be the game changing technology and no doubt, this will be the future technology in the global construction sector.

Kerala State Nirmithi Kendra has constructed the first 3D Printed Building in the State. This 400 sq.ft Conference Hall named: “AMAZE-28”, is built in just 28 days and in fact, it took only 28 hours for printing the whole structure and the salient insights and foresights are analysed and highlighted in this paper.

2 Methodology

Cost Effectiveness Analysis (CEA) is utilized in breaking down the information, which portrays the expenses of mediations comparative with how much advantage and benefit that they yield as against the conventional methods of construction. It likewise gives a uniform method for contrasting intercessions with spot those that give ideal cost impact. Information and models were utilized to mean the connection between the different measurements. Materials and Man days used, time of construction, etc., for completing AMAZE-28 having an area of 400 Sq.ft., are depicted in the following table 1:

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Table 1. Materials, man days and time for construction of “amaze-28” using 3 d printing technology

Sl.No.	Materials	Man Days	Construction Time
1.	<u>Wall:</u> a.Cement b.Dry Sand c.Plastic Polymer	9	3 Days
2.	<u>Roof</u> a.Cement b.M-Sand c.Coarse aggregate	16	14 Days
3.	<u>Foundation</u> a.Cement b.M-Sand c.Gravel d.Steel	18	5 Days
4.	<u>Floor</u> Verified Tiles	4	2 Days
5.	<u>Doors/Window</u> a.Steel/Aluminium b.Glass	4	1 Day
6.	Electrical Fittings	4	1 Day
7.	Finishing Works/Paintings, etc	8	2 Days
	Total	63 Man days	28 Days

Above table shows that the walls are constructed using a mixture of Cement, M-Sand, and a Plastic Polymer which is a Patented product and the combination of the mixture is also Patented. It is further noticed that Wall construction was completed using 9 man days and the whole structure could be completed in 28 days. Printing of the walls took only 28 hours and the construction of the entire building, including flooring, window /door fittings, electrical works ,etc., could be completed in just 28 days .

Various views of the building are shown in Figures 1 & 2.



Fig. 1. 3D Printing in Progress in KESNIK Campus, India.



Fig. 2. 3D Printed Building-‘AMAZE-28’ in KESNIK Campus, India.

3 Results and discussions

The study reveals that construction of “Amaze- 28” a 400 sq.ft building using 3D printing Building technology was completed in 28 days and the printing took only 28 hours, where as a building of same area using conventional method will take 4 to 6 months to complete. It is also realised that only 63 man days were utilised for this 3 D printing building against a requirement of 200 to 250 man days in conventional method, which is about 3 to 4 times higher. End of the day there is no wastage of material ,as the mixing was computerised. Therefore, there is no pollution and there is substantial savings on carbon footage and it is indeed an environment friendly

technology. The Design of the building is complex and it reveals that any complicated design can be printed successfully using 3 D Printing. Compared to conventional method the cost can be reduced in 3 D Printing if the same design can be replicated for large number of buildings, as the design cost is about 10 % higher compared to the conventional one. 3 D Printing needs to be fine tuned and scaled up to derive more cost benefits. The study further reveals that the roof was constructed using conventional methods and it took 14 days to complete this work, which contributes to 50 % of the total time of construction of the whole building and thus demands for appropriate 3 D printing technology in roof work also.

4 Conclusion

3D printing is a cutting-edge technology that has intriguing prospects for the construction sector, including lower operating costs and more flexibility. Construction projects may be completed more quickly thanks to 3D printing technology, which also prevents material waste that occurs while building a structure in the old-fashioned manner. The research recommended employing energy-efficient, reasonably priced, and environmentally friendly building technology while building affordable homes. In order to maximize the benefits of both economic and environmental concerns, local materials and other inputs for home construction should be promoted. Technology should be developed for Roof work also to save on time. The technology that will change the game and undoubtedly shape the worldwide building industry going forward is 3D printing.

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