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OVERVIEW OF 3D PRINTING TECHNOLOGY IN THE FIELD OF CIVIL ENGINEERING

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ABSTRACT

In the field of civil engineering, there are so many advanced technologies are invented. Among them 3D printing is one of the most efficient technology used now a day for construction purpose. The term 3D printing consists of a robotic arm which extrude the materials like polymer, mortar, composite material and specially concrete to build the various component parts of building. This technology results into lower the cost of construction near about 20 % and increases the speed of construction about 25% to 30 % depending upon the type of work. This technology is helpful in the construction of bungalows, houses, swimming tanks, compound walls, benches, small span bridges, etc. using this technology. Using the CAD software and scanning technology it is easy to cat the complicated shapes and components of decorative work. By maintaining appropriate proportion of ingredients and using few admixtures now it is possible to construct the structural members like wall, staircase, dummy columns etc.

KEYWORD: Additive Manufacturing, Mortar, Concrete Extrusion.

INTRODUCTION

Construction sector is continuously growing new technologies are evolving which helps to improved efficiency of work and to maintain the sustainability. 3D printing is the most effective technology which can be utilized to build new infrastructures. But as per the increasing demand of fastest and unique designs in construction sector it is really difficult to maintain the stable progress in case of innovative and unorthodox designs. Also it will

increase the cost of construction and there are chances of difficulties to get required shape and finishing of the component. Hence there is always a need of new technologies and development which makes easier construction possible even in case of unconventional shapes and sizes of building components. 3D construction printing technology is genuinely one of the technology that results into most effective construction technology for faster and easier construction. 3D printing also known as additive manufacturing includes the arm of machine continuously laying down layers of concrete or mortar as per the given data by software. Additive manufacturing process results into cleaner, clearer, faster and well finished designs. Additive manufacturing is an advanced technology which creates the three-dimensional objects from Computer-Aided Design (CAD) inputs. Additive manufacturing is based on a simple concept that is layer-by- layer construction. Which produces the layer wise components using different materials like concrete and mortar.

Fig.1. 3D printing of Wall.

Background of 3D printing

The background of 3D printing in civil engineering comes from the broader evolution of additive manufacturing and the construction industries need for faster, cost effective and sustainable construction techniques. The additive manufacturing, began in the 1980s, with the first working 3D printer was developed by Chuck Hull in 1983 using the theory of stereolithography. The idea of applying 3D printing to construction emerged in the early 2000s. The researcher Behrokh Khoshnevis developed the contour crafting which is used for automate construction using robotic systems. In the year 2010 first house and few building components are printed using this technology. After that the technology is used in various construction projects such as buildings, row houses, bridges, walls, etc.

Advantages of 3D printing:

3D printing significantly reduces construction time by building structures layer by layer without waiting for traditional processes like curing, shuttering, and manually laying the material. Using this technology, a small house can be completed within 48 hours where the conventional method takes the multiple days. Traditional construction method needs a large manpower. But additive manufacturing reduces the dependency of work on the labours. It is most suitable method where the shortage of manpower occurs. In case of cost reduction, the 3D printing technology gives good results which reduces 20% to 40% cost reduction. In traditional construction method the wastage of material occurs very often. But in case of additive manufacturing the wastage is reduces up to huge extent. Additive manufacturing gives ability to create complex and innovative designs easily using computer automated system. There are few limitations while casting the complex structures like curved walls, organic shapes, uncertain structures, etc. using the traditional methods. 3D printing system follows the CAD or BIM models, so it ensures high precision by reducing human errors. Maintaining the uniformity in construction is most challenging part in conventional methods of construction. In case of additive manufacturing the cost of formwork is reduced.

Fig.1. 3D printing of Dome.

Working of 3D printer

1. Computer based design modeling

The process is based on digital model using CAD software. The design includes all dimensions, layers, and structural details of building.

2. Layer-by-layer data sorting

By using the slicing software, the CAD model is converted into thin layers. Using the printer the layers can be horizontally laid.

3. Material preparation

The material used for the additive manufacturing is not the ordinary concrete but it is the special printable mixture which has good workability, quick setting time and high compressive strength.

4. Setup of printer

The required sized gantry system or a robotic arm is installed at the site which can be moved in horizontal and vertical direction. The nozzle is connected to the robotic arm which deposits the material or mortar in horizontal direction layer by layer without using the formwork.

5. Setting and hardening

Each layer of mortar or concrete is set before the next layer is deposited. But partial moist condition is maintaining between two adjacent layer to increase the bonding and interlocking capacity between the layers.

6. Reinforcement

In case of reinforced cement concrete, steel bars or cables can be introduced during the printing of concrete or after the printing of concrete as per the requirement of strength and depends upon the site conditions.

7. Finishing work

The finishing work is carried out if required and the door, window, electrical and plumbing work is carried out after the structure inspection once done.

Fig.1. 3D printing of Swimming Tank.

CONCLUSION

additive manufacturing or 3D printing is emerging as a revolutionary technology in the field of civil engineering. It has the ability to convert the traditional construction systems into the faster, economical and sustainable construction system. Also it reduces the material wastage, labor cost and results into easy way for complex designs. Also the introduction of computer based models and designs enhances precision and accuracy in the work. However, being a most economical and precise working, there are few limitations are there like, insufficient standard data and codes, high initial cost, and quality control. But the additive manufacturing gives good hold in future regarding the faster, economical, precise and sustainable practice in civil engineering work.

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