

# Research Progress of Concrete 3D Printing Technology

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**Abstract:** Concrete 3D printing technology has attracted wide attention due to its advantages of high automation, economic efficiency and green construction. This paper surveys the relevant research at home and abroad, summarizes the relevant technology of concrete 3D printing, puts forward the existing problems in the current research of concrete 3D printing technology and suggestions for the future research direction, and provides a reference for the future research of concrete 3D printing technology.

**Keywords:** Concrete; 3D printing; Constructability

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## 1. Introduction

With the rapid development of urbanization and industrialization, the current problems of skilled labor shortage, resource depletion and safety have seriously restricted the development of the construction industry. The development of 3D printing technology provides new ideas for researchers and engineers in the construction industry. 3D printing, also known as additive manufacturing, is different from the traditional material forming technology - material reduction processing. 3D printing uses layered processing and superimposed forming to add materials layer by layer to generate 3D solids, which is a rapid prototyping technology. As a typical example in the field of rapid prototyping, 3D printing technology has prominent advantages such as high precision, short production cycle and low manufacturing cost. It has been widely used in many fields such as aerospace, national defense technology, biomedical, automobile and electronic manufacturing. 3D printing technology has become an important production technology to guide the third industrial revolution.

## 2. Application status of 3D printing concrete

In recent years, the connection between 3D printing technology and the construction industry has become more and more close, and 3D printing buildings have been built at home and abroad successively: ICON Corporation of Texas, the United States, printed a 60.4m<sup>2</sup> house in March 2018 <sup>[1]</sup>; Arup and CLS Archietti of the European Union jointly built a 3D printing house named "3D Housing 05" <sup>[2]</sup>; Shanghai Yingchuang Construction Technology Co., Ltd. printed 10 buildings in Qingpu Park, Zhangjiang High-tech Zone, Shanghai in April 2014 <sup>[3]</sup>; In October 2019, the team of Ma Guowei of Hebei University of Technology printed Zhaozhou Bridge at a scale of 1:2 <sup>[4]</sup>; Wang Hong Kong of Southeast University and others successfully built epidemic prevention and control shelter in Jiangbei New Area of Nanjing by using concrete 3D printing technology <sup>[5]</sup>, and put it into use in Nanjing, Xiong'an, Puzhou and other places. The reasonable use of 3D printing technology in construction technology can improve the utilization rate of building materials, liberate labor force and reduce production costs; Significantly improve the level of digital and intelligent design and the degree of assembly and refinement of construction. The site operation is safe and can reduce carbon emissions and other waste emissions.

## 3. Future research directions of concrete 3D printing technology

At present, the research on concrete 3D printing technology is in the ascendant. In order to promote the engineering application of concrete 3D printing technology, it is necessary to break through the key technical problems in this field. The author believes that the future research direction of coagulation 3D printing technology should be mainly in the following three aspects:

### 3.1 The breakthrough of on-site printing technology has improved the printability

How to reasonably arrange the printing direction and order and control the climbing height of the printing head are important factors to determine the printing efficiency, and also an aspect that needs to be paid attention to in future research. At present,

the printing height of concrete 3D printing technology has been greatly limited. However, with the development of society, land resources are increasingly scarce, and concrete buildings have to develop in a towering direction. Therefore, a new printing process is needed to realize the printing of high-rise buildings, and can effectively solve the problems of structural strength, stiffness and reinforcement.

### **3.2 Durability study of building 3D printing materials.**

The main focus of current research is the rheology, constructability, anisotropy of mechanical properties and interlayer adhesion of printable concrete materials. Considering the service life and environment of printing structures and buildings, the durability of their materials needs to be studied in detail. Therefore, it is necessary to quantitatively evaluate the durability of different 3D printing concrete to compare the durability of different 3D printing concrete, and finally improve the durability of 3D printing concrete.

### **3.3 Research on concrete materials.**

At present, although some scholars have done a lot of research on 3D printing concrete materials and put forward some characteristics required by 3D printing concrete, these are mainly based on the preliminary understanding of concrete 3D printing technology, and lack of systematic, theoretical and in-depth research. In order to promote the rapid development of concrete 3D printing technology, it is necessary to carry out systematic and in-depth research on concrete materials. Therefore, new concrete mix proportion theory and new raw material requirements should be put forward according to the performance requirements, which will be the main research topic for the development of concrete 3D printing technology.

## **4. Conclusion**

Although the current concrete 3D printing technology still has many limitations, with the continuous development of the construction industry, the concrete 3D printing technology will continue to improve with the efforts of scientific researchers. As a new construction technology with economic efficiency, high automation and green construction, concrete 3D printing technology will have a broad application space in the future; In turn, the wide application of concrete 3D printing technology will further innovate the development of the construction industry and inject new vitality into this ancient traditional industry.

Future research on concrete 3D printing technology can not only focus on the development of printing hardware and software to break through the limitations of printing height and printing environment, but also focus on the research of printable materials, try to use geopolymers, other industrial solid waste, construction waste or waste minerals and other materials, and combine the concept of “carbon neutrality” to promote the concrete 3D printing technology to approach the direction of green and sustainable development, Realize the comprehensive development of concrete 3D printing technology.

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