Comparative Analysis of Carbon Emission of Special-Shaped Concrete Pier Constructed by 3D Printing and Traditional Construction

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Abstract

3D printing technology has the sustainable advantages of saving formwork, labor and time, reducing pollution and so on, so it is gradually applied to the field of bridge engineering. In order to explore the advantages and potential of 3D printing technology in carbon reduction, this paper makes a comparative analysis on the carbon emission of 3D printing and cast-in-situ construction in the materialization stage of complex shaped pier. The results show that the carbon emission in the materialization stage mainly comes from the production stage of building materials, and the proportion of carbon emission in the construction stage and transportation stage is very small; The combination of 3D printing shell and cast-in-situ construction has less carbon emission than using one of the construction methods alone; Compared with traditional construction, the application of 3D printing technology reduces the carbon emission of this example by more than 20%.

Keywords: 3D printing concrete; carbon emissions; formwork; materialization stage.

1 Introduction

In recent years, the application of concrete 3D printing technology in the field of civil engineering has developed rapidly[1]. Its highly automated characteristics improve productivity and construction accuracy, reduce construction safety risks and reduce environmental pollution[2]. This paper lists the world-famous 3D printed bridge engineering examples, and introduces their respective characteristics and innovations. 3D printing technology can produce complex modeling structures that are difficult to complete in traditional construction in a short time. Therefore, in order to explore the distribution characteristics of carbon emissions of 3D printing special-shaped concrete structures and the advantages of carbon reduction compared with traditional construction methods, this paper divides a designing bridge construction scheme into the following three types: 1. 3D printing scheme for full section of pier structure (hereinafter referred to as 3D printing scheme), that is, the reinforcement is erected manually, and the concrete section is made by 3D printer; 2. 3D printing + traditional construction scheme (hereinafter referred to as mixed scheme), that is, after 3D printing the concrete shell, pour concrete inside; 3. The traditional cast-in-situ construction scheme (referred to as the traditional scheme) is to erect the concrete construction formwork and place the reinforcement before pouring the concrete. The research route of this paper is as follows: 1. The topology optimization of the bridge substructure is carried out by using the finite element analysis software ANSYS Workbench; 2. Use BIM software Rhino to process the boundary of the rough model after topology optimization; 3. Carry out static and dynamic checking calculation, and count the quantities after ensuring the safety

https://doi.org/10.2749/nanjing.2022.2016
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