Automated structural design for 3D printed circular composite bridges

Bart-Jan van der Gaag, Liesbeth Tromp

Royal HaskoningDHV, Rotterdam, the Netherlands

Maurice Kardas

Royal HaskoningDHV, Amersfoort, the Netherlands

Kees van IJselmuijden

Royal HaskoningDHV, Amsterdam, the Netherlands

Pieter Leen

Covestro Additive Manufacturing, Geleen, the Netherlands

Contact: bart-jan.van.der.gaag@rhdhv.com

Abstract

The construction industry is in transition. Recyclable materials will become more common to minimise the negative impact of materials. Additive manufacturing with circular composite material is introduced to infrastructure, requiring new design solutions. A thorough understanding of the material behaviour during and after the 3D printing process is needed. It is a misunderstanding that large 3D printing is an upscale of the commonly known small desktop 3D printing. The geometric layout for large print is highly dependent on the window of operation, dominated by the thermal material characteristics. Besides material orthotropy because of fiber orientation, the printed structure is geometrically orthotropic. Different print strategies result in different structural behaviour of the printed part. This paper aims to explain the important factors to consider for the design and engineering of 3D printed load bearing structures, such as bridges, with circular composites, as well as the associated disruption of the value chain.

Keywords: Structures; Circular; 3D-printing; DFAM; Automated design; Parametric design; FRP; Engineering; Architecture.

1 Introduction

Companies in the architecture, engineering, and construction (AEC) industry are in transition from a linear economy to a circular economy. Furthermore, processes in design and manufacturing are increasingly automated. Never has it been more important to reinvent our design, process, and embodied energy-and material usage in construction, to make a drastic change to our carbon footprint.

It is important to consider the end of life of everything we build. How can we reuse and recycle materials we apply in an object or structure? Given the fact that we can create such materials, how are we going to design, engineer and process these

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