Material efficient WAAM Steel Construction Details

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Abstract

With the new manufacturing process Wire Arc Additive Manufacturing (WAAM), it is possible to produce new shapes that previously could only be manufactured with a great effort. The energy-intensive manufacturing process can be positively compensated by the sensible use in mainly material-saving components. In this article, the enormous potential is illustrated by the example of a conventional head plate. Here, 80 % of the material can be saved and waste is eliminated completely. The article furthermore presents the printing, the load-bearing tests and the numerical simulation of the novel structure. A homogeneous component behavior is shown, which can be predicted very well by finite elements.

Keywords: Additive Manufacturing, Carbon Steel, WAAM, Material Efficiency, Bolted Connection, Head Plate, Optimization, Steel Construction

1 Introduction

In today's world, we are feeling the effects of our reckless treatment of nature more and more acutely as extreme weather events become more frequent. The buildings and construction sector has made no small contribution to this. It is responsible for over a third of global CO_2 emissions, uses a large proportion of resources and generates large amounts of waste even during the construction of new buildings. As the population continues to grow and the general pursuit of prosperity continues, there will be an increasing demand for the built environment in the future. It is therefore essential to look at and develop sustainable, alternative building concepts, materials and shapes.

3D printing as an alternative manufacturing method has the potential to contribute to this change. It allows new structures to be made that adapt to the flow of forces, saving material without excessive waste production during fabrication.

For steel structures, Wire Arc Additive Manufacturing (WAAM) seems to be a promising process in this regard. Compared to other metal 3D printing processes, it is cost-effective and fast, and because it is an arc welding process, it can be easily implemented in conventional steel construction industry [1].

The material-saving potential of AM is particularly evident in applications for connecting components and beam reinforcements. Here, material only needs to be placed where it is needed without wasting material by subtractive production steps.

Structural optimization can be used to find and produce new shapes that save over 50 % of material compared to conventional construction details. This article presents a resource-optimized component in terms of design, manufacturing and load-bearing behavior and shows how WAAM can be used to create new construction details that can permanently change the way we look at structural design.

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