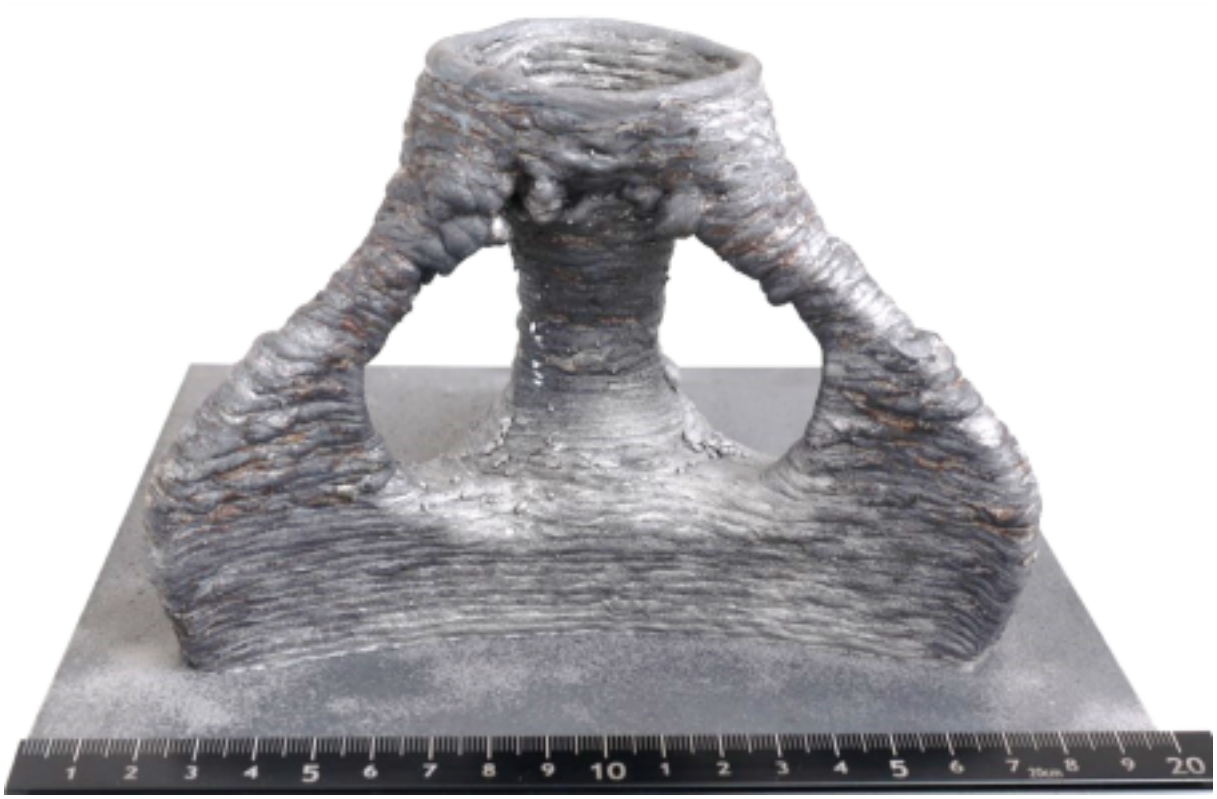
Producing complex steel nodes efficiently and resource-saving: using arc 3D printing

About this project



WAAMlight

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Markets:

Material: Steel

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Technology Transfer Program Leichtbau

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Context

Architecturally sophisticated supporting structures in steel construction are becoming increasingly complex - and therefore more difficult to manufacture. Particularly in the case of spatially curved structures with a low repetition rate, such as those realised in Stuttgart's new main railway station, conventional manufacturing processes are reaching their limits. The steel node components required for this have to be welded, milled or cast by hand in small sections. This is not only costly and time-consuming, but also resource-intensive.

At the same time, the requirements for sustainable construction methods are increasing: Solutions are needed that save material, are durable and have a good carbon footprint. Additive manufacturing processes - in particular Wire Arc Additive Manufacturing (WAAM), a 3D printing process in which metal components are built up layer by layer from wire using arc welding - promise a solution here. They make it possible to produce complex geometries based on natural models with a high degree of efficiency. However, their use in large-format lightweight steel construction is still in its infancy - this is where the WAAMlight research project comes in.

Purpose

The project team is pursuing the goal of additively manufacturing steel node components with complex geometries in a resource-efficient, functional and high-quality design manner - and thus creating the basis for the broad industrial use of this technology in lightweight construction. The focus is on the transfer of WAAM to structural steel construction, in particular for bionically inspired node structures with a high degree of design freedom. To this end, the researchers want to develop new construction methods and design concepts that take into account the special features of the WAAM process. The aim is to reduce weight, use material specifically where it is mechanically necessary and achieve locally optimised strengths by combining different types of steel. The project participants are also focussing on the corrosion protection of additively manufactured components - a critical aspect for longevity. In the long term, WAAMlight should contribute to the establishment of new standards in lightweight construction and significantly improve the carbon footprint of load-bearing structures.

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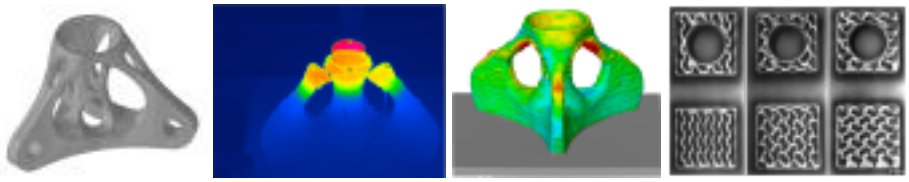
Procedure

The project team analyses the entire manufacturing process - from the digital design to the galvanised end component. To begin with, the researchers design bionically inspired node structures, which they design to be material-efficient with the help of topology optimisation. They use numerical simulation methods to optimise weight, strength and stiffness.

In production, the team uses the WAAM process: welding robots apply welding wire layer by layer - quickly, flexibly and with high material deposition. The scientists are also testing methods for controlling the strength of materials by using different types of steel.

For quality assurance purposes, they analyse the mechanical-technological properties of the components, as well as distortion, residual stresses and surface quality. They also comprehensively test corrosion resistance - a key step for construction practice. Finally, the researchers develop design approaches and guidelines for the standardised design and application of the new WAAM nodes in steel construction.



Funding duration:

Funding sign: 03LB3056 **Funding amount:** EUR 1.1 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3056A - WAAMlight in the federal funding catalogue

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Project coordination

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Lightweighting classification

	Realisation
Offer	
Products Parts and components	✓
Services & consulting Consulting, Engineering, Prototyping, Validation, Simulation	✓
Field of technology	
Design & layout Lightweight manufacturing, Lightweight design, Hybrid structures, Lightweight construction concepts	✓
Functional integration	
Measuring and testing technology Component and part analysis, Visual analysis (e.g. microscopy, metallography), Destructive analysis, Non-destructive analysis	✓
Modelling and simulation Loads & stress, Life-cycle analysis, Structural mechanics, Materials, Reliability validation	✓
Plant construction & automation	
Recycling technologies	

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Lightweighting classification

	Realisation
Manufacturing process	
Additive manufacturing 3D printing, Deposition welding, Others (DED-Arc)	✓
Coating (surface engineering) Others (Galvanising)	✓
Fibre composite technology	
Forming	
Joining Welding	✓
Material property alteration Heat treatment	✓
Primary forming	
Processing and separating	
Textile technology	
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites	
Fibres	
Functional materials	
Metals Steel	✓
Plastics	
Structural ceramics	
(Technical) textiles	