A07

Wire and Arc Additive Manufacturing (WAAM) of Complex Individualized Steel Components

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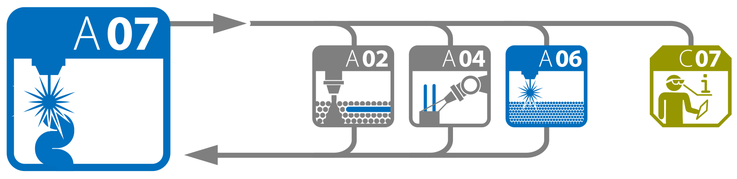
Summary

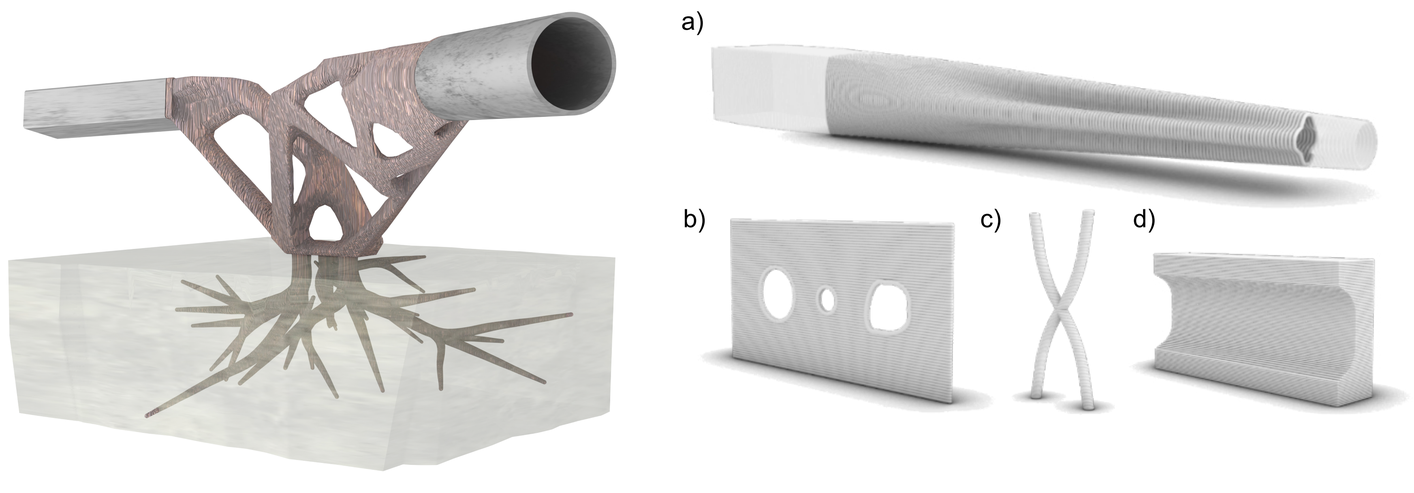


Project A07 investigates structural design, WAAM methods and component testing of complex, large-scale, individualized steel components. The objective is to connect conventionally manufactured steel components and semi-finished products with additively manufactured, complex steel components (connection nodes, 3D steel inserts for concrete). The research programme is based on innovative design and manufacturing methodologies that take both additive manufacturing parameters and material properties into account. The evaluation of the WAAM components follows a novel test method, which considers potentially anisotropic component behaviour, surface topographies, geometric irregularities and residual stresses in addition to the relevant material properties.

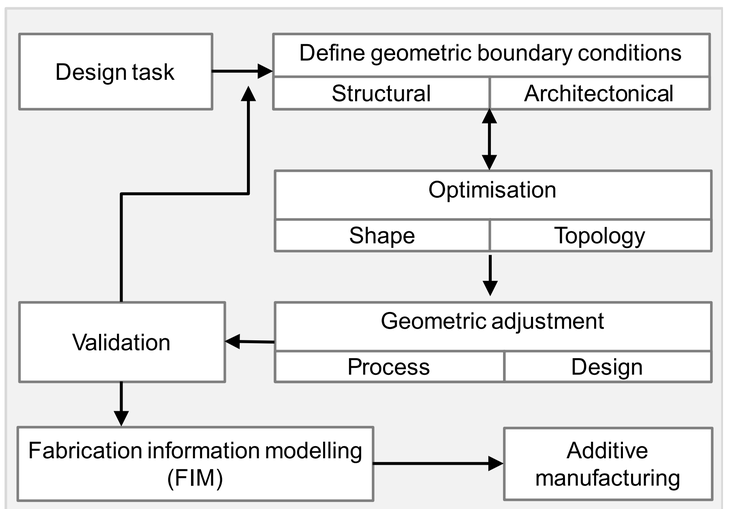
Research Approach

- Design of complex and individualized WAAM steel components under consideration of manufacturing possibilities and WAAM material behaviour
- WAAM process development for complex and individualized steel components in combination with semi-finished products (i.e. plates, pipes)
- Advanced material and component testing to evaluate WAAM-specific material behavior under static loading
- Generation of input data for digital twins for virtual component tests

- Final demonstrator
  → Design, manufacturing and testing
  → Digital twin data



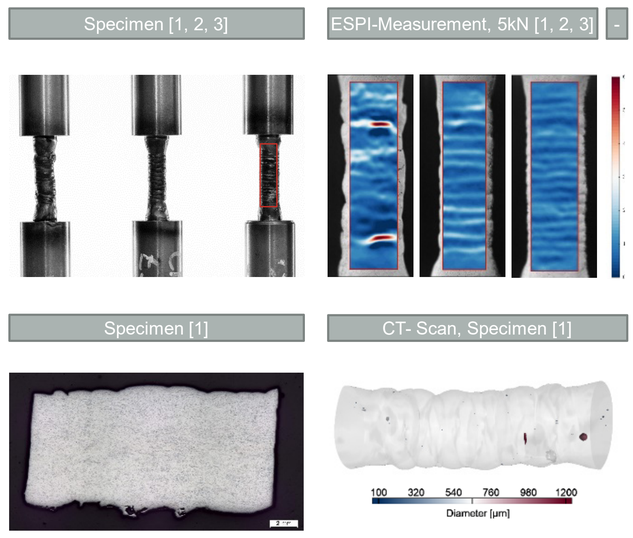
Final WAAM demonstrator. Connection of semi-finished steel products and 3D-anchoring element in cast concrete. Case study demonstrators a) connection between different cross sections and diameters b) undercuts in building direction c) intersection of bars d) variable wall thickness in building direction.



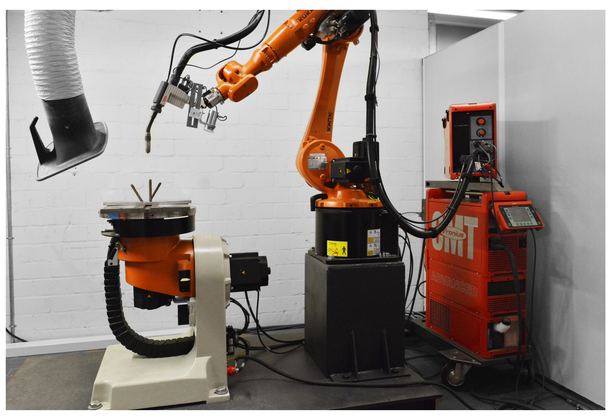
Flowchart for the creation of a design process for WAAM components

Left: WAAM component with varying cross section in build up direction

Right: Inclined WAAM steel bars for use as 3D-anchoring element in cast concrete



Advanced material testing with ESPI, microsection and CT-Scan



WAAM experimental setup of WG Hensel

Research Objectives

- Development of an architectural and structural design methodology to utilize the geometric degree of freedom of WAAM. Design methodology for design according force flow and efficient production and material use.
- Establishment of a stable and reliable WAAM process leading to predictable material properties.
- Evaluation of the process limitations and possibilities with regard to the manufacturing of geometric complex and refined steel components.
- Test methods for material and component characterization must be evolved to capture WAAM-typical effects such as surface topography and heterogeneous material properties.
- The future certification process of WAAM components for safe use in buildings or infrastructure must be applicable to individual parts, taking into account all relevant features of the AM process. For this, the digital twin approach is adopted to reflect individual component properties and behaviour.