A04

Integrated Additive Manufacturing Processes for Reinforced Shotcrete 3D Printing (SC3DP) Elements with Precise Surface Quality

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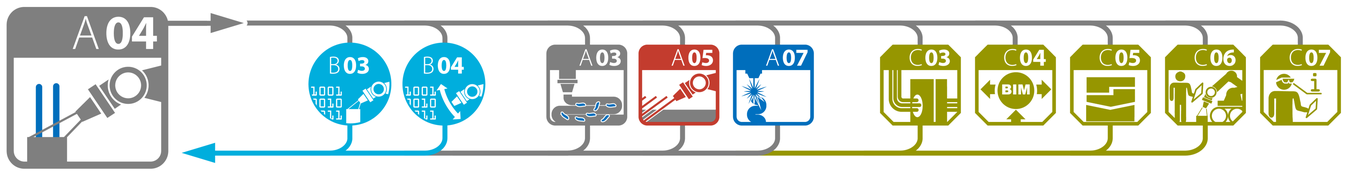
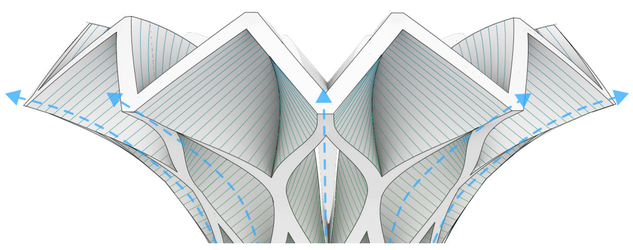
Summary



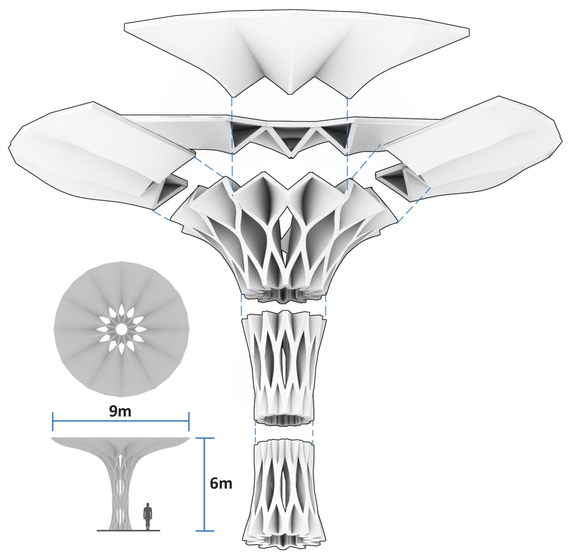
Within this project, basic research on various SC3DP strategies, materials, tools and methods will be conducted with regard to enhanced material and process control, reinforcement integration, surface quality and automation. To that end, different reinforcement materials in combination with suitable reinforcement manufacturing and integration concepts will be investigated based on force-flow optimised reinforcement alignment. Besides, design strategies as well as material and process control will be investigated in detail. Furthermore, tools and strategies for precise control of the surface quality and geometric resolution of SC3DP elements are subject of research. Finally, strategies, materials and tools elaborated within the project will be synergistically combined and validated at large scale.

Objectives

- Material efficiency by force optimised design
- Integration of reinforcement
- Precise geometry and high surface quality
- Material and process control
- Cooperative fabrication
- Process automation

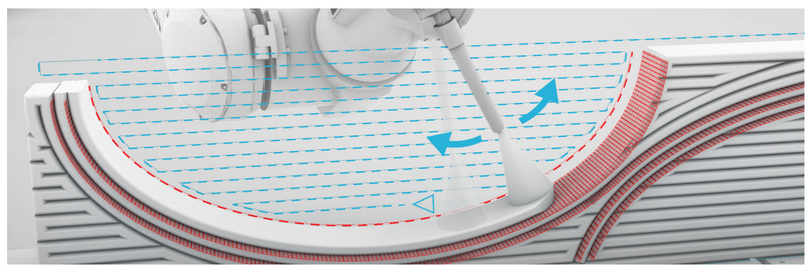


Final Demonstrator

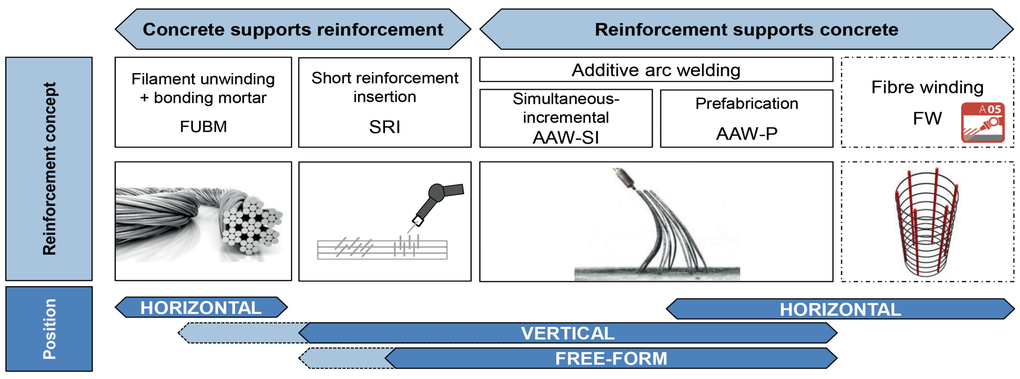


Methods

- Creating a digital model of the printing process
- Investigating force-flow-compliant reinforcement systems
- Developing material and process control algorithms
- Inventing suitable tools and end effectors
- Monitoring of process and material parameters
- Investigating & modeling rheological material properties as a function of shear history



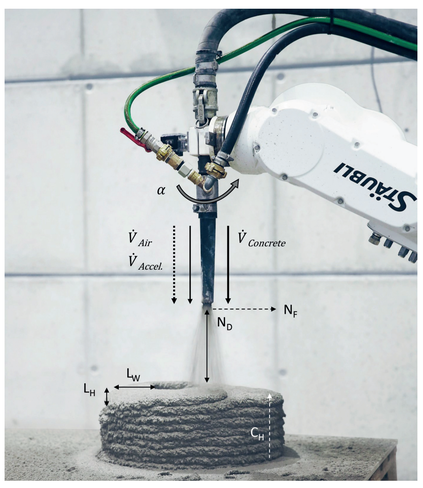
Reinforcement



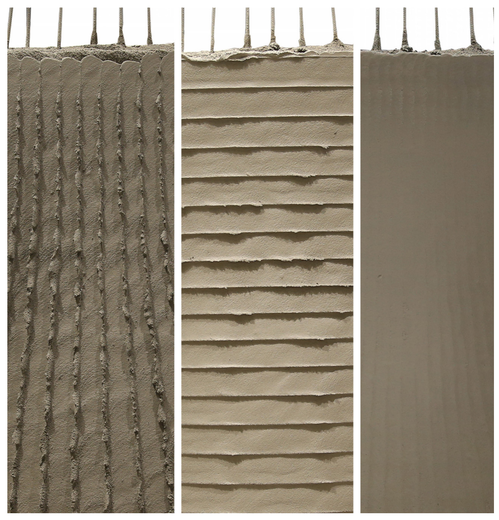
Geometrical Complexity

- Control of material behaviour & rheological properties
- Printing strategies to create complex structures (overhangs and openings)
- Initial concepts for path planning
- Develope a form-adaptive nozzle
- Sensor data acquisition for process qualification

$\dot{V}_{Concrete}$: Volumetric flow concrete
$\dot{V}_{Accel.}$: Volumetric flow accelerator
$\dot{V}_{Air}$: Volumetric flow air
N_D : Nozzle distance
N_F : Nozzle feedrate
τ_0 : Yield stress
L_H : Layer height
L_W : Layer width
α : Spraying angle



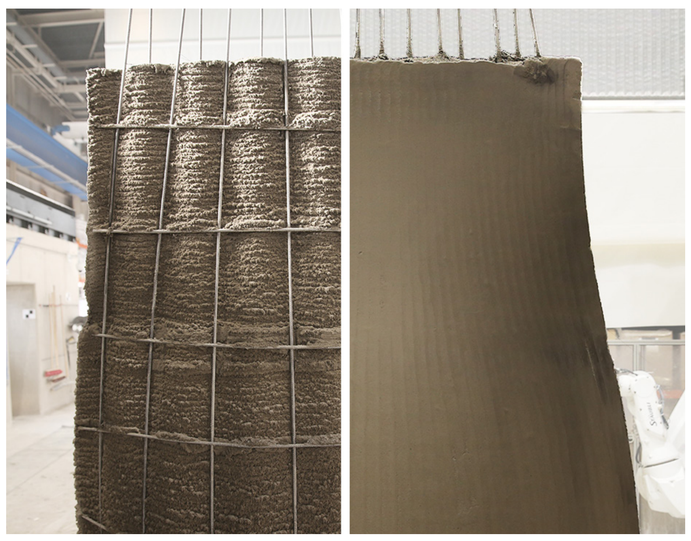
Surface Quality



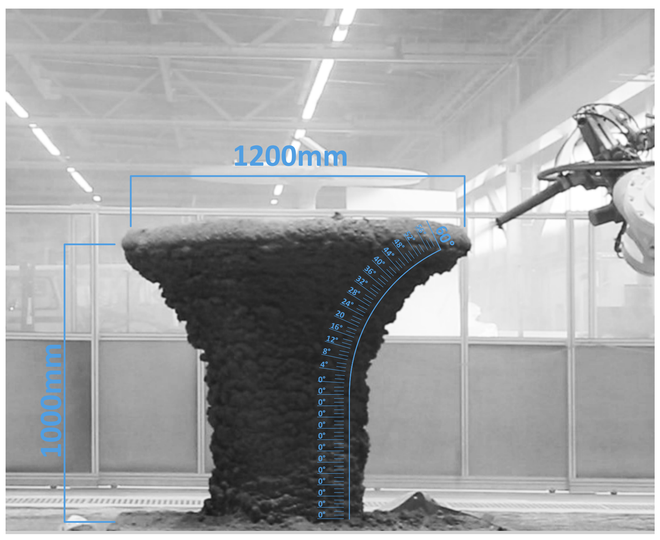
Double curved wall with different surface patterns

- Develope tools for post-processing the surface
- Adhesion and rheology control of the material
- Investigate processing and design strategies
- Control of geometrical precision
- Investigate different design options

Preliminary Work



Double curved wall, 2.85 m high, reinforced, smoothed



Gradual transitional 3D printing of a funnel