

# UHPC sheet metal forming

## Tool active elements made of ultra high-performance concrete

### Motivation

Developments in the field of ultra high-performance concrete (UHPC) make the material usable in forming technology. UHPC has a high compressive strength. In addition, the properties of the material can be adjusted by reinforcement and aggregates. Through a heat treatment, the minimum curing time can be reduced from 28 days to 48 hours without negatively affecting the final strength.

### Approach

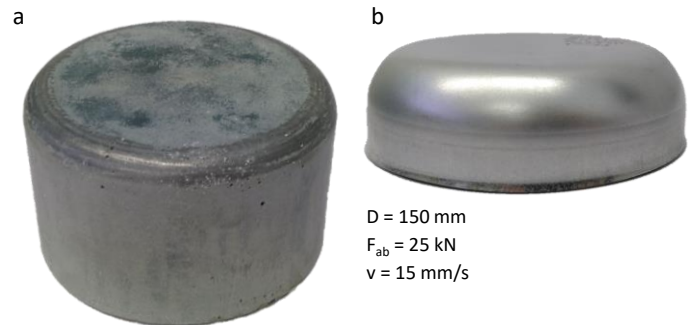
At the beginning of the project, a UHPC formulation with optimized properties for forming technology will be developed. The target parameters are high strength with low shrinkage, good self-deaeration and improved post-fracture behavior. Various cements, pozzolans and additives such as gravels, sands and fibers are used. In order to cast the UHPC close to the final geometric specification, an application-oriented indirect rapid tooling approach is pursued. In a first additive step, mold negatives are manufactured and reproduced with silicone (Fig. 1).



**Abb. 1** Indirect Rapid Tooling approach; casting mold with hard mold (1), silicone mold (2), silicone lid (3), FDM lid (4) and FDM mold negative (5)

A new machining process should be introduced to fabricate drawing radii or geometric details for the fastening. In particular, the wear of the cutting tools is to be minimized.

In addition, the forming process with UHPC tooling is to be modeled using FEM. For this purpose, a material model for UHPC will be developed. The FEM analysis simplifies the development of UHPC tooling. The limits and potentials of UHPC tooling will be evaluated and compared with conventional steel tooling on a prototype drawing setup. At the end of the project, a design guideline will make the design and use of UHPC tooling for different component sizes, geometries and batch sizes usable.



**Abb. 2** a) UHPC punch after drawing tests and b) formed cup

### Summary

In forming technology, faster development and production cycles are hampered by the production of forming tools, which are already mandatory for small series. With the established manufacturing process, a combination of wire electrical discharge machining and CNC milling, a minimum of 10 weeks must be allowed for tool production.

With UHPC tool active elements, the aim is to shorten the delivery time for tooling so that the tool or sample parts can be delivered to the customer within a few weeks of receipt of the order. The reduction in raw material prices for the tool active elements is expected to increase the cost-effectiveness of formed parts, especially for small series or one-off parts.