Strategies and limits in multi-stage single-point incremental forming - DTU Orbit
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**Strategies and limits in multi-stage single-point incremental forming**

Multi-stage single-point incremental forming (SPIF) is a state-of-the-art manufacturing process that allows small-quantity production of complex sheet metal parts with vertical walls. This paper is focused on the application of multi-stage SPIF with the objective of producing cylindrical cups with vertical walls. The strategy consists of forming a conical cup with a taper angle in the first stage, followed by three subsequent stages that progressively move the conical shape towards the desired cylindrical geometry. The investigation includes material characterization, determination of forming-limit curves and fracture forming-limit curves (FFLCs), numerical simulation, and experimentation, namely the evaluation of strain paths and fracture strains in actual multi-stage parts. Assessment of numerical simulation with experimentation shows good agreement between computed and measured strain and strain paths. The results also reveal that the sequence of multi-stage forming has a large effect on the location of strain points in the principal strain space. Strain paths are linear in the first stage and highly non-linear in the subsequent forming stages. The overall results show that the experimentally determined FFLCs can successfully be employed to establish the forming limits of multi-stage SPIF.

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