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Tensile stresses in fine blanking tools and their relevance to tool fracture behaviour

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Abstract

In order to enhance the productivity of the fine blanking process there is a tendency to apply high strength tool materials with superior resistance to wear and plastic deformation such as WC-Co hard metals. Due to the mean stress sensitivity of these high strength materials under fatigue loading conditions, there is a need to describe the tool load situation including previously unconsidered tensile tool load components and mean stress. To this end a finite element-based tool load analysis was performed that describes the cutting process and the tool's retraction from the remaining sheet material. The tool load was revealed to contain significant tensile components that occur during tool retraction. Their location on the lateral punch surface coincides with origins of tool fracture in two thirds of investigated fine blanking punches that failed close to the cutting edge in an industrial production scale fine blanking environment. The influence of friction between punch and sheet on the magnitude of the cyclic stress range and mean stress that act locally at the tool surface was investigated. As one of the main results, a first approximation for a surface quality requirement for fine blanking tools made of WC-Co hard metal was quantitatively estimated as a function of the friction coefficient based on linear elastic fracture mechanics.

Highlights

- Validated finite element model for fine blanking including cutting and tool retraction.
- Localized tensile tool load components present during tool retraction.
- Quantitative correlation between local loading and critical local defect size proposed.
- Location of tensile loads and experimentally found origins of tool fracture coincide.
- Surface quality requirement estimated as a function of friction coefficient.

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