Investigation of the Tool Wear Behaviour in Shear-clinching Processes During the Running-in Phase

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Abstract. The multi-material design of modern cars is a challenge for common joining technologies. Joining by welding is often not possible, due to the different melting temperatures of the joining partners and the formation of intermetallic phases. Indeed, the usage of fasteners allows the joining by forming of high-strength steels with aluminium, but increases the weight and the costs. Common joining by forming technologies without additional fasteners are limited by the mechanical properties of the joining partners. Critical factors are the tensile strength and the ductility of the processed materials. Thus, clinching of ultra-high strength steels with low ductility, like press-hardened manganese-boron steels, is not possible. However, the innovative shear-clinching technology enables the joining by forming of ultra-high strength steels and aluminium without fasteners. In one combined process, the die-sided steel is cut and the punch-sided aluminium is pressed into the cut out hole, resulting in a form and force fitting joint. However, the cutting of the high-strength steel and the subsequent upsetting of the aluminium both result in high process forces. This leads to high tool loads, especially for the die. As the occurring loads are related to the wear, it is necessary to analyse the wear behaviour of the active tool elements in shear-clinching with regard of the process stability and the joint quality. Within the scope of this work, the tool wear behaviour in shear-clinching will be investigated experimentally. The focus of the investigation will be on the die, as the highest loads occur for this active tool element during the cutting of the die-sided sheet material. Moreover, the investigation concentrates on the running-in phase of the tool set, since there are no references for the tool wear behaviour in shear-clinching yet. The influence of the wear on the process stability will be evaluated by the process forces and the geometric features of the joint.