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The effect of punch contraction, springback and compaction tooling design on the cutting edge of positive WC-Co compacts

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Abstract

In the current work the effects of machine-tool deflections, component unloading, and component-tool interactions on the dimensions of positive WC-Co compacts were determined on the basis of various tests performed using different compact geometries, compaction materials, tool designs and press decompression settings. Specifically the machine-tool deflection was defined and examined in terms of the punch-ram system contraction along the vertical axis of the press, component unloading in terms of axial, radial and volumetric compact springback, and component-tool interaction in terms of contact between the ejecting compacts and the die-wall. A new tool design was introduced to study the springback behaviour of compacts and compared against the conventional tooling design which makes use of a tight-fitting upper punch and die combination. As a result of the new tool design, positive compacts that were formed had near perfectly sharp cutting edges. Contraction experiments allowed for the determination of the contraction profile along several points of the machine-tool system especially contraction of the upper punch-ram. This quantity was found to be independent of tool geometry; a significant result which allows for the prediction of contraction behaviour and therefore increased control over the final pressing position of a variety of other production punches. Natural springback behaviour of positive compacts was studied on the basis of the determined contraction measurements and the newly introduced tool design which allowed for the formation and ejection of compacts free from die-wall contact and associated frictional influences. Axial and radial springback, as well as their fractional counterparts, could be expressed in terms of the same functions of the pressing force, dependant only on the hold-down setting (geometric and material factors being accounted for and embodied in the pressing force parameter). This new result simplifies the prediction of linear springback and its effect on the net shape of production items. Volumetric springback was found to be independent of compact shape which can then be used to make general predictions regarding the effect of three-dimensional springback on the total net shape of compacts in production. Both relative and volumetric springback were also found to be independent of the compaction material and hold-down setting.