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Effect of Punch Diameter on Optimal Loading Profiles in Hydromechanical Deep Drawing Process

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Abstract : Hydromechanical deep drawing (HMD) process is an advanced manufacturing process used to form deep parts with only one forming step. In this process, sheet metal blank can be drawn deeper by means of fluid pressure acting on sheet surface in the opposite direction of punch movement. High limiting drawing ratio, good surface quality, less springback characteristic and high dimensional accuracy are some of the advantages of this process. The performance of the HMD process is affected by various process parameters such as fluid pressure, blank holder force, punch-die radius, pre-bulging pressure and height, punch diameter, friction between sheet-die and sheet-punch. The fluid pressure and bank older force are the main loading parameters and affect the formability of HMD process significantly. The punch diameter also influences the limiting drawing ratio (the ratio of initial sheet diameter to punch diameter) of the sheet metal blank. In this research, optimal loading (fluid pressure and blank holder force) profiles were determined for AA 5754-O sheet material through fuzzy control algorithm developed in previous study using LS-DYNA finite element analysis (FEA) software. In the preceding study, the fuzzy control algorithm was developed utilizing geometrical criteria such as thinning and wrinkling. In order to obtain the final desired part with the developed algorithm in terms of the punch diameter requested, the effect of punch diameter, which is the one of the process parameters, on loading profiles was investigated separately using blank thickness of 1 mm. Thus, the practicality of the previously developed fuzzy control algorithm with different punch diameters was clarified. Also, thickness distributions of the sheet metal blank along a curvilinear distance were compared for the FEA in which different punch diameters were used. Consequently, it was found that the use of different punch diameters did not affect the optimal loading profiles too much.

Keywords : Finite Element Analysis (FEA), fuzzy control, hydromechanical deep drawing, optimal loading profiles, punch diameter
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