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DETERMINATION OF FORMING LIMIT DIAGRAM USING FINITE ELEMENT METHOD

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Sheet-metal forming processes play an important role in modern industries because they allow for production many different parts from small metal fancy goods to as big parts as car-body or aircraft ones. With an increase in demand for the drawn-parts the need for predicting forming behaviour of sheet-metal becomes an essential issue. Forming limit diagram (FLD), also known as a Keeler-Goodwin diagram, is used for this purpose. FLD is generated as a line at which failure is onset. It is a good instrument for determination as to whether a given forming process will result in failure or not. Until now the FLDs have been mostly constructed experimentally by measuring the material deformation. Although modern optical strain measurement systems are available, determination of FLDs for some kinds of sheets, such as: high strength titanium alloy or stainless steels used in aircraft industry, poses a serious problem. Applying the measurement points to these sheets is one of the main problems.
Therefore, the Authors decided to combine experiments with finite element analysis to determine FLDs for some aluminium, titanium and stainless steel sheets.
At the beginning, in order to obtain a full FLD, a set of 6 samples with different geometries underwent plastic deformation in stretch forming (like in the Erichsen cupping test) till appearance of fracture. The heights of the stamped parts at fracture moment were recorded.
Then, the sheet-metal forming process for each sample was numerically simulated based on the Finite Element Method (FEM). The values of calculated plastic strains in the place where the fracture was initiated, were marked on the FLD. The FLDs were graphed in a two-dimensional coordinate system, with the major strains plotted on the y-axis and the minor strains plotted on the x-axis. The resultant FLDs are than used in the numerical simulations of sheet-metal forming. A comparison between strains in the numerically simulated drawn-parts and limit strains gives the information if the sheet-metal forming process was designed properly.

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