STUDIES ON FORMABILITY OF AL/CU BIMETALLIC SHEETS IN SINGLE POINT INCREMENTAL SHEET FORMING

A Chennakesava Reddy
Sr. Professor, Department of Mechanical Engineering
JNT University Hyderabad

Abstract: Single Point Incremental Forming (SPIF) is an unconventional forming process that is suitable for prototype production and small lot production due to the economical tooling cost, short lead time, and the ability to create symmetrical and asymmetrical complex geometries without the use of expensive dies. Experiments were conducted at a constant rotational speed and feed rate, with the use of rapeseed oil as a lubricant. The tests were carried out with the use of a forming tool on both sides of the bimetallic sheet. The shape and dimensions of the formed elements are determined by non-contact optical 3D scanning. It has been proved that an increase in the step size Dz affects the deterioration of the surface quality of the specimens, while a small step size down Dz favours the geometric stability of the samples. It was also found that the mechanical properties of the bimetal sheet decreased as a result of incremental forming. The greatest decrease in strength and ductility was recorded for a pitch of 1.2 mm. Strength decreased from 225 MPa (for sheet in initial state) to approximately 80 MPa, elongation from 11% to approximately 8.5%, and hardness from 125 HV10 for Cu and 65 HV10 for Al to approximately 35 HV10 for both layers.

2. Materials and Methods

The research material was Al/Cu bimetallic sheet. The ratio of Al/Cu layers was 1:1. The sheet was produced by the roll bonding method in industrial conditions. The process of incremental sheet metal forming was performed on a CNC precision drilling–milling machine. The machine is numerically controlled by means of a computer station equipped with the Mach3 program and is also equipped with a dedicated table equipped with a sheet mounting system with two plates and screws. Dimensions of the square workspace were 100 X 100 mm. The forming tool is composed of 145Cr6 hardened steel. The tip of the tool had a spherical end with diameter of 12 mm. Rapeseed oil was used as a lubricant.

3. Key Results

3.1 Wall Thickness

The measurement of the thickness of the wall of the drawpieces was made on the basis of 3D scans obtained with the GOM Inspect software. With an increase in tool step size in the direction of the Z axis, the average thickness of the drawpiece wall decreased as shown in figure 1. At the same time, it was noticed that when forming the bimetallic sheet on the aluminum side of the sheet, greater thinning only occurred in the range of Dz values from 0.7 to 1.0.

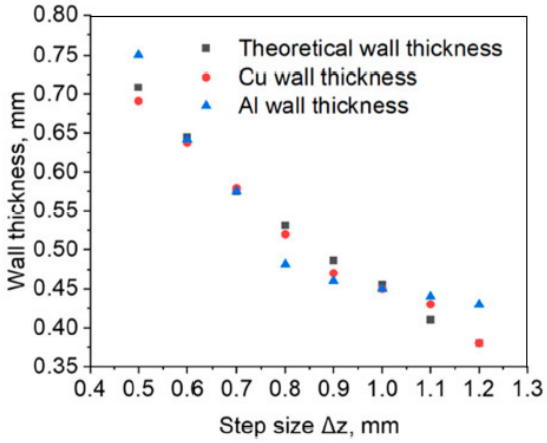

Figure 1: Variation in the average wall thickness of the drawpiece depending on step size Δz

3.2 Mechanical Properties of Bimetallic Sheet after SPIF

It was observed that a decrease in sheet strength was found as a result of additive forming as noticed from figure 2. The larger it is, the larger the step size used. The probable cause of this situation may be heating of the material during forming and an increase in grain size due to recovery and/or recrystallization.

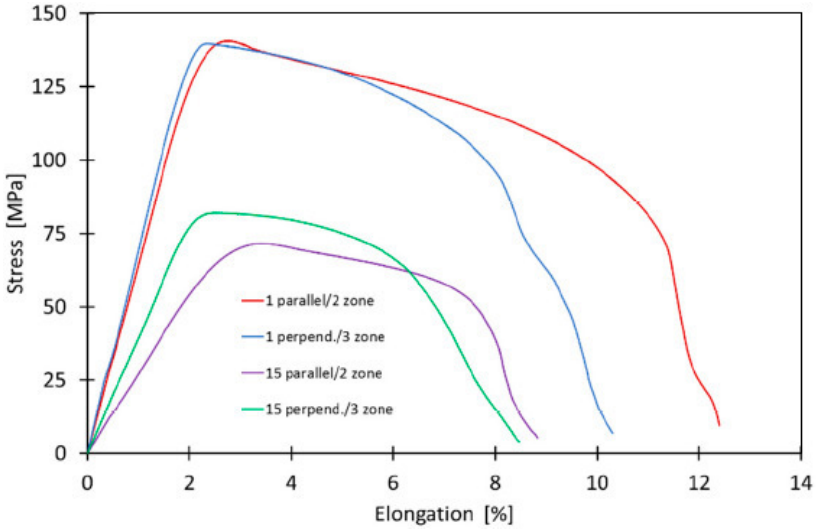

Figure 2: Tensile curves of as-received bimetallic sheet and of specimens cut from drawpieces.

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