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Effect of Normal Load and Bulk Strain on Real Area of Contact in Aluminum Sheet Forming

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Friction is one of the key parameters in sheet metal forming. It not only influences the punch and blank holder forces, but also affects the quality of the products. Predicting the correct value of the friction force in the sheet metal forming poses a significant challenge. Among all factors, real area of contact stands out as one of the most important parameters.

During the forming process, the surface of the aluminum sheet undergoes flattening and roughening, leading to corresponding changes in real area of contact. Predicting real area of contact based on the loading condition would enable the estimation of friction forces under different circumstances. An analytical relationship between the real area of contact and uniaxial strain has been developed by Westeneng [1]. This research involved conducting combined normal load – bulk strain experiments on two different aluminum grades. The results of these experiments have been utilized to determine the fitting parameters of the analytical model.

A test matrix encompassing different normal forces and strain values has been designed to cover various conditions found in forming processes. Initially, the normal force has been applied on the surface of the uniaxial tensile test samples. Subsequently, employing a tensile tester, the displacement required to achieve the desired tension has been prescribed. The precise strain value can be measured by a laser extensometer. During the tensile test, due to material thinning, the normal pressure can drop quite rapidly. To mitigate this pressure drop, a spring mechanism has been integrated, ensuring pressure stability as much as possible [2]. The surface topography of the samples have been measured using confocal microscope. The asperity density of each surface can be calibrated using the experimental results, facilitating the establishment of an analytical relationship for the real area of contact as a function of the equivalent strain and contact pressure in the sheet.

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References

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