

Public Abstract

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Title:DEVELOPMENT OF TAILORED PREFORM PROCESSING TECHNOLOGY FOR NET-SHAPE MANUFACTURING OF LARGE MONOLITHIC STRUCTURES

Structural parts for transportation industry requiring tailored properties to meet stiffness and durability specifications are commonly produced by mechanically joining discrete forged or cast components. Tailored Preform Processing™ (TPP) technology has been developed as an alternative in this research by integrating Friction Stir Welding (FSW), Sheet Metal Forming and Optimization. FSW is a solid fusion process developed recently in the last decade. Sheet metal forming is a very important process in manufacturing industry. It is used to manufacture simple parts like beverage cans to very complicated shapes like automobile body parts and airplane panels. The process-induced damages in sheet metal forming are very serious concerns. Major modes of failure are springback (shape deviation after the forming process due to the elastic recovery of the material), wrinkling, excessive sheet thinning and weld line movement. The process parameters like weld speed and rotational speed in FSW and interface friction and blank holder force (restraining force applied on the blank during the forming process) affect the formability of the final product. In this research, the effects of the process parameters are investigated.

Simulation of friction stir welding and sheet metal forming process was performed using the Finite Element Method (FEM) software, ABAQUS. The FEM results are integrated with optimization technique, Genetic Algorithm (GA) to find the optimal conditions to reduce process induced damages. The integrated model was used to study the interactions between blank holder force and interface friction.

A square pan model is used as a case study for experimental and numerical study in this research. The materials used in this study are Al-Zn and Al-Cu alloy. Different case studies were conducted with weld velocities and rotational velocities are used during friction stir welding. The welded blank from different case studies are then formed using stretch forming and deep drawing processes to determine the formability. The results of the investigation showed that process-induced damages were reduced to minimal when rotational velocity was 675rpm and weld velocity of 5.75ipm. Fracture doesn't occur in the weld zone but in cup corner area.

An integrated model combining Finite Element Method and Optimization technique was developed. This model was found to be an effective and efficient method to predict and control wrinkling, weld line movement, sheet thinning and springback in sheet metal forming.