

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

ABSTRACT

The aim of the present research effort involves exploration of a new processing approach, 'Tailored Preform Processing (TPP)' technology for net-shape manufacturing of monolithic structures for the transportation industry. The proposed technology combines friction stir welding (FSW) and forming in order to tailor the properties of the preform to meet design requirements and provide net-shape preforms, which can subsequently be turned into finished structural parts through light machining or other standard processes. TPP can provide several advantages including weight reduction, part count reduction, improved damage tolerance, improved material and energy utilization, and cost saving. The research focuses on understanding of the process behavior and the effects of various process parameters on the properties and integrity of the produced structure during different stages of the TPP approach. Objectives of the proposed work also include providing capability for robust process design, prediction and characterization of process-induced damage and properties of the finished structure. These objectives are accomplished through innovative solution to the Tailored Perform Processing problems using the presented experimental and virtual models. Finite Element

Method was used to model 3-D friction stir welding and forming processes. Numerical model of friction stir welding was carried out using Fully Coupled-Temperature Displacement Analysis. Forming of the Tailor Welded Blanks was modeled using ABAQUS/Explicit followed by the Springback simulation using ABAQUS/ Standard. FEA models were used to investigate the process behavior and effects of various parameters on the properties and integrity of produced structure. An optimization scheme based on Genetic Algorithm is integrated with the numerical models to provide the optimal process conditions for quality and cost effective production.