11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

BUCKLING BEHAVIOUR OF FRICTION STIR WELDED STIFFENED PANELS

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Key Words: *Friction stir welding; Residual stresses; Finite element analysis; Buckling; Contour method; Collapse load, Thermal softening; Aluminium alloy 2024-T3.*

Friction stir welding (FSW) is a solid-phase welding technique effectively applied on aluminium alloy structures. During this process, a non-consumable rotating tool, constituted by a shoulder and a pin, is plunged between the adjoining edges of the parts to be welded and moved along the desired weld line. The combined rotation and translation of the tool locally increases the work piece temperature due to heat generated by frictional effects and plastic deformation. The softened material flows around the pin, from the front to the rear, resulting in a solid state weld. The temperature increase and the high strain rate deformation lead to the formation of micro-structurally different zones: the nugget or stir zone (NZ) in the center of the weld, surrounded by the thermo-mechanical affected zone (TMAZ) and also the heat affected zone (HAZ). Additionally, the heat input generates residual stresses and geometrical distortions of the welded assemblies [1,2].

The impact of these factors should be properly accounted for at the design stages in order to predict the buckling behaviour of thin-walled structures [3-6]. In the present work, a finite element-based numerical model, based on a shell formulation, is implemented and validated to reproduce the FSW process and predict its effects. The validation of the model is achieved by comparing the numerical results with the longitudinal residual stress distribution, experimentally inferred by means of the contour method [7], induced by the FSW on 2024-T3 aluminum alloy plates [8]. A second simulation stage is performed to assess the influence of welding effects on the strength of a stiffened panel when subjected to compressive loads. The obtained results highlight the influence of process induced residual stresses, material properties changes and distortions on the collapse load of structures submitted to compressive loads.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support given by *Fundação para a Ciência e a Tecnologia, Ministério para a Educação e Ciência*, Portugal, under project PTDC/EME-PME/113835/2009 and grant SFRH/BD/82456/2011

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