

Introduction

The new Airbus A380 is a very high capacity aircraft and is developed to deal with the large predicted growth of civil air traffic. New technologies like the application of the Fibre Metal Laminate GLARE are necessary to build this large aircraft and to operate cost effectively. GLARE consists of aluminium and fibre reinforced layers. It saves weight and has superior fatigue properties compared to monolithic aluminium.



Figure 1 : GLARE panels (green) on the Airbus A380.

A large part of the GLARE panels for the A380 are designed and manufactured by Fokker Aerostructures. The use of flat aluminium sheets introduces large membrane stresses during the production of doubly curved GLARE panels. Due to these stresses, the panels will spring back towards a more flat shape after the curing cycle.

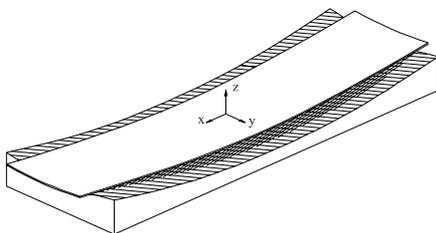


Figure 2 : Springback of a small test panel.

Objective

The objective is to predict the springback of doubly curved GLARE panels and the influence of different geometries and material parameters on this springback.

Methodology

A nonlinear, analytical model is developed, which simulates the effects of the doubly curved shape on the final curvatures of the laminate. The model is based on an 'energy' approach: the final curvatures are calculated by minimizing the potential energy stored in the laminate.

Results

The analytical model is validated with Finite Element calculations. Both methods agreed very well. Experiments are done with a small test mould to validate the model in practice.

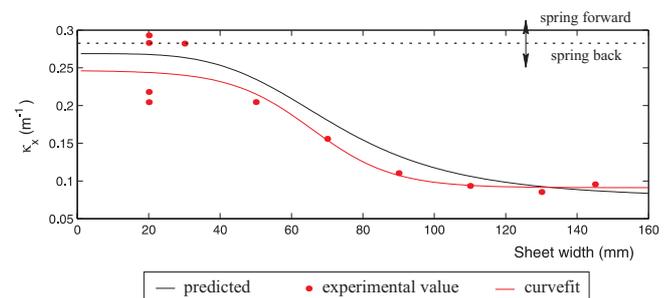


Figure 3 : Final curvature of a small doubly curved test panel.

The experiments revealed that the interaction between mould and panel during the production can have a large influence on the final curvature. If this interaction is minimized, the experimental and predicted curvatures show the best correlation.

Discussion

The analytical model is very fast and hence well suited for preliminary design calculations. The effect of a small change in panel dimensions or material parameters on the springback can be investigated quickly. The model identifies the dominant parameters in springback. This can be employed in subsequent process optimisation.