NUMERICAL STUDY OF AXIALLY COMPRESSED FML PROFILE INCLUDING DELAMINATION

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1. INTRODUCTION

Fiber Metal Laminates are multi-layered hybrid structures composed of alternating layers of fiber reinforced composites and metal sheets. One of the FML type - GLARE (a combination of aluminium sheet with glass-fiber reinforced lamina), is widely used in aerospace industry due to countless advantages: as high strength to weight ratio, good impact and fatigue resistance [4]. However, FML's structures, as well as composites ones are very sensitive to a delamination formation (mode of failure leading to separation between adjacent layers) [1]. The next form of risk, for which thin-walled composites structures are prone to is a buckling phenomenon. In the real structures, often those two mechanisms could occur together - in buckled structure decohesion of adjacent layers occurs what decreases structure toughness [2].

The subject of this research was to investigate numerically the behaviour of thin-walled FML channel section profiles subjected to axial compression when the possibility of delamination was included. FML profile consists of 3 sheets of aluminium $t_{al} = 0.3$mm and two double layer of prepreg $t_p = 0.25$mm each, with the stacking sequence [Al/0/90/Al/90/0/Al]. Numerical (FEM) model of considered FML column is presented in Figure 1.

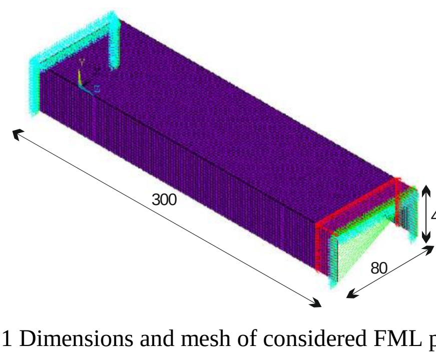

Fig 1 Dimensions and mesh of considered FML profile

2. NUMERICAL MODEL

Numerical model was performed in ANSYS software, where channel section profile was modelled with solid-shell elements whereas the delamination area with contact elements. The localisation of delamination was chosen based on a previous nonlinear buckling analysis where the failure criteria were employed. Thus, a weakened area was detected and the delamination on each flange between aluminium sheet and prepreg layer with fibre orientation 90° was modelled. Further analysis was performed in two steps. The first one, the linear Eigenvalue Buckling analysis was performed to determined buckling modes. Secondly, a nonlinear buckling analysis was conducted which included large deflection response, with geometric and material imperfections.

2. RESULTS

Equilibrium paths and modes of failure for perfect and delaminated model were compared. Results presented in Fig. 2 show that the delamination process influences not only the post-buckling behaviour but also the shape of failure mode of FML profile.

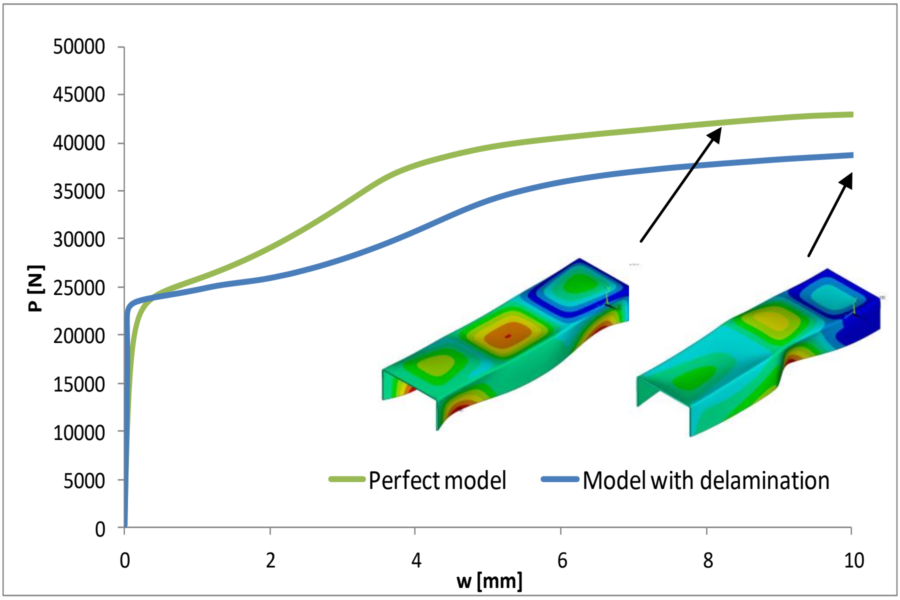

Fig. 2. Comparison of equilibrium paths for perfect and delaminated model

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