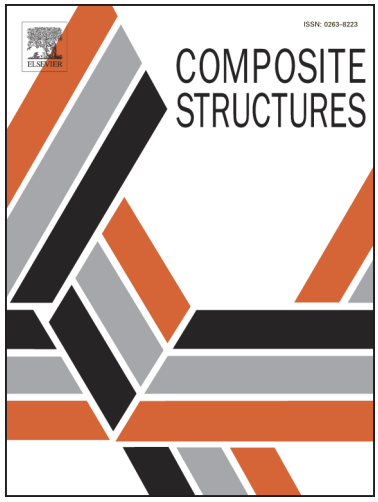

Elastic-plastic behavior and failure analysis of selected Fiber Metal Laminates

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PII: S0263-8223(17)30318-5
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.05.007
Reference: COST 8516

To appear in: *Composite Structures*

Received Date: 30 January 2017
Revised Date: 2 May 2017
Accepted Date: 3 May 2017

Please cite this article as: Nowak, T., Elastic-plastic behavior and failure analysis of selected Fiber Metal Laminates, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.05.007

Elastic-plastic behavior and failure analysis of selected Fiber Metal Laminates

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Abstract

Today, fiber reinforced polymer composites and aluminum alloys represent the most dominant materials that are applied in various industries. As such structures offer high performance-to-weight ratio, they are widely used in aerospace, subsea and high-pressure applications. This paper describes some untypical failure modes, which have been observed during unloading in selected designs of multi-layered structures. GLARE® plates with a (0/90) stacking sequence of composite layers which are subjected to the tensile load, can undergo delamination and buckling of external AL layers when the external force is released. However, this effect is not observed for the internal AL layers. In order to clarify this behavior, the Classical Lamination Theory was applied to an elastic-plastic model for aluminum layers. The total deformation theory, as proposed by Hencky and Ilyushin, was applied to capture the influence of the plasticity of the metal on the mechanical performance of the hybrid structure. It was found that unloading of the metal-composite plates, which were first subjected to the plastic flow within metal layers, can generate even higher stresses and higher equivalent plastic strains, than during the loading phase. For this reason the multi-layered structures must be designed with special care. The proposed calculation method allows for very fast, yet accurate, analysis and optimization of Fiber Metal Laminates.

Key Words: *Layered structures, composite-reinforced metal structures, analytical modelling, Finite Element Analysis, elastic-plastic behavior*

1. Introduction