Development of Design Methodology for Hybrid Metal-Composite Aircraft Drag Strut

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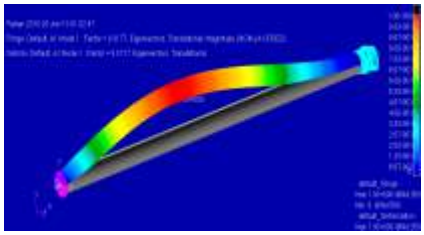
Abstract:

Composites have many advantages over metals like, better global strength characteristics, higher stiffness, longer fatigue life, lower density, low thermal conductivity, better wear resistance, improved corrosion resistance, etc. However, composites have certain limitations too, for example they respond very poorly under local loading, properties highly depend on manufacturing conditions, strength characteristics vary with direction, have complex and costly manufacturing processes, formability is not easy, etc. Hence, complete elimination of metal alloys from an aircraft structure is not right. Accordingly, use of hybrid metal-composites for major part of the aircraft structure is the rational option. The uses of hybrid metal composites, wherein metal as well as composites are used for different parts of an assembly, provide great performance and durability benefits inherent to both metal alloys as well as composites. There are many areas in an aircraft structure where hybrid metal-composite may be implemented.

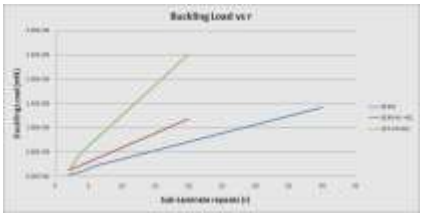
This project is aimed at deriving a methodology for the design of hybrid metal-composite tubular elements applicable to aircraft structures. For this purpose, the landing gear drag strut of B-737 main landing gear is chosen. Loads acting on the drag strut were calculated. The geometric design of the tubular element based on the obtained load was done using analytic calculations done in MS-Excel spreadsheets. Based on the geometry, a numerical model was created using CATIA and HYPERMESH and was solved for buckling and natural frequencies using PATRAN-NASTRAN. Further parametric study was done on the numerical model by varying ply combinations. Stress distributions have been obtained and discussed for all layer pairs and the pins in the joint zone of a generic metal-composite specimen. The stress distribution and deformation plots reveal that de-lamination is likely to initiate at the corner of the outer most layer.

From the present results, we see that, the MS-Excel spreadsheet solutions agree fairly well with the NASTRAN results for buckling and vibration. We thus conclude that the spreadsheet sizing can be a good initial design for hybrid metal-composite struts.

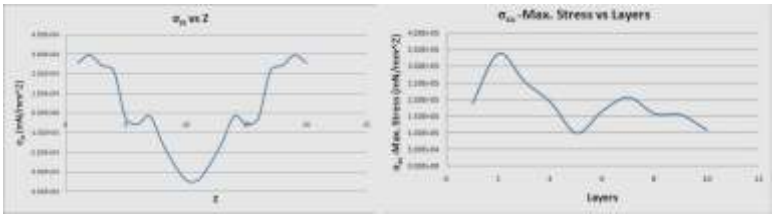


Buckling composite tube

Deformation of composite layer and steel pins



Buckling load variation with sub-laminate repeats



Stress variation through the layers