DESIGN AND ANALYTICAL ANALYIS OF AN ANISOGRID PREPREG STRUCTURE CONCEPT

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Abstract

This paper reports on results of a conceptual design phase, aimed at the development of a new anisogrid concept for aircraft fuselage structures. The weight saving potential is analyzed in comparison with an orthogonal stiffened skin structure, satisfying fundamental requirements of airworthiness for airframes.

The novelty of the structural concept is load bearing skin in addition to the grid structure and the usage of prepreg material with 60% fiber volume ratio in combination with a fiber placement manufacturing process. As a result the ribs can be built up as a laminate with different orientations to increase damage tolerance and crack growth resistance compared to unidirectional built up ribs. The different orientations are placed as pre-stacked tape material which reduces the manufacturing effort significantly. Fabric layers are added in this stacking which are facing the rib sides and are forming a large interface from the rib structure to the load bearing skin. In consequence of the intersecting rib directions a design that interrupts some of the layers in the rib knot area has been invented to avoid laminate thickening.

While the static strength of the ribs especially in tension will be reduced drastically, the resulting triangular bays of the load bearing skin has a highly increased buckling resistance. This optimization field is analyzed analytically for different pure loads and load combinations and is compared to an orthogrid structure with orthogonal stiffened load bearing skin. The loads are derived from different panel positions of a single aisle fuselage with representative flight and ground load cases. For the weight saving potential analysis, the anisogrid and orthogrid structure are sized with the same sizing criteria including panel stiffness, strength criteria, local skin and stiffener stability and global panel stability.

40 words Abstract

For the weight saving potential analysis, a novel anisogrid structure concept and an orthogrid structure, both with load bearing skin, are sized and compared for different pure and combined load cases with the same sizing criteria including panel stiffness, strength criteria, local skin and stiffener stability and global panel stability.

Main items to be shown:

- new anisogrid structural concept with load bearing skin developed for prepreg material and manufacturing
- structural mechanic potential analysis in comparison to orthogrid structure with skin performed

New Anisogrid structural concept with load bearing skin

- usage of prepreg material with 60% fibre volume ratio require cut design of layers in rib knot area to avoid laminate thickening of intersecting rib directions
- the cutting of layers in the rib knot area lowers the strength drastically especially under tension – structural performance of the structure decreases
- usage of different orientations for rib laminate during fibre placement process, to increase damage tolerance and crack growth resistance
- placement of laminate stackings which reduces the manufacturing efforts by many times
- usage of fabric layers to increase the interface from ribs to skin
- resulting triangular bays of load bearing skin has highly increased buckling resistance which rises the structural performance of the design

Structural mechanic potential analysis

- the optimization field of decreased strength but increased buckling resistance has been analytically analyzed for different pure loads and load combinations and compared to an orthogrid structure with orthogonal stiffened load bearing skin
- pure loads and load combinations taken from single aisle fuselage in flight and ground loads
- same sizing criteria used like panel stiffness, strength, local stability of skin and stiffeners and global stability of the panel