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STRUCTURAL PROPERTIES OF STITCHED T-STIFFENERS: WEB TEAR-OFF AND COLUMN BUCKLING

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Summary: Textile preforming is regarded as a potential manufacturing process step to accelerate fabrication and to help produce complex 3D composites parts. Stitching has shown to be an effective method to mechanically assemble dry fiber preforms. However, for large parts, when access to both sides of the preform can be challenging, conventional stitching is not practical. The one-side-stitching (OSS®) technique has been developed to assemble preforms where access is limited. A better comprehension of the influence of OSS® on flat and complexes parts is required before industrial implementation.

The study focuses on the effect of stitching location on a "T" shaped stiffener typical in lightweight structures. The dry-fiber preforms consist of a carbon quasi-isotropic stacking assembled with a carbon stitch. The parts are then moulded with epoxy using a high-temperature vacuum assisted liquid moulding process. The effect of stitching was first studied with both asymmetrical and symmetrical tear-off tests. Five stitching configurations were compared with a non-stitched reference. While the width and the pitch were kept constant, the location and the orientation of the stitching are studied. Based on tear-off results, the stitch pattern providing the best performance was retained. The behaviour of a stitched T-stiffener with the optimal stitching configuration was then studied, under compressive loading, to observe the effect of stitching on the failure modes.

For asymmetrical tear-off tests, the most promising stitching configuration showed an increase for both failure initiation load (+11%) and failure loads (+7%). Stitching seems to increase the flexural stiffness of the web and the flanges, which is coherent with flat panel tests published in an earlier study. Therefore, less strain is put on the noodle region and the overall load bearing capacity is increased. For symmetrical tear-off tests, all stitching configurations showed a decrease in strength. The drop in tear-off resistance is believed to be attributed to the presence of defects, such as resin rich zones and voids. These seem to be created by the addition of stitching thread near the filler region at the intersection of the web and the skin (noodle). The result of the on-going compression tests will be presented in the conference article and will be compared with a finite-element model based on a stitching knockdown factor. The objective of these tests is to study the influence of stitching on local buckling onset loads and the failure mode of the column. Lamina properties and the effect of stitching are derived from flat panel coupon test.

The selection of a stitching configuration for a T-stiffener is a preliminary step in the final objective of the project, the fabrication of a skin-stiffened demonstrator panel common in aerospace structures. This study is part of a project, "3D Textile Carbon Fibre Preforms", in partnership with Bell Helicopter, Bombardier Aerospace, Hutchinson Aerospace and the Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ).