Improved Method for Increased-Rate Stitched Composites Manufacturing

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Introduction

> Stitched composites are created by stitching a dry preform and then infusing with resin

- > Stitched stiffened composites have benefits over unstitched stiffened composites
 - Improved damage tolerance, reduced weight, fewer fasteners

> Stitched unitized composite preforms fabricated using a *single-sided* stitching head

- Uses two needles to stitch from only one side of the preform
 - Modified chain stitch
 - Insertion needle and catcher needle
- Requires a jig with large needle-relief slot to hold preform
- Needles can push material, such as stiffener flange into slot
 - Requires thin fiberglass material
 "veil" to support preform material



Objective

Reduce manufacturing time associated with stitching of unitized dry preforms to make stitched composites to increase interest in their use in the aerospace industry

Two approaches to reducing manufacturing time for stitched composites

- Reduce the time to perform the actual stitching
 - Method presented by Lovejoy at CAMX 2022 (continuous stitching across stiffeners)
- Reduce the time to perform pre- and post-stitching activities
 - Focus of the current presentation
 - $\circ\;$ Key feature is to remove the need for the veil to support the preform during stitching



Solution: Developed a method, termed sideslip stitching, that rotates the single-sided stitching head with respect to the seam direction during stitching to reduce needle slot width at the stitching surface

Sideslip Stitching: Definition

- Rotate the stitching head with respect to the direction of the seam
- Execute a single stitching motion
- Move head to start of next stitch
- Repeat













Eliminate pre- and post-stitching operations

- Eliminate veil wrapping (pre) and removal (post)
- Single-piece stitching jig can be used if preform can be removed without disassembly

Manufacturing Time/Cost Reduction: Time Percent

Based on total stitching manufacturing time

Includes pre- and post-stitching operations, and stitching operations

Utilizing time reduction due to continuous seam stitching (CAMX 2022)

- 10-mm sideslip stitch length compared to 5-mm conventional stitch length
- Twice as many sideslip seams compared to conventional seams
- Time reduction is 10% of actual stitching time, but only an additional 1% of the total stitching manufacturing time

Single-piece stitching jig

- Elimination of veil support material
- Elimination of need to assemble and disassemble stitching jig
- Time reduction is about 40% of the total stitching manufacturing time



Concluding Remarks



Objective to reduce stitched preform manufacturing time (increase rate)

- Previous study developed method to reduce time in the stitching process
 - Continuous seams across stiffeners
- Current study developed method to reduce time in the pre- and post-stitching operations

Sideslip stitching

- Used unique control method that yields reductions in time and cost
- Significant time reduction
 - 40% if using single-piece stitching jig
 - Including continuous seam across stiffeners yields only a 1% reduction in total manufacturing time
 But 10% reduction of actual stituting time
 - But 10% reduction of actual stitching time
- Capital cost savings for same production rate
 - Up to 67% if using single-piece stitching jig
- Labor cost savings
 - Eliminated all labor cost associated with wrapping and removing veil support fabric
 - If single-piece stitching jig eliminated all of assembly and disassembly labor cost

