DEVELOPING EXTRACTABLE TOOLING TO ADAPT BLADDER MOLDING OF SHORT FIBER COMPOSITES TO CREATE BENT FORMATIONS

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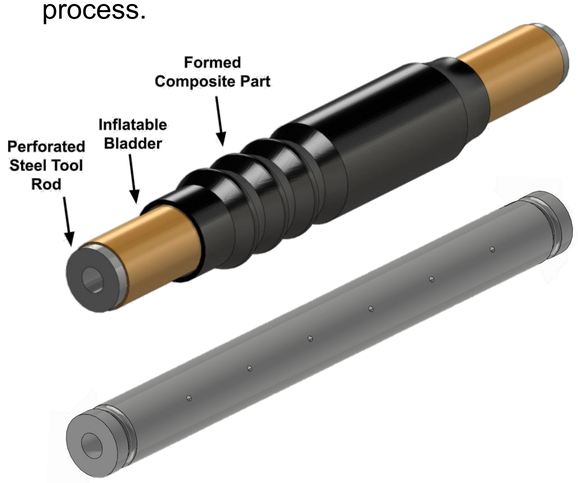
Introduction

With traditional, continuous carbon fiber composites, the ability of forming the material to create complex geometries is highly limited. However, with highly aligned discontinuous fiber T*u*FF composites (Tailored *U*niversal Feedstock for Forming), complex parts can be stretch formed using a bladder molding process. Previous work has demonstrated a hollow, corrugated cylindrical strut can be formed with this process.



The tool core is used as a structure for laminating the composite.

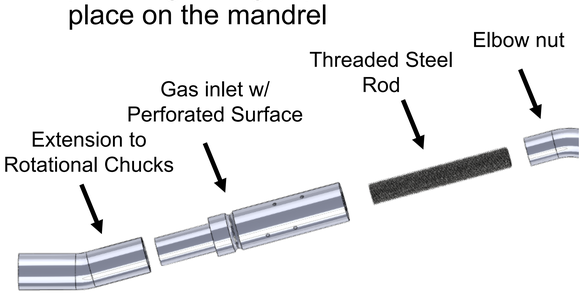
This project aims to develop an extractable tooling concept to increase design freedom. For a bent structure, in order to tailor the composite fiber orientation, an automated fiber placement (AFP) process is used to steer the T*u*FF tape as it is laminated onto the tool. Additionally, the tool must be disassembled from within the part to allow for removal after cure.

Extractable Tooling Concept

Modular Construction

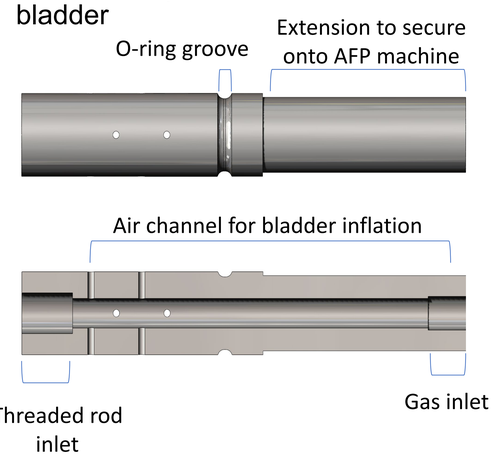
A new, multi-piece design was created to form a bent strut and allow for tooling extraction.

- An elbow nut forms 30-degree bend and joins two straight halves together
- Threaded rod allows for both ends of the tool to be unscrewed after the finished part is formed
- Gas inlets on both ends apply 300 psi to inflate the bladder stretched over top
- Extensions attach to rotational chucks providing enough space for AFP head to place on the mandrel



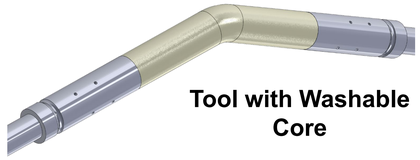
Pressure Seal

- When placed in the mold, O-rings create a seal for the bladder
- An air channel runs through the axis to allow air pressure and inflate the bladder



Washable Mold Tool

To keep a consistent outer diameter across the tool, Aquacore washable ceramic material is molded onto the core structure to create a rigid core that can be washed away for disassembly

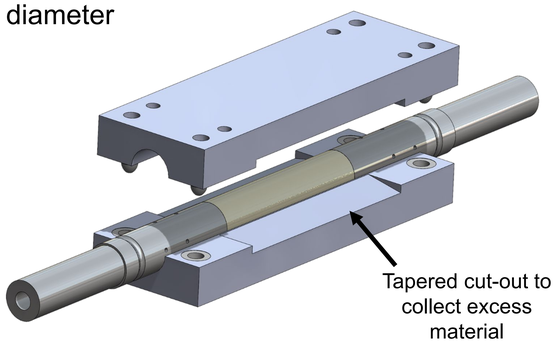


Tool with Washable Core

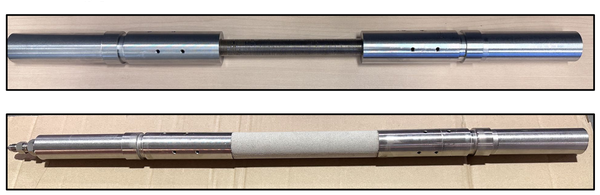
- A clamshell mold with a cylindrical cavity holds the assembled tool while the ceramic material is added
- Mold is compacted at 250 psi and heated at 110°C for one hour, then demolded and heated for an additional hour

Results

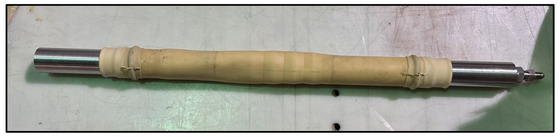
To test this concept, a straight tool was fabricated using the new multi-piece design. Two endpieces are joined by a threaded rod where Aquacore will be molded over to create a consistent 1.4” diameter



Prototype with Washable Core



After Bladder Molding



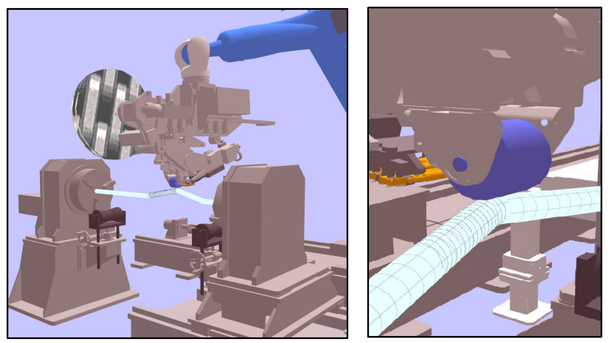
- After bladder molding the prototype, the tool successfully disassembled from within the bladder for extraction

Applications of New Design

Future work will seek to demonstrate the translation of the design from our prototype to a bent tool to successfully form a bent structure.

- Automated Fiber Placement (AFP) will be used for placing the composite by using the tool as a rotational mandrel
- T*u*FF tape will be placed onto the mandrel and steered to conform to bent geometry

Simulation of AFP on Bent Mandrel



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