Automated Fibre Placement of Thermoplastic Carbon Fibre / Nylon Material

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**The Material: What is Thermoplastic Carbon Fibre / Nylon?**

Fibre reinforced polymer composites offer high specific strength and stiffness, enhanced fatigue properties and increased design flexibility when compared to metallic counterparts. They are becoming increasingly used in a variety of industries ranging from aerospace and automotive to renewable energy. In particular, thermoplastic composite materials, such as carbon fibre/nylon, are gaining popularity as they can be manufactured without long cycle times (curing in a matter of seconds) and with low levels of emissions.

**The Method: What is Automated Fibre Placement (AFP)?**

Automated Fibre Placement (AFP) is an automated manufacturing process consisting of placing composite strips, called tows, which have unidirectional fibers pre-impregnated with resin. The composite tow bands are collimated on an AFP head mounted on an industrial robot and placed on a tool or mold. During placement, the material is delivered to a compaction roller where heat and force are applied to the material.

**The Apparatus: How is AFP used at the ANU?**

The experimental apparatus at the ANU consists of an ABB IRB6600 industrial robot (2.55m reach and 175kg handling capacity) which is placed in a fixed position within an enclosure.

An AFP head was built and mounted on the robot. It features a heat gun, a cutting system, a tension roller, a custom-made nozzle and a conformable roller. Thermoplastic prepreg tape (carbon fibre/nylon) is fed through a channel and placed under the conformable roller where compaction force and heat are applied for placement on a mould.

**The Project: Optimising AFP parameters for Thermoplastic Aerospace Parts**

The quality of the materials produced using AFP is highly dependent on the consistency of process parameters. This project focuses on optimising key process parameters by using an off-the-shelf heat gun and a force sensor to set and monitor compaction force.

Operational parameters such as robot velocity, contact force, and applied heat were optimised and resulted in a set of process parameters allowing ANU to produce carbon fibre/nylon parts at a significantly reduced cost compared to commercial turn-key systems. This setup is now being used to investigate manufacturing of prototype aerospace thermoplastic parts for Boeing.