Technology/Process: **Automatic forming of pre-preg**

Responsible: **KTH**

Partners: **SAAB**

Work package: **3.5 - "Automatic forming"**

GRÖN FLYGTEKNISK DEMONSTRATION

Description of Technology/Process:

A composite C-spar for a cargo door is formed automatically using a combination of an industrial robot and a mechanical tool. Where typically two plies of different fibre directions are stacked together and formed, the overall strategy is similar to the one used in hand lay-up, with the same starting point and progression of the lay-up. However, the forming pressure is more evenly distributed and well controlled. Further, the technique seems to be feasible for laying up larger sheets compared to hand lay-up, where some layers are cut to ensure correct fibre angles.

Before:

This geometry is commonly produced through manual hand-layup. Automatic forming was developed as part of the Triple Use project, where quasi-isotropic stacks with thickness 5 mm was formed onto a simpler geometry.

Illustration:

Robot forming equipment and c-spar with laid up pre-preg.

Keywords:

Automation,
pre-preg,
forming

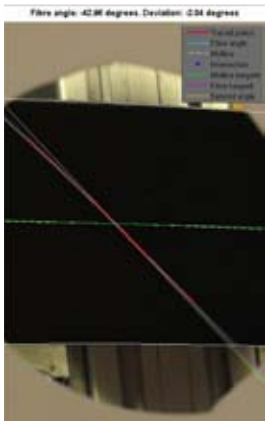
Benefits:

Increasing the degree of automation reduce manufacturing costs through lower labour costs and improves workplace ergonomics by eliminating heavy manual forming steps. Additionally, automation and introduction of simpler forming tools offers increased repeatability and robustness in the forming process. This opens up for better correlation between structural design and manufactured component, a need for lower safety margins and is thereby a potential for reduced weight.

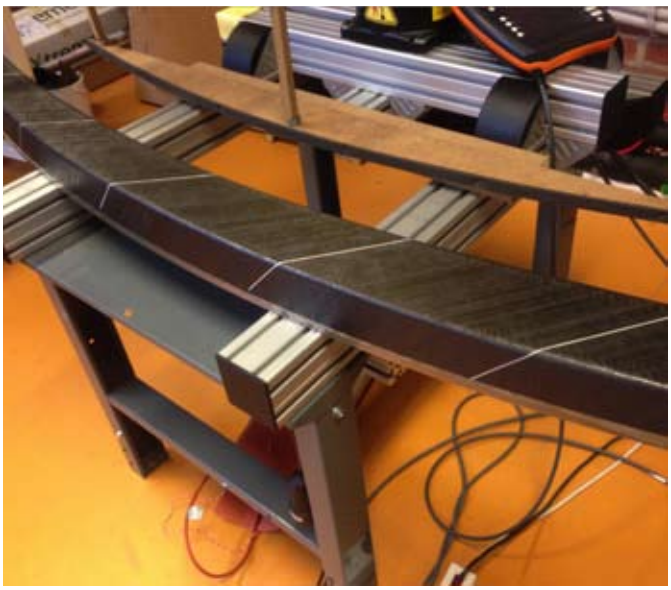
Work performed:

To produce a complete c-spar, the composite stack is divided into pairs(e. g. 90/45) of plies. These pairs are formed one by one onto the tool until the entire stack is laid up. Here an industrial robot with a pneumatic scraper is used to form the two flanges of the spar. On the web, a blade spanning the length of the spar is used to form the layers manually, however, since this forming step is performed in a single linear motion. It is possible to automate this part as well.
Depending on the fibre combination in the pairs, different forming behaviour could be shown. Therefore all different possible ply combinations are formed. The fibre angle deviation on the web is then measured for the different combinations.

The fibre angle measurement done on the 45/-45 shows that the fibre angle deviation is within the allowed limit of 2 degrees. The rest of the ply combinations have yet to be measured.



Fibre angle measurement of 45/-45 pair.



Formed 45/-45 degree pair with reference for fibre angle measurement.

Future developments & exploitation:

The technique requires further trimming before use in full scale manufacturing. Different kinds of forming tools need to be investigated in order to improve the degree of compaction over the radius and make the pressure more even during forming over highly curved surfaces. Further development of simple forming tools, like the blade, where the forming is dictated by the shape of the tool instead of the actions of an operator could lead to easier implementation of automation.