Evaluation of cfrp machining by applying industrial robots

Robots as an alternative to machine tools

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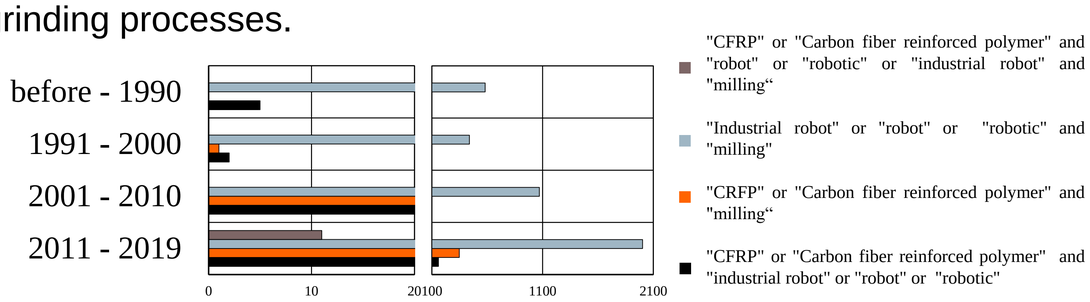
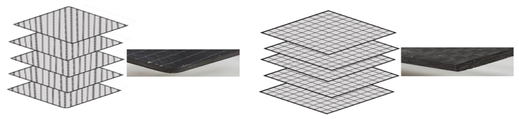
Introduction

- Carbon fibre reinforced polymer (CFRP) are widely used in high-performance applications
  - → High strength to weight ratio and high stiffness
- CFRP has two main components:
  - → high-strength carbon fibres
  - → the flexible and tough matrix material
- The main challenges in machining of CFRP's arise from the anisotropy and inhomogeneity
- Only 2.0 % of industrial robots (IR) are used in cutting, milling, or grinding processes.



Materials and Methods

- Material for milling
  - → The unidirectional composite -11 inner layers
  - → The woven composite - epoxy matrix reinforced with 55 % - 0/90 °
- Cutting Tool
  - → F0 has a geometry with 4 cutting teeth and 4 secondary teeth
  - → F1 has the geometry with 9 teeth in right helix, chip breaker.
  - →F2 has a geometry with 2 teeth, narrow-toothed with pyramidal edge

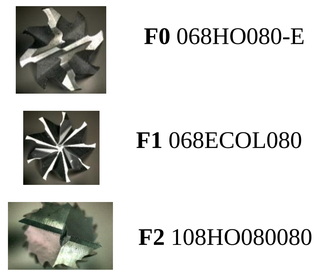


CFRP – unidirectional and woven

v_c (m/min)	301	602	904
v_f (m/min)	1	2	4
Tool	F0	F1	F2

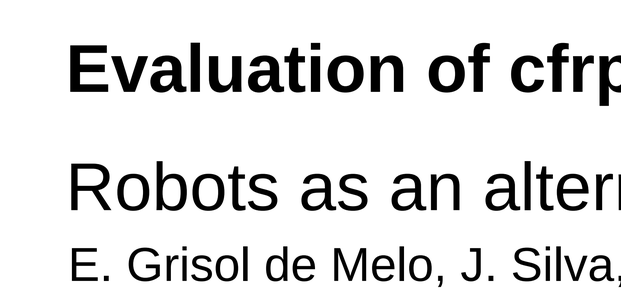
Cutting parameters

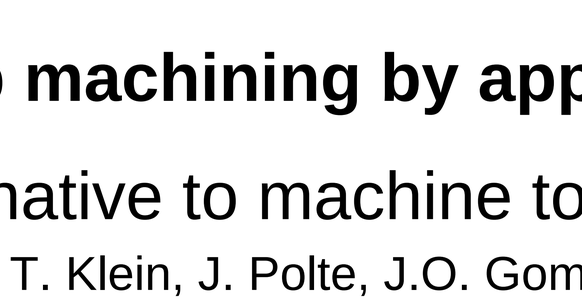
KUKA KR 60 HA

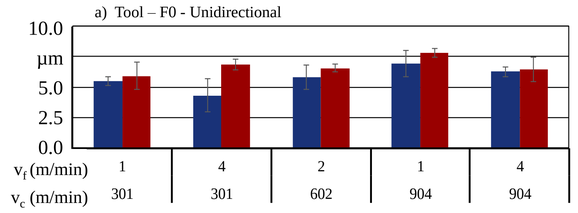


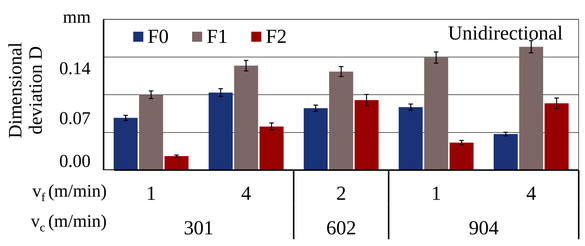
Cutting tools

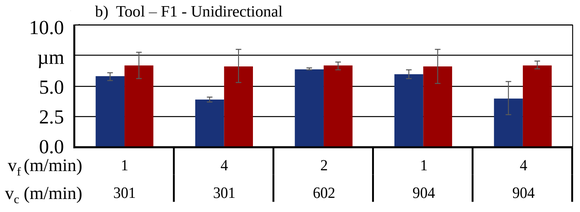
Results

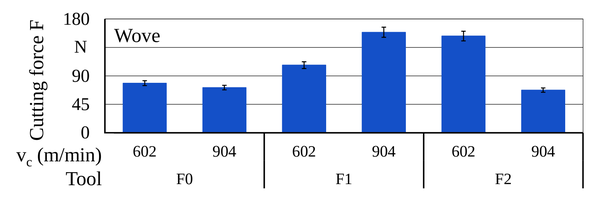


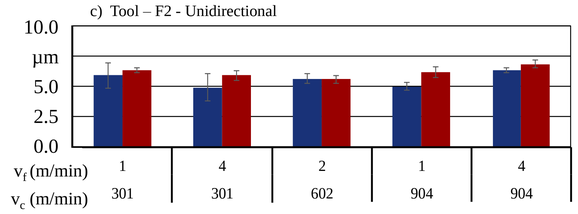


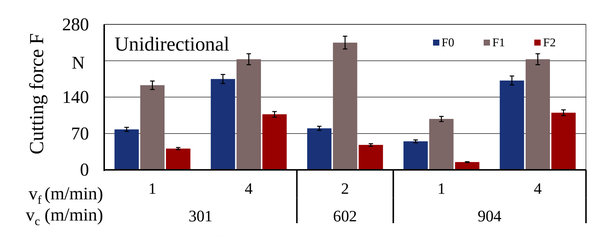












Conclusion

- The surface roughness Ra for both materials was less than 8 µm in all tests. This results are satisfactory.
- The correlation of the cutting tool geometries, cutting parameters and up and down milling, the milled roughness surface was not changed significantly.
- All experiment did not present delamination during the CFRP milling, for both materials.
- The cutting tools F0 and F2 showed dimensional deviation below D = 0.14 mm in the experiments for the unidirectional material and the cutting tool F1 has the largest dimensional deviations, Dmax = 0.23 mm.
- The cutting force F, it can be observed that the increase in cutting speed v_c has made it possible to gain the feed rate v_f, in addition to maintaining or even reducing the cutting force.
- The material has diverse structures (fibre and matrix) that will directly affect its machinability.
- Finally, the proposed cutting parameters for the machining process by application of the IR, as well as the cutting tools showed that during the milling of CFRP – unidirectional and wove, non-standard results to pull-out, delamination, dimensional quality and cutting force.

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