

HAN Master Major Project

Plan of approach

Using Fanuc FANUC R-2000iC (6-axis robot) for improved efficiency in FRC parts formation

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1. Background

Fiber-reinforced composite materials are seeing a widespread use in a large number of applications ranging from aerospace systems over renewable energy production to automotive parts [5] [2]. These composite materials generally provide high specific strength and improved stiffness compared to other materials [3]. Through the combination of different materials, desirable mechanical properties like low weight with high stiffness can be achieved that would be hard or near impossible to recreate with single compound materials [7]. An FRC can generally be described as the combination of three components [6]:

- The matrix, made of a polymer. This polymer can either be applied as a resin and hardens irreversible or a thermoplastic is used, that needs to be heated for application.
- The reinforcement component which consists of fibres with high strength and modulus. These days preferred materials are glass, carbon or polyethylene fibers.
- The fine interphase region. It's the interface between the matrix and the reinforcement that transfers the load between these.

FRC's can look back to a long history since the beginning of the 19th century with phenolic sheet Bakelite being the first fiber-reinforced plastic. Bakelite, a thermoset being the matrix was combined with different fiber materials like paper, cotton fabrics, or synthetic fabrics to create parts that can meet diverse mechanical, electrical and thermal requirements. [4]

In this project, a thermoplastic matrix will be used together with carbon or glass fibers. The mixed reinforced thermoplastic being supplied as pellets in various sizes for different properties is dried and then melted in an extruder through a continuous process. The material is then portioned into pieces by a guillotine into pieces and combined and stacked into assemblies by a delta robot. These assemblies are then brought to temperature again before being loaded into a hydraulic press with a mold by an industrial robot arm. [1]

2. Problem Definition

Assemblies of hot, formable Thermoplastic are delivered on a conveyor belt after being reheated in an oven. The assemblies then need to be picked up with a FANUC R-2000iC/210F 6-axis Industrial robot arm from the conveyor belt through a small window in a heat shield that keeps the assemblies warm. The Industrial robot then swings over to the press when it is open and the mould is free. The assemblies are then placed inside the mould at desired spots while making sure, the robot arm does not collide with any part of the press. After all parts are placed, and the robot arm has pulled back in a safe position, the press is activated and forms the parts with heat and pressure. When the forming process is finished, the press opens, the product is picked by the robot arm and placed on another conveyor belt for further processing. As the press is free, the cycle can repeat. [1]

3. Project Objectives

4. Requirement Analysis

5. Activities and Products

6. Master Level

7. Restrictions

Bibliography

- [1] Jens and Timo Jacobs Lubbers. *Smart X-Cell Production SYSTEM RQUIREMENTS DOCUMENT*. Tech. rep. HAN automotive Research, Jan. 2015.
- [2] C.A. Lawrence. *High Performance Textiles and Their Applications*. Jan. 2014, pp. 1–437.
- [3] Angela Madeo. *Generalized Continuum Mechanics and Engineering Applications*. Elsevier Science, Sept. 2015. ISBN: 9781785480324.
- [4] nimrodplastics. *Bakelite*. URL: <http://www.nimrodplastics.com.au/product-bakelite.htm>.
- [5] S.J. Park and M.K. Seo. *Interface Science and Composites*. Interface Science and Technology. Elsevier Science, 2011. ISBN: 9780123750495. URL: <https://books.google.nl/books?id=DewhZ53WgLwC>.
- [6] Zohaib Sultan et al. *Advanced Dental Biomaterials*. June 2019. ISBN: 9780081024768.
- [7] George Voyiadjis and Peter Kattan. *Advances in Damage Mechanics: Metals and Metal Matrix Composites With an Introduction to Fabric Tensors*. Jan. 2006. DOI: 10.1016/B978-0-08-044688-2.X5000-0.

8. Timeplan

Appendices

A. Appendix 1