the Learning Network on Sustainability

GLEBANITE® FOR MODELS AND MOULDS IN SHIPYARDS APPLICATIONS RATHER RESORTING TO MONOMATERIC SOLUTIONS

Andrea Ratti,
Politecnico di Milano – Design Department, andrea.ratti@polimi.it
Mauro Ceconello,
Politecnico di Milano – Design Department, mauro.ceconello@polimi.it
Cristian Ferretti
Politecnico di Milano – SmartLab Lecco, cristian.ferretti@polimi.it
Carlo Proserpio
Politecnico di Milano – SmartLab Lecco, carlo.proserpio@polimi.it
Giacomo Bonaiti
Rivierasca Spa – omnia.res@rivierasca.it
Enrico Benco
GS4C, enrico.benco@gs4c.com

ABSTRACT

Despite the recovery of the boating industry today, the crisis in the field sector has brought with it a great amount of boats and related obsolete production equipment (Marsh, 2013). The Glebanite® project aims to create a possibility for all these products considered waste, giving a clear answer to the problem of their disposal, with particular attention to fiber-reinforced composite materials. The project prsented aims to trigger a Circular Economy process for the generation of a new recycled and re-processable materials and for a new economy to support recreational boating.

The project has as its starting point the engineering and systemization of the Glebanite material (secondary raw material derived from GRPs waste) for an innovative production strategy of nautical shipbuilding equipment through the use of CNC machine. The project thus straddles the main areas of Eco-Industry, Advanced Manufacturing and Sustainable Mobility.

Keywords: Composite Materials, Eco-industry, Circular Economy, Marine field.

1. INTRODUCTION AND LITERATURE REVIEW

The project starts working in the yachts field with the aim of improving the environmental performance of boats and their production tools, reducing the use of resources and emissions throughout the entire life cycle and generating a Circular Economy system that cuts down the costs for boats disposal and of all end-of-life GRP products (Marsh, 2013).

The project thus straddles the main areas of specialization Eco-Industry, Advanced Manufacturing and Sustainable Mobility. The project envisages as a starting point the use of Glebanite® material for the definition of a strategy for the production of molding tools for composite products. Glebanite® is the second raw material deriving from the recovery of fiberglass products. The use of this material for the creation of production tools of the same composite materials aims to close the circle of industrial production with a view to a continuous Circular Economy (Bonaiti, 2017). Currently, the molds for composite material are created from raw materials and assembled with the aid of metallic frames. The use of panels in Glebanite® positioned and assembled using nesting solutions would allow complete recyclability of the tool at the end of its life cycle (E. Luttersa et al., 2012). To date, Glebanite® is obtained by grinding the production waste and/or fiberglass manufactured articles at the end of their life. The obtained inert, of different granulometry, is loaded with polyester resin, vinylester or epoxy, depending on the derivation of the inert material, and then passed through a rolling mill or a mold under press or an extruder. Through these three production processes, panels of the desired dimensions are obtained with a recycled filler charge equal to 60%; the remaining 40% is a resin of current production (polyester, vinylester or epoxy).

2. FIELD OF APPLICATION

The objective of the Glemould project is the generation of innovative solutions in the use of composite materials for boating through the validation, technology transfer and up-scaling of advanced techniques and materials already subject to research and applications in other production sectors (Summerscales et al., 2016).

With the Glemould project it is therefore intended to demonstrate that the decommissioned vessels, but more generally the molds in GRPs at the end of their life cycle, can be re-introduced into the nautical production chain. By that, it's possible to generate a virtuous Circular Economy which will not only tend to eliminate the molds and boats being divested, but will create a new microeconomics to support recreational boating (Bonaiti, 2017).

3. LIFE CYCLE ASSESSMENT & LIFE CYCLE DESIGN

Specifically, the methodologies applied were those of Life Cycle Assessment for the assessment and quantification of environmental benefits and Life Cycle Design for the design and continuous improvement part. Concerning to the state of the art in the maritime field, it is worth highlighting the current lack of an optimized end-of-life management system for abandoned marine products and waste materials generated along the supply chain. The causes of this criticality are different and can be traced back to various factors. Among these factors, the lack of valorization of the second raw material has a significant weight. To date, also due to the intrinsic complexity of the characteristics of the composite materials, knowledge is lacking for the launch of an efficient recycling chain.

Through the Glemould project, a circular economy model for FRP materials will be experimented and tested on several levels, technological, design, and production. This study was made not only with the aim of obtaining a second raw material, but also and above all to provide for efficient exploitation and application.

4. IMPACT OF THE PROJECT

Glemould has identified in the field of molds for composite materials a receptive sector for a substance obtained from fiberglass recycling that can, when fully operational, feed itself with material derived from the molds themselves at the end of their life, in a virtuous circular cycle that will become an example for others industrial sectors.

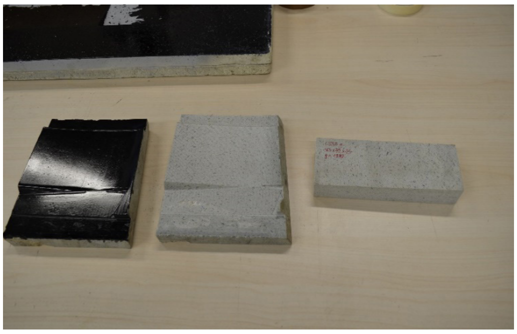
Glemould offers new-design approaches and a software platform to support producer-designer-customer interactions along the main product design process phases (Valle, 2012).

Thanks to specific project actions, the research team aims to bring the percentage of recycled material around 80 - 85% (Grandi, 2018) (Maggiulli, 2018).

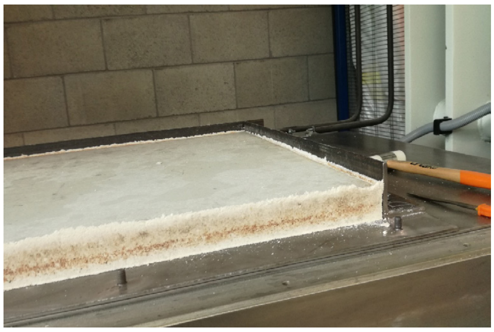
4.1 PANELS PRODUCTION

From the technological point of view, the Glebanite panels were produced either by a vacuum extrusion process or by using a hot plate press. The production of the vacuum material, although promising in terms of surface quality after processing and contained porosity, has been set aside to pursue the aim of having a content of recycled material equal to 80% of the total.

The production of the material by pressing has been concentrated on two main aspects, the first being that of the composition, working on the chopped particle size, the second most on a technological level, focusing on the operating parameters of the production cycle.



[Figure 1] Sample tests obtained by extrusion



[Figure 2] Panels obtained by press

[Figure 3] Blend of resin and fibres

[Figure 4] Panels obtained by pressing

The result of these tests leads to a composition of the material with a content of 80% recycled with a fiber composition of about 2/3 of big fiber and 1/3 of thin fibre. From the operational point of view the material was compacted with a specific pressure of 20kg / cm2 and a post-curing for one hour at 90 ° C. Although the manufactured articles had a superficial porosity, it was considered a satisfactory result to produce the material necessary for making the mold.

[Figure 5] Porosity check on samples

[Figure 6] Mould prototype

In order to refine the process and obtain better quality results in the numerical control machining phase, different molds and models have been realized to optimize the working parameters and to define the optimal solution in terms of choice of tools. These models and molds were then used to refine the post-processing suitable for vacuum molding.

5. RESULTS & DISCUSSION

The Glemould® project, through the transfer and optimization of technologies for the valorization of recycled fiberglass, has demonstrated the possibility of spreading a solution to the problem of the decommissioning of boats and fiberglass in more general terms. The project, in all its actions, applies a model in which the abandonment of the linear economy is expected and the approach to the circular economy, passing through new business models and transformation of waste into high added value resources.

In this scenario, the contribution of research and eco-innovation envisaged in the project strengthens the competitiveness of our industry in terms of sustainably. Using (and re-using) internally generated recycled material allows us to be less dependent on foreign procurement, with lesser vulnerability to price volatility, especially at a time of significant instability in countries that have the highest endowments of these resources. A key role in the project is related to the development of products and solutions that reflect the principles of the circular economy and can enhance the characteristics of the material derived from fiberglass recycling. In fact, during the design and development phase, decisions are taken that can significantly affect the sustainability or otherwise of the product during its life cycle (Valle, 2012).

BIBLIOGRAPHY

1. Luttersa, E., Dama, D. ten, Fanekera, T., (2012), *"3D Nesting of Complex Shapes"*, Procedia 45th CIRP Conference on Manufacturing Systems *2012,* Elsevier, Volume 3, 2012, pp. 26-31
2. Bonaiti, G., (2015). *Riciclo della vetroresina,* Compositi Magazine, Tecnedit, n.38 Dicembre 2015, pp. 48
3. Bonaiti, G., (2017). *Riciclo dei compositi verso un'economia circolare,* Compositi Magazine, Tecnedit, n.43 March 2017, pp. 56
4. Eklund, B. (2013). *Disposal of plastic end-of-life-boats*. Nordisk Ministerråd.
5. Maggiulli, F., (2018), *New Life for fiberglass,* Nautech, Tecniche Nuove, n.6 Novembre 2018, pg.12-14.
6. Marsh, G. (2013). *End-of-life boat disposal–a looming issue.* Reinforced Plastics, 57(5), 24-27.
7. Summerscales, J., Singh, M. M., & Wittamore, K. (2016). "*Disposal of composite boats and other marine composites*". In Marine Applications of Advanced Fibre-Reinforced Composites, Woodhead Publishing, pp. 185-213.
8. Giorgini, L., Leonardi, C., Mazzocchetti, L., Zattini, G., Cavazzoni, M., Montanari, I., ... & Benelli, T. (2016). *Pyrolysis of fiberglass/polyester composites: recovery and characterization of obtained products.* FME Transactions, 44(4), 405-414.
9. Carchesio, M., Tatàno, F., Tosi, G., & Trivellone, C. H. (2015). R*ifiuti industriali dal settore manifatturiero della nautica da diporto nella regione Marche: caratterizzazione parametrica e chimico-fisica*. Ingegneria dell'Ambiente, *2*(1).
10. Valle, M. (2012). *Y-DfD: yacht design for disassembly.* Progettazione modulare e nuove soluzioni di connessione reversibile per il disassemblaggio dell'imbarcazione a fine vita.
11. Pickering, S. J. (2006). *Recycling technologies for thermoset composite materials—current statu*s. Composites Part A: applied science and manufacturing, 37(8), 1206-1215.
12. La Rosa, A. D., Banatao, D. R., Pastine, S. J., Latteri, A., & Cicala, G. (2016). *Recycling treatment of carbon fibre/epoxy composites: Materials recovery and characterization and environmental impacts through life cycle assessment*. Composites Part B: Engineering, 104, 17-25.
13. Yu, K., Shi, Q., Dunn, M. L., Wang, T., & Qi, H. J. (2016). *Carbon fiber reinforced thermoset composite with near 100% recyclability.* Advanced Functional Materials, 26(33), 6098-6106.
14. Oliveux, G., Dandy, L. O., & Leeke, G. A. (2015). *Current status of recycling of fibre reinforced polymers: Review of technologies, reuse and resulting properties*. Progress in Materials Science, 7*2*, 61-99.