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Manufacturing a Boat Hull Sample Using Composite Materials

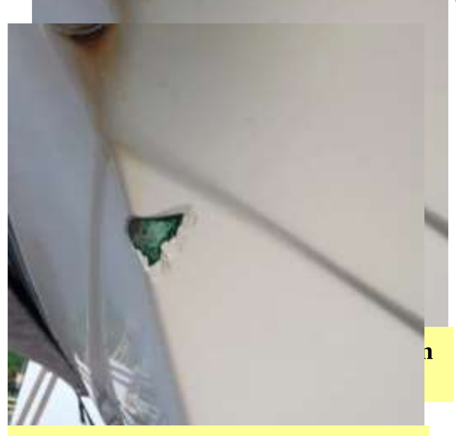
Amine BELOUFA[1], Mohamed AMIRAT[2] & Nabil BENMANSOUR[1]

1- Smart Structure Laboratory, University of Ain Temouchent, Algeria

2- Mechanical Engineering Department, Laboratory LAMCOM, University of Tlemcen, Algeria

INTRODUCTION & AIM

In this work, we are interested in manufacturing a hull sample for a boat using composite materials. Indeed, marine structures must have high mechanical resistance to the damage that can be caused by various sources of impact, which is further aggravated by a humid and corrosive environment. In addition to the damage caused by falling objects, slamming waves, or collisions with dock structures, composite components must be designed to withstand an aggressive marine environment. In our work, we focused on the manufacture and study of the mechanical resistance of a boat hull sample. This sample is manufactured using composite material in the form of a laminate and will be used, for example, to repair the main hull.

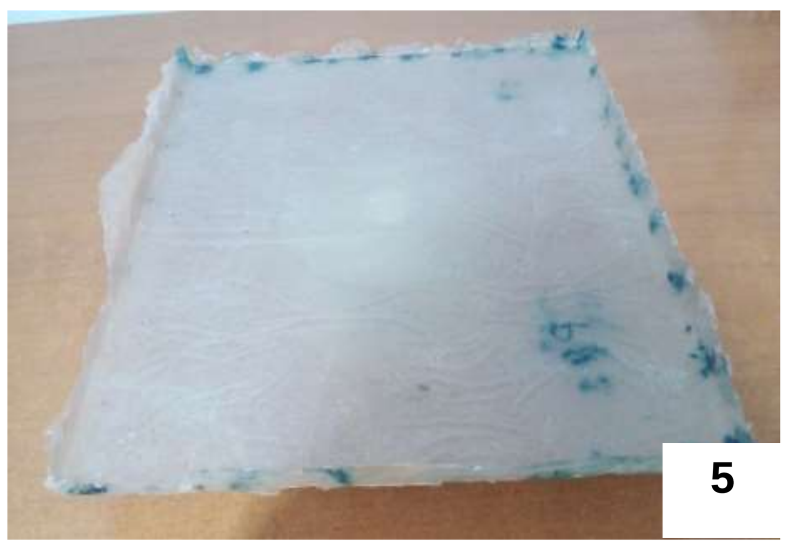


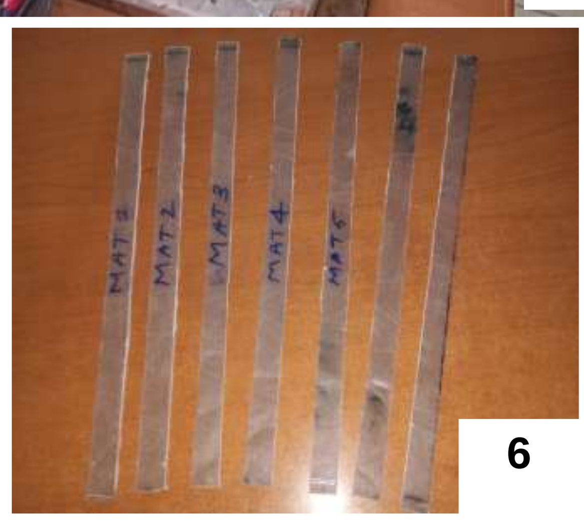
Damage observed on the hull of a boat due to an impact

Composite repair patch

METHOD OF MANUFACTURING

Manufacturing steps of our composite material sample





1- Cutting the fiber mat plies; 2- Calculating the required amount of resin and preparing it; 3- Spreading the resin in the mold; 4- Placing the plies; 5- Demolding; 6- Cutting the composite samples for use in tensile testing.

MATERIALS PROPERTIES

Mechanical and thermal properties of E-type glass fiber

Fiber or Reinforcement	Material Density ρ (kg/m^3)	Young's Modulus E (GPa)	Shear Modulus G (GPa)	Rupture Strength Rr (Mpa)	Rupture Elongation A% (%)	Poisson's Ratio ν
Type E Glass	2600	74	30	2500	3.4	0.25

Fiber or Reinforcement	Thermal Expansion Coefficient α (°K)	Thermal Conductivity Coefficient K (W/m °C)	Heat Capacity Cp (J/kg°C)	Limit temperature of use T_{Max} (°C)	Melting Temperature T_M (°C)
Type E Glass	5.10^{-6}	1	800	700	800-1400

Mechanical and thermal properties of polyester resin

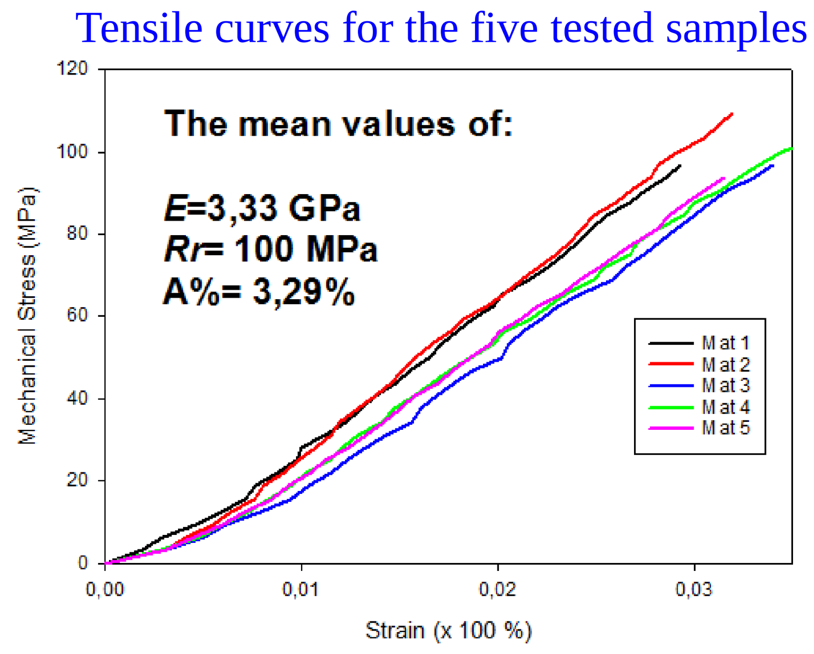
Thermosetting polymer (resin or matrix)	Material Density ρ (kg/m^3)	Young's Modulus E (GPa)	Shear Modulus G (GPa)	Rupture Strength or Tensile Strength Rr (Mpa)	Rupture Elongation A% (%)	Poisson's Ratio ν
Polyester	1200	1.3-4.5	0.5-1.6	50-70	2.5	0.4

Thermosetting polymer (resin or matrix)	Thermal Expansion Coefficient α (°K)	Thermal Conductivity Coefficient K (W/m °C)	Heat Capacity Cp (J/kg°C)	Limit temperature of use T_{Max} (°C)	Melting Temperature T_M (°C)
Polyester	80.10^{-6}	0.2	1400	80-180	250

RESULTS & DISCUSSION

Results of the behavior law of the manufactured composite material

Tensile curves for the five tested samples



Hardness tests

Measure Points	Rockwell Hardness (Ball) HRB	Vickers Hardness HV	Brinell Hardness HB
Mean Values	76.36	139	137.4

CONCLUSION

During this work, we have made a mold to manufacture our sample in a laminated composite material, which is subsequently intended for the construction of boat hulls or to repair these hulls. Our composite material is made of polyester resin and fiberglass; these are recommended for the maritime industry. The tensile test carried out on the different specimens gave us a Young's modulus of around 3.3 GPa. Also, the measurement of hardness by the rebound technique gives a value of Vickers hardness equal to 139 HV. Other tests were carried out, such as the permeability test; the latter confirmed that our composite material is waterproof.

FUTURE WORK / REFERENCES

1-D. Gay, Composite Materials: Design and Applications, Ed CRC Press, USA, 2014.

2-The Boat Maintenance Bible: Refit, Improve and Repair with the Experts, Ed Bloomsbury Publishing Plc, UK, 2011.

3-The Boat Repair Bible, Ed Bloomsbury Publishing Plc, UK, 2012.