Analysis of Mechanical Property in the Difference of Worker's Skill and Curing Process

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Introduction

Many companies are currently researching composite material molding method for practical application. In this research, we made three subjects with varying number of years' experience create preforms and produce a VaRTM molding. The test results for comparing the mechanical properties of the molding product, on the one hand, they revealed a higher intensity in order of the most years of experience to least. On the other hand, results reversed to what was intend at all. Moreover it is said the accuracy affect transmitted way of curing besides manufacturing preform. In order to confirm the effects, we compared the mechanical properties by focusing on the curing process from outside and inside the materials. A molding method is hand-lay-up. It used a fan heater concerning the external heating. As for the internal heating, it made the fiber heated by adding a voltage in set copper wires on the fiber. Based on the fact that there were results, while optimizing the creation of systems which produce exactly the same accuracy, we will continue to conduct research that leads to the development of automated production technology.

Experimental Materials, Molding Method and Evaluation Method

We used a fiber base-material,a carbon fiber NCF (Non-Crimp Fabric). The fixing agent was powder. And we used a matrix epoxy resin for VaRTM. In case of Internal and External heating, we used a carbon fiber UD (Uni-Direction) and Resin Composition of Quick Curing type.

Its process flow of Manufacturing Preform: Step 1 was the Skin section (n ply Fiber orientation confirmation and n ply Stacking sequence), Step 2 was Installation Section (setting the Silicon mold and Fillers installation), finally Step 3 was the Hat-Shaped Mold Section (n ply Fiber orientation confirmation and n ply Stacking sequence) as follows Table 1 and Figure 1. It was evaluated by five experiments: Video footage, Interview with the Subjects, Measurement of Eye Movements, Interlaminar Shear Strength Test, Tensile Test, Measurement of Elasticity, Observation of Cutting Section. As for Internal and External heating panels, they were examined by Bending Test and SEM Fracture Surface Observation.

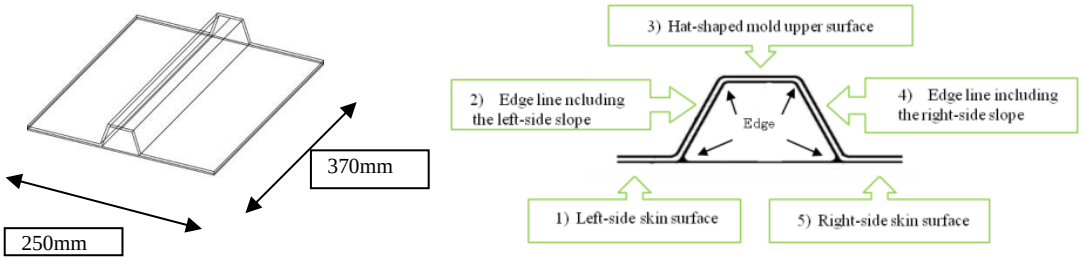

Figure 1: *CFRP perform for comparison with experience differences.*

Table 1: *Stacking Sequence.*

Skin Section			***Hat-shaped Section***		
ply #	*Fiber Orientation*	*Thickness(mm)*	*ply #*	*Fiber Orientation*	*Thickness(mm)*
1	[+/- 45]	0.25	1	[+/- 45]	0.25
2	[0 / 90]	0.25	2	[0 / 90]	0.25
3	[90 / 0]	0.25	3	[90 / 0]	0.25
4	[-/+ 45]	0.25	4	[-/+ 45]	0.25
Total		1.00	*Total*		1.00

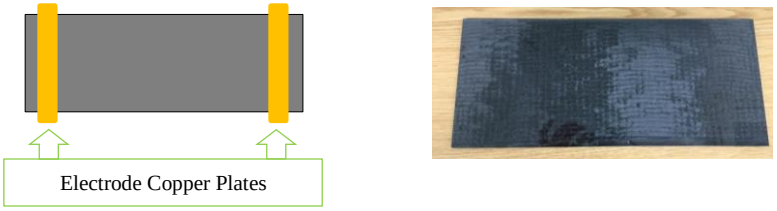

Figure 2: *CFRP plate for Internal heating.*

Experimental Results, Discussion and Conclusion

In the future, in order to improve the accuracy of the mold and to enable the manufacturing of the products with the uniform quality, it will be required to verify the preferable conditions for the manufacturing of the preform with the uniform precision by measuring Vf, void content of the mold, pressure on the fiber base in contact with the heating unit of the iron, and so forth. With regard to the areas and the direction where the iron is pressed, we will conduct several analyses under various molding angle conditions to ascertain the causes of the difference in strength and eventually to minimize the difference of strength resulting from angles and variance of fiber orientation. It will also be necessary to have the subjects more conscious to the relationships between the verbal recognition and their action (behavior patterns and eye motions resulting from the way of using tools or the way of placing fiber base) by giving an appropriate instruction to the subjects under the uniform working condition. In order to enable any performer to manufacture the preform mold and the products with the uniform accuracy, our future researches shall be aimed at creating the working guidelines that explain an effective eye movements as to where a performer should focus on, with recognizing the vital points of the working procedures at the first glance. These working guidelines will enable the handlings as well as the automation of the manufacturing process.

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