講演番号	259

文献番号	20226259

Effect of Crystallinity on Energy Absorption Properties of Carbon Fiber Reinforced Thermoplastic Pipes

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KEY WORDS: **Polymer composite material, CFRTP, Energy absorption properties, Crystallinity (D3)**

1. Purpose

CFRTP(Carbon Fiber Reinforced Thermoplastic) has higher specific strength and modulus than metals and is expected to be applied to automotive impact absorbers. However, When a crystalline resin is used, the degree of crystallinity of the molded product varies depending on the molding conditions. It is said that when the crystallinity changes, the microscopic damage growth behavior and mechanical properties of the molded product change greatly. The objective of this study is to clarify the effect of crystallinity on the fracture behavior and the resulted energy absorption properties of braided CFRTP pipes under axial compressive load.

2. Experimental methods

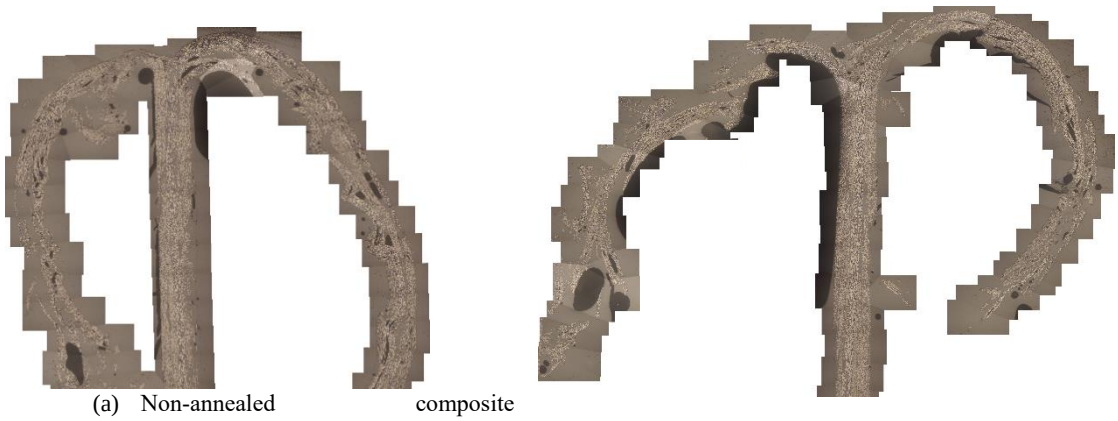
A braided fabric as reinforcements of CFRP pipe was fabricated using commingled yarns composed of carbon fiber and crystalline nylon resin fiber and CFRTP pipe was molded with pultrusion moldings as a continuous molding method. After molding, heat treatment (annealing) was performed to increase the crystallinity and crystallinity was measured by DSC（Differential Scanning Calorimetry）. Static compression tests were conducted to determine and compare the energy absorption. After the test, the cross-section in axial direction of the pipe was observed to clarify the fracture mode.

3. Result

DSC results showed that the heat of fusion of the annealed composite was 16.4% higher than that of the non-annealed composite. Therefore, the annealing treatment resulted in higher crystallinity.

Static compression test results showed that the energy absorption was 7.5% higher for the non-annealed composite than for the annealed test piece composite. The cross sections after the test were shown in Fig. 1. The non-annealed composite showed longer delamination between each layer and less bending and fiber cracks. The annealed composite exhibited longer delamination between each layer, but more bending and fiber fractures. This suggests that the annealed composite absorbed more energy for bending and fiber fracture.

These results reveal that high crystallinity improves energy absorption properties.



(a) Non-annealed composite
(b) Annealed composite

Fig.1 Fracture aspect after the static compression test in longitudinal cross section.