30th of June, 2017

17CeANA/041

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Task

Determination of water absorption and blister formation of composites at accelerated conditions

Sample data

Samples:

- The construction of glass fibre composite (GFRP) is as shown in Figure 1.

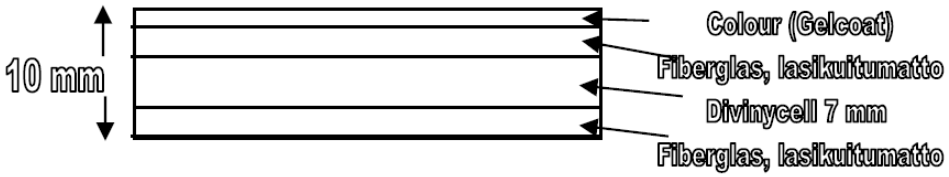

Figure 1: Schematic representation of GFRP under testing

Arrived:	08.06.2017
Analysed:	8-28.06.2017
Sampler:	Customer

Methods

Customer delivered 5 test specimens with dimensions 100 mm x 100 mm and thickness as seen from the Figure 1. The edges and the side of specimen without gelcoat was sealed by silicone. Before the test was started, the samples were conditioned/dried at 50°C for 3 days. The samples were visually inspected and images were captured before starting the test.

The specimens were weighed after conditioning and this weight is assigned as initial mass ($m_{initial}$). Then the specimens were fully immersed in ultra-pure water contained in a plastic vessel which was kept in climate chamber pre-heated at 40°C. After 24 hours the samples were weighed and re-immersed in water. This step was repeated after 48 h, 144 h, and 336 h. The water absorption was calculated from equation (1)

$$\text{Water absorption (\%)} = (m_{final} - m_{initial}/m_{initial}) * 100 \qquad \text{Equation (1)}$$

Assuming activation energy of 0.7 ev [1], an acceleration factor (AF) of 5-6 can be applied when the test temperature is 40°C [2]. That means the accelerated test at 40°C for 2 weeks resembles the water absorption of material immersed in water for 10-12 weeks at ambient condition.

Results

Accelerated water absorption

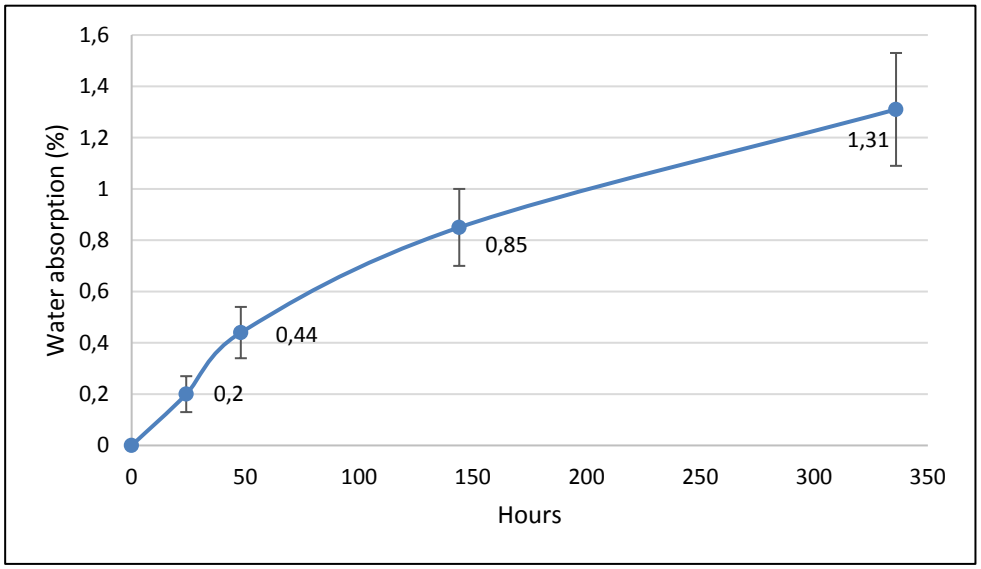

Figure 2: Water absorption of GFRP under accelerated conditions

Comments

- Since all other side are sealed with silicone, the result corresponds to water absorption through gelcoat.
- The water absorption of GFRP increased with increasing time. The GFRP under study did not reach saturation point during the test period. When GFRP is immersed in water, the water molecules will be attracted by the hydrophilic groups in the unsaturated polyester resin and glass fibre if exposed. On the other hand, the capillarity would conduct the water molecules to the material, voids and cracks in the composites are ideal spaces to accept the water.
- The 24 hour water absorption for commercially available GFRP is in range of 0.20-1.3% (ASTM D570) [3]. Assuming that those test were conducted at ambient condition, the accelerated water absorption results obtained for the GFRP under study shows very low water absorption during period of 24 hours.
- Structural changes of GFRP and blister formation on gelcoat surface (visual inspection) were not observed after accelerated water absorption test.
- As already mentioned, the accelerated water absorption at 40°C corresponds to the samples immersed in the water at ambient condition for 10-12 weeks. Since the GFRP under testing is not immersed in water during its life time, the material will much less absorb water. It could be concluded that the gelcoat of the GFRP has excellent protection against water absorption.

References

[1] T. Wells, R. E. Melchers. Determining hydrolysis behaviour and durability from short term water sorption data (2005). *In* FRP Composites in Civil Engineering – CICE 2004 – Seracino (ed). Taylor & Francis Group, London. p.924-930.
[2] L. Norwood, E. C. Holton. The effect of poor interlaminar adhesion on blister formation in GRP in contact with water (1991). Materials & Design 12(2): 75-79.
[3] http://www.matweb.com (Accessed on 29th June 2017)

Further information

Will be given on a request.

In Kokkola, Finland, 30th June, 2017

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Delivery

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