

PhD THESIS ABSTRACT

Modelling and Prediction of the Environmental Degradation of Fibre Reinforced Plastics

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In their service life, fibre reinforced plastics (FRP) face a variety of environmental conditions resulting from natural or artificial factors. These include variable temperature and humidity conditions, energetic radiations such as ultraviolet rays from the sun, and diverse chemical reactants such as liquid in storage tanks and pipes. These factors are always combined and negatively affect the material properties over the time.

Therefore, optimized utilization of FRP material requires reliable methods for quantifying, controlling, and predicting environmental effects. This allows for optimal handling of issues related to component design, economic assessment and safety considerations, as well as the technical problems relating to equipment maintenance.

Efforts worldwide are devoted to the modelling of FRP environmental degradation. However, modelling efforts have been hindered by the complexity of the process.

This analysis presents a comprehensive model of the environmental degradation of FRP and a prediction method. The modelling method consists of a theoretical demonstration based on material science theories. An analytical approach is proposed. It resolves the complexity of the process into only three components: the chemical degradation, the physical degradation, and the stress state modification. A method to represent the real service environment as a constant environment in laboratory is also introduced.

Then, the comprehensive model is expressed as a dynamic constitutive equation resulting from the combination of the historical variation in chemical link density and cohesive forces and the stress history of the material. It is shown that:

- The average of the chemical and physical degradation as well as its upper and lower limits can be determined in a laboratory, in a constant environment, as exponential functions of the degradation time.
- The environmental degradation can be comprehensively measured as a stress relaxation.

Acceleration of the predictive test can be obtained from a modified time temperature shift principle.