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TOUGHNESS OF FIBREGLASS LAMINATED COMPOSITES

KAM PEI YI

This report is presented in
partial fulfilment of the requirements for the
Degree of Bachelor of Mechanical Engineering (Thermal Fluid)

Faculty of Mechanical Engineering
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APRIL 2009

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"I hereby, declare this thesis is result of my own research except as cited in the references"

Signature	: ………………………...
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To my beloved family

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ABSTRACT

Charpy impact test were carried out for E-glass/polyester and E-glass/epoxy composite specimens to determine the amount of energy absorption of the specimen. Woven roving type [0/90] and [45/45] of E-glass used in this research. Hand lay-up method was used in fabricating the composite specimens. Specimens were fabricated with the dimension according to ASTM standard E23 of 55mm x 10mm x 10mm. In this research, the specimens were put under different environment conditions before impact test such as under different temperature range from room temperature to 55˚C, under UV light and also tested its resistance against distilled water, sea water, river water, acid and alkaline solution. Unexposed specimens (under ambient temperature) of same parameter were used as a baseline for comparison specimens. The effects of different environment conditions on the toughness of fiberglass laminated composite specimens were studied. Results shown that the impact energy of E-glass/polyester [0/90] specimens decrease with increasing testing temperature. There was a significant reduction of energy absorbed when subjected to UV light. It was found that the specimens immersed in acids solution has the highest impact energy, followed by sea water, alkaline solution, river water whereas distilled water has the lowest impact energy values. E-glass with orientation [45/45] shows higher impact energy compare to orientation [0/90]. On the other hand, both polyester and epoxy resin with orientation [0/90] and [45/45] were studied.

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ABSTRAK

Ujian hentaman Charpy telah dijalankan terhadap bahan komposit ‘E-glass/polyester’ dan ‘E-glass/epoxy’ untuk menentukan kebolehan penyerapan tenaganya. ‘E-glass’ jenis tenunan[0/90] dan [45/45] digunakan dalam penyelidikan ini. Kaedah ‘Hand lay-up’ digunakan untuk fabrikasi bahan komposit. Bahan-bahan tersebut difabrikasikan berdasarkan piawai ASTM E23 iaitu 55mm x 10mm x 10mm. Dalam kajian ini, bahan spesimen diuji dalam keadaan tertentu seperti dengan suatu julat suhu, di bawah cahaya matahari, dan juga diuji kerintangan terhadap air, air laut, air sungai, asid dan larutan bes sebelum ujian hentaman dijalankan. Spesimen yang tidak terdedah (di bawah suhu ambien) digunakan sebagai asas rujukan untuk perbandingan. Selain itu, ujian hentaman dijalankan untuk menentukan keliatan bahan dengan dimensi yang sama. Keputusan menunjukkan bahawa suhu yang diuji semakin meningkat, keliatan ‘E-glass/polyester’ [0/90] semakin berkurangan. Semasa spesimen terdedah kepada cahaya UV, keliatan spesimen menunjukkan pengurangan yang signifikan. Spesimen yang direndam dalam larutan asid mempunyai nilai keliatan yang tertinggi, diikuti oleh air laut, larutan alkali, air sungai manakala air suling mempunyai nilai keliatan yang paling rendah. E-glass dengan orientasi [45/45] menunjukkan keliatan yang paling tinggi jika berbanding dengan orientasi [0/90]. Tambahan pula, kedua- dua polyester dan epoxy dengan orientasi [0/90] dan [45/45] telah dikaji.

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CHAPTER I

INTRODUCTION

1.1 Background

According to the current global market, conventional structural materials such as steel and aluminium in construction, automotive, aerospace industries and other fields were widely replaced by the usage of fiber reinforced polymers. This overwhelming demand of application is attributed to the high strength-to-weight ratio of the polymer composites, better mechanical properties and ease of handling.

In the past centuries, fibrous reinforcement concept has been applied in the olden daily days. There are biblical references to straw-reinforced clay bricks in ancient Egypt. Iron rods were used to reinforce masonry in the nineteenth century, leading to the development of steel-reinforced concrete. Phenolic resin reinforced with asbestos fibers was introduced in the beginning of the twentieth century. The first fiberglass boat was made in 1942; reinforced plastics were also used in aircraft and electrical components at this time. Dupont developed Kevlar (or aramid) fibers 1973. Starting in the late 1970s applications of composites expanded widely to the aircraft, automotive, sporting goods, and biomedical industries. The 1980s marked a significant increase in high modulus fiber utilization (Isaac and Ori 1994).

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Polymer composites are increasingly being used in a wide range of applications where long-term service in hostile environment is required. The competitive quality and good mechanical properties of glass fibers has led them to widespread use in reinforced polymer composites. However, composite are prone to degrade when they are exposed to certain environment conditions. Therefore, it is crucial that polymer composite materials be able to retain their mechanical properties and show minimum degradation in this environment (Bagherpour *et al.* 2008).

1.2 Objective

The main objective in this research is to study the toughness of fiberglass laminated composite under different environment conditions. In addition, it includes the study of type and properties of laminated composites and their manufacturing process.

1.3 Scope

In this research, a brief survey of different types of composite materials, some of their important features and their properties are presented. The basic characteristics of manufacturing processes that is relevant to the polymer matrix composite such as hand lay-up, filament winding, compression molding, resin transfer molding, pultrusion and vacuum bag molding are described. The fabrication of fiberglass laminated composite is done by using hand lay-up technique. Toughness of the test sample will be put to the test under various conditions such as under different temperature range, under sunlight, and also tested its resistance against water, sea water, river water, acid and alkaline solution. Next, the toughness of the samples is determined by using Charpy test. Then, analyze the effect of difference environment condition on the test sample.

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1.4 Problem statement

Fiberglass laminated composite are widely used in application due to their low cost and easy to fabricate especially using hand lay-up technique. However, according to Bagherpour *et al.* (2008), the lack of resistance of composite structures to degradation agents often becomes apparent within a short period of exposure. In some circumstances, only a few hours of exposure may lead to catastrophic failure or seriously damaging structural integrity. Irreversible property changes in polymer matrix composites can be induced by any number of degradation agents such as UV light, water, humidity, alkaline and acid steam environments. Hence, it is necessary to further understand the effect of environment on composites toughness.

1.5 Report Overview

In this report, it contains 6 chapters. In chapter 1, it is about the description of the background of composite materials, the objectives and scope of this research and the problem statement that lead us to conduct the experiment.

Literature review on composite materials, type and properties of composite material, fabrication process to fabricate the composite will be described detail in chapter 2. Whereas chapter 3 explains the methodology, which contain the description on specimens that undergo Charpy test after specimen was exposed to environment. Charpy impact test was carried out for fiberglass/epoxy composite specimens to determine the amount of energy absorption of the specimen. Chapter 4 is about the results from the research. Chapter 5 is the discussion, explaining the effect of different environmental condition on the specimens. Lastly, Chapter 6 is the conclusion.

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CHAPTER II

LITERATURE REVIEW

2.1 Composite Materials

Composite materials are formed by the combination of two or more materials to achieve properties (physical, chemical, etc.) that are superior to those of the constituents (Barbero 1998). The main components of composite materials are fibers and matrix. Daniel and Ishai (1994) explained that one of the phases is usually discontinuous, stiffer, and stronger and is called reinforcement, whereas the less stiff and weaker phase which continuous is called matrix. Sometimes, because of chemical interactions or other processing effects, an additional phase, called interphase, exist between the reinforcement and the matrix as shown in Figure 2.1.

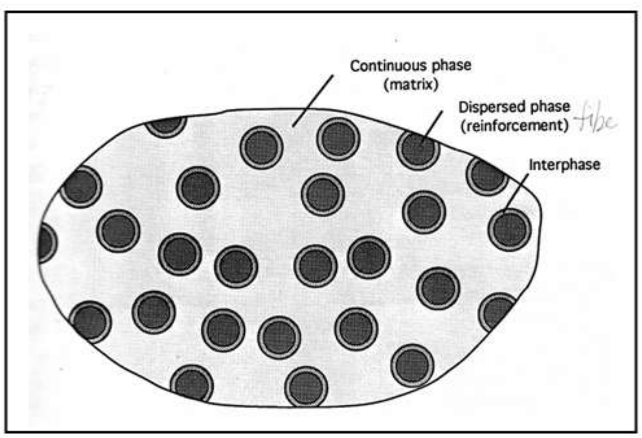

Figure 2.1: Phases of a composite material.

(Source: Daniel and Ishai, (1994))

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