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CARBONIZATION CBN550 EFFECT ON TENSILE PROPERTIES OF COMPOSITE FOR MARINE STRUCTURE APPLICATION

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ABSTRACT

The composites have gained commercial success, where strength, stiffness, durability and light weight are required as well as retardant capacity. Improvement has been made such new series of resin such as vinyl ester and epoxy type[1, 2]. However 95% of pleasure vessels and boats under 60 feet today are still made with polyester resin. The main consideration for most composite builders is cost, with performance and more importantly value for money often being a secondary consideration. Therefore, this study investigate the tensile – mechanical effects of mixing carbon black CBN550 with wax and non-wax type resin and manufactured according to fiber orientation of [0º] and [90º]. The 10% CBN550 exhibit highest reading for stress under [90º] fiber orientation and the lowest reading when arranged at [0º] fiber orientation. The preliminary study on CBN550 flammability has indicated the suitability for this study to pursue in. The structural composites samples of 1000 mm by 1000 mm prepared which consist of 10 of composite mats layer in combination of CSM 450 g/m² and Woven Roving 600 g/m². The carbon black (CB) volume fraction range from/with 0% to 20% volume fractions. Optical observation revealed the most suitable fraction of CBN550 in wax polyester resin is at 10% and non-wax polyester resin is also at 10%. The fire resistance behaviour of this CBN550 - CSM 450 g/m² - Woven Roving 600 g/m² composite (polyester wax) and polyester non wax was investigated previously as per[3]. This results are in line with the finding of the maximum load where the highest reading was recorded by the 10%CBN550 specimen. This study showed that the introduction of carbon black into the resin mixture helps reinforce the matrix materials. The results suggested that CBN550 mixture should attend to next level of experiment investigation such as oxygen content, TG value, microstructure and other mechanical destructive test. The CBN550 could be a suitable candidate for fire retardance application in marine composite structure.

Keywords: performance, cost, CBN550, tensile, marine composite.

INTRODUCTION

Composite materials are have become very popular in marine manufacturing and fabrication companies. The scenario is the reaction of composite ability offering a comprehensive desirable characteristics of the components. In structural and mechanics sense, the constituents as element shifting forces to adjacent members. Glass-reinforced plastic (GRP) is a composite material made of a plastic (resin) matrix reinforced by fine fibres made of glass. An individual structural glass fibre is both stiff and strong in tension and compression i.e., along its axis. Although it might be assumed that the fibre is weak in compression, it is actually only the long aspect ratio of the fibre which makes it seem so; i.e., because a typical fibre is long and narrow, it buckles easily. Furthermore, by laying multiple layers of fibre on top of one another, with each layer oriented (stacking) in various preferred directions, the stiffness and strength properties of the overall material can be controlled in an efficient manner as chosen by the designer or naval architect.

With chopped strand mat, this directionality is essentially an entire two dimensional plane; with woven fabrics or unidirectional layers, directionality of stiffness and strength can be more precisely controlled within the plane. However the properties can improved further with the introduction carbonize particle[4-6] in polymer matrix system. The size and volume fraction [7]is expected to affect mechanical properties of the composites. The CBN550 has average primary particle diameter (53 nm) and 43g/kg iodine absorption number. Carbon black has smooth particle surface and high structure, resulting in best reinforcement properties among soft carbon blacks. CBN550 is easy to disperse, resulting in high enduring property, high extrusion rate, smooth surface, small expansion, high temperature resistance and high heat conductive, high reinforcement, high elasticity and rebounding properties. The CBN550 is commonly used for natural rubber and synthetic rubbers. Therefore objective of this study is to investigate the tensile behaviour of mat and woven GRP, which is hand lay-up plane-weave woven E-glass/Polyester laminate (wax and non-wax type) with added CBN550 particle, in order to determine the tensile strength, tensile modulus and other characteristics.

Objective of the study

The investigation is mainly to study the CBN550 effect on tensile properties of composite for marine structure application. This work is an extension attempt at retardant fabrication additional material and to get into the mainstream of the technological frontiers of the 21st century at acceptable reduction of flammability and cost. The effect of CBN550 has studied previously where it has produced of promising result for the intended application and implementation.

MATERIAL

Polyester resins(wax and non-wax) were used as matrix material and E-glass fibre as reinforced material. The added material used in this research was carbon black (CBN550) where it was made by Thai Tokai Carbon Product Company Limited, Chonburi, Thailand and supplied by local supplier from Ipoh, Perak. While the polyester supplied by Polynt Composite Malaysia Sdn. Bhd., Johor Malaysia for Norsodyne 3338W/3338NW and methyl ethyl ketone proxide made by PT. Kawaguchi Kimia Indonesia, Cikup-Taggerang, Indonesia.

Fabrication

The test samples were prepared according to ASTM D3039/D3039-08 Standard Test Method for Tensile Properties of Polymer Matrix Composite Material standards[8]. The test samples should be straight sided and has a constant cross section with bevelled tab adhesively bonded at its ends. The test samples are prepared based on the preliminary finding through visual inspection from the best mixture of carbon black and resin where 10% carbon black of weight of resin was reported as the best mixture for both wax and non-wax resin type. Four types of test samples were prepared; 10% CBN550 wax and non-wax resin type and 0% carbon black wax and non-wax resin type. The 0% of carbon black samples were used as datum for this study. Two type of arrangement identified for the research where 0º and 90º orientation. The lamination schedule is referred to ClassNK or NK[9], is a ship classification society as in Table-1.

Table-1. Lamination arrangement.

No. of Arrangement	Type of FRP cloth (gram/m^2)
1.	CSM (300)
2.	CSM (450)
3.	WR (600)
4.	WR (600)
5.	WR (600)
6.	CSM (450)
7.	WR (600)
8.	WR (600)
9.	WR (600)
10.	CSM (450)
11.	CSM (450)

Experimental procedure – Tensile test

Tensile samples of polymer composites [10] were prepared by using hand lay-upmethod. The specimens were prepared accordingly to ASTM D638 Tensile Properties of Plastics [10]–bone specimen and the burrs were removed with smooth cloth and the specimens were cleaned. ASTM D 638 [10]specimens are placed in the grips of the universal testing machine at a specified grip separation and pulled until failed for all tensile variables. Seven specimens were prepared and six specimen tested in each case as shown in Figure-1.The tests are performed using 600kN Universal Testing Machine Close Front Crosshead Instron model Satec as used previously [11-13].The stress calculation was defined based on the nominal cross-sectional of the test specimen, while the nominal stain values had been defined on the basis of the gauge length and the modulus of elasticity (Young's modulus) was calculated on the basis of two specified strain values[14, 15].

RESULT AND DISCUSSIONS

The tensile test is generally performed on ASTM specimens are typically shown in the Figure-1 to Figure-15 for both resin type according to NK Class formulation[9].The result of experimental test is that the nature of the divergent interactions such as the physical mixing of matrix and sizing resins and the nature of chemisorption's at the composite matrix system give escalation to an inter-phase constituency as opposed to a distinct the matrix in the fiber-reinforced composite is to transfer the load to the stiff fiber at the interface. This process requires a good bond between the polymeric matrix and fiber. From the test conducted, the tensile strength and modulus of the composites filled with CBN550 increased with increasing mat orientation for both resin type. Composites with 0° orientation with 10% volume carbon black exhibit brittle for wax resin type as per Figure-2 to Figure-6. There are traces of matrix is still adhered to the fiber. This in an indication that the adhesion between fiber and the new matrix was not lost and the failure process was dominated by the matrix material properties. However, the non-wax resin type shown better improvement in Figure-7 to Figure-11 of the tensile characteristic results for each lay-up arrangements matrix which means a greater adhesion or interfacial bonding. The curing pressure all have shown a similarity in trend growing for 90° orientation and eventually develops into linear properties expansion. It is also found the maximum load, tensile stress, tensile strain and Modulus Young are found to be reduced. The carbon black-filled composites able to increase volume resistivity by a synergistic effect along with an improvement in mechanical properties of the non-wax resin composite. However, the test has triggered of decrease synergistic effect in wax resin composite.

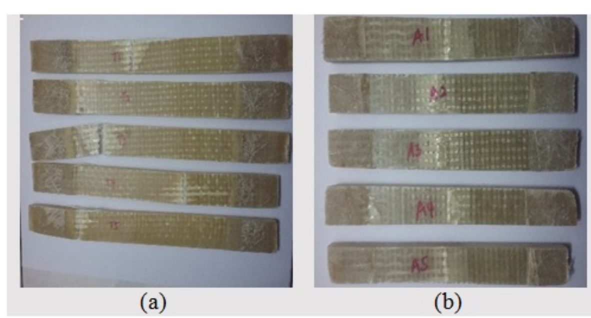

Figure-1. Original specimen (a) 0 degree (b) 90 degree.

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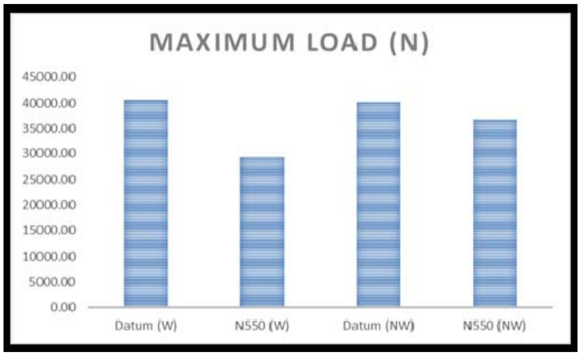

Figure-2. Maximum load at 0° orientation.

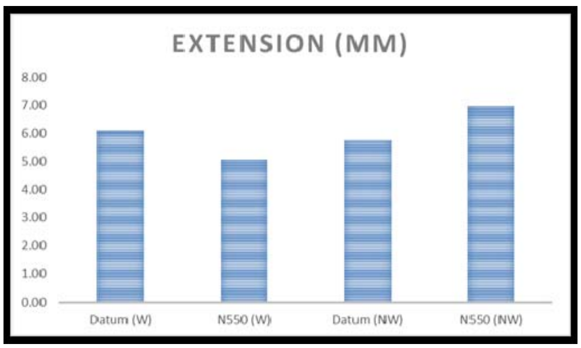

Figure-3. Extension at 0° orientation.

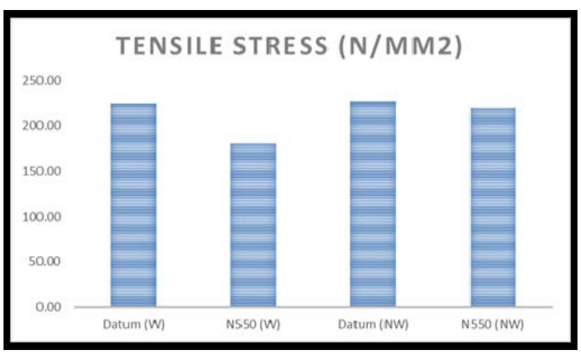

Figure-4. Tensile stress at 0° orientation.

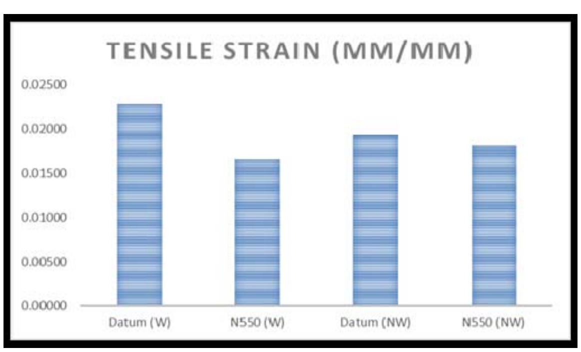

Figure-5. Tensile strain at 0° orientation.

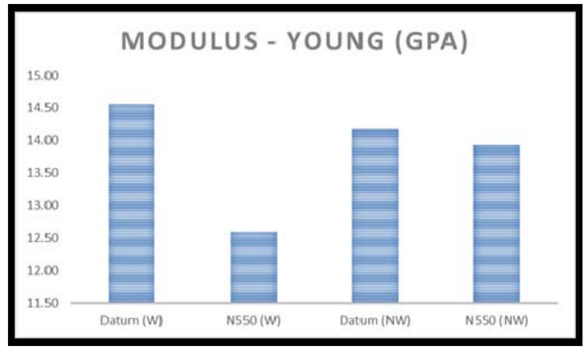

Figure-6. Modulus Young at 0° orientation.

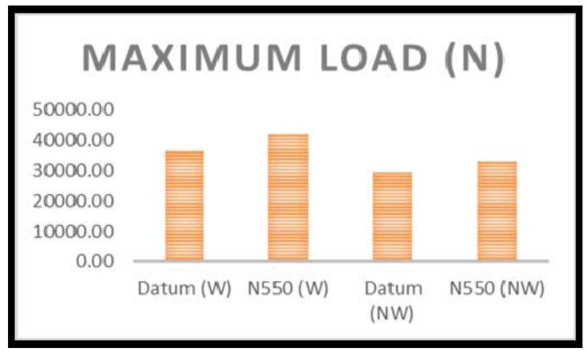

Figure-7. Maximum load at 90° orientation.

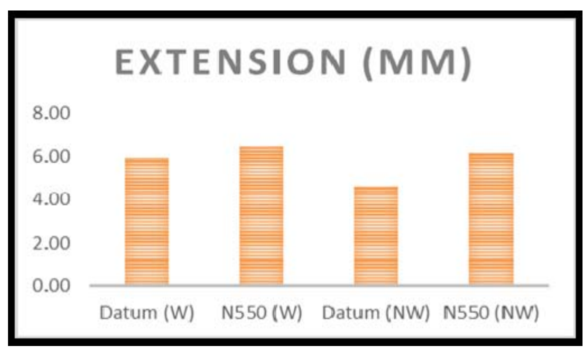

Figure-8. Extension at 90° orientation.

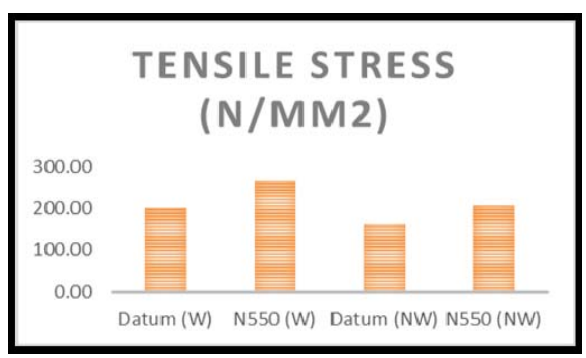

Figure-9. Tensile stress at 90° orientation.

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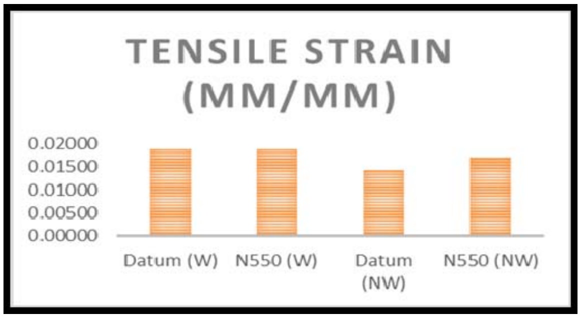

Figure-10. Tensile strain at 90° orientation.

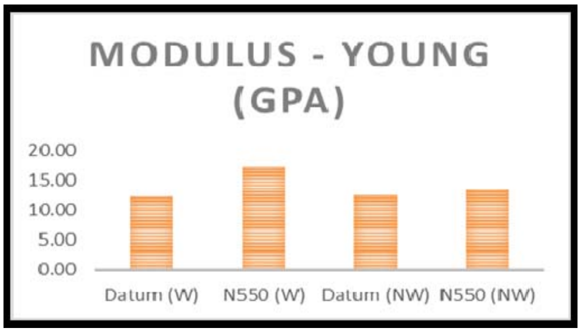

Figure-11. Modulus Young at 90° orientation.

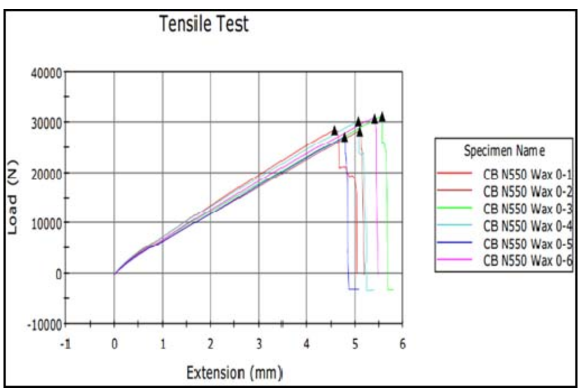

Figure-12. Tensile test at 0° orientation of wax resin type.

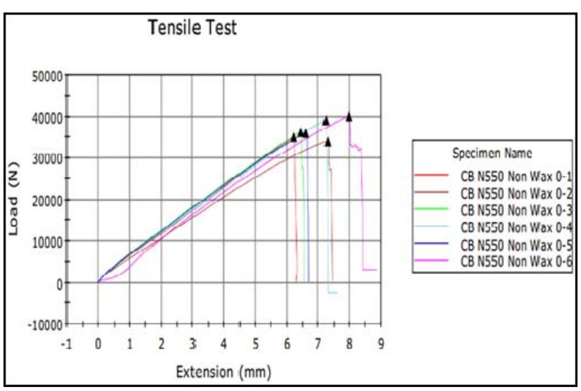

Figure-13. Tensile test at 0° orientation of non-wax resin type.

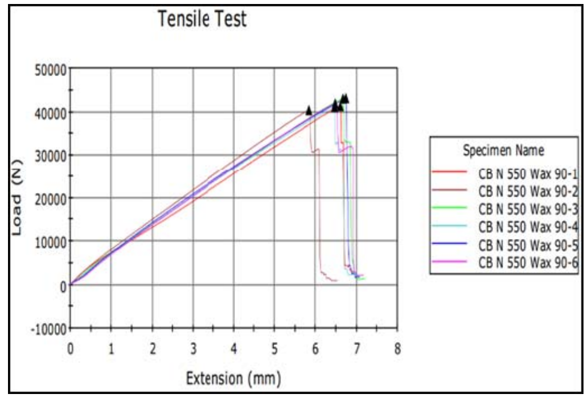

Figure-14. Tensile test at 90° orientation of wax resin type.

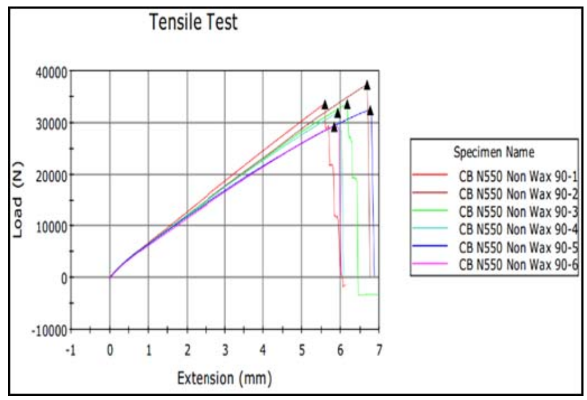

Figure-15. Tensile test at 90° orientation of non-wax resin type.

Closing remarks

The use of carbon material in matrix system of composites, is of great interest in view of reduction in combustibility of the polyester resin in marine composite structure. The "green" composites mixture can be find in other several industrial applications, with limitations of different chemisorption ability, process ability and dimensional stability. This limitation can be reduced and material properties can be enhanced with the suitable parameter values and matrix components. Research is carried out on the impact of the addition of filler material –CBN550 in the polyester resin in marine composite structure. 10% volume of the CBN550 are added to the FRP and tested.

- On analysis of the results, it is inferred that the FRP with carbon black possesses better tensile properties on 90° orientation than the FPR with 0° orientation.
- On the other hand, it is also observed that the tensile properties of FRP with added material are satisfactory if orientation changes as compared to the FRP without orientation change.

Therefore the research work can be extended in future to next level of experiment investigation such as oxygen content, TG value, microstructure as well as mechanical destructive test.

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