INFLUENCE OF STACKING SEQUENCE ON THE MECHANICAL, THERMO MECHANICAL AND MOISTURE ABSORPTION BEHAVIOR OF NYLON / GLASS FIBER COMPOSITES

Aswin S[1], Badarinath M S[2], Benish J V[3], Rama Udaya Marthandan R[4]

[1]Student, Department of mechanical engineering, Ponjesly college of Engineering, Nagercoil, Kanyakumari, Tamilnadu, India - 629003
[2]Student, Department of mechanical engineering, Ponjesly college of Engineering, Nagercoil Kanyakumari, Tamilnadu, India - 629003
[3]Student, Department of mechanical engineering, Ponjesly college of Engineering, Nagercoil Kanyakumari, Tamilnadu, India - 629003
[4]Professor, Department of mechanical engineering, Ponjesly college of Engineering, Nagercoil Kanyakumari, Tamilnadu, India - 629003

Abstract-*Fiber reinforced polymer composites have different applications in many fields as a class of structural materials because of the fabrication, low cost for producing & superior cost as compared to polymer resins. The fiber which can be use as a reinforcement in reinforced plastics may be artificial or natural. Although the artificial fibers such as glass, carbon, has high specific strength, their fields of applications are low because of their higher cost of production. Hybrid type composites of polyester reinforced with nylon plates and glass fibers will be prepared to form fiber plastic laminates. The mechanical, themo-mechanical and moisture absorption properties of these nylon plate-glass fibres reinforced polyester composites will be investigated for reference to different stacking sequence of the composites.*

Keywords: Nylon, Glass fiber, Resin, Hardener, Accelerator, Flexural testing, Impact testing, Water absorption Test, Hybrid composites.

1. INTRODUCTION

Composite materials are using in engineering fields whichare made up of two or more different type of materials which remain in a macroscopic level when changing into one component .the constituent materials are matrix and reinforcement.The matrix supports reinforcement at relative positions.

A composite is a synthetic material a combination of two or more micro-constituents which has different physical form and chemical composition. Due to its various advantages such as high strength, durability, ductility it is used for wide range of applications.

1. The influence of layer pattern on mechanical properties (*Tensile, Flexural, Impact*) of hybrid combination of glass fibers and nylon are investigated.

2. The influence of layer pattern on thermo-mechanical properties (Storage modulus, loss modulus, damping factor) of hybrid combination of nylon and glass fibers are investigated.

3. Their thermo-mechanical and water absorption properties are investigated.

2. EXPERIMENTAL

At First the mould for the composite is made. We have to make moulds at a size of 300 x 300 x 3 mm . A clean surface wooden board is taken and washed clearly to remove impurities. Cover the wooden board with a thin plastic sheet. Glass fiber used is woven fabric mat. The samples are taken correctly and mix it well. Take 600_{gm} of polymer correctly and 30 spoon of its hardener. Then mix them thoroughly till it get mixed well.

Glassfibers and nylon are reinforced in polyester resin to prepare the composite by conventional hand-lay-up technique. The fibers were weighed in the same way the resin and hardeners were weighed. Polyester and hardener were mixed in a bowl. Avoid formation of bubbles. Formation air bubbles may causes failure in the material.

Sl. No.	Stacking pattern	SampleID
1	G/G/G	GGG
2	G/G/N	GGN
3	G/N/G	GNG
4	N/G/N	NGN
5	N/N/G	NNG
6	N/N/N	NNN

Table -1: Sample ID employed to specify composites with different layer pattern

G: glass fiber; N: nylon

First clean the surface then slowly apply releasing film on the mould surface. Apply polymer coating. Place the fiber ply of glass and rolling process is done. Again apply the resin ande fiber ply glass is placed and rolledproperly.finally apply polymer coting on the surface.

A releasing sheet was put on the top surface; rolling was carried out lightly. Then a 25 kgf weight was placed on the material. It was left for 24 hrs to allow sufficient time for curing and hardening. The above procedure was followed for the subsequent composites plates of different layer patterns are made (GGG, GGN, NNN, NGN, and NNG).

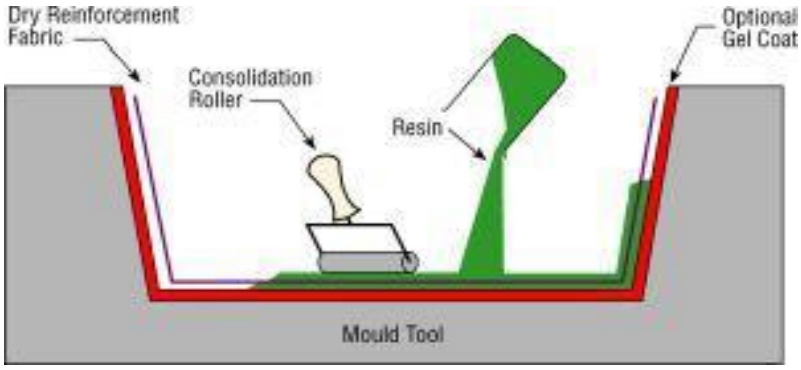

Fig-1: Hand Lay-up technique

2.1. Tensile Strength

The tensile test is normally applied on flat specimens. The dimension of the material to be tested is 300 mm ×25 mm × 3 mm and uniformly axial load is applied through both the ends.

The experimental set up is shown in Figure 2. This test is repeated for two or three times on composite and report was made.

Fig-2 : Tensile testing machine

2.2. Flexural Strength

The flexural strength of a composite is the maximum tensile stress that it can hold during application of load before reaching the breaking point. The dimension of specimen is 127 mm ×12 mm × 3 mm. Span length of the specimen 40 mm and the cross head speed of 10 mm/min are maintain.

Fig -3: Flexural testing machine (UTM)

2.3 Impact Strength

Impact strength of the composite was analysis by using impact testing machine. Sudden force was applied by a pendulum hammer at the v-notched specimen, the energy spend was measured.. The size of the specimen is 65 mm x20mm x3mm and notch depth is 10mm.Impact energy is measured in the dial indicator.

Fig-4: Impact testing maching

2.4. Dynamic mechanical analysis

Dynamic mechanical analysis take placed using DMA Q800 V20.6 Build 24 make evaluate Storage modulus, Loss modulus and Damping factor. The experiment is performed under bending mode at a frequency of 1 Hz. The specimen dimensions were 50×10×3 mm. The test is conducted from room temperature to 200º C at a heating rate of 2º C/min.

2.5. Water absorption test

The effect of water absorption on jute/glass hybrid composites was investigated in accordance with ASTM D 570. Five samples of size 50x50x3. They were dried at 105 ^{0} C for 24 h in a oven. The weighed samples were submerged in water at room temperature at various time intervals. The materials are from water and surface water was removed with tissue paper before weighing.

3. RESULTS AND DISCUSSION

Composites	Mechanical properties				
	Tensile strength (MPa)	Tensile modulus (GPa)	Flexural strength (MPa)	Flexural modulus (GPa)	Impact strength (Joule)
1. GGG	21.843	4.1013	15.3	7.65	9.6
2. GGN	18.564	3.7614	12.51	6.27	10.5
3. GNG	20.424	5.2674	14.82	7.44	11.5
4. NGN	15.285	3.42	9.72	4.89	12.1
5. NNG	16.812	3.3891	7.62	3.861	11.4
6. NNN	12.006	3.0816	6.93	3.51	12.3

Table -2: Mechanical properties of the hybrid fiber epoxy composites

3.1 Tensile strength and modulus of hybrid composites

The tensile strength of the maximum glass fiber composites is in the range of 20MPa to 21MPa. Whereas, in case of maximum nylon composites from 12MPa to 15MPa. Therefore, inclusion of nylonfor composites GGN and GNG have tensile strength and modulus more or less equal to pure glass fiber composites.

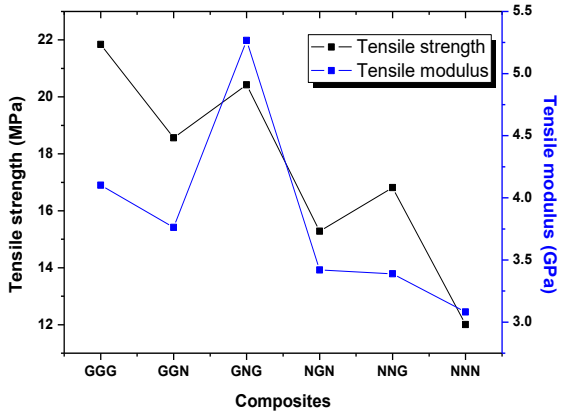

Chart -1 : Tensile strength and modulus of hybrid composites

3.2 Flexural strength and modulus of hybrid composites

Flexural strength of the glass fiber composites increases with the increase in fiber loading. Flexural strength of hybrid nylon/glass fiber composites is comparable to the pure glass fiber composites.

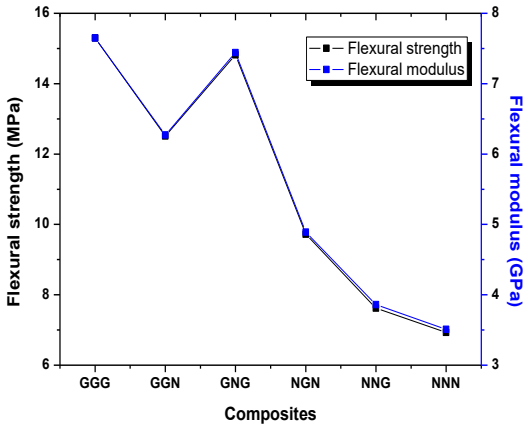

Chart-2 : Flexural strength and modulus of hybrid composites

3.3. Impact strength of composites

The impact energy of the glass fiber laminates is found to be lesser than the hybrid combination with the nylon. The impact energy of the NNG and NGN laminates exhibits nearly the same values. There is a sharp increase in the impact properties with the addition of the nylon with the glass fibers.

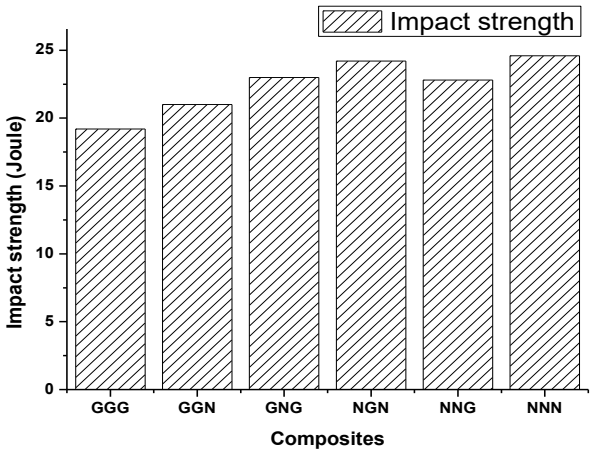

Chart-3: Impact strength

3.4. Water absorption test

The water absorption characteristics of composites NNN is high when compared to other composites because more nylon material added into the composites. The water absorption property of composites GGN and GNG has not many high because increase glass fiber content. However, water absorption of nylon composite is very useful making material for outdoor application.

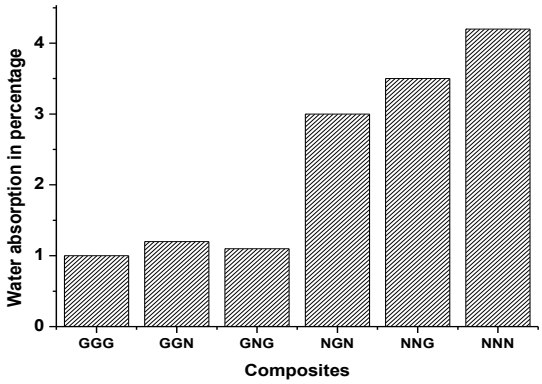

Chart-4 : Water absorption properties of composites

4. CONCLUSIONS

- The tensile strength of glass fiber is 21.84MPa and the nylon included composite is 18.564, 20.424, 15.285,16.81, 12.006 MPa respectively. So the tensile strength of the nylon composite is comparable to standard glass fiber.
- Tensile strength and stiffness are improved by the matrix material.
- The flexural strength of glass fiber is 15.3MPa and the nylon included composite is 12.51, 14.82, 9.71, 7.62, 6.93MPa respectively. So the flexural strength of the nylon included with glass fiber composite is comparable to standard glass fiber.
- The impact strength of the standard glass fiber is 9.6 Joules and the other composites with nylon are 10.5, 11.5, 12.1, 11.4, 12.3 respectively.
- For impact properties, the addition of nylon in the composites increases the impact strength
- Hence this composite can be used for application where impact strength is prominent.

- The DMA result for storage modulus of hybrid composites was found to be less at higher temperature, but it increased on increasing the nylon content.
- The storage modulus values are found to be more or less same for composites GGG and GNG which suggest that nylon can be a good substitute for glass fiber.
- Similarly, the loss modulus was observed to increase on increasing the nylon content due to effective stress transfer.
- There is significant effect on nylon content and less effect on stacking sequence.

5. ACKNOWLEDGEMENT

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