

Mechanical Properties of Prepreg Glass Fibre Reinforced Polyester Composite

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Abstract

This research investigates the mechanical properties of prepreg polyester fibre glass composites by analysing the effect of different prepreg times on their tensile strength. The objective is to determine the variation in tensile force for composite samples prepared with different prepreg durations: 0, 60, 120, 180, and 240 minutes. The samples were fabricated using a hand lay-up method, where polyester resin and glass fibre were layered in a standard mould and allowed to undergo prepregging for the specified durations. Each sample was then tested using a Universal Tensile Machine to evaluate its maximum tensile strength. The findings suggest that prepreg time influences the tensile performance of the composite, indicating a correlation between pre-curing duration and the mechanical properties of the material. This study highlights the significance of optimizing prepreg time in enhancing the structural performance of polyester resin glass composites.

Key Words: *Glass Polyester Composite, Glass Fibre, Tensile Test, Maximum Load, Prepreg*

1.0 Introduction

Polyester resin is one of the most widely used thermosetting polymers in composite manufacturing due to its low cost, ease of processing, and adequate mechanical properties for a wide range of structural applications (Sathishkumar et al., 2014). When reinforced with fibre glass, polyester composites—commonly known as polyester glass composites—exhibit significant improvements in tensile, flexural, and impact strength, making them ideal for use in transportation, marine, and civil engineering industries (Pimenta & Pinho, 2011).

Among the various forms of fibre-reinforced polymers, prepreg composites offer several advantages, such as improved fibre wet-out, controlled resin content, and reduced porosity (Bledzki & Gassan, 1999). However, the influence of prepreg conditions—specifically the prepreg time, or the interval between lay-up and final curing—on the mechanical properties of composites remains an area that requires further exploration. Prepreg time can affect the resin's viscosity, fibre-resin bonding, and ultimately the curing behaviour (Azwa et al., 2013).

Tensile testing is a key method for characterizing the mechanical behaviour of polymer composites. It provides insights into the load-bearing capacity and failure mechanisms under axial stress (Kim et al., 2005). Studies have shown that processing parameters, including curing and aging time, influence the crosslink density and fibre-matrix interfacial strength, which in turn affect tensile performance (Singha & Thakur, 2008; Sreekala & Thomas, 2003).

This study aims to investigate the effect of different prepreg durations (0, 60, 120, 180, and 240 minutes) on the tensile properties of polyester resin-fibre glass composites. By understanding the relationship between prepreg time and tensile behaviour, manufacturers can better control processing conditions to enhance performance and reduce material waste.

2.0 Material and method

2.1 Materials

The matrix material used in this study was a general-purpose polyester resin (Encore 30) commonly applied in boat manufacturing applications. The resin was catalysed with 2% methyl ethyl ketone peroxide (MEKP) to initiate the curing process. Continuous unidirectional fibre glass was selected as the reinforcing material due to its availability and

compatibility with polyester resin systems. The arrangement of the glass fibre is shown in Figure 1.



Figure 1: Unidirectional fibre glass

2.2 Sample Preparation

The composite specimens were fabricated using the hand lay-up technique in an open-air environment as shown in the Figure 2. Layers of glass fibre were manually impregnated with catalysed polyester resin and placed into a flat mould. To investigate the effect of prepreg time, the fibre–resin layups were left in open air for 60, 120, 180, and 240 minutes before final pressing and full curing. A comparison sample without any prepreg process was also prepared and designated as 0 minutes. This prepreg stage allowed for partial resin gelation prior to compression moulding.



Figure 2: Preparing sample by hand lay-up method

After the specified prepreg times, the composites were compressed gently using a steel plate and left to cure fully at ambient temperature (approximately 25°C). Once cured, the composites were removed from the mould and cut into rectangular strips with dimensions of 1.18 mm thickness and 15 mm width accordance with ASTM D3039, which specifies the geometry and preparation of flat composite specimens for tensile testing as shown in the Figure 3. This standard was selected over ASTM D638 because it is more suitable for fibre-reinforced polymer laminates, avoids the need for moulding complex dumbbell shapes, and ensures accurate measurement of tensile properties in flat coupon specimens.

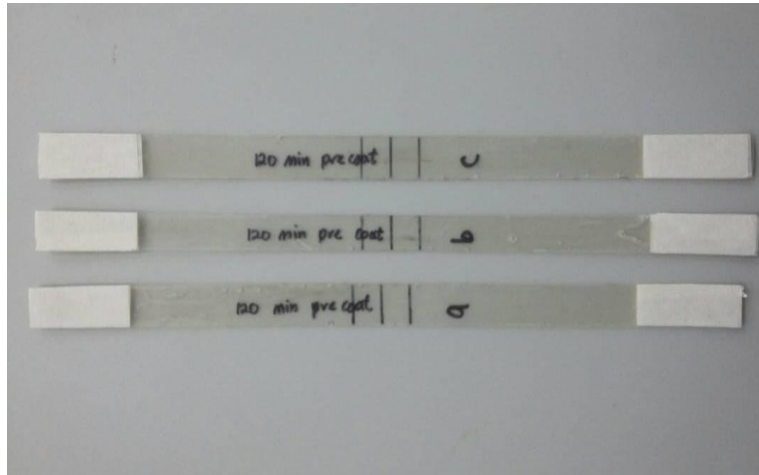


Figure 3. Samples of prepreg 120 minutes

2.3 Tensile Testing

Tensile properties of the samples were measured using a Universal Testing Machine (UTM) under ambient conditions. Each sample was clamped and subjected to a constant crosshead speed rate being 2 mm/min until failure. The maximum tensile force sustained by each sample was recorded. Three specimens were tested for each prepreg duration to ensure consistency and repeatability of results. Average values were computed to analyse trends in tensile performance as a function of prepreg time.

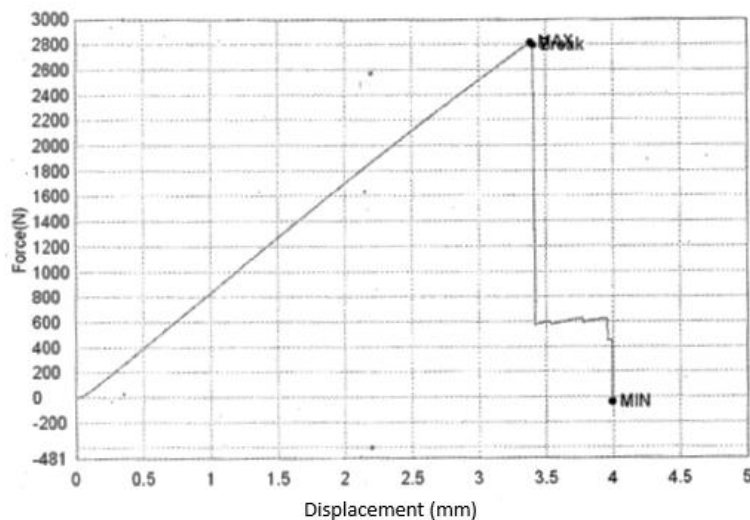


Figure 4: Sample C with prepreg time 0 minute.

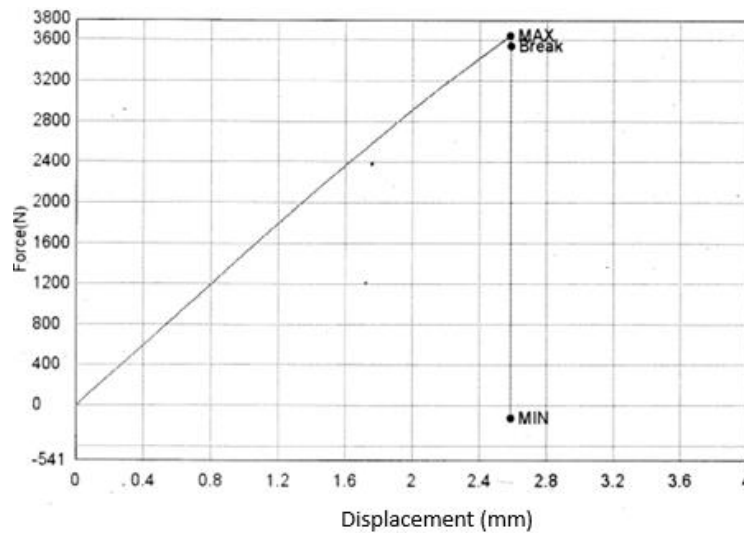


Figure 5: Sample A with prepreg time 60 minutes.

Figure 4 and Figure 5 respectively show the average maximum load before failing and break which is 3000 N for 0 minute (sample C) and 3700 N for 60 minutes (Sample A). Average maximum load for all sample is show in the Table 1.

3.0 Result and Discussion

3.1 Effect of Prepreg Time on Tensile Strength

The tensile test results for the polyester resin–fibre glass composites with varying prepreg times are summarized in Table 1 and Figure 6. Both the average maximum force and the corresponding maximum tensile stress values show clear trends in relation to the prepreg duration.

Table 1: Effect of prepreg time on the tensile properties of the composites.

Prepreg Time (min)	Avg. Max Load (N)	Avg. Max Stress (N/mm ²)
0	2791.30	157.1
60	3333.16	177.6
120	3867.01	206.7
180	3382.83	184.9
240	2835.95	155.9

The composite samples with 120 minutes of prepreg time recorded the highest tensile strength, reaching 206.7 N/mm², while the lowest value of 155.9 N/mm² was observed at 240 minutes. This suggests that an optimal prepreg duration exists that enhances fibre-matrix bonding without excessive premature curing.

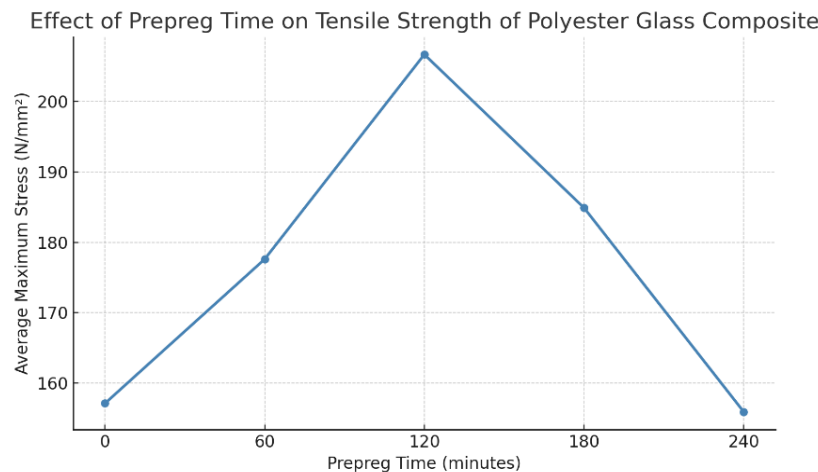


Figure 6: Effect of prepreg time on tensile of polyester glass-fibre composite

The initial increase in strength from 0 to 120 minutes can be attributed to improved resin penetration and partial crosslinking before final curing. As the resin becomes slightly more viscous during early gelation, it likely enhances adhesion to the glass fibres, leading to better load transfer under tensile loading (Bledzki & Gassan, 1999; Singha & Thakur, 2008).

However, beyond 120 minutes, a decline in tensile properties was observed. At 240 minutes, the tensile strength dropped significantly. This reduction may result from over-curing during the prepreg stage, which limits final crosslinking during the full curing process, leading to poor interfacial bonding and possible embrittlement (Azwa et al., 2013; Sreekala & Thomas, 2003).

3.2 Summary of Mechanical Behaviour

The results confirm that prepreg time is a critical parameter influencing the tensile performance of polyester resin–glass fibre composites.

- i. Moderate prepreg time (120 minutes) enhances fibre–matrix adhesion, resin distribution, and overall tensile strength.
- ii. Excessive prepreg time (>180 minutes) leads to premature resin hardening, diminished interfacial bonding, and reduced mechanical performance.

4.0 Conclusion

The results show that a 120-minute prepreg time produces the highest tensile strength (206.7 N/mm²) for polyester resin–glass fibre composites. This highlights the practical importance of optimising prepreg duration to achieve maximum fibre–matrix adhesion and mechanical performance. Proper control of prepreg time can prevent incomplete wetting at shorter durations and premature resin hardening at longer durations. These findings are directly applicable in industries such as automotive, marine, and aerospace, where prepreg composites are used for lightweight, high-strength structural components, enabling better performance and durability.

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