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ANALYSIS OF MECHANICAL BEHAVIOUR OF COMPOSITE PLATES MADE WITH NATURALRESIN UNDER ULTRA VIOLET CURING -IN COMPARISON WITH NATURAL CURING

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ABSTRACT

In the recent years, natural resins have received much more attention than ever before in the research community. The natural resins offer a number of advantages over commercial resins [1]. In the present communication a study on the synthesis and mechanical properties of Acacia resins reinforced with E-Glass fiber based polymer composites has been reported. Mechanical properties of intimately mixed Acacia resins reinforced polymer composites such as tensile, shear, adhesive and wear properties were investigated. Initially Acacia resin prepared was subjected to evaluation of its optimum mechanical properties. Then the natural fiber reinforced composite was cured under Ultra Violet radiation. Present work reveals that mechanical properties such as tensile strength, water resistance and wear resistance etc, of those natural resins increases to considerable extent when cured under Ultra Violet Radiation. It is also compared with synthetic resins.

Keywords: natural resins, mechanical testing, reinforcements, ultra violet radiation.

INTRODUCTION

Natural resins have gained major attention in the recent research field as they are degradable and easy to use when compared to the traditional polymer resins especially epoxy [1]. Epoxy resins are well known for their release of volatile organic compounds when they are set to cure [8]. But however epoxy and similar polymer resins are more brittle and a very good adhesive agent, this raises their upper hand when it comes to manufacturing of fiber matrix composite structures [2]. Use of epoxy resins increases the chance of cancer and related diseases to the humans and other living creature when they are exposed to it. In this paper we aim at replacing polymer resins with natural resins [5].

In our previous study we have discussed about the adhesive property of the natural resisns and how to increase the same. During the study we have understood the natural resins only have very less adhesive property and that can be increased by addition of nano powders like calcium oxide and so. We also observed that the nano particles can only increases their adhesive and tensile property on the natural resins, and it is more flexible and less brittle [4]. In this paper we have discussed about how to manufacture composite plates with natural resins and the ways to increase its mechanical properties and production time by introduction it to Ultra Violet (UV) rays [7].

MATERIALS AND METHODS

For study purpose we have useduni-directional E grade glass fiber laminates, Acacia Resin as plant based resin, UV lamps, glass plate, breather, polyethylene sheets, thinner for the purpose of cleaning, wax pol as a separator between glass plate and composite plate, epoxy paint brush and a roller, m-seal for creating dam. Hand lay-up method is used for making the samples. Initially the glass plate is cleaned with thinner and is coated with wax pol [8]. Commonly available m-seal sealant is fixed around the glass plate so that epoxy will not flow outside the glass plate. E glass fiber laminates are placed one over the other with O^O orientation. For analysis of the strength of the composite plate O^O orientation will be suitable for the study purpose. The mixed up epoxy with hardener is evenly spreaded over the laminates and the rolled over by the roller. The roller is rolled gently so that the epoxy fills all the gap between the laminates leaving no voids. The prepared composite plate is let to cure naturally for 12 hours [7]. It is cut into 150mm X 10mm plates. Similarly another set of composite plates are prepared let to cure under UV light for 6 hours. It is then cut into 150mm X 10mm plates [8]. 9 samples of each of the cases is collected and subjected to flexural rigidity test, three point bending test and hardness test. Samples cure under UV light is named as UV-CP<sample_number>, and samples cured naturally are named as N-CP<sample_number>.

EXPERIMENTATION

In each of the experiment three samples from each case are used. Inter-laminar shear stress test tells us about the rigidity of the composite material and also how far the laminates separate from the matrix. For flexural rigidity test, sample length is reduced to 50mm and is placed on a simply supported supports which are 30mm apart in a Universal Testing Machine (UTM). The force is given at the center of the test sample and ultimate load at which the sample buckles is noted down. The results for the same are tabulated in Table-1 and are discussed in Figure-1.

A flexural rigidity test also known as three point bending test is widely used to study the bending property of plates, rods and so on. Sample of 150mm length is placed on a 100mm wide support in an UTM and is subjected to load in its center. The sample will tend to

bend and ultimate breaking load is collected for each sample in Table-2 and is discussed in Figure-2.

Brinell hardness test is specifically used to identify the hardness of the composite plate cured naturally and cured under UV radiation. The values for the same are listed in Table-3 and discussed in Figure-3.

REINFORCEMENT WITH NANO PARTICLES CALCIUM OXIDE FOR BETTER TENSILE AND SHEAR STRENGTH

The addition of nano powders of calcium oxide in the mixture of resins improves the tensile and shear strength of the samples joined by these mixtures. After the synthesis of the resins and before applying to the rustic wooden samples, the calculated amount of calcium hydroxide is mixed with resins [10]. Then applied over the wood and left it for same curing time as mentioned above under same conditions. The same testing procedures are followed and the adhesive and tensile strength after reinforcement are calculated with the load applied till the samples tore and separated from each other.

In order to mix the nano powders of calcium oxide with the mixture of resins, the amount of those nano powders need to be precisely calculated for better curing of the sample and for the precise reading in testing procedures [13].

SILICON DIOXIDE FOR BETTER TENSILE AND SHEAR STRENGTH

The addition of nano powders of silicon dioxide in the mixture of resins improves the tensile and shear strength of the samples joined by these mixtures. After the synthesis of the resins and before applying to the rustic wooden samples, the calculated amount of calcium hydroxide is mixed with resins. Then applied over the wood and left it for same curing time as mentioned above under same conditions. The same testing procedures are followed and the adhesive and tensile strength after reinforcement are calculated with the load applied till the samples tore and separated from each other.

In order to mix the nano powders of silicon dioxide with the mixture of resins, the amount of those nano powders need to be precisely calculated for better curing of the sample and for the precise reading in testing procedures.

RESULTS AND DISCUSSIONS

From Figures-1 and 2 we have absorbed that there is a considerable increase in the shear and flexural strength the composite plate which is cured under ultra violet radiation [11]. The increase in strength is not so huge, but however there is a considerable increase in the strength of the composite plate. The flexural rigidity strength increases from 575MPa to 593MPa, whereas the inter-laminar shear stress strength increases from 36MPa to 38MPa. The main objective of this study is to identify the increase in brittleness of the composite plate made up of natural resin. As we know that the natural resin after cured will not be as brittle as glass, which is now overcome with the introduction of UV radiation during the curing. From Figure-3 we have observed that the brittleness has increased a lot from 39HB to 45HB, which makes the natural resin composite plate to be brittle like composite plate made up of epoxy resins.

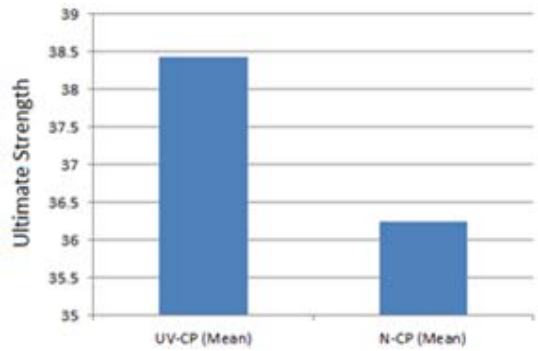

Figure-1. Interlaminarshear stress.

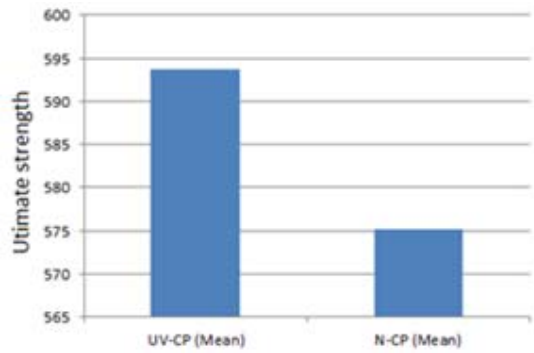

Figure-2. Flexural rigidity test.

It is also discussed earlier in material and methods that curing time given for composite plates subjected to cure under UV radiation is only 6hours against the composite plates cured naturally. Form this it is observed that there is only increase in material property of the composite plate cured under UV radiation with less curing time. Henceforth natural resin composite plates can be recommended to cure under ultra violet radiation. The work can be extended further to find the manufacturing process for bulk production of the natural resin composite plate cured under UV radiation.

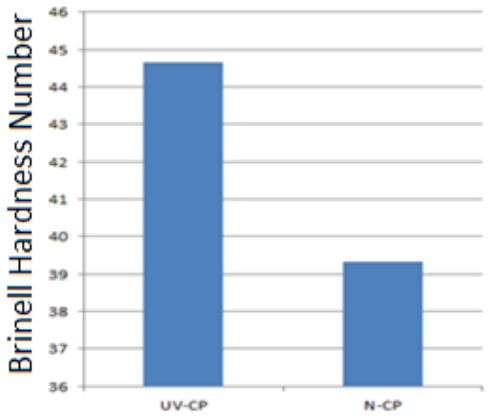

Figure-3. Brinell hardness test.

Table-1. Inter-laminar shear stress.

Sample number	Initial strength (MPa)	Ultimate strength (MPa)
UV-CP-1	24.86	38.48
UV-CP-2	23.24	38.35
UV-CP-3	24.52	38.47
UV-CP (Mean)	24.21	38.43
N-CP-1	22.72	36.15
N-CP-2	22.63	36.33
N-CP-3	22.74	36.25
N-CP (Mean)	22.70	36.24

Table-2. Flexural rigidity test.

Sample number	Initial Strength (MPa)	Ultimate strength (MPa)
UV-CP-4	521.28	593.61
UV-CP-5	521.18	594.01
UV-CP-6	521.52	593.65
UV-CP (Mean)	521.33	593.76
N-CP-4	501.16	575.01
N-CP-5	501.22	575.56
N-CP-6	501.19	575.00
N-CP (Mean)	501.19	575.19

Table-3. Brinell hardness number.

Sample number	Brinell Hardness Number (HB)
UV-CP-7	45
UV-CP-8	44
UV-CP-9	45
UV-CP (Mean)	44.66667
N-CP-7	40
N-CP-8	39
N-CP-9	39
N-CP (Mean)	39.33333

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