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Examination of Modulus of Rupture of Fibre mat Bonded with Potential Adhesives

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ABSTRACT

Composites made up of synthetic fibre mats are strongly recommended to various structural applications due to its excellent load resistance and light weight comparably to metals directing to replace the conventional materials for potential applications. In addition to this, the glass fiber reinforced epoxy composites, like any other fiber reinforced polymer composites, offer many advantages over the conventional structural materials due to their excellent resistance against bending. These alternatives plays dignified role in multi disciplinary sections of engineering. The performance of the composites can further be improved by adding fillers to them. The present work aims at using wollastonite as a filler material and this work also includes the experimental evaluation of flexural properties of series of such as wollastonite filled glass-epoxy composites (for both woven and chopped mat type). It was clearly noticed that addition of filler material aims to vary the resistance of material against rupture. As the filler percentage increases which increases the load taking ability of material is clearly recorded and the corresponding values are detailed to examine the rupture resistance of fibre mat bonded with thermo set adhesives.

Keywords: Rupture Strength, Fibrous Composites.

I. INTRODUCTION

Counteracting with load acting on light weight fibre plastics it is more essential to modify the core composition of bonding configuration to resist the sudden rupture of the material. In this aspect composite materials emerge as a promising alternative to correct the deficiencies caused by steel reinforcement in concrete structures [1-5]. Composite materials have replaced metals in various engineering applications owing to their numerous advantages, like high strength/weight ratio, low cost, low density, better stealth properties, etc. Because of the characteristic resemblance of these composite structures find versatile applications in various streams like navy force, aerospace, army vehicles. The structural domains of PMC's hardly depict the reinforcing material and load transfer and bonding agent called matrix material. Generally the fibre material used is forecasted with strong and tough material chosen among varieties of classification of fibre materials which is shaped with the help of soft polymer called matrix material which is usually ductile, and holds the reinforcement together permanently and thereby deliver actual shape for the composites. FRP's found widespread applications in construction due to strength to weight ratio and stiffness of the structural laminates when subjected to bending load. The most energetic feature about composites like better corrosion resistance and resistance to fatigue loading makes engineers very exciting to adapt these materials to the applications related to the structural interpretation through different types of testing. It has been observed that the cost effectiveness is the significant factor which derives the commercial choice to decide the cost of the developing material initializing from production of the material, response of a material towards testing related to application and durability of the material over the period of time. In this theme glass fibre reinforced composites sounds greatly in marine structures along with civil engineering applications. The most common type of glass fibre used is woven fabric which is available with varieties of GSM(gram/square meter).The reason is ease of manufacturing with faster wet out while mixing with resin. In addition to this easy of handling and cost effectiveness makes material experts to grab the glass ravings from the family of different GSM's. Compared with other fibres family the glass fibre assures better interlaminar shear properties due to the proper nesting between interlaminates.

II. FABRICATION OF SPECIMENS

The glass fibre mat is used as a reinforcement where the type of fibre mat is utilized are named as woven fabric (360gsm) and chopped strand mat (200gsm) type respectively. The matrix material employed here is epoxy resin (araldite GY250) and hardener (teta). With the introduction of highly pronounced material in the concrete technology which execute more strength in concrete structure called wollastonite powder having the chemical name calcium-ino-silicate mineral is used as a filler material to load in composite structures with different percentage. Glass fibre constitutes with fine threads which contributes greatly against external loading due to glass fibre shows exceptional properties. Even though glass fibres are not strong as like graphite fibres,because of negligible brittlness and availability with less price makes these fibres are chosen as better option to consider it as reinforcing material. Here type of glass fibre used is E-glass; The Electrical insulators (E-glass) composed with oxides of silica, aluminium and calcium. The glass fiber is known for calcium alumino borosilicate glass. Epoxy resin with lesser molecular weight pre polymers which are being processed under a different conditions. In this present research work, mineral material called wollostonite with fine powder is used as a filler material. Wollastonite sample collected is as shown in Fig.1. The arrangement of die for synthesizing composites and compressing arrangements are shown in Fig 1.

Fig1. Die arrangement

According to the volume fraction calculation made,16 layers of 250x250 mm sized laminates of both type (woven fabric &CSM) glass fiber was cut and corresponding amount of Epoxy resin was weighed. Required amount of powdered filler was added. The different percentage (1%,3%, 5%, 7%) of filler material was added to the resin and hardener mixture. The epoxy and hardener proportion ratio of 10:1 was premixed and thoroughly stirred before starting layup process. The surfaces of the laminate will be completely cleaned to ensure that the laminates are free from any impurities. This process is primary operation that could be carried out before binding of laminates takes place with room temperature and pressure. The most convenient method, hand layup technique was employed as the glass fiber along with resin was compressed and allowed to cure for 24hours in the die arrangement. Prepared sample thicknesses of 4mm are maintained. Fabricated and completely cured specimens of both woven fabric and chopped strand samples are shown in fig 2 and 3 respectively.

Fig2. Woven fibre mat sample   Fig.3 Chopped mat

III. EXPERIMENTAL METHOD

Under flexural loading conditions, the flexural test measures the force required to bend a beam. The data regarding to flexural properties help to select materials for parts that will resist loads without flexing. The ability of material to oppose deformation under load concludes the flexural strength of the material. Here material's stiffness when it is flexed is determined by Flexural modulus [6]. The damage occurrence to the material is observed but it does not contribute greatly to cause the fracture of the specimen to occur. At yield point the value of the load is found to be 5% deformation/strain of the exterior surface which is documented as flexural strength. The test beam specimen is under compressive stress at the concave (inner) surface and tensile stress (Outer) at the convex surface. The flexural modulus of the material (the ratio of stress to strain in flexural deformation)is overtaken with the help of ASTM D790 test procedure.

Fig 4. UTM MACHINE (three point bend test)

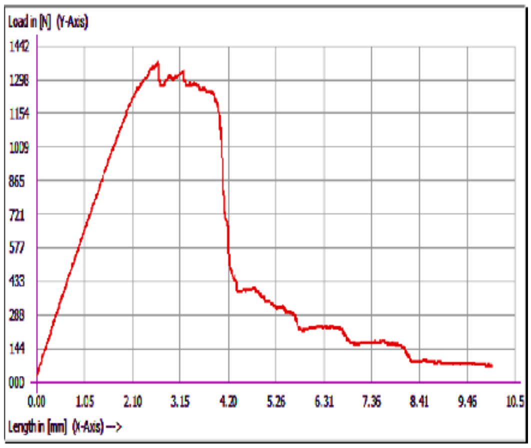

Fig 5.load v/s length graph for woven(1%filler)

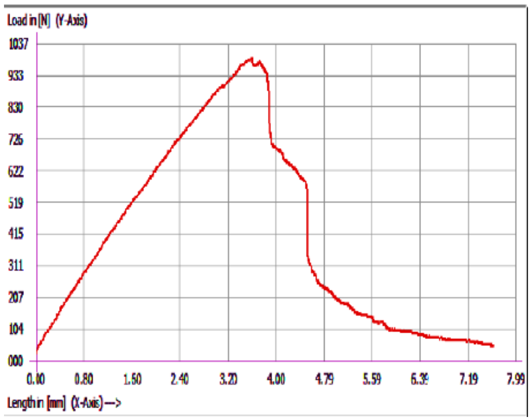

Fig 6.load v/s length graph for chopped(1%filler)

1. Test Procedure

The three-point bending test is conducted as according to ASTM standards. As per ASTM D790, the test is terminated when the specimen attaines 5% deflection or the specimen breaks.The specimen with the given span is supported between two supports as a simply supported beam and the load is applied at the centre by the loading nose producing three point bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM[7]

2. Standard specimen size

Three-point bending tests were conducted in a servo controlled UTM machine having a load cell capacity of 100kN which is as shown in fig 5.A varying specimen shapes and sizes can be used for this test, but the most commonly used specimen size for ASTM D790 is 3.2mm x 12.7mm x 125mm [8]. In this experiment dimensions for all flexural specimens is maintained to be 4mm x 10mm x 90mm. The crosshead speed was maintained at 2mm/min .Both woven and chopped samples of constant thickness were prepared, testing is to be done and results are tabulated.

Table – 1 Result of Bend Tests

a) For woven fabric samples

Details	**Woven sample with different filler in (%)**				
	0	**1**	**3**	**5**	**7**
Max. peak load (KN)	1.3	1.4	1.45	1.5	2.1
Flexural Strength N/mm2	772.7	789.8	819.3	874.5	1202.54
3Point Bend Modulus[MPa]	64331.5	33961	43066	66829	42435

b) For chopped strand mat samples

Details	**Chopped sample with different filler in(%)**				
	0	**1**	**3**	**5**	**7**
Max. peak load (KN)	5.7	9.8	1.2	1.2	1.3
Flexural Strength N/mm2	326.2	555.29	706.36	735.32	767.53
3Point Bend Modulus[MPa]	39013.5	31189.7	11728.2	17334.6	27273.1

IV. RESULTS & DISCUSSIONS

The filler filled woven and chopped samples with different proportions of filler such as 1%,3%,5%,7% are carried out perfectly. In order to determine the flexural parameters such as flexural stiffness, Strength of composite specimens, Simple digital flexural test System is used. Flexural parameters of laminated Composites were tested and results tabulated for various variation of sample thickness as per tests recommended by ASTM standards. Based on the available test data the values are analyzed and there is meaningful obey of test results has been observed. Fig 6&7 describes typical flexural load vs. deflection of woven sample of having 1% filler and chopped sample of 1% filler (only 2 sample graphs have been indicated). For both the specimens it is clearly observed that curves depicts the linear behavior until failure. Curves show inflection at the point of yielding in both cases; however the deflection is more in case of chopped when compared to woven.

Flexural strength and Flexural stiffness have been recorded. It can be observed from table 1, that increase in the percentage of adding filler for both woven and chopped specimens there is significant increase in the strength as well as stiffness values. However, the increase in strength and stiffness in case of woven seems to be more significant as compared to chopped fibers. Finally, the application of woven fibers seems to manifest in terms of flexural properties as compared to glass fibers.

V. CONCLUSION

The present research work reflects the significance of adding wollastonite filler which take part in improving the bending strength, stiffness of glass fabric composites and also point outs the work of comparing the test results of both woven and chopped laminates. Three point bending tests were performed on Glass fiber (360 gsm woven & 200 gsm chopped) composite specimens. The load-deflection curve was evaluated. Two types of laminates were tested with increased filler percentage. The outcome of the present investigation is discussed as follows:

1. Under flexural loading conditions, while assessing the behaviour of composite material, it is clear that addition of filler material will greatly improves bending strength of glass fibres and thereby results higher stiffness values.
2. Three point bending method probably provides a better estimate of the actual material behaviour under flexural loading.
3. While compared with woven fabric composites, chopped samples exhibits lower bending strength, this indicates that there is a significant improvement in strength and stiffness of woven laminates as compared to chopped for equal thicknesses under test. This may be due to good adhesion between woven fibre and matrix.

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