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Analysis of Fique Fiber Thermoset Vinyl Estercomposite stensile and Flexural Strengths

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Abstract: Fique fiber reinforced thermoset vinyl estercomposites are most widely used ascomposite materials. The demand for light weight composite materials hasled to the development of fly ash based composite materials. In the present work, the effects of fly ash content on tensile strength and flexural strength of 10wt. % fique fiber thermoset vinyl ester composites werestudied. The fly ash content is varied from 0 to 10grams in steps of 2grams. The composite with 6grams fly ash exhibited better tensile strength when compared to the other composites. Similarly the composite with 4grams fly ash exhibited better flexural strength.

Keywords: thermoset vinyl estercomposites, fly ash, tensile strength, flexural strength.

1. Introduction

Natural fiber reinforced epoxy composites results in an attractive combination of physical and strength properties which cannot be obtained by monolithic materials ((Kotiveerachari et al, 1999), (Chennakesava et al, 2010)). These are widely used due to ease of availability of natural fibers and economic processing techniques adopted for production of components. Developments are still under way to tailor their properties for extreme loading conditions. One way to improve the strength of the FRP composites is to add various filler materials. These filler materials act as additional reinforcing components and enhance their strengthproperties. The properties of these composites depend on the type and size of the filler material used ((Sateesh et al, 2013), (Devendra et al, 2013)). Addition of silicon carbide, alumina, and titanium carbide improves hardness, strength and wear resistance of the composites ((Amar et al, 2009),

(Chauhan et al, 2009)). Graphite particles improved erosive wear resistance of natural fiber epoxy composites (Basava et al, 2011). Interest in reinforcing fly ash to FRP composites is mainly due to low density, low coefficient of thermal expansion and high strength obtained in these composites. The addition of fly ash and mica particles to the polyetheretherketone (PEEK) composites increased the tensile strength, tensile modulus and flexural modulus (Rahail et al, 2010). The addition of fly ash to epoxy resin composites increased the compressive strength (Manoj et al, 2010). The addition of fly ash as filler material in natural vinyl ester composite increased its wear resistance (Chauhan et al, 2010). The impact strength of the epoxy laminated bamboo composite increased with addition of cenospher as a filler material (Hemalata et al, 2012). The addition of coal ash to natural fiber polymer matrix composites improved their mechanical strength (Naresh et al, 2013). In the present workan attempt is made to study the effect of fly ash as a filler material in thermoset vinyl esterfique fiber reinforced composites.

2. Experimentation

The following section highlights the materials used, fabrication and testing of composites.

2.1. Materials

The matrix material used for fabrication of the composites is vinyl esterresin and corresponding hardeners are used. Fique fiber is used as the reinforcing material and the fly ashis used as the filler material.

2.2. Fabrication and Testing of Composites

Hand lay-up technique is adopted for fabrication of the composites. Releasing agent is applied in the mould and a cut ply of fique fiber is placed in the mould. The resin mixed with the fly ash, additives and catalyst is poured into the mould and allowed to dry for 24 hours. The dried sample is removed from the mould and cut into the shape of standard specimens. The designation of the specimens is shown in Table 1. Electronic tensometer is used for determining the tensile and flexural strength of the composites.

Table 1: Designation of the Specimen.

S/N	SPECIMEN DESIGNATION	FIQUE FIBER (GRAMS)	VINYL ESTER THERMOSET MATRIX	FLY ASH (GRAMS)
1	A1	7	50	0
2	A2	7	48	2
3	A3	7	46	4
4	A4	7	44	6
5	A5	7	42	8
6	A6	7	40	10

3. Results and Discussions

From the fabricated composites, the test specimens are prepared as per ASTM standards and are tested to evaluate their tensile and flexural strength. The results obtained by conducting these tests are given below.

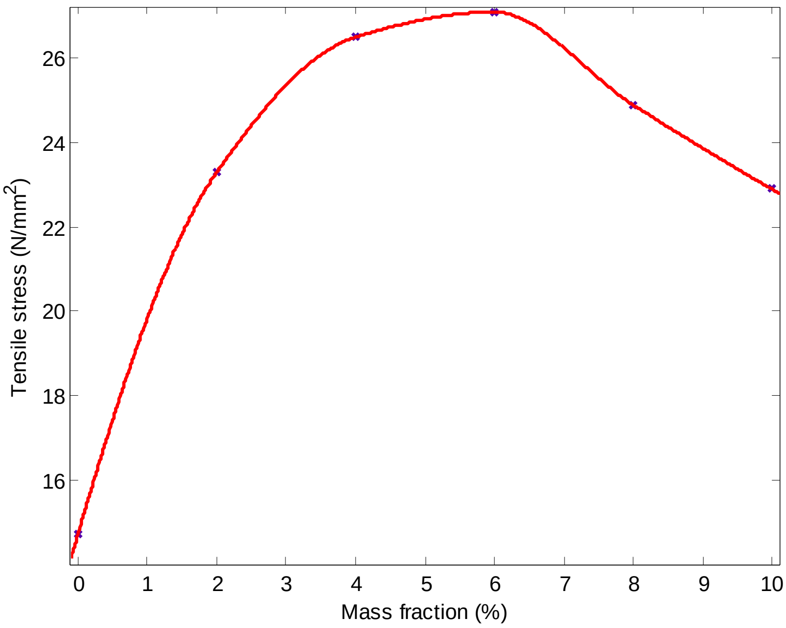

Figure 1: Tensile strength of composites

Table 1a: Analysis table for tensile strength of composites

X_i	$f(X_i)$	$df(X_i)/dX$	$d^2f(X_i)/dX^2$	$integral\ f(X_i)$
0	14.7	5.65	-0.732203	0
1	19.8294	4.45445	-1.6589	17.3644
2	23.3	2.3322	-0.36967	39.1059
3	25.3567	1.69063	-0.91347	63.4878
4	26.5	0.505263	-0.110526	89.5149
5	26.9263	0.323684	-0.252632	116.243
6	27.1	0	-2.25238	143.283
7	26.2619	-1.3881	-0.52381	170.08
8	24.9	-1.04762	0.0452381	195.633
9	23.8756	-1.0006	0.0488095	220.016
10	22.9	-0.95	0.052381	243.4

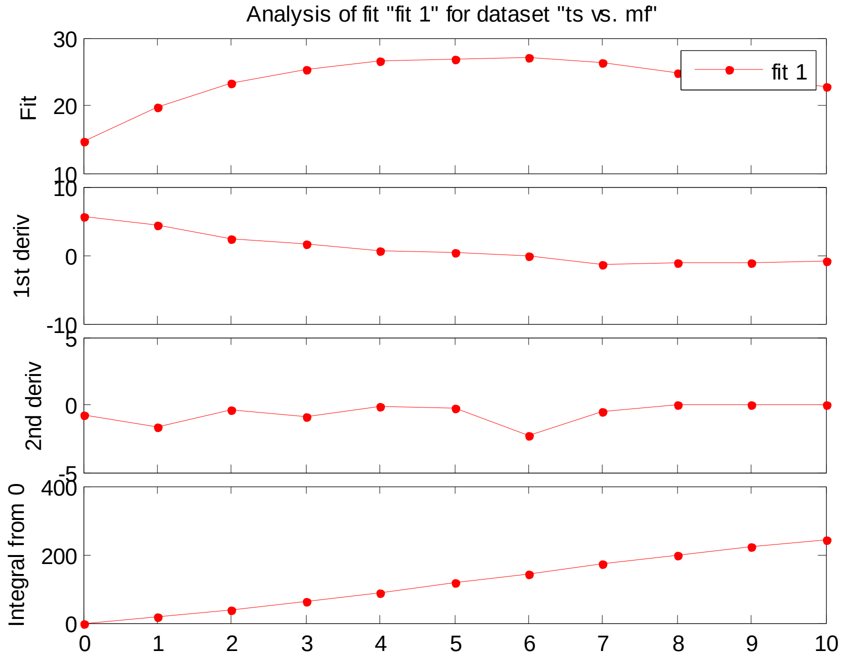

Figure 1a: Analysis fit for tensile strength of composites

3.1. Tensile Strength

The effect of fly ash content on the tensile strength of the composite is shown in figures 1 and 1a. It is observed that the tensile strength varies from 14.7727N/mm^2 to 27.17N/mm^2. The tensile strength increases with the increase in fly ash upto 6grmas and thereafter it decreases. The increase in tensile strength with the increase in fly ash can be attributed to the good interfacial bonding between the fly ash and the matrix. As the fly ashcontent is further increased the composite transforms into brittle and hence the tensile strength decreases.

3.2. Tensile Modulus of Elasticity

Figure 2 and 2a shows the effect of fly ash on the tensile modulus of elasticity for various composites. The tensile modulus of elasticity varies from 946.067 N/mm^2 to 2548.428 N/mm^2 and the maximum is obtained for specimen with fly ash content equal to 8grams.

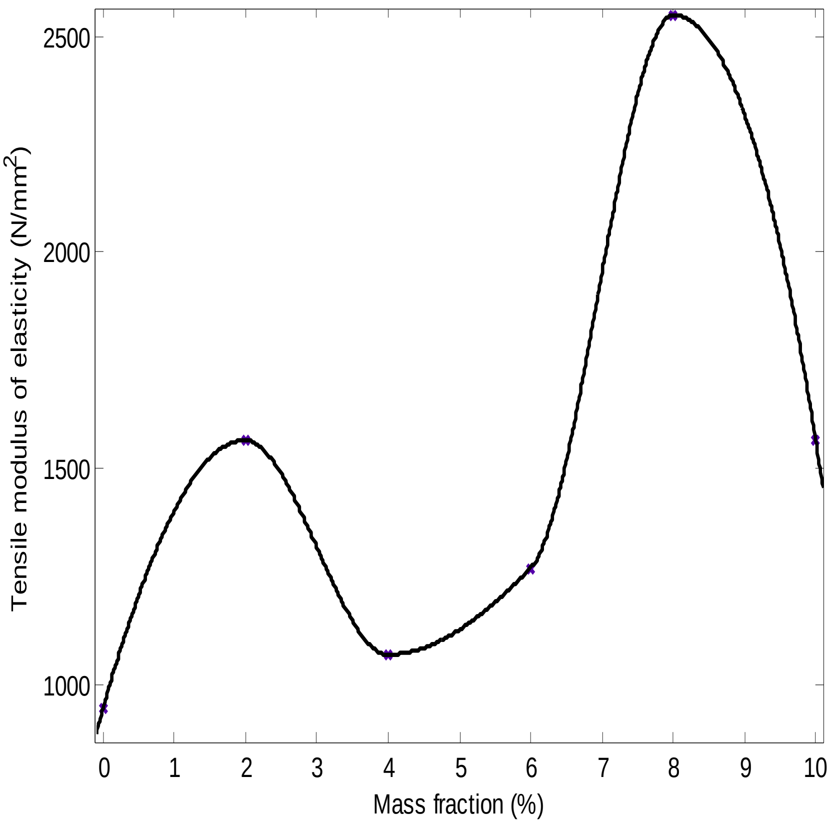

Figure 2: Tensile modulus of composites

Table 2a: Analysis table for tensile modulus of composites

X_i	$f(X_i)$	$df(X_i)/dX$	$d^2f(X_i)/dX^2$	$integral\ f(X_i)$
0	946	588.75	-247.5	0
1	1403.19	317.813	-294.375	1197.17
2	1566	0	-742.5	2708.25
3	1318.5	-371.25	0	4181.44
4	1071	0	126.312	5345.25
5	1127.45	106.203	86.0941	6435.63
6	1270	172.188	1572.62	7628.85
7	1952.05	915.453	-86.0941	9177.94
8	2548	0	-417.75	11504.2
9	2320.69	-473.063	-528.375	13978
10	1565	-1056.75	-639	15969.5

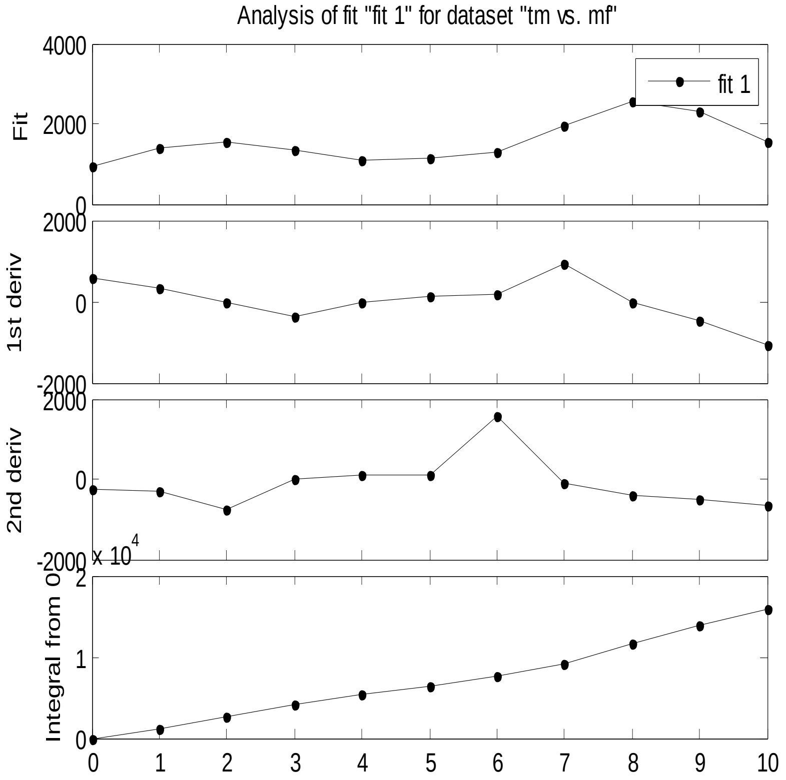

Figure 2a: Analysis fit for tensile modulus of composites

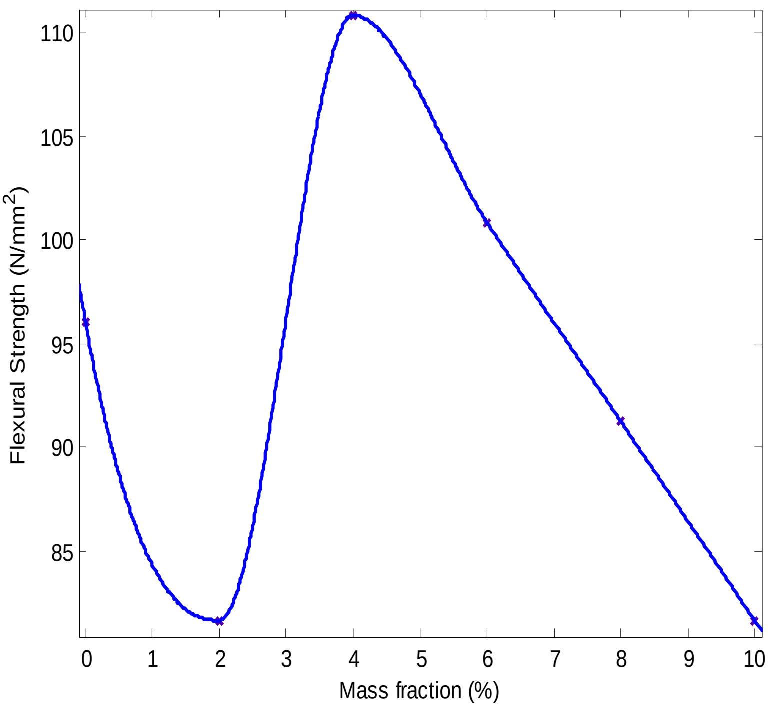

Figure 3: Flexural strength of composites

Table 3a: Analysis table for flexural strength of composites

X_i	$f(X_i)$	$df(X_i)/dX$	$d^2f(X_i)/dX^2$	$integral\ f(X_i)$
0	96.048	-18.098	14.596	0
1	84.3235	-6.2755	9.049	89.2005
2	81.648	0	43.788	171.663
3	96.648	21.894	0	258.785
4	110.84	0	-10.1041	364.151
5	107.064	-6.27603	-2.44794	473.626
6	100.84	-4.89588	0.201751	577.463
7	96.0195	-4.77053	0.0489384	675.883
8	91.248	-4.798	-0.00200167	769.519
9	86.449	-4.8	-0.00200042	858.367
10	81.648	-4.802	-0.00199917	942.416

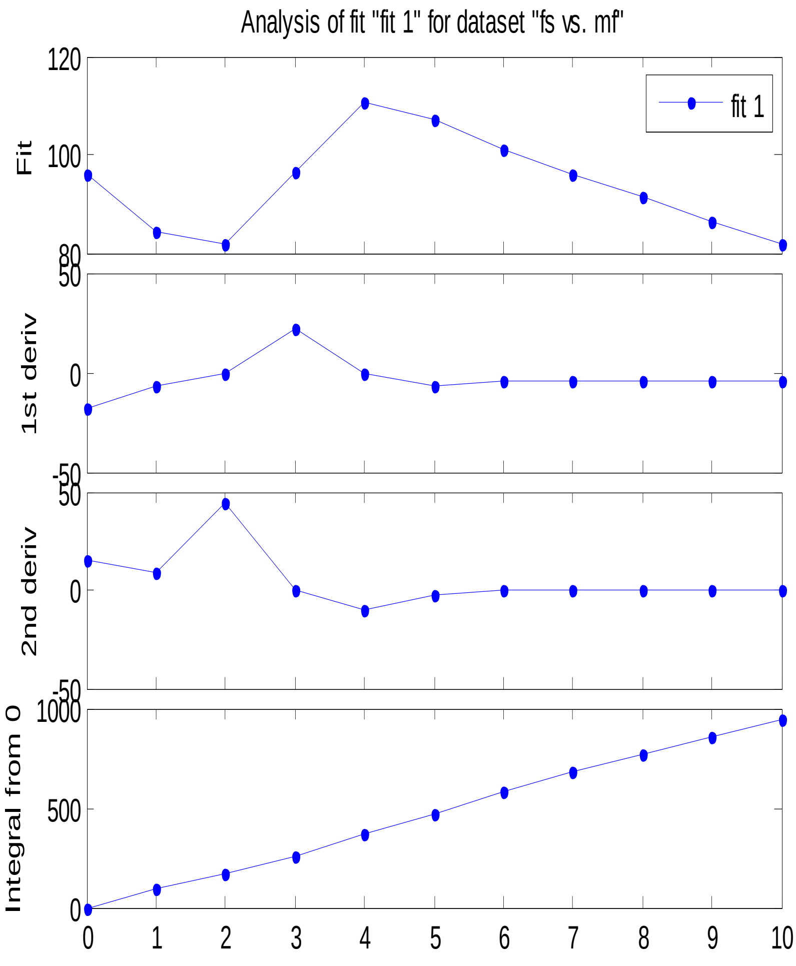

Figure 3a: Analysis fit for flexural strength of composites

3.3. Flexural Strength

The flexural strength of the composite is determined from 3-point bend test. The flexural strength for various composites is shown in figures 3 and 3a. The flexural strength of the composites varies from 81.648 N/mm^2 to 110.497 N/mm^{2}and the maximum value is obtained for composite with 4grams of fly ash. The flexural strength decreases, reaches a maximum value and again decreases with the addition of fly ash in the vinyl ester matrix.

4. Conclusions

The experimental investigation on the analysis of tensile and flexural behavior of fly ash reinforced fique fiber vinyl ester composites with different weight percent of fly ash have been studied out. The conclusions drawn from the present work are.

1. The tensile strength of the composites varied from 14.7727 N/mm^2 to27.1790 N/mm^2 and the maximum is obtained for composite with 6grams fly ash.
2. The maximum tensile modulus of elasticity is obtained for the composite with 8grams fly ash.
3. The flexural strength of the composite varies from 81.648 N/mm^2 to 110.497 N/mm^2. The maximum flexural strength is obtained for the composite with 4grams fly ash.

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