



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

**Volume 9, Issue 9, September 2020**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# Experimental Study of Mechanical Behaviour of Fiber Matrix Interfaces of The Epoxy and Polyester Reinforced with En-8 Carbon Steel

M.Ajith Kumar<sup>1</sup>, Giritharan P<sup>2</sup>, Hari Prasad M<sup>3</sup>, Yogesh S<sup>4</sup>

P.G. Scholar, Department of Manufacturing Engineering, Kamaraj College of Engineering and Technology, Madurai, India<sup>1</sup>

Alumnus, Mangayarkarasi College of Engineering, Madurai, India<sup>2</sup>

UG Scholar, Department of Mechanical Engineering, Mangayarkarasi College of Engineering, Madurai, India<sup>3</sup>

UG Scholar, Department of Mechanical Engineering, Mangayarkarasi College of Engineering, Madurai, India<sup>4</sup>

**ABSTRACT:** An Experimental study of the fiber matrix Interfaces on the stress of the Epoxy and polyester reinforced with long ferrous (En-8 carbon steel) and Nonferrous (Aluminium) is desired. Tensile test, Impact test Torsion test shows the existences of interfaces between fiber & matrix which are linear and Nonlinear of the material with two different types of long fibers. The number of debonding stress are characterizing each interface of the different debonding length. Mechanical properties are calculated by the manual testing using Tensile, Torsion, and Impact tests.

**KEYWORDS:** Bimetal, Torsion test, bounding, Matrix composites

## I. INTRODUCTION

A composite material is a material made from two or more constituent significantly different physical or chemical properties that, when combined, produce a material with characteristics different from individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expansive when compared to traditional materials.

Typical engineered composite materials include:

- Mortars, concrete
- Reinforced plastics, such as fiber-reinforced polymer
- Metal composites
- Ceramics composites

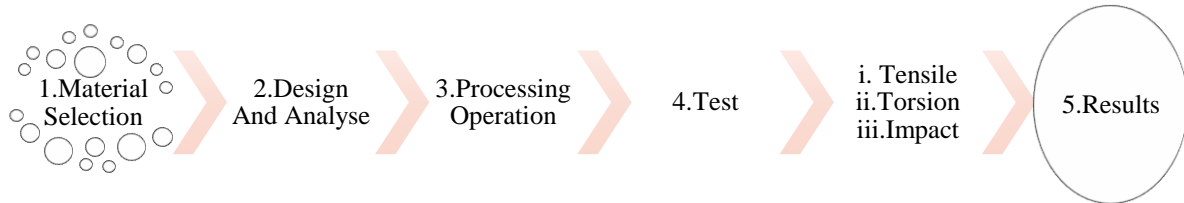
Many composite materials are composed of just two phase; one is termed the matrix, which continuous and surrounds the other phase, often called the dispersed phase. The properties of composites are a function of the properties of the constituent phases, their relative amounts, and the geometry of the dispersed phase.

## II. OBJECTIVES

Our objective is to:

- Select the right material for design and analysis.
- Make the composite sample workpiece from designed material.
- Performing Tensile, Torsion, and Impact test on finished product and tabulate the results.

**III.METHODOLOGY**



**IV.MATRIX FORMATION**

We had make the composite matrix of metals combination of two that is Steel vs. polyester and Steel vs. Epoxy. These two composite matrix are processed to bounding of 50%, 100%. The bounded work sample is subjected to Tensile, Torsion and Impact test. Tensile test is done by UTM machine. Torsion is done by Twisting machine, Impact test is accomplished by Izoid and charpy experiment test.



Fig 1. Composite workpiece sample

**Table 1. Materials used for experiment**

s.no	Material	Quantity
1	EN-8 steel rod	4
2	MS square rod	4
3	MS square	4
4	Steel pipe	8
5	Washer	8
6	Epoxy resins	1/2kg
7	Polyester resins	1/4kg
8	Accelerator	1/4kg
9	Catalyst	1/4kg
10	Polyvinyl(releasing agent)	1/4kg
11	Hardener	1/4 kg



V.RESULTS AND DISCUSSIONS

TENSILE TEST:

LATHE OPERATION:

Cutting speed  $S = \pi DN/1000 = \pi * 20 * 300/1000$   
 $S = 9.424m/ min$

Time for Facing  $F = \text{length of cut} / (\text{feed} * \text{rpm}) = 9 / (0.2 * 300)$   
 $F = 0.15 min$

Both side of facing  $= 2 * 0.15 = t1 = 0.3 min$

4 no of facing  $= 4 * t1 = 4 * 0.3$

$T1 = 1.2min$

Time for Turning  $T = \text{length of job to be turned} / (\text{feed} * \text{rpm}) = 320 / (0.2 * 300)$   
 $T = 5.333 min$

4 No of turning  $= 4 * T = 4 * 5.333 = 21.332 / (0.2 * 300)$   
 $k = 0.8333$

Both side of knurling  $= 2 * k = 2 * 0.833$   
 $K = 1.666$

4 No of knurling  $= 4 * K = 4 * 1.666$   
 $T3 = 6.664 min$

Machining time  $T = T1 + T2 + T3$   
 $= 1.2 + 21.332 + 6.668$

$T = 29.2012 min$

Tensile Test

100% bounded of Steel vs. epoxy:

(1) Area  $= \{ \pi/4 [(D^2)-(d^2)] \} = \pi/4 [(28^2)-(10^2)] = 537.21mm^2$

(2) Stress  $= \text{Load} / \text{Area} = 35000 / 537.21 = 65.151N/mm^2$

(3) Strain  $= \text{change length} / \text{original length} = 210/200 = 1.05$

(4) Yield stress  $\sigma_y = \text{Yield point} / \text{Initial Area} = (3250) / 537.21 = 60.497N/mm^2$

UTM MACHINE OPERATION:

Table 1: Results for Tensile Test

S.NO	MATERIAL	LENGTH OF SPECIMEN (mm)		DIAMETER OF SPECIMEN (mm)		YIELD LOAD (kgf)		ULTIMATE LOAD (kgf)		BREAKING LOAD (kgf)		INTERFACING (kgf)		% of elongation in length (%)		% of Reduction in Area (%)	
		100%	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%
1	Polyester	208	210	7	6	33	24	42	38	36	35	30	25	4	10	92	94
2	Epoxy	210	223	7.5	7.5	32.5	30	35	33	33	32	32	32.5	5	11	91.7	91

(6) Nominal breaking Stress ( $\sigma_{bn}$ ) = Breaking Load / Initial Load =  $33000/537.21 = 61.428N/mm$

(7) Neck Area  $= \pi/4 d^2 = \pi/4 * (7.5)^2 = 44.17mm$

(8) Actual breaking Stress ( $\sigma_{bn}$ ) = Breaking Load / Neck Area =  $33000 / 44.178 = 747.11N/mm$

(9) % Elongation in Length = (Final gauge length – Initial gauge length) / Initial gauge =  $(210-200) / 200 = 0.05 (5) \%$

(10) % Reduction in Area = (Initial Area - Neck Area) / Initial Area = (537.21-44.178) / 537.21 =0.917 (91.777) %  
 = (91.777) %

Other calculated values are shown in table 1.

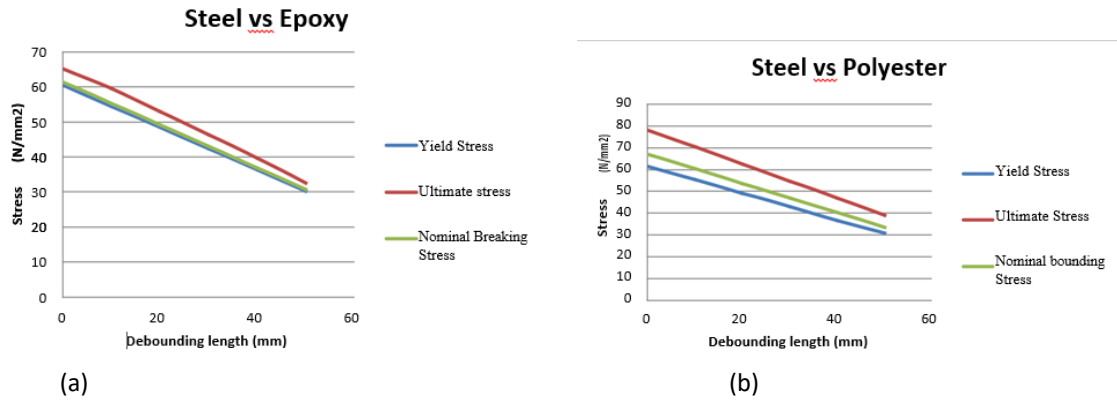


Fig 2. Stresses vs. debonding length Curve: (a) Steel vs. epoxy, (b) Steel vs. Polyester

**TORSION TEST:**

LATHE OPERATION for Torsion Test:

Time for facing = length of cut/ (feed\*rpm) = 6/ (0.2\*300) f =2\* 0.1 min= 0.2 min

4 material for facing = 4\*0.2

T1 = 0.8 min

Time for turning = length of job to be turned/ (feed\*rpm) = 200/ (0.2\*300) t = 3.333 min

4material for turning = 4\*t =4\*3.333, T2 = 13.332 min

Total Machine Time T1+T2 = 0.8+13.333 = 14.333 min



Fig 2. workpiece in Twisting Machine  
 Table 2: Test Results for Torsion test

S l. n o	MATERIAL	LENGTH OF SPECIMEN (mm)		INTERFACE						Modulus Of Elasticity (C) (Kpa)		SHEAR STRESS (τ) (N/mm <sup>2</sup> )	
				Torque (kgf)		Degree (Φ)		Radian					
1	EPOXY	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%	100%	50%
		182	172	204	202	150	130	2.618	2.268	2.316	2.52	471.68	466.96
2	POLYESTER	178	176	239	199	178	90	3.108	1.570	3.684	2.26	460.126	552.57

**MODEL Calculation for Twisting operation:**

100% bounded: (steel vs. epoxy)



Shear Stress ( $\tau$ ):  $T = \pi/16 * \tau [(D^4)-(d^4)/D] = (2.00 * 10^6) = \pi/16 * \tau [((28^4)-(10^4))/28]$   
 $\tau = 471.68 \text{Nmm}^2$

Polar Moment of Inertia:  $J = \pi/32 [(D^4)-(d^4)] = \pi/32 [(28^4)-(10^4)] = (59.36 * 10^3) \text{ mm}^4$

Modulus of Elasticity:  $T/J = C * \theta / L$   
 $(2.00 * 10^6) / (59.36 * 10^3) = [(C * 2.618) / 180]$   
 $C = 33.692 * 180 / 2.618 = 6064.690 / 2.618$   
 $C = 2.31653 \text{kpa}$

50% bounded: (steel vs. epoxy)

Shear stress ( $\tau$ ):  $T = \pi/16 * \tau [(D^4)-(d^4)/D]$   
 $(1.98 * 10^6) = \pi/16 * \tau [((28^4)-(10^4))/28]$   
 $\tau = 466.96 \text{Nmm}^2$

Polar Moment of Inertia:  $J = \pi/32 [(D^4)-(d^4)] = \pi/32 [(28^4)-(10^4)]$   
 $J = (59.36 * 10^3) \text{ mm}^4$

Modulus of Elasticity:  $T/J = C * \theta / L$   
 $(1.98 * 10^6) / (59.36 * 10^3) = [(C * 2.268) / 172]$   
 $C = 33.355 * 172 / 2.268 = 2.52956 \text{kpa}$

Other calculated values are shown in table 2.

**IMPACT TEST:**

Impact test is done by using Izoid and Charpy Impact test experiments.

**Model calculation for Impact Test:**

100% bounded: (steel vs. polyester)  
 $V = 1 * b * d = 56 * 8 * 8.5 = 38,080 \text{ mm}^3$   
 Impact Modulus = 90 J

Other calculated values for Epoxy, Dip on Polyester, and Normal MS Materials are tabulated in table 3.

**Table 3: Impact Test Results**

S NO	MATERIAL	TESTING	LENGTH (mm)	BREATH (mm)	DEAPTH (mm)	VOLUME (mm <sup>3</sup> )	IMPACT Strength (J)
1	POLYESTER	IZOD	56	8.4	8	3673.6	90
2	DIP ON POLYESTER	IZOD	56	8.2	8	3763.2	88
3	EPOXY	CHARPY	56	8.5	8	3808	112
4	NORMAL MS	CHARPY	56	8.0	8	3584	110

**VI.CONCLUSION**

The Application of composite materials in modern world is increase now, for example aircrafts windows frames, racing car, etc., If a 20% of debonding in the composite material will increase the stress inside the composite in our experimental setup we tested in composite material more than 20% debonding which resulted in immediate breakdown in the material and the stress created inside the material is high.



#### REFERENCES

- [1] Anderson. J.C., Leaver. K.D., Leever. P. and Rawlings. R.D., “Materials Science for Engineers”, Nelson Thornes Ltd., Cheltenham, Fifth Edition, 2003.
- [2] ASM Handbook, Vol.8, “Mechanical Testing”, ASM International, MaterialsPark, Ohio, 1985.
- [3] “Engineer’s Guide to Composite Materials”, American Society for Metals Park,Ohio, 1986.
- [4] James F. Shackelfold., “Introducing to Materials Science for Engineering”,Chapmen & Hall, London Third Edition, 1996.
- [5] Lawrence H. Van Vlack., “Elements of Materials Science and Engineering,” Addison-Wesley Publishing company, Massachusetts, Fifth Edition, 1985.
- [6] Metals Handbook, Vol.1, “Properties and Selection :Irons, Steels, and High-performance Alloys and Special-Purpose Materials,” ASM Internationals park,Ohio, 1991
- [7] Suresh R. and Jayakumar. V., “Materials Science”, Lakshmi Publications,Chennai, 2003
- [8] William D. Callister, Jr., Materials Science and Engineering - An Introduction”, John Wiley & Sons, Inc., New York, Third Edition, 1994.
- [9] Benmedakhene S. Etude ph\_enom\_enologique du comportement \_\_impact des mat\_eriaux composites. PhD thesis, Universit\_e de Technologie de Compi\_egne, 1996.72 E. S\_eegard et al. Composite Structures 60 (2003) 67–72
- [10] Aboura Z, Benzeggagh M. Methodology’s experimental d\_identification \_a l\_impact des mat\_eriaux composites \_a renfort tiss\_e. JNC 8, Paris, France, November 1994



**INNO SPACE**  
SJIF Scientific Journal Impact Factor

**Impact Factor:  
7.512**

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details