MAT JOURNALS

International Journal of Industrial Production and Material Science
Volume 1 Issue 1

Design and Analysis of Reinforced Ceramic with Epoxy Resin and Graphite

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Abstract

Nowadays, polymer matrix composite plays a vital role in automotive, aerospace and marine engineering. The epoxy composite was prepared using the hand layup method in room temperature. The reinforcement of ceramic/graphite with epoxy resin composite is to improve the mechanical properties like impact strength and hardness. The tensile strength, compression strength, impact strength and hardness of mixtures of epoxy resin and ceramic powder and graphite (granite powder) were reported. The sample consists of mixtures with percentage weights of 70 % epoxy resin with 28 % ceramic and 2 % graphite, where the epoxy resin (ly556) was the majority phase; the hardener (hy951) was used as catalyst. The material is tested to obtain the hardness, compression strength, tensile strength and impact strength.

INTRODUCTION

Composite is a mixture of or extra wonderful components or phase. Each part has to be present in reasonable property. Constituent phases have exceptional properties, and for this reason the composite homes are important extraordinary from the houses of the constituents. The constituent this is continuous and is often but now not always, gift inside the greater amount within the composite is called as matrix. The second constituent is known as the reinforcing segment or reinforcement segment because it reinforces the mechanical properties of matrix.

The reinforcement is harder, stronger and stiffer than matrix in most cases (Bryan Harris, 2000). Most composites are made of just two materials. One is the matrix or binder. It surrounds and binds together the fibers or fragments of the other material, which is called the reinforcement (Chung, 2003). The biggest advantage of modern composite materials is that they are light as well as strong. By choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements of a particular application. Composites also provide design flexibility because many of them can be molded into complex shapes. The downside is often the cost. Although the resulting product is more efficient, the raw materials are often expensive (Seropekalpakjian and Schmidt, 2007).

Matrix Material for PMCs

The classification of plastic and the number polymers available for PMC is shown in the Fig 1.

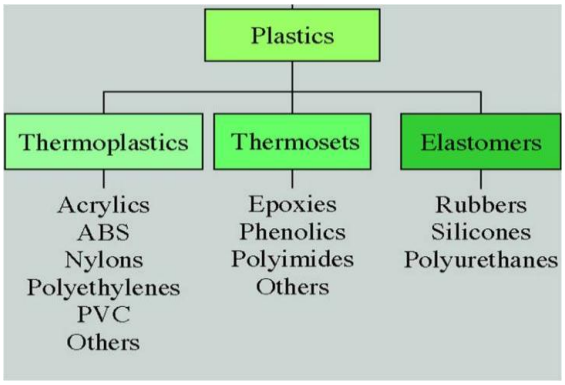


Fig. 1: *Classification of Plastics*

Matrix materials or resins in case of polymer matrix composites may be categorized in step with their chemical base i.e. thermoplastic or thermosets. Thermoplastics have exceptional durability, resilience and corrosion resistance however have fundamental drawback compared to thermosetting resins, in that they have to be molded at improved temperature. The primary thermoplastic used in fiber bolstered plastics are unsaturated polyesters which have lower fee however are generally no longer as strong as thermoset plastics like epoxy resins. Consequently the primary research attempt is concentrated on thermosetting plastics.

Granite Dust Powder

Granite is a not unusual type of felsic intrusive igneous rock that is granular and phaneritic in texture. Granites can be predominantly white, purple, or grey in colour, depending on their mineralogy. The word "granite" comes from the Latin granum, a grain, in connection with the coarse-grained structure of any such holocrystalline rock. through definition, granite is an igneous rock with at the least 20 % quartz and up to sixty five % alkali feldspar by way of extent. The Fig. 2 shows the granite duct powder and table 1 indicates the diverse residences of granite duct powder.

Granite belongs to igneous rock family. The density of the granite is between 2.sixty five to two.75 g/cm3 and compressive energy might be extra than 2 hundred MPa. Granite powder obtained from the sprucing gadgets and the houses have been determined. for the reason that granite powder changed into satisfactory, hydrometer analysis become done on the powder to decide the particle size distribution. From hydrometer evaluation it was determined that coefficient of curvature was 1.ninety five and coefficient of uniformity turned into 7.82. The particular gravity of granite powder turned into determined to be 2.5. Granite has negative number one permeability, but sturdy secondary permeability.

Fig. 2: *Granite Dust Powder*

Table 1: *Properties of Granite Dust Powder*

S. No	Properties	Values
1	Porosity	Very low
2	Absorption	0.5 to1.5 %
3	Specific Gravity	2.6 to 2.8
4	Density	2500 – 2650 kg/m^3
5	Crushing strength	1000 - 2500 kg/m^3
6	Frost resistance	Good
7	Fire resistance	Low

Graphite Powder

Graphite archaically referred to as plumbagos, is a crystalline shape of carbon, a semimetal, a native element mineral, and one of the allotropes of carbon. Graphite is the most stable shape of carbon beneath preferred situations. therefore, it's far used in thermo-chemistry as the standard country for defining the heat of formation of carbon compounds. Graphite can be taken into consideration the highest grade of coal, simply above anthracite and rather referred to as meta-anthracite, even though it isn't always generally used as fuel due to the fact it's miles tough to ignite.

In graphite, each carbon atom is covalently bonded to 3 carbon atoms to give trigonal geometry. Bond angle in graphite is 120oC. Every carbon atom in graphite is sp2 hybridized. Three out of 4 valence electrons of each carbon atom are used in bond formation with three different carbon atoms even as the fourth electron is loose to transport in the structure of graphite.

Fig. 3: *Graphite Powder*

EXPERIMENTAL SETUP

Hand lay-up technique is the only approach of composite processing. The infrastructural requirement for this method is likewise minimal. The processing steps are pretty easy. to start with, a launch gel is sprayed on the mildew floor to keep away from the sticking of polymer to the floor. skinny plastic sheets are used at the top and bottom of the mould plate to get proper surface finish of the product. Reinforcement within the form of woven mats or chopped strand mats is cut as according to the mildew length and positioned at the surface of mildew after Perspex sheet. Then thermosetting polymer in liquid form is blended very well in appropriate percentage with a prescribed hardener (curing agent) and poured onto the floor of mat already positioned inside the mildew.

The polymer is uniformly unfold with the assist of brush. Second layer of mat is then positioned at the polymer surface and a curler is moved with a mild pressure on the mat-polymer layer to eliminate any air trapped in addition to the excess polymer present. The method is repeated for every layer of polymer and mat, until the specified layers are stacked. After placing the plastic sheet, release gel is sprayed on the internal surface of the pinnacle mildew plate that is then saved on the stacked layers and the strain is applied.

After curing either at room temperature or at some specific temperature, mold is opened and the developed composite part is taken out and further processed. The time of curing depends on type of polymer used for composite processing. For example, for epoxy based system, normal curing time at room temperature is 24-48 hours.

This method is particularly suitable for thermosetting polymer based totally composites. Capital and infrastructural requirements are much less in comparison to other strategies. Production price is less and high extent fraction of reinforcement is hard to obtain within the processed composites. Hand lay-up technique finds software in many regions like aircraft components, car components, boat hulls, deck and many others. usually, the materials used to increase composites via hand lay-up

METHOD

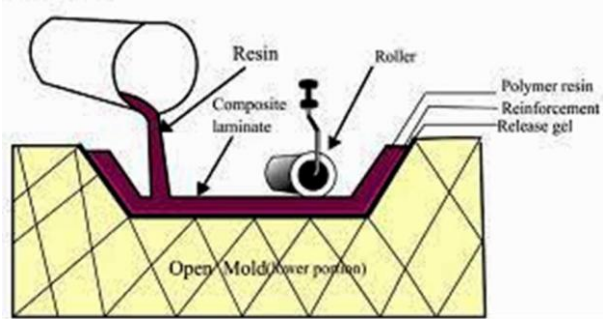
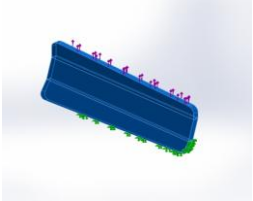


Fig. 4: *Hand Layup Process*

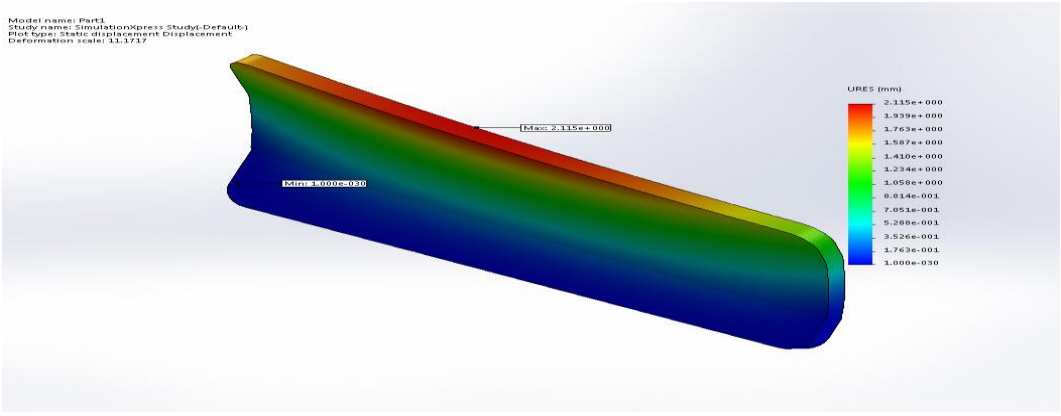
The Composite material is used for the present investigation and it is fabricated by hand layup process. The granite dust is get filtered and removed the sand and stone particles from the granite dust. Then, the filtered granite dust is crushed until the powder gets fine and smooth. The undertaken mould has the capacity of 2 kg. Then, the granite powder is taken as 28 % i.e., 560 g of granite power. Then, the fine granite powder is pour into the 70 % of epoxy resin i.e., 1.4 kg of epoxy. Before, pouring the granite powder the epoxy is getting treated with the hardener (catalyst). Then, the filler is added into the epoxy resin. The undertaken fillers are graphite. The composition of graphite is 2 % i.e, 40 g of graphite is stir along with granite dust and epoxy resin, until it gets mixed up. Then, the Poly Vinyl acetate is applied in the mould. The Poly vinyl acetate act as protective colloid. Then, the mixed material is poured into the mould. Then, it tends to dry for 2 days. It takes 48 hours to dry. After the curing time of reinforcement of ceramic and epoxy resin, the material is removed from the mould and it let to test for the testing such as hardness, impact, tensile,flexuralstrength.

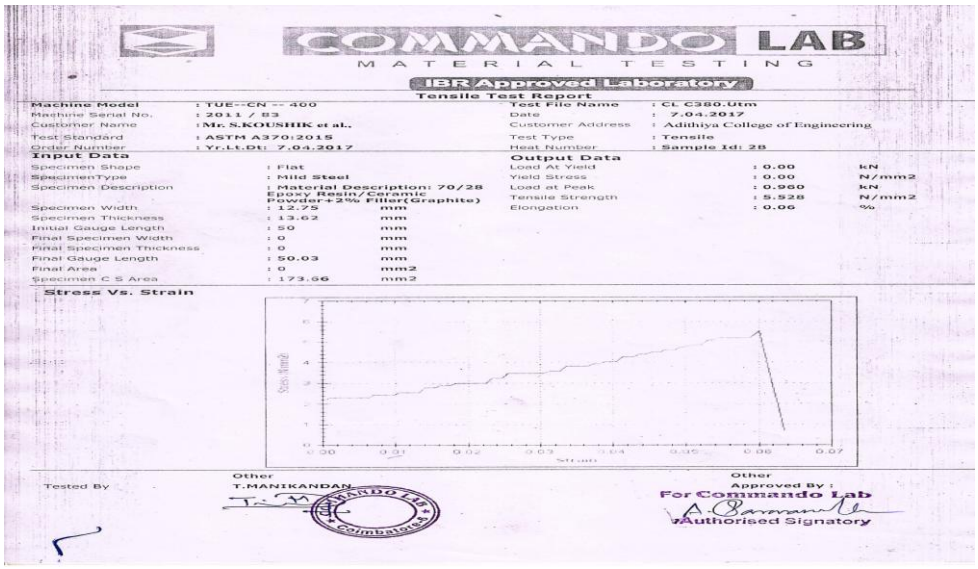
TESTING AND ITS VALUES

Model	Properties	Component Name
	Mass: 0.375171 kg Volume: 0.000144296 m^3 Density: 2600 kg/m^3 Weight: 3.67667 N	Fan Blade

Tensile Test

Test Name	Type of Stress	Min. Value	Max. Value
Tensile Test	Von Mises Stress	0	5.528 kN/m^2





COMMANDO LAB
MATERIAL TESTING
IBR Approved Laboratory
Tensile Test Report

Machine Model	: TUE--CN -- 400	Test File Name	: CL C380.Utm
Machine Serial No.	: 2011 / 83	Date	: 7.04.2017
Customer Name	: Mr. S.KOUSHIK et al.,	Customer Address	: Adithiya College of Engineering
Test Standard	: ASTM A370:2015	Test Type	: Tensile
Order Number	: Yr.Lt.Dt: 7.04.2017	Heat Number	: Sample Id: 28

Input Data

Specimen Shape	: Flat	
SpecimenType	: Mild Steel	
Specimen Description	: Material Description: 70/28 Epoxy Resin/Ceramic Powder+2% Filler(Graphite)	
Specimen Width	: 12.75	mm
Specimen Thickness	: 13.62	mm
Initial Gauge Length	: 50	mm
Final Specimen Width	: 0	mm
Final Specimen Thickness	: 0	mm
Final Gauge Length	: 50.03	mm
Final Area	: 0	mm2
Specimen C S Area	: 173.66	mm2

Output Data

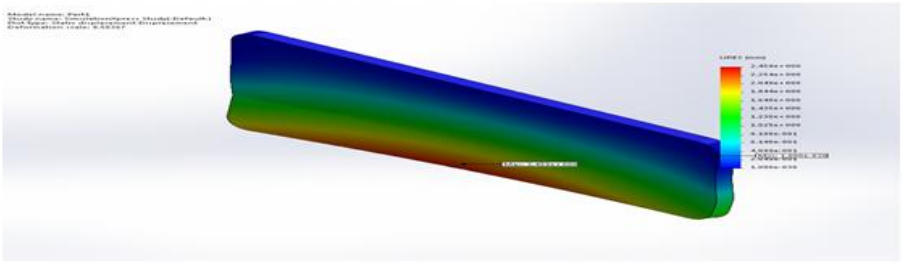
Load At Yield	: 0.00	kN
Yield Stress	: 0.00	N/mm2
Load at Peak	: 0.960	kN
Tensile Strength	: 5.528	N/mm2
Elongation	: 0.06	%

Stress Vs. Strain

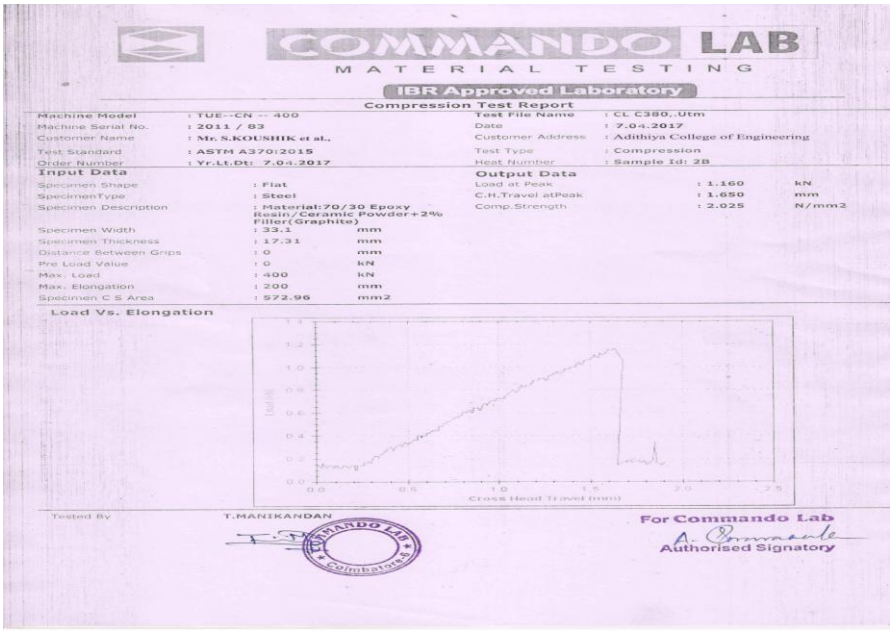
Tested By — Other — T.MANIKANDAN

Other — Approved By : For Commando Lab — Authorised Signatory

Test Name	Type of Stress	Min. Value	Max. Value
Compression Test	Von Mises Stress	1.160 kN/m^2	2.025 kN/m^2



Compression Test



COMMANDO LAB
MATERIAL TESTING
IBR Approved Laboratory
Compression Test Report

Machine Model	: TUE--CN -- 400	Test File Name	: CL C380..Utm
Machine Serial No.	: 2011 / 83	Date	: 7.04.2017
Customer Name	: Mr. S.KOUSHIK et al.,	Customer Address	: Adithiya College of Engineering
Test Standard	: ASTM A370:2015	Test Type	: Compression
Order Number	: Yr.Lt.Dt: 7.04.2017	Heat Number	: Sample Id: 28

Input Data

Specimen Shape	: Flat	
SpecimenType	: Steel	
Specimen Description	: Material:70/30 Epoxy Resin/Ceramic Powder+2% Filler(Graphite)	
Specimen Width	: 33.1	mm
Specimen Thickness	: 17.31	mm
Distance Between Grips	: 0	mm
Pre Load Value	: 0	kN
Max. Load	: -400	kN
Max. Elongation	: 200	mm
Specimen C S Area	: 572.96	mm2

Output Data

Load at Peak	: 1.160	kN
C.H.Travel atPeak	: 1.650	mm
Comp.Strength	: 2.025	N/mm2

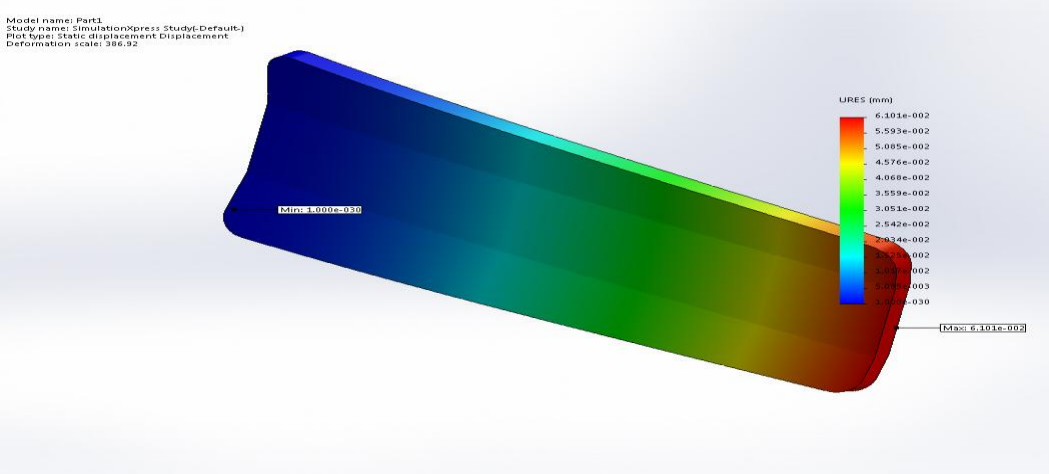
Load Vs. Elongation

Tested By — T.MANIKANDAN

For Commando Lab — Authorised Signatory

Impact Test

Test Name	Type of Stress	Min. Value	Max. Value
Impact Test	Von Mises Stress	2 J	20 J



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MATERIAL TESTING
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TEST REPORT NO : CL C381 PAGE: 1 of 1 DATE : 04.04.2017

TEST REPORT OF CHARPYIMPACT TEST

Work Order No	: CL C381	CUSTOMER DETAILS:	
Received on	: 04.04.2017	Mr. S. KOUSHIK., B.E., Mechanical Engineering,	
Tested on	: 04.04.2017	Adithiya College of Engineering,	
Test Method	: ISO-148-1:2009	Coimbatore.	
Deviation from the method	: NIL	Customer Ref	: Yr.Lt.Dt. 6.03.2017

SAMPLE DESCRIPTION

Material Grade : Composite Material

TESTING FACILITY

Machine No.	: CL/ME/IMPA02	Validity	: 03.11.2017
Model	: AIT-300-EN	Ambient temp., °C	: 27.0
Capacity	: 300 J		

TEST RESULTS

S. No	Sample Id	Specimen Temp., °C	Thick mm	Width mm	Length mm	Charpy Impact Energy, Joules
1.	Epoxy-70% + Ceramic-28% + Graphite – 2%	Room Temperature	10.00	10.00	55.00	2

------- END OF TEST REPORT ------

Tested By
(T.MANIKANDAN)
Testing Engineer

Approved By
(A.SARAVANAKUMAR)
Technical Manager

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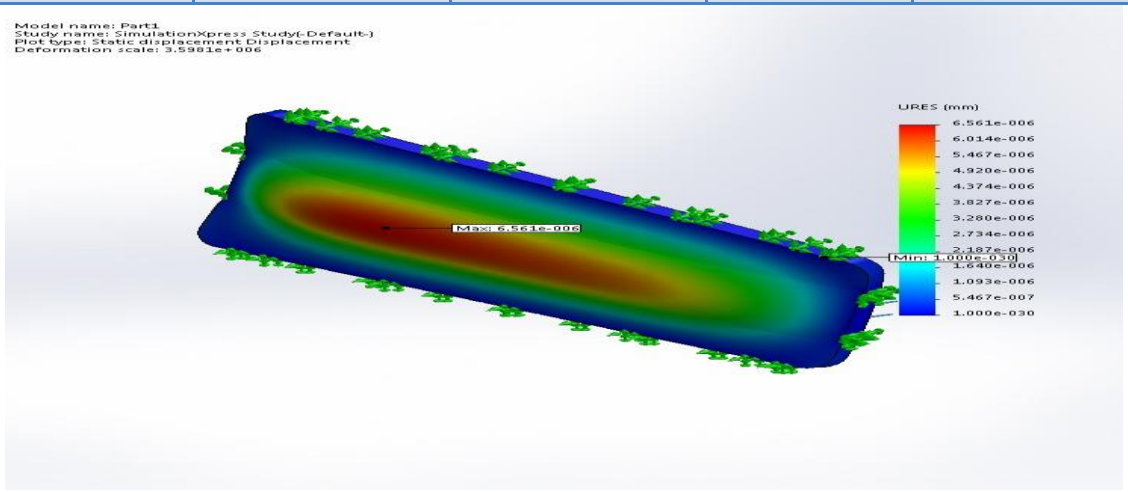
CLFME04/00/01/03.15

No. 3A, 5th South Street, Avarampalayam, Coimbatore - 641 006.
Ph : 0422 - 2560907 Mob : 99430 14772, 99430 33225 E-mail : commandolab@gmail.com, Web : www.commandolab.com

Hardness Test

Test Name	Observed Value 1	Observed Value 2	Observed Value 3	Final Hardness
Hardness Test	51	52	50	51



COMMANDO LAB
MATERIAL TESTING
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TEST REPORT No. : CL/D013 PAGE: 1 of 1 DATE : 04.04.2017

TEST REPORT OF SHORE-D HARDNESS TEST

Work Order No. : CL/D013 Received on : 04.04.2017 Tested on : 04.04.2017 Test Method : ASTM D 2240 Deviation from the method : NIL	CUSTOMER DETAILS: Mr. S. KOUSHIK., B.E., Mechanical Engineering, Adithiya College of Engineering, Coimbatore. Customer Ref.: Yr. Lt. Dt.03.04.2017

SAMPLE DESCRIPTION

Material : Epoxy-70% + Ceramic-28% + Graphite – 2%

DETAILS OF TESTING FACILITY

Machine No.	: CL/ME/SHRD40	Sl. No.	: 25068
Model	: SHORE-D GOLD	Ambient Temp.°C	: 25.2

TEST RESULTS

S.No.	Material	Observed Values, SHORE-D			Average, SHORE-D
		1	2	3	
1.	Epoxy-70% + Ceramic-28% + Graphite – 2%	51	52	50	51

------- END OF TEST REPORT ------

Tested By
(J.GODWIN PRABHU)
Testing Engineer

Approved By
(A.SARAVANA KUMAR)
Quality Manager

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CONCLUSION

The main aim of the project is to study the property of a new composite. The composite was fabricated by the epoxy resin as base material and ceramic as reinforcement. The result shows, when adding the graphite as filler material with the ceramic reinforced epoxy resin composite, the properties of the composite material such as hardness, impact strength, tensile strength and compression strength are altered. The brittleness of the pure ceramic material is highly reduced and the various applications for the newly created ceramic compound are discussed. A fan blade is created using the newly created composite material and the other application of the composite that is created is explained based on the composite's property.

REFERENCE

1. Bose, S.S., Mahanwar, P.A., 2004. Effect of fly-ash on the mechanical thermal dielectric rheological and morphological properties of filled nylon 6, J. Min. Mater. Charact. Eng. 3, 65–89.
2. Chand, N., Jain, D., 2006. Effect of temperature on electrical behavior of fly-ash filled epoxy gradient composites, Journal of Applied Polymer Science, 100, 1269–1276.
3. Chand, N., 2002. Development structure and strength properties of PP/PMMA/FA blends, Bull Mater. Sci. 23, 103–107.
4. Guhanathan, S., Devi, S., Murugesan, V., 2001. Effect of coupling agents on the mechanical properties of fly ash/polyester particulate composites, Journal of Applied Polymer Science 82, 1755–1760.
5. Kishore, Barpanda, P., Kulkarni, S.M., 2005. Compression strength of silane water exposed epoxy system containing fly ash particles, Journal of Reinforced Plastic and Composites, 24, 1567–1576.
6. Kefeng Tan, Xincheng, P.U., Strengthening effects of finely ground fly ash, granulated blast furnace slag and their combination, Cement and Concrete Research, 28 (12), 1998, 1819 -1825.