International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

AN INVESTIGATION ON MECHANICAL PROPERTIES OF GLASS FIBER EPOXY COMPOSITES WITH FILLER OPTIMIZED WITH RESPONSE SURFACE METHOD

V. Sanju[1], S. Satheesh[2], S. Selvin Mon[3]

[1]*Student, Department of Mechanical Engineering, Ponjesly College of Engineering, Nagercoil.*
[2]*Student, Department of Mechanical Engineering, Ponjesly College of Engineering, Nagercoil.*
[3]*Student, Department of Mechanical Engineering, Ponjesly College of Engineering, Nagercoil.*

***

ABSTRACT: *Now a days Glass Fibre Reinforced Plastics (GFRPs) find their application into various industries due to their better and distinctive properties. However, these properties can be improved further by incorporating different filler materials in the glass/epoxy polymer composite. The optimization techniques have a crucial role in developing advanced composites with enhanced properties. Response Surface Methodology (RSM) has been incorporated for optimizing fabrication parameters using Box-Behnken Design (BBD). The Polymer composite fabrication process parameters are optimized with various percentages of Hardener (5%, 10%, and 15%), various percentages of Curing Temperatures (400C, 500C, and 600C) and Aluminium Oxide as a filler having particle size of 5 microns will be added to the resin with varying percentage (5%, 10%, and 15%) to find the optimum value. The main goal of this project is to enhance the strength and reinforcement of fiber glass epoxy composites by comparing the results of composites with different fillers in the optimize condition.*

Key Words: *Fibers, Glass Reinforcements, Glass Fiber Composites, Mechanical Properties, Pre-pregs, S-glass fiber, RSM method*

INTRODUCTION

A composite material (also called a composition material or shortened to composite, which is the common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure, differentiating composites from mixtures and solid solutions. A composite material consists of two phases: Forms the matrix within which the secondary phase is imbedded, any of three basic material types: polymers, metals, or ceramics. Referred to as the imbedded phase or called the reinforcing agent Serves to strengthen the composite (fibres, particles, etc.). Can be one of the three basic materials or an element such as carbon or boron. There are five basic types of composite materials: Fiber, particle, flake, laminar or layered and filled composites.

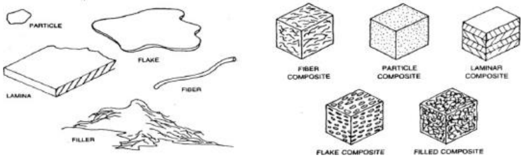


Fig 1.1 Types of Composites

Classification of composite material

Metal Matrix Composites (MMCs): A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal necessarily, the other material may be a different metal or another material, such as a ceramic or organic compound. Ceramic Matrix Composites (CMCs): Ceramic matrix composites (CMCs) are a subgroup of composite materials as well as a subgroup of ceramics. They consist of ceramic fibers embedded in a ceramic matrix. Polymer Matrix Composites (PMCs): A polymer matrix composite (PMC) is a composite material composed of a variety of short or continuous fibers bound together by an organic polymer matrix. PMCs are designed to transfer loads between fibers through the matrix. S-Glass Fibers is the most common fiber used in PMC's. Its advantages include its high strength, low cost, high chemical resistance and good insulating properties. E-glass stands for electrical. The S in S-Glass stands for high content of 'silica'. It remains its strength at high temperatures and has higher fatigue strength used mainly in aerospace applications.

Property	Units	E-Glass	S-Glass
Specific Gravity		2.54	2.49
Young'sModulus	GPa	72.4	85.5
Ultimate Tensile Strength	Mpa	3447	4585
Coefficient Of Thermal Expansion	deg C	5.04	5.58

Table1.1: Comparison of E-Glass and S-Glass Properties

Since our approach to the project is to strengthen the structure we have used the S- glass fibers. S-

Glass has a typical nominal composition of SiO_2 65wt%, Al_2O_3 25wt%, MgO 10wt%. Some other materials may also be present at impurity levels

Material	% weight	
	E-Glass	S-Glass
Silicon Oxide	54	64
Aluminium Oxide	15	25
Calcium Oxide	17	0.01
Magnesium Oxide	4.5	10
Boron Oxide	8	0.01
Others	1.5	0.8

Table1.2: Chemical Composition of E Glass and S-Glass Fiber

Polymer matrix composites find many uses in automotive, aerospace, and marine applications. Some examples of these uses are provided below. See Polymers and Composites in the Transportation Industry for a more detailed discussion. **Automotive Vehicles**: Examples of polymer matrix composite use include tire and various belts and hoses as well as polymer matrix composite components in automotive bodies. Some very expensive sports cars, such as Bugatti, use carbon fiber reinforced polymer matrix composite as the main material of construction of the body of the car. **Aerospace Vehicles**: Polymer matrix composites are also used in aircraft tires and interiors. Of even greater value, however, is the ability of polymer matrix composites to help satisfy the relentless drive in the aerospace industry to enhance performance while reducing weight. **Industrial Equipment**: Polymer matrix composites are used in a vast range of industrial equipment. They are used as the main material of construction, or as components of equipment, or in some instances both as the main material of construction and as components. The uses of equipment in which polymer matrix composites are incorporated span almost all industries. **Building, Construction, And Civil Engineering**: Examples of polymer matrix composite use include the replacement, repair, retrofitting, or reinforcement of a structural component manufactured from a traditional structural material with fiber- reinforced polymers. **Energy Storage Devices**: Polymer matrix composites are used in many energy storage devices. The following are some examples. **Electronics and Optics**: Polymer matrix composites are used in many electrical and electronics applications. **Oil And Gas Exploration, Production, Transport, and And Storage**: Polymer matrix composites are used in many oil and gas industry applications. The following are some examples.

Reinforcements: In continuously reinforced composites, the fibers carry nearly all of the load applied to the system, with the matrix transferring the load into the fibers. In chopped fiber reinforced plastics, the load is distributed between the fibers and matrix, depending upon the nature of the constituents, percentages of each and the orientations of the fibers. Glass reinforced epoxy composites filled with various compositions (1, 3, 5 and 7%) of cloisite clay particles was prepared. The as-prepared samples of unfilled or neat epoxy glass fibre composites and clay particles reinforced composites were tested for their morphological and mechanical properties. **Literature Review:** The morphological behaviour was investigated by the use of scanning electron microscope for visualizing the distribution of nanoclay in the epoxy matrix. The study on mechanical properties such as tensile, flexural and impact test was carried out test the hardness of the prepared reinforced composites. The mechanical studies were carried out for all the compositions of 1, 3, 5 and 7% of the epoxy matrix composites. For 5% reinforced clay composites, the tensile strength and modulus were found to increase by 23.58 and 23.66% when compared to the unfilled composite. Further increase in nanoclay content decreases the tensile properties of nanocomposite. For the flexural strength and modulus for 5% nanoclay reinforcement, there is an increase of 34.10 and 53.86%, respectively, when compared to the unfilled composite. The impact strength for 5% reinforcement of nanoclay has an increase of about 29.65% [1].

Nowadays, polymer matrix composite plays a vital role in industries namely automotive, aerospace and marine. This paper involves the fabrication of epoxy and polyester resin composites using aluminium oxide, silicon carbide with different proportion of Al_2O_3 and SiC along with GFRP. A mixing unit has been fabricated for making reinforcement mixtures. Mechanical testing like tensile, impact hardness shear bi axial is conducted in order to know the properties of fabricated composites. The result shows that composites with epoxy resin shows higher strength as compared to composites with polyester resin [2].

Glass fibre reinforced plastic (GFRP) composites are an economic alternative to engineering materials because of their superior properties. Some damages on the surface occur due to their complex cutting mechanics in cutting process. Minimisation of the damages is fairly important in terms of product quality. In this study, a GFRP composite material was milled to experimentally minimise the damages on the machined surfaces, using two, three and four flute end mills at different combinations of cutting parameters. In addition, analysis of variance (ANOVA) results clearly revealed that the feed rate was the most influential parameter affecting the damage factor in end milling of GFRP composites. Also, in present study, Artificial Neural Network (ANN) models with five learning algorithms were used in predicting the damage factor to reduce number of expensive and time-consuming experiments. The highest performance was obtained by 4-10-1 network structure with LM learning algorithm. ANN was notably successful in predicting the damage factor due to higher R2 and lower RMSE and MEP [3].

The rapid utilization of carbon fibre reinforced composite (CFRC) and glass fibre reinforced composite (GFRC) in main sectors, such as automobile, aerospace, wind turbines, boats and sport parts, has gained much attention because of its high strength, light weight and impressive mechanical properties. The Study will also introduce the strong connection between recycling and re-usability of fibres which would help to explain the concept of circular economy and cradle-to-cradle approach. Finally, based on updated studies and critical analysis, research gaps in the recycling treatments of fibrous composite waste using pyrolysis processes are discussed with recommendations [4].

The author presents a new approach for optimizing the machining parameters on turning glass-fibre reinforced plastic (GFRP) pipes. Optimization of machining parameters was done by an analysis called desirability function analysis, which is a useful tool for optimizing multi-response problems. In this work, based on Taguchi's L18 orthogonal array, turning experiments were conducted for filament wound and hand layup GFRP pipes using K20 grade cemented carbide cutting tool. The Machining parameters such as cutting velocity, feed rate and depth of cut are optimized by multi-response considerations namely surface roughness, flank wear, crater wear and machining force. A composite desirability value is obtained for the multi-responses using individual desirability values from the desirability function analysis. Based on composite desirability value, the optimum levels of parameters have been identified, and significant contribution of parameters is determined by analysis of variance. Confirmation test is also conducted to validate the test result. It is clearly shown that the multi-responses in the machining process are improved through this approach. Thus, the application of desirability function analysis in Taguchi technique proves to be an effective tool for optimizing the machining parameters of GFRP pipes [5].

An experimental study has been carried out to investigate the bearing strength behavior of pinned joints of glass fiber reinforced composite filled with different proportions of $Al2O3$ particles. The weight fractions of the filler in the matrix were 7.5, 10, and 15%. Single- hole pin-loaded specimens of each composite material were tested in tension. The increase of the $Al2O3$ particle loading in the matrix improved the bearing strength of the composites. The highest bearing strengths were obtained for composite specimens with 10 wt. % $Al2O3$ particle content. Further increases in the $Al2O3$ particle content in the matrix resulted in a decrease of the bearing strength, but remains above that of the unfilled glass reinforced epoxy composites [6].

The conflicting objectives for optimization were to minimize the cost and weight of the composite subject to the constraint of a minimum specified flexural strength. The optimal sets for different levels of minimum flexural strength have been presented and it was concluded that the fully carbon/epoxy or fully glass/epoxy composites are not necessarily the best solutions. This result emphasizes that the hybridization of CFRP composites through the partial substitution of carbon fibres by glass fibres (and vice versa) not only improves the flexural strength but can also optimize the weight and cost of the composite structure [7].

A classical lamination theory (CLT) based model was developed to predict the flexural properties of composite laminates under three-point bending. Four objective functions, namely, maximizing the flexural strength and robustness and minimizing the weight and cost were chosen. The weighted sum method (WSM) was applied to find the optimal solution with the weighting factors being calculated from the analytical hierarchy process (AHP). As an illustration of the method, five different scenarios for the relative objective preferences were examined with the corresponding optimal solutions being determined. The authors suggest that the proposed method is a powerful tool that can be utilized to design more stable and realistic components with minimal weight, cost and variability of response when subjected to manufacturing uncertainties in material design parameters. [8].

The surface characteristics of blends and composites of epoxy resin were investigated. The modified epoxy resin was used as the matrix for fibre reinforced composites (FRP's).E-glass fibre was used as the fibre reinforcement. The scanning electron micrographs of the fractured surfaces of the blends and composites were analyzed. The surface free energy, work of adhesion, interfacial free energy, spreading coefficient and Girifalco-Good's interaction parameter were changed significantly in the case of blends and composites. The incorporation of thermoplastic and glass fibre reduces the wetting and hydrophilicity of epoxy resin [9].

We here report a comprehensive study of glass fibre reinforced polymers (GFRP) incorporating ferromagnetic micro wires for microwave absorption applications. With wire addition, a remarkable dependence of microwave absorption performance appears on the local properties of wires such as wire geometry and the microstructure such as inter-wire spacing, as well as the embedded depth of the wires layer. The impact testing further demonstrates that the metallic micro wires can to some extent improve the impact performance. Based on both the absorption and impact behavior, we propose an optimized design of the micro wire/ GFRP composites to achieve simultaneous best possible absorption and impact performance for multifunctional applications in aeronautical structures and wind turbines [10].

Author presents an experimental modal analysis was performed in order to get information on natural frequencies and mode shapes, which are related to the mechanical properties. The experimental modal results were compared with numerical ones, obtained through finite element model using the initial set of mechanical properties. Finally, in order to get a good numerical-experimental correlation, the mechanical properties throughout the panel were updated using an inverse modeling method based on parallel genetic algorithms [11].

The machining experiments are conducted to analyse the effects of the predominant machining parameters, i.e. cutting speed rate, feed rate and stand-off distance on the required machining characteristics, i.e. surface roughness (Ra), kerf top width (kw) and material removal rate (MRR). The range of values of each parameter is set at three different levels, and Taguchi's L9 orthogonal array is used to design factors so that all the interactions between the response variables and machining variables can be investigated. Single best compromise solutions with respect to the MOOPs of GFRP, CFRP and CGFRP composites are also determined from the Pareto optimal solutions obtained by NSGA-II. Finally, confirmation tests are conducted on specimens of GFRP, CFRP and CGFRP composites machined at their corresponding optimum parameters given by the GA. It is observed that the optimum values of Ra, kw and MRR of all the optimization problems are closer to the corresponding experimental values of confirmation tests [12].

The GA obtains the optimal operational conditions through using the NNs. From this, it can be clearly seen that a good agreement is observed between the predicted values and the experimental measurements [10]. Composites in general are very strong, stiff, light weight, possess high strength-to-weight ratio in comparison to pure matrix alternatives, and are widely used in many industrial applications. Glass fiber epoxy composites have been subjected many researches to increase the strength and reinforcement. Adding fillers to various weight percentages has been many more effects to increase the mechanical properties of glass fibers. Ceramic fillers with different percentages by weight (5 wt%, 10 wt%, 15 wt%) are introduced into epoxy-based fiber composites, since ceramic materials are rigid in nature and affect property Flexibility in bending. Alumina (Al2O3), Silicon Carbide (SiC) and Titanium Dioxide (TiO2) Particulate Fillers used in producing Composites by Hand Layup technique and tested in accordance with ASTM D 790. Results show that it has a significant effect of loading on the Flexural Strength of the GFRP composite; It varies greatly depending on the filler material and its percentage. In this study, the objective was to develop, investigate and evaluate the mechanical properties of glass fiber epoxy composite materials using Alumina (Al2O3) as filler with various percentages by weight for enhancing the strength properties [13].

EXPERIMENTAL

Epoxy Resin: Resin: Epoxy 103/ Hardener: HY 991. Epoxy 103 / HY 991 is a multipurpose, two components, and room temperature curing, transparent liquid adhesive of high strength. It is suitable for bonding wide variety of metals, ceramics, glass, rubbers, rigid plastics, and most other materials in common use. It is particularly easy to apply over large areas.

Sl. No	Properties	Resin	Hardener
1	Specific Gravity	1.1-1.5	0.8-0.95
2	Viscosity (Pas)	1.8-2.4	15-35
3	Colour (Visual)	Pale Yellow	Pale Light Yellow

Table-1.3: Properties of Epoxy Resin and Hardener

SAMPLE PREPARATIONS

Design of Experiments calculated for the sample preparation is listed below:

DOE Sheet			
Sl. No	Hardener(in %)	Curing Temp (Deg Celsius)	Filler (%)
S1	15	50	15
S2	15	40	10
S3	10	50	10
S4	5	50	5
S5	10	60	15
S6	15	60	10
S7	10	50	10
S8	10	40	15
S9	15	50	5
S10	10	50	10
S11	5	50	15
S12	5	40	10
S13	10	60	5
S14	10	40	5
S15	5	60	10

Table 4.1: DOE Table for Samples Fabrication

Summary of Calculation

Mass Ratios	Filler ratios		
	5%	10%	15%
Epoxy	46.238	44.438	45.32
S-Glass	21.34	22.219	24.723
Fiber	3.557	7.4	12.3619
Total Mass	71.135g	74.064g	82.41g

Table 4.2: Summary of calculation for Epoxy, S-glass and Fiber mass ratios

METHODOLOGY

Fabrication process

The present works are glass fiber Epoxy composites with filler to making specimens. Manufacturing process has a significant influence on the quality, productivity and competitiveness of polymer composite structures. This paper study plates from reinforced carbon fiber polymer composites obtained by Hand lay-up. Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel (PVA) is spread on the mold surface to avoid the sticking of polymer to the surface. Thin OHP sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of woven glass fiber mats is cut as per the mold size (100X160X3mm). Then with a prescribed hardener HY 991 (curing agent), with Fillers (Ceramic powder Al2O3) then mixed more than 10 minutes for perfect mixture of resin and hardener and poured onto the surface of mat already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the sheet, PVA gel is spread on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure 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 18-24 hours. Under a pressure of 280 psi in UTM machine. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural requirement is less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites.

The following are the procedure for manufacturing composites, using hand lay-up method:

The DOE method used to fabricate 15 different compositions of samples. Glass fibre reinforced composites with filler specimens fabricated in different % of Hardener (5%, 10% and 15%), Different weigh % of Filler (5%, 10% and 15%) and Different Curing Temperature (40^{O}C, 50^{O}C and 60 ^{O}C) composition

- The fibers for ready as per the dimension beforehand and to make easy to accessible.
- The die base horizontal and is should be straight to prevent polymer uneven spread
- Apply the PVA (releasing agent) on the Die base.
- Put one Non Stick sheet on the Die base for good surface finish in the composites.
- Then the mould (PVA applied) placed on the

die base.

- The polymer mix poured in the mould as light layer, Brush used to spread the resin in even the surface of mould.
- Then first layer carbon fiber mat positioned manually in the mould.
- Entrapped air is removed manually with squeegees or rollers to complete the laminate structure.
- Apply the second layer, impregnating it by using the resin from the previous layer.
- When there is no more resin in underneath layer, new resin is applied.
- The rest of the layers are applied as described above.
- This process is continued till the final layer of glass fiber mat is coated with resin.

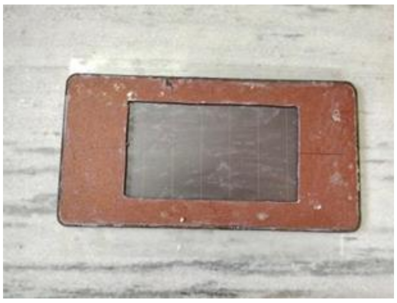
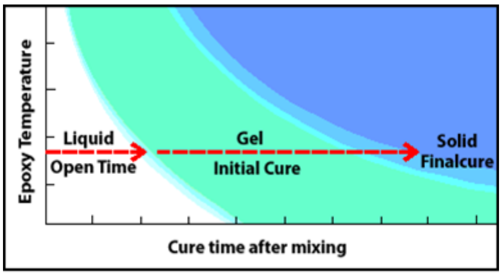


Fig 5.4: Mould release Wax applied on Die for Hand Lay-up Process

- The top plate of mould place on the middle of complete assembly.
- Then the mould compressed by weight
- The compression ensures that entrapped air bubbles are completely removed and the excess resin flows out.
- This mould is left for 18 hours to 24 hours at a room temperature to complete the curing process.
- Under a pressure of 280 psi in UTM machine.
- The same technique was used to fabricate the remaining laminates.

In order to convert epoxy resin into hard, infusible, and rigid material, it is necessary to cure the resin with hardener, Curing initiated by the catalyst in the resin system. The speed curing is controlled by the amount of hardener in an epoxy resin. Epoxy resin cure quickly and easily at practically any temperature from 5-150^{0}c depending on choice of curing agent.



As it cures, mixed epxoy pass from a liquid state, through a gel state, to a solid state. (figure 1)

Fig 5.5 Epoxy cure time

Some major considerations in selecting the proper cure cycle for a given composite material are:

- The temperature inside the material must not exceed a preset maximum value at any time during cure.
- At the end of cure, all the excess resin is squeezed out from every ply of the composite and the resin distribution is uniform.
- The material is cured uniformly and completely.
- The cured composite has the lowest possible void content.
- The curing process is achieved in the shortest amount of time.

RESULTS AND DISCUSSION

Test Results

Samples	Charpy Impact (J/mm2)	Hardness (BHN)	UTS (Mpa)
S1	0.21	88	385
S2	0.164	80	311
S3	0.19	79	275
S4	0.175	72	298
S5	0.29	86	364
S6	0.27	84	370
S7	0.195	80	365
S8	0.169	76	256
S9	0.178	73	344
S10	0.186	72	290
S11	0.199	76	301
S12	0.17	71	241
S13	0.24	83	380
S14	0.181	71.52	243
S15	0.235	85	381

Table 6.1: Mechanical Test Results of Samples

RESPONSE SURFACE METHODOLOGY

Input Parameters

Sl.No	Parameters	Low	Mid	High
1	Hardner	5	10	15
2	Curing Temp	40	50	60
3	Filler	5	10	15

Table 6.5: RSM Input Parameters

6.2.2 RSM OPTIMIZATION RESULTS

Regression Equation:

Hardness = 83.14 + 1.291 Hardner - 1.283 Curing Temp + 0.102 Filler + 0.01826 Hardner * Hardner + 0.02126 Curing Temp * Curing Temp - 0.00893 Filler * Filler - 0.04442 Hardner * Curing Temp + 0.11048 Hardner * Filler - 0.00729 Curing Temp * Filler.

Tensile= -245.72 + 6.481 Hardner + 13.818 Curing Temp + 2.094 Filler + 0.74403 Hardner * Hardner - 0.02777 Curing Temp * Curing Temp + 0.13732 Filler * Filler - 0.40540 Hardner * Curing Temp + 0.36775 Hardner * Filler - 0.14976 Curing Temp * Filler.

Impact = 0.8143 - 0.00594 Hardner - 0.02522 Curing Temp - 0.01812 Filler - 0.000202 Hardner * Hardner + 0.000245 Curing Temp * Curing Temp + 0.000208 Filler * Filler + 0.000205 Hardner * Curing Temp + 0.000080 Hardner * Filler + 0.000310 Curing Temp * Filler.

3D SURFACE PLOTS SURFACE PLOT OF IMPACT VS CURING TEMPERATURE, HARDENER

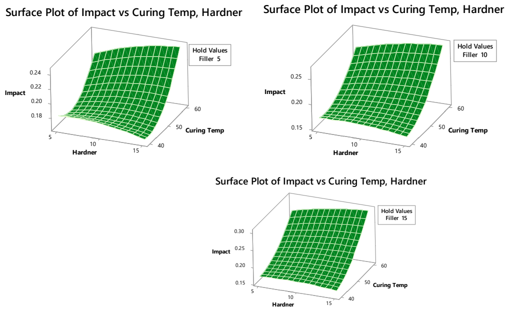


Fig 6.1: Surface Plot for Impact Vs Curing Temperature, Hardener

SURFACE PLOT OF IMPACT VS FILLER, CURING TEMPERATURE

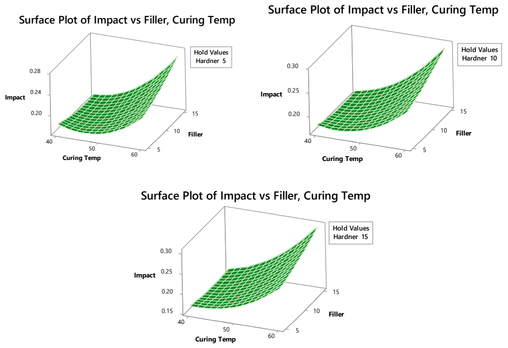


Fig 6.2: Surface Plot for Impact Vs Filler, Curing Temperature

SURFACE PLOT OF IMPACT VS FILLER, HARDENER

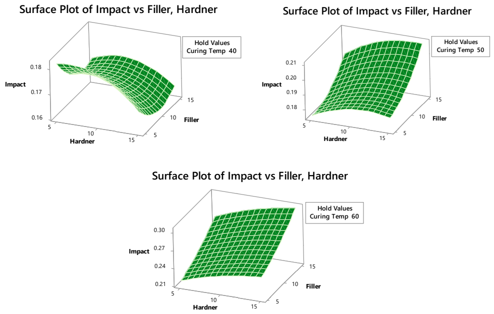


Fig 6.3: Surface Plot for Impact Vs Filler, Hardener

SURFACE PLOT OF HARDNESS VS CURING TEMPERATURE, HARDENER

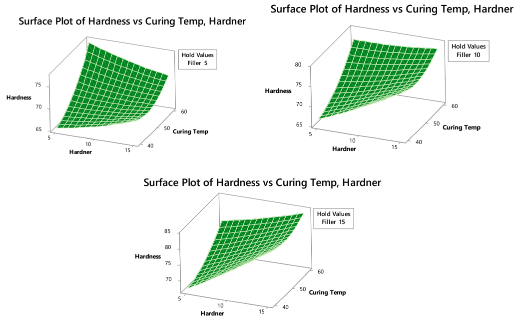


Fig 6.4: Surface Plot for Hardness Vs Curing Temperature, Hardener

SURFACE PLOT OF HARDNESS VS FILLER, CURING TEMPERATURE

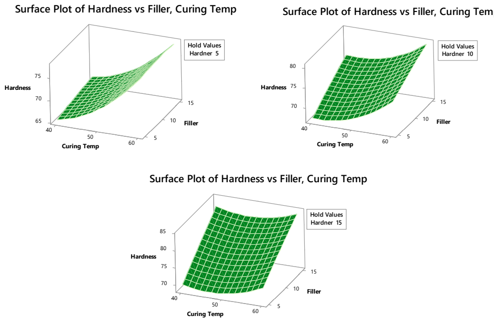


Fig 6.5: Surface Plot for Hardness Vs Filler, Curing Temperature

SURFACE PLOT OF HARDNESS VS FILLER, HARDENER

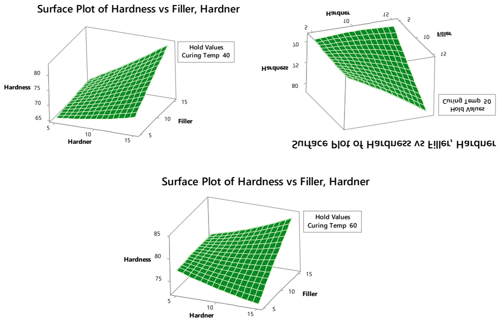


Fig 6.6: Surface Plot for Hardness Vs Filler, Hardener

SURFACE PLOT OF TENSILE VS CURING TEMPERATURE, HARDENER

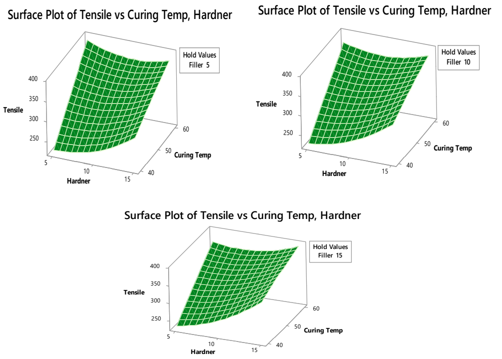


Fig 6.7: Surface Plot for Tensile Vs Curing Temperature, Hardener

SURFACE PLOT OF TENSILE VS FILLER, CURING TEMPERATURE

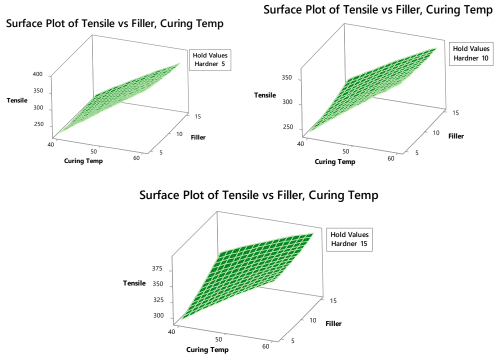


Fig 6.8: Surface Plot for Tensile Vs Filler, Hardener

SURFACE PLOT OF TENSILE VS FILLER, HARDENER

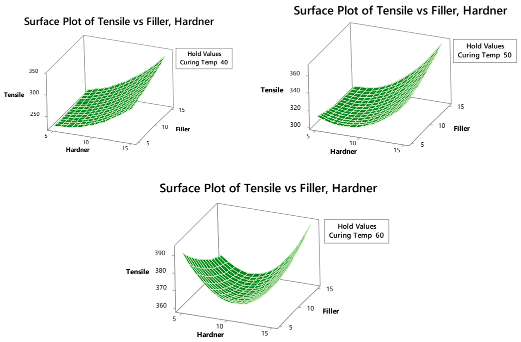


Fig 6.9: Surface Plot for Tensile Vs Filler, Hardener

6.2.4 RSM Optimized Parameters Plot

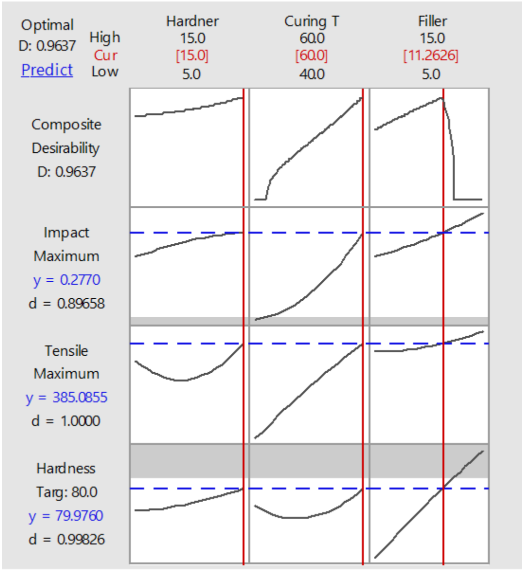


Fig 6.10: RSM Optimized Parameters Plot

RSM Optimized parameters are Hardener: 15%, Curing Temperature: 60 ^{0}C, Filler: 11.262 %.

RSM OPTIMIZED CONDITION TEST RESULTS

Hardness Test Results for RSM Optimized Condition are tabulated below:

Sample	Hard Opt	Hard Exp	% Error
OS-1	80	80.102	-0.127337645
OS-2	80	80.081	-0.101147588
OS-3	80	79.878	0.152732918

Table 6.6: Hardness Test Results for RSM Optimized condition

Tensile Test Results for RSM Optimized Condition are tabulated below:

Sample	Tensile Opt	Tensile Exp	% Error
OS-1	385.085	385.485	-0.103765386
OS-2	385.085	385.547	-0.119829748
OS-3	385.085	385.878	-0.205505367

Table 6.7: Tensile Test Results for RSM Optimized condition

Impact Test Results for RSM Optimized Condition tabulated below:

Samples	Impact Opt	Impact Exp	% Error
OS-1	0.277	0.271	2.21402214
OS-2	0.277	0.276	0.362318841
OS-3	0.277	0.278	-0.35971223

Table 6.8: Impact Test Results for RSM Optimized condition

CONCLUSION

Engineers, researchers, non-abrasives, environmental friendly and adequate mechanical properties around the world are a substitute for fiber reinforced polymer compounds, due to the high quality properties of fiber specific strength, low weight, and low cost, very good mechanical properties. From this point of view, there is a brief analysis of the use of a large number of fibers. This paper presents an analysis of the mechanical properties and frictional Epoxy + glass fiber + ceramic composite (70:25:5), Epoxy + glass fiber + ceramic (65:25:10), Epoxy + glass fiber + ceramic composite (60:25:15), properties of polymer blend glass fiber with ceramic (Al2O3) filler. The integration of intermittent bonds between fiber and polymer matrix is an important aspect of the optimal mechanical performance of fiber-reinforced compounds with general and elegance. The proportions are 70:30 and 80:20. The quality of the fiber-matrix interface is important to strengthen the plastics to use glass fibers and different ceramic fillers (10, 15 wt %). Since fibers and modules are chemically different, strong adhesion in their interfaces requires an effective transition to stress and bond distribution through an interface. The Test results are optimized by response surface methodology.

The RSM parameters are optimized and those parameters are Hardener: 15%, Curing Temperature: 60 ^{0}C, Filler: 11.262 %. The RSM Responses are optimized, that are Impact Strength is 0.277 N, Tensile Strength is 385.0855 MPa and Hardness is 79.9760.

REFERENCES

1. R. Jeyakumar1P. S. Sampath2, R. Ramamoorthi1 & T. Ramakrishnan (2017), ‘Structural, morphological and mechanical behaviour of glass fibre reinforced epoxy nanoclay composites’.
2. S. Rajesh a*, B. VijayaRamnathb, C.Elanchezhianb, N.Aravindc, V.Vijai Rahuld & S. Sathishd (2014),‘Analysis of Mechanical Behavior of Glass Fibre/ Al2O3- SiC Reinforced Polymer composites’ 12th Global Congress On Manufacturing and Management,GCMM.
3. Omer Erkan & Birhan Işik & Adem Çiçek & Fuat Kara (2012),’Prediction of Damage Factor in end Milling of Glass Fibre Reinforced Plastic Composites Using Artificial Neural Network’.
4. S.R. Naqvia, H. Mysore Prabhakaraa, E.A. Bramera, W. Dierkesa,b, R. Akkermanb & G. Brema, ‘A critical review on recycling of end-of-life carbon fibre/glass fibre reinforced composites waste using pyrolysis towards a circular economy’.
5. Naveen Sait,S. Aravindan & A. Noorul Haq (2008), ‘Optimisation of machining parameters of glass-fibre-reinforced plastic (GFRP) pipes by desirability function analysis using Taguchi technique’.
6. N. Hameed1, S. P. Thomas1, R. Abraham2 & S. Thomas1*(2007), ‘Morphology and contact angle studies of poly (styrene- co-acrylonitrile) modified epoxy resin blends and their glass fibre reinforced composites’.
7. Osman Asi, ‘An experimental study on the bearing strength behavior of Al2O3particle filled gas fiber reinforced epoxy composites pinned joints’.
8. Mehdi Kalantari, Chensong Dong & Ian J. Davies (2015),‘Multi-objective robust optimization of unidirectional carbon/glass fibre reinforced hybrid composites under flexural loading’.
9. Mehdi Kalantari, Dr Chensong Dong & Ian J. Davies (2015), ‘Multi-objective analysis for optimal and robust design of unidirectional glass/carbon fibre reinforced hybrid epoxy composites under flexural loading.
10. F.X. Qin,H.X. Peng,Z. Chen,H. Wang,J.W. Zhang & G. Hilton (2013), ‘Optimization of microwire/glass-fibre reinforced polymer composites for wind turbine application’.
11. Giuseppe Petrone & Viviana Meruane (2016), ‘Mechanical properties updating of a non-uniform natural fibre composite panel by means of a parallel genetic algorithm’.
12. V. Durga Prasada Rao1, M. Mrudula1 V,Navya & Geethika (2018), ‘Multi-objective Optimization of Parameters in Abrasive Water Jet Machining of Carbon-Glass Fibre-Reinforced Hybrid Composites’.
13. M R Razfar & M R Zanjani Zadeh (2008), ‘Optimum damage and surface roughness prediction in end milling glass fibre-reinforced plastics, using neural network and genetic algorithm’