ISSN: 2278-0181
NCRAEM - 2019 Conference Proceedings

Tensile and Flexural Strengths of Epoxy Composite with Fibre Glass, Black Granite, White Granite and Stone Powder

D. K. Jawad, Dr. A.Ramesh
Department of Mechanical Engineering,
JJTU, Jhunjhunu, Rajasthan-333001

ABSTRACT:
Study and experimentally analysis of Mechanical properties of Epoxy Resin composite and glass fibre with additives of 5%, 10% and 15% nano particles of White Granite, Black Granite and Stone powder separately, considering three test samples and finding the Tensile strengths and Flexural strength.

KEY WORDS:
Epoxy Resin, Black Granite powder, White Granite powder, Stone powder, Tensile Strength, Flexural strength.

INTRODUCTION:

A composite is defined as a combination of two or more materials with a distinguishable interface. The oldest man-made composite is concrete, which is associated with a macrolevel reinforcement. The urge to improve the properties of composite materials, has prompted material scientists to investigate composites with lower and lower reinforcement size, leading to the development of microcomposites and the recent trend in composite research is nanocomposites (with nanometer scale reinforcements). On the basis of the nature of the matrices, composites can be classified into four major categories: polymer matrix composite (PMC), metal matrix composite (MMC), ceramic matrix composite (CMC) and carbon matrix composite or carbon carbon composites. PMC can be processed at a much lower temperature, compared to MMC and CMC. Depending on the types of polymer matrices, PMC are classified as thermosetting composites and thermoplastic composites.

Epoxy resins are a class of versatile polymer materials characterised by the presence of two or more oxirane ring or epoxy groups within their molecular structure.

Like other thermosets they also form a network on curing with a variety of curing agents such as amines, anhydrides, thiols etc. Amine curing agents are most widely used because of the better understanding/control of epoxy-amine reactions.

The broad interest in epoxy resins originates from the versatility of epoxy group towards a wide variety of chemical reactions and the useful properties of the network polymers such as high strength, very low creep, excellent corrosion and weather resistance, elevated temperature service capability and adequate electrical properties. Epoxy resins are unique among all the thermosetting resins due to several factors namely, minimum pressure is needed for fabrication of products normally used for thermosetting resins:

- Shrinkage is much lower and hence there is lower residual stress in the cured product than that encountered in the vinyl polymerisation used to cure unsaturated polyester resins.
- Use of a wide range of temperature by judicious selection of curing agent with good control over the degree of crosslinking.
- Availability of the resin ranging from low viscous liquid to tack free solid, etc. Because of these unique characteristics and useful properties of network polymers.
- Epoxy resins are widely used in structural adhesives, surface coatings, engineering composites, and electrical laminates.

Generally, in composite systems, there are three main matrix types including polymer, metal, and ceramic with different additives in various forms such as lamina, fillers, fibre (short and continuous), flake, and particles. In this field, nanocomposites are defined with at least one component in nanometric scale.

Glass fibre (or glass fibre) is a material consisting of numerous extremely fine fibres of glass.

Granite powder, a waste material from the granite polishing industry, is a promising material for use in concrete similar to those of pozzolanic materials such as silica fume, fly ash, slag, and others. These products can be used as a filler material (substituting sand) to reduce the void content in concrete. Granite powder: These products can be used as a filler material (substituting sand) to reduce the void content in concrete. Granite powder is an industrial by product obtained from crushing of granite stone and granite stone polishing industry in a powder form.

LITERATURE SURVEY:

H.V.Rama Krishna at all (2005), they conducted the test on Granite powder-reinforced epoxy composites have been developed with varying granite powder content by weight percentage. The variation of tensile strength and impact strength has been studied and the tensile strength and impact strength were found to be at a maximum for the 50% granite powder-reinforced epoxy composite[4].

H.V. Ramakrishna and S. K. Rai (2005), they carried out study on the properties of two particulate reinforced epoxy composites namely granite powder and fly ash have been assessed. An attempt has also been made to improve the pure matrix system epoxy resin using commercially available thermoplastic (polymethyl methacrylate). Pure blend matrix with different weight fractions of polymethyl methacrylate and epoxy are prepared and the blend matrix having the highest strength is selected for preparing composites[5].

H.V.Ramakrishna at all (2005), they carried out the test on Composites using unsaturated polyester as the matrix and granite powder and fly ash as fillers. The tensile and flexural strengths of these composites are determined. The variation of tensile and flexural properties with weight fraction of the fillers is studied. The properties of granite powder composites are found to be better than those of fly ash composites[7].
H.V.Ramakrishna at all (2005), they studied the Epoxy is toughened with polymethylmethacrylate (PMMA) and different percent weights of granite powder and fly ash are added to this matrix. The tensile and flexural strengths of these composites are determined. The variation of tensile and flexural strengths with granite powder and fly ash content is studied. For comparison, epoxy is also used as the matrix. The tensile and flexural strengths increased with PMMA content up to 4% (w/w) in the composites. The granite powder composites showed better properties than fly ash composites[8].
H.V.Ramakrishna and S. K. Rai (2006), they performed the study on the tensile, flexural, compression, and impact strength of granite powder–epoxy composites on toughening epoxy with unsaturated polyester and unsaturated polyester with epoxy resin has been assessed. The water absorption studies revealed that an increase in the strength of the composites showed a positive toughening effect[6].
H.V.Ramakrishna at all (2007), they conducted the experiments on Granite powder is an inexpensive material that can reduce the overall cost of a composite if used as a filler in epoxy and acrylonitrile butadiene styrene (ABS)-toughened epoxy matrices. Epoxy and ABS-toughened epoxy resins filled with granite powder were cast into sheets. To enhance the properties of these composites, granite powder was treated with triethoxymethyl silane coupling agent. Flexural properties, compression properties, chemical resistance, and morphology of these composites were studied[9].
J.Cho bat all (2007), they did the experiments on the epoxy matrix in carbon fiber/epoxy composites was modified with graphite nanoplatelets to improve their mechanical properties. Graphite nanoparticles were mixed and dispersed in the epoxy matrix by sonication, followed by a vacuum assisted wet layup process. The composites reinforced with nanoparticles showed enhanced compressive strength and in-plane shear properties. A simple analytical model was used to predict the longitudinal compressive strength, which was in good agreement with experimental results[10].
Nishar Hameed at all (2007), they used E-glass fibre as the fibre reinforcement, dynamic mechanical and thermal characteristics of the systems were analyzed. The dynamic moduli, mechanical loss and damping behaviour as a function of temperature of the systems were studied using dynamic mechanical analysis (DMA). DMA studies showed that DDS cured epoxy resin/SAN/glass fibre composite systems have two T_gs corresponding to epoxy rich and SAN rich phases[12].
Shetty Ravindra Rama and S. K. Rai (2008), they did the experiment on Hydroxyl terminated polyurethane (HTPU) in different proportions has been incorporated into DGEBA based epoxy resin, cured with triethylene tetramine. Composites are developed using varying weight fractions of silane coupling agent treated granite powder as reinforcement in pure and toughened epoxy resin. Various physico-mechanical properties such as tensile and flexural behavior, density, and void content have been determined. Studies revealed that toughened resin composites enhance the properties compared to neat matrix[18].
A. Godaraa, at all (2009) they performed the study on Carbon nanotubes (CNTs) were incorporated in an epoxy matrix that was then reinforced with carbon fibres. A fixed amount (0.5 wt.%) of different types of CNTs (functionalized and non-functionalized) were dispersed in the epoxy matrix, and unidirectional prepregs are produced[1].
Amal Nassar and Eman Nassar (2013), they studied the effect of NanoSiC particles on the mechanical properties for the polymer composite material and using the epoxy resin (EPOBOND Epoxy) supplied from epobond for chemicals and electrical components in Egypt as matrix reinforced with silicon carbide nanoparticles with different weight percentage (5, 10, 15 and 20). The tensile tests were made by using LLOYD" Universal Tensile Testing Machine System at room temperature, the wear tests were made by Pin-on-Disc machine and Charpy impact test machine was used for measuring the impact toughness during impact testing[2].
Arun Kumar Rout1 and Alok Satapathy (2013), they studied a new class of low cost hybrid composites consisting of glass-epoxy and filled with four different weight proportions (0 wt%, 10 wt%, 15 wt% and 20 wt%) of granite particulates (a solid waste generated from stone processing industries) are developed. Mechanical study reveals that hardness, tensile modulus and impact energy of these composites are improving with filler addition while a steady decline in tensile and flexural strength is observed[3].
Patil Deogonda and Vijaykumar N Chalwa (2013), they described the development and mechanical characterization of new polymer composites consisting of glass fibre reinforcement, epoxy resin and filler materials such as TiO_2 and ZnS. The newly developed composites are characterized for their mechanical properties. Experiments like tensile test, three point bending and impact test were conducted to find the significant influence of filler material on mechanical characteristics of GFRP composites[14].
Satnam Singh at all (2013), they did the work on determination of mechanical properties of pure epoxy and random oriented glass fibre (mat) reinforced epoxy at 10% and 20% weight fractions of glass fibres. The test specimens were prepared and tested according to ASTM standards. The experimental results revealed that with increase in weight fraction of reinforcement, the tensile strength and flexural strength increased by 14.5 % and 123.65% for 20 % glass reinforced composites over pure epoxy[17].
Jorge Antônio Vieira Gonçalvesa at all(2014), they studied the mechanical properties including traction, flexion, compression, and hardness characteristics of a composite made from the combination of epoxy resin and granitic stone powder from the fold-and-thrust belt located in the municipality of Nossa Senhora da Glória, in the state of Sergipe, Brazil. Chemical and mineralogical analyses of the stone and analysis by SEM of the particle/matrix interface are performed[11].
Rajkumar.S and Dr.Marimuthu.K (2014), they did the experimental investigation study of basalt fibre reinforced epoxy composites was conducted and their tensile, flexural and impact Strengths were analysed. Owing to the scarcities of

information about their mechanical performances in present literature studies, this work was directed towards providing mechanical characterization of basalt-fibre reinforced epoxy composite, manufactured at various ratios such as 35:65, 40:60, 45:55 (Fibre: Resin)[15].

Ravikumar and M.S.Sham Prasad (2014), they conducted the Fracture toughness at six different compositions of composites. Three samples have to be tested for each composition of the composites. It can be concluded that by the addition of small percentage of aluminum oxide filler there is marginal improvement in fracture toughness of glass fabric reinforced epoxy matrix up to 4wt%[16].

O.O. Daramola and O.S. Akintayo (2017), they investigated the Mechanical properties (tensile, flexural, hardness) of the developed composite. Silica particles incorporation shows beneficiary effect on the modulus of elasticity, flexural modulus and hardness with threshold value experienced at 2wt%., However tensile strength and flexural strength where found to decrease upon silica addition, the flexural strength values being somewhat higher than their tensile counterparts. SEM images of the specimens revealed the manner of silica dispersion in the matrix[13].

EXPERIMENTAL METHODOLOGY:

After the preparation of Composite material, The material is made in the form of plate and cut into corresponding profiles as per ASTM(American Standards of Testing and Materials) standards for conducting the Tensile test, Impact test , Flexural test , XRD test and check out the tribological properties.

Fabrication:


Fig.1 Arranging first layer of glass Fibre


Fig.2 Applying Epoxy for second layer


Fig.3 Cutting of Glass fibre


Fig. 4 Applying Epoxy for first layer


Fig.5 Arranging second layer of glass fibre


Fig.6 Curing at room temperature


Fig.7 Composite without Filler


Fig. 8 All Composites

Tensile Test:

Tensile test is a material science test in which the sample is subjected to a controlled tension until failure. Properties that are directly measured via tensile test are ultimate tensile strength, maximum elongation and reduction in area.


Fig. 9 Tensile Test

Tensile test is a material science test in which the sample is subjected to a controlled tension until failure. Properties that are directly measured via tensile test are ultimate tensile strength, maximum elongation and reduction in area.

According to the ASTM standards D 3039/D 3039M

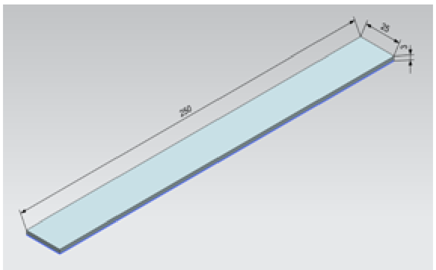


Fig. 10 Tensile Test Specimen

Three Point Flexural Test:

The three points bending flexural test provides values for the modulus of elasticity in bending, flexural stress, flexural strain and the flexural stress-strain response of the material.

The test method for conducting the test usually involves a specified test fixture on a Universal testing machine. Details of the test preparation, conditioning, and conduct affect the test results. The sample is placed on two supporting pins a set distance apart and a third loading pin is lowered from above at a constant rate until sample failure.

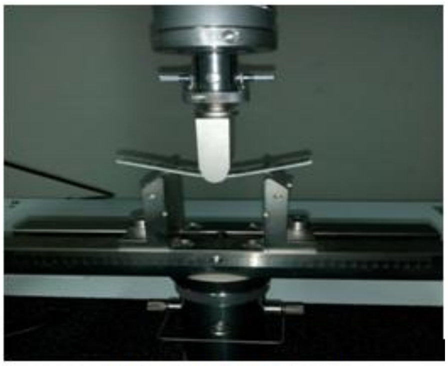


Fig. 11 Three Point Flexural Test

According to the ASTM standards D7264

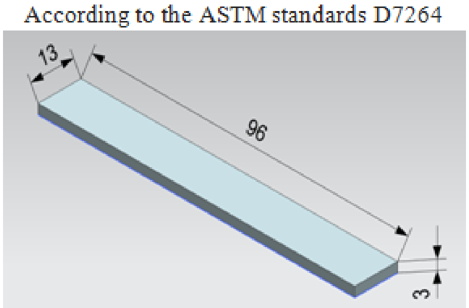


Fig. 12 Three Point Flexural Test specimen

RESULTS AND DISCUSSION:

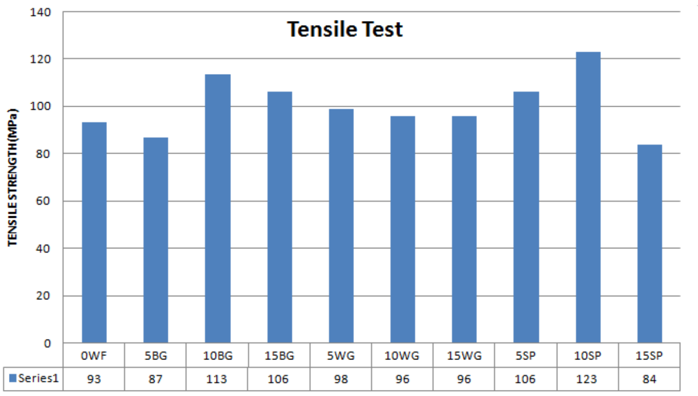
Notations:

WF	Without Filler
BG	Black Granite
WG	White Granite
SP	Stone Powder
WF	100% of Glass Epoxy
5BG	5% of Black Granite Filler and 95% of Glass Epoxy
5WG	5% of White Granite Filler and 95% of Glass Epoxy
5SP	5% of Stone Powder and 95% of Glass Epoxy

Tensile Test:

Filler %	Test 1	Test 2	Test 3	Avg load	Cross sectional area	Stress	Test 1	Test2	Test3	Avg. Strain	Flex Modulus (MPa)
0WF	9837.65	9818.02	5721.87	8459.18	75	93	0.12167	0.12584	0.1185	0.12200333	762
5BG	3430.09	8181.53	7874.23	6495.28	75	87	0.05233	0.07267	0.07366	0.06622	1308
5WG	7972.52	7183.96	7004	7386.83	75	113	0.06666	0.056	0.05833	0.06033	2057
5SP	6711.04	8708.61	8449.55	7956.4	75	106	0.04251	0.08134	0.08267	0.06884	1552
10BG	9178.89	6673.32	9654.31	8502.17	75	98	0.0595	0.043	0.06283	0.05511	1633
10WG	6834.32	8652.16	6031.66	7172.71	75	96	0.05417	0.065	0.05133	0.05683333	1683
10SP	8477.36	9170.81	10012.1	9220.07	75	96	0.05333	0.06084	0.06533	0.05983333	1887
15BG	8631.02	8637.03	6582.87	7950.31	75	106	0.08067	0.072	0.05218	0.06828333	1541
15WG	8044.5	6897.66	6593.85	7178.67	75	123	0.06117	0.04784	0.04317	0.05072667	2055
15SP	5366.46	8430.5	5038.65	6278.54	75	84	0.03883	0.073	0.03267	0.04816667	1738

Filler (%)	Load (N)	Cross sectional area (mm)	Stress (MPa)	Strain	Modulus (MPa)
0WF	6968.78	75	93	0.122	762
5BG	6495.28	75	87	0.066	1308
10BG	8502.17	75	113	0.055	2057
15BG	7950.31	75	106	0.068	1552
5WG	7386.83	75	98	0.060	1633
10WG	7172.71	75	96	0.057	1683
15WG	7178.67	75	96	0.051	1887
5SP	7956.4	75	106	0.069	1541
10SP	9220.07	75	123	0.060	2055
15SP	6278.54	75	84	0.048	1738



Activate Windows

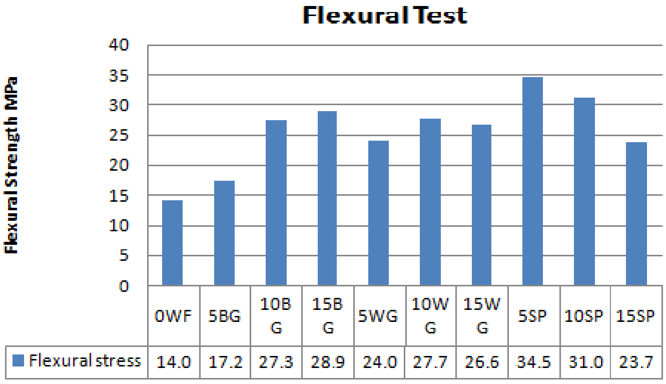
.

Maximum Tensile strength value increases up to addition of 10 % filler material for Black Granite and Stone Powder, Further addition of filler decreases their strength whereas in White Granite composite, maximum strength is observed at 5%of filler and further addition of filler material decreases and remains constant.

Flexural Test:

Filler%	Test 1	Test 2	Test 3	Avg. Load	Stress1	stress2	stress3	Avg. Stress	FM1	FM2	FM3	Flex Modulus (MPa)
0WF	0.05	0.07	0.05	0.0566	30.13	39.53	28.57	14.065238	1094.72	1418.24	1042.71	1185.22333
5BG	0.08	0.08	0.07	0.076	41.98	41.98	36.23	17.21381	1974.61	1974.61	127244	1740.55333
5WG	0.11	0.09	0.1	0.1	62.26	50.34	55.41	24.058571	2093.86	1945.58	2075.32	2038.25333
5SP	0.13	0.12	0.19	0.146	69.5	66.07	105.73	34.555238	2743.61	2678.98	3841.93	3088.17333
10BG	0.11	0.11	0.12	0.113	60.28	61.98	68.68	27.341905	2107.58	2088.29	2276.56	2157.47667
10WG	0.13	0.1	0.1	0.11	73.31	67.02	53.39	27.737143	2433.36	1937.53	1963.56	2111.48333
10SP	0.09	0.12	0.09	0.1	47.27	69.24	49.62	23.79	2590.16	3158.91	3061.33	2936.8
15BG	0.14	0.11	0.11	0.12	79.87	63.42	58.62	28.912857	3113.71	2616.19	2454.55	2728.15
15WG	0.11	0.12	0.11	0.113	59.48	64.42	62.08	26.633333	2171.43	2319.85	2290.36	2260.54667
15SP	0.14	0.13	0.12	0.13	75.46	74.82	66.82	31.088571	3074.51	3152.04	2972.42	3066.32333

Filler%	Load	Flexural stress	Flex Modulus (MPa)
0WF	0.05666667	14.065238	1185
5BG	0.07666667	17.21381	1741
10BG	0.11333333	27.341905	2157
15BG	0.12	28.912857	2728
5WG	0.1	24.058571	2038
10WG	0.11	27.737143	2111
15WG	0.11333333	26.633333	2261
5SP	0.14666667	34.555238	3088
10SP	0.13	31.088571	3066
15SP	0.1	23.79	2937



It is observed that the flexural strength increases as the filler composition increases in Black Granite and White Granite from 5% to 15% whereas it is gradually decreased by addition of filler composition in to StonePowder from 15% to 5%.

Conclusion

Tensile strength value increases up to addition of 10 % filler material for BG and SP, Further addition of filler decreases their strength whereas in WG composite, maximum strength is observed at 5% of filler and further addition of filler material decreases and remains constant. The Maximum tensile strength is obtained at filler composition of 10% of SP i.e.123 MPa.

Flexural strength increases as the filler composition increases in BG and WG from 5% to 15% whereas it is gradually decreased by addition of filler composition in SP from 15% to 5%.The Maximum flexural strength is obtained at filler composition of 5% of SPi.e.34.5MPa.

REFERENCES:

1) A. Godaraa, L. Mezzoa, F. Luizia, A. Warrierb, S.V. Lomovb, A.W. van Vuureb, L. Gorbatikhb, P. Moldenaersc & I. Verpoestb (2009), "Influence of carbon nanotube reinforcement on the processing and the mechanical behaviour of carbon fibre/epoxy composites", Elsevier Ltd, journal homepage: www.elsevier.com/locate/carbon, doi:10.1016/j.carbon.2009.06.039.

2) Amal Nassar & Eman Nassar (2013), "Study on Mechanical Properties of Epoxy Polymer Reinforced with NanoSiC particles", Nanoscience and Nanoengineering 1(2): 89-93, 2013, DOI: 10.13189/nn.2013.010201.

3) Arun Kumar Rout1 and Alok Satapathy (2013), "Study on mechanical and erosion wear performance of granite filled glass-epoxy hybrid composites", Institution of Mechanical Engineers, Journal of Materials Design and Applications published online 6 August 2013, DOI: 10.1177/1464420713499483.

4) H. V. Rama Krishna, S. Padma Priya and S. K. Rai (2005), "Tensile, Impact, and Chemical Resistance Properties of Granite Powder–Epoxy Composites", Journal of Reinforced Plastics and composites, 2005 24: 451, DOI: 10.1177/0731684405043549.

5) H. V. Ramakrishna and S. K. Rai (2005), "A Study on the Mechanical and Water Absorption Properties of Granite Powder/Epoxy Toughened with PMMA and Fly Ash/Epoxy Toughened with PMMA Composites", Journal of Reinforced Plastics And Composites, Vol. 24, No. 17/2005, DOI: 10.1177/0731684405052202.

6) H. V. Ramakrishna and S. K. Rai (2006), "Effect on the Mechanical Properties and Water Absorption of Granite Powder Composites on Toughening Epoxy with Unsaturated Polyester and Unsaturated Polyester with Epoxy Resin", Journal of Reinforced Plastics And Composites, Vol. 25, No. 1/2006, DOI: 10.1177/0731684406055450.

7) H. V. Ramakrishna, S. Padma Priya and S. K. Rai (2005), "Tensile, Flexural Properties of Unsaturated Polyester/Granite Powder and Unsaturated Polyester/Fly Ash Composites", Journal of Reinforced Plastics And Composites, Vol. 24, No. 12/2005, DOI: 10.1177/0731684405049862.

8) H. V. Ramakrishna, S. Padma Priya and S. K. Rai (2005), "Studies on Tensile and Flexural Properties of Epoxy Toughened with PMMA/Granite Powder and Epoxy Toughened with PMMA/Fly Ash Composites", Journal of Reinforced Plastics And Composites, Vol. 24, No. 12/2005, DOI: 10.1177/0731684405049863.

9) H. V. Ramakrishna, S. Padma Priya and S. K. Rai (2007), "Flexural, Compression, Chemical Resistance, and Morphology Studies on Granite Powder-Filled Epoxy and Acrylonitrile Butadiene Styrene-Toughened Epoxy Matrices", Journal of Applied Polymer Science, Vol. 104, 171–177 (2007), DOI 10.1002/app.25115.

10) J. Cho, J.Y. Chen and I.M. Daniel (2007), "Mechanical enhancement of carbon fibre/epoxy composites by graphite nanoplatelet reinforcement", Elsevier Ltd, Scripta Materialia 56 (2007) 685–688, doi:10.1016/j.scriptamat.2006.12.038.

11) Jorge Antônio Vieira Gonçalvesa, Diego Adalberto Teles Camposb, Gislane de Jesus Oliveirab, Maria de Lourdes da Silva Rosac and Marcelo Andrade Macêdoa (2014), "Mechanical Properties of Epoxy Resin Based on Granite Stone Powder from the Sergipe Fold-and-Thrust Belt Composites", Materials Research. 2014; 17(4): 878-887, DOI: http://dx.doi.org/10.1590/S1516-14392014005000100.

12) Nishar Hameed, P.A. Sreekumar, Bejoy Francis, Weimin Yang and Sabu Thomas (2007), "Morphology, dynamic mechanical and thermal studies on poly(styrene-co-acrylonitrile) modified epoxy resin/glass fibre composites", Elsevier Ltd, Composites: Part A 38 (2007) 2422–2432, doi:10.1016/j.compositesa.2007.08.009.

13) O.O. Daramola and O.S. Akintayo (2017), "Mechanical Properties of Epoxy Matrix Composites Reinforced With Green Silica Particles", ISSN:1584-2665 [print; online],ISSN:1584-2673 [CD-Rom; online], a free-access

multidisciplinary publication of the Faculty of Engineering Hunedoara.
14) Patil Deogonda and Vijaykumar N Chalwa (2013), “Mechanical Property of Glass Fibre Reinforcement Epoxy Composites”, International Journal of Scientific Engineering and Research (IJSER), ISSN (Online): 2347-3878, Volume 1 Issue 4, December 2013.
15) Rajkumar.S and Dr.Marimuthu.K (2014), “Experimental Research on the Fundamental Mechanical Properties of Basalt Fibre Reinforcement with Epoxy”, International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753, Vol. 3, Issue 11, November 2014.
16) Ravikumar and M.S.Sham Prasad (2014), “Fracture Toughness and Mechanical Properties of Aluminum Oxide Filled Chopped Strand Mat E-Glass Fibre Reinforced–Epoxy Composites”, International Journal of Scientific and Research Publications, ISSN 2250-3153, Volume 4, Issue 7, July 2014.
17) Satnam Singh, Pardeep Kumar and S.K. Jain (2013), “An experimental and numerical investigation of mechanical properties of glass fibre reinforced epoxy composites”, Advanced Materials Letters, Adv. Mat. Lett. 2013, 4(7), 567-572, DOI: 10.5185/amlett.2012.11475.
18) Shetty Ravindra Rama and S. K. Rai (2008), “Tensile, Flexural, Density and Void Content Studies on Granite Powder Filled Hydroxyl Terminated Polyurethane Toughened Epoxy Composite”, Journal of Reinforced Plastics And Composites, Vol. 27, No. 15/2008, DOI: 10.1177/0731684408088891.

.

AUTHORS PROFILE:

D.K.Jawad, Completed Diploma in Automobile Engineering in 1995 at Govt. polytechnic, Anantapur, B.Tech. Mechanical Engineering in 2000 from Kakatiya Institute of Technology and Science, affliated To Kakatiya University, Warangal and M.Tech. in Advanced Manufacturing System in 2015 from Kasireddy Narayan Reddy College of Engineering Affliated To JNTUH, Hyderabad.

Dr. A. Ramesh, comp-leted Diploma in Mechanical Engineering in 1985, B.E. in Mechanical Engineering in 1989 under Bangalore University, M.E. in Metal Casting Engineering, 1995, from Bangalore University, Ph.D. in Mechanical Engineering in the year 2004 from Mysore University and Sir having the 30 years of Teaching Experince in Engineering Colleges.