International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 6 Issue 4, April - 2022, Pages:8-15

Evaluation of Compressive strength of Building Structures Modified with Polymer Reinforcement

Ravindra Babu. G,

Karavali Institute of Technology, Mangalore

Abstract: *Cement-based materials are the most extensively utilised civil engineering materials due to their good physical qualities and inexpensive cost. These materials, however, have several disadvantages: they are brittle, have a low failure strain, and are weak under tension. Polymer modification and fibre reinforcement have both been utilised successfully in practise to alleviate these issues. The mechanical properties of three types of concrete, namely plain concrete, steel fibre reinforced concrete, and latex modified steel fibre reinforced concrete, were determined in this study. Polymer latex considerably improves workability (slump and Vee Bee time). A high-strength PMC can be made with the addition of 15% latex. The compressive strength of concrete increases as the steel fibre content in the concrete increases, reaching its maximum strength at 1% steel fibre content of total cement volume. The insertion of fibre has a significant impact on the arrest, deferral, and proliferation of cracks.*

Keywords; Polymer Structures, Concrete materials, SFRCC

I.INTRODUCTION

Concrete is the most commonly utilised building material. Concrete has a number of desired features, including great compressive strength, stiffness, and long-term durability in a variety of environments [1-5]. Because of the hydration of cement, concrete has a high compressive strength [6,8]. The combined usage of polymer and fibres was investigated experimentally in this paper. Steel fibre reinforced concretes are structural materials that are rapidly gaining popularity as a result of rising demand [9-12]. As a result, fibre reinforced concrete is more resistant to cracks and the spread of fissures [13]. All of this adds up to a high level of post-cracking ductility in the fibre composite that is unheard of in conventional concrete [14-16]. By adding a suitable polymer to SFC, these qualities can be improved [17]. Recent Study reveals that, Due to the creation of a three-dimensional polymer network via the solidified cementitious networks, polymer concrete cements have high rigidity, great flexible way of behaving, and high effect obstruction abilities [18-22]. The porosity reduces and the pore radius is refined as a result of this network's void-filling function and bridging over cracks [23]. In addition, Moreover, the change zone might be worked on because of the attachment of a polymer [24]. A styrene butadiene elastic emulsion is joined to work on the pliable way of behaving and flexural strength of steel fiber built up concrete cements (SFC) [25,27]. Silica smoke and fly debris are additionally used to upgrade the densification of cementitious lattice [28]. The mechanical properties, microstructure, porosity and pore size dissemination of polymer changed steel fiber supported concrete are contemplated. The adherence of a polymer may likewise assist with further developing the change zone [29-31]. To work on the malleable way of behaving and flexural strength of steel fiber supported concrete cements, a styrene butadiene elastic emulsion is utilized (SFC)[32]. To work on the densification of the cementitious lattice, silica smoke and fly debris are additionally employed [33]. Polymer altered steel fiber built up cement's mechanical attributes, microstructure, porosity, and pore size dispersion are explored.

1.1 STEEL FIBRE REINFORCED CONCRETE

Concrete without support is a fragile material with restricted rigidity and strain limit. Steel fiber support is generally used in modern substantial floor slabs, shotcrete, and pre-assembled substantial merchandise as the essential and one of a kind building up. It's likewise utilized for underlying purposes in heap upheld pieces, burrow sections, substantial cellars, foundation chunks, and prestressed component shear support. Solely after the steel fiber breaks or is removed from the concrete lattice does SFC flop in pressure. The motivation behind haphazardly appropriated spasmodic strands is to offer some post-breaking malleability by connecting over breaks that happen. The strands' principle commitment is to support the substantial's sturdiness under a wide range of stacking. With regards to the Short discrete strands go about as hard incorporations in the substantial network when the fiber support is as short discrete filaments.

1.2 MIX DESIGN OF SFC

SFC blend extents, similar to some other sort of, not entirely settled by the necessities of a particular occupation concerning strength, usefulness, and different elements. There are multiple ways for proportioning SFC blends that accentuation the usefulness of the completed item. There are, notwithstanding, a few issues that are interesting to SFC. Overall, have bigger concrete fixations and fine-to-coarse total proportions than customary cements, subsequently the blend plan procedure utilized for ordinary cement may not be totally applicable to SFC. Up to 35% of concrete can be supplanted with fly debris to decrease how much concrete used[34].

Likewise, to work on the usefulness of higher fiber volume blends, water decreasing admixtures and, specifically, super plasticizers are much of the time utilized, related to air entrainment [35]. The scope of extents for ordinary weight SFC is displayed in Table.1

Table.1 Shows Range of proportions for normal weight fiber reinforced concrete (steel fiber reinforced concrete, Nguyen Van).

Property	Mortar	9.5mm Maximum aggregate size	19 mm Maximum aggregate size
Cement (kg/m^3)	415-710	355-590	300-535
w/c ratio	0.3-0.45	0.35-0.45	0.4-0.5
Fine/coarse	100	45-60	45-55
aggregate(%)	7-10	4-7	4-6
Entrained air (%)	1-2	0.9-1.8	0.8-1.6
Fibre content (%) by volume	0.5-1.0	0.4-0.9	0.3-0.8
smooth steel			
deformed steel			

1.3 PROPERTIES OF SFC

a. Compressive strength
Filaments unimportantly affect the static compressive strength of cement, with gains going from basically none to maybe 25%. The steel strands affect compressive strength even in individuals with traditional support notwithstanding the steel fibres [36]. The strands, then again, altogether further develop the material's post-breaking malleability, or energy retention.

b. Tensile strength
Fibers aligned in the tensile stress direction can result in significant gains in direct tensile strength, up to 133 percent for 5% of smooth, straight steel fibres[37]. The expansion in strength for pretty much haphazardly scattered strands, then again, is fundamentally more modest, going from no expansion sometimes to around 60% in others, with many examinations finding middle qualities [38], as displayed in Fig.1 Parting pressure trial of SFRC uncover comparable outcomes. Adding filaments alone to support direct rigidity is thusly probably not going to be beneficial. Steel strands, similar to pressure, give critical expansions in the composites' post-breaking conduct or durability

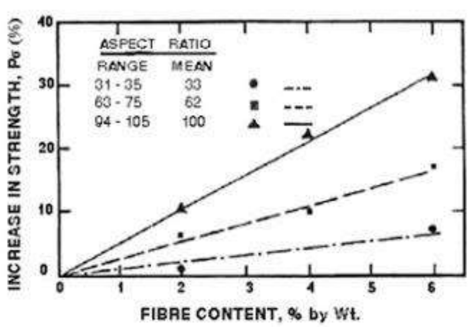


Fig. 1 Influence of fiber content on tensile strength

International Journal of Academic Engineering Research (IJAER)
ISSN: 2643-9085
Vol. 6 Issue 4, April - 2022, Pages:8-15

Steel fiber have a substantially bigger influence on the flexural strength of SFC than on the compressive or tensile strength, with increases of over 100% observed [39]. Flexural strength increases are sensitive not only to fiber volume but also to the aspect ratio of the fibres, with a higher aspect ratio resulting in bigger strength increases. The fibre impact is described concerning the mix boundary Wl/d, where l/d is the perspective proportion and W is the weight % of filaments, as displayed in Fig.2. It ought to be stressed that the blend characteristics for Wl/d > 600 were by and large deficient [40]. Due to their improved association, disfigured filaments show similar kinds of increments at smaller volumes.

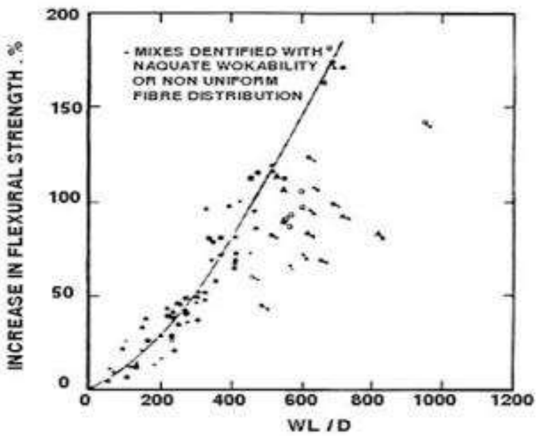


Fig.2 The effect of Wl/d on the flexural strength of mortar and concrete

The impact of Wl/d on the flexural strength of mortar and concrete as displayed in fig.2 (steel fiber supported concrete, Nguyen Van) asphalts, span deck section fixes, etc. are probably the most well-known applications [41]. There has likewise been some new exploratory work on steel fiber-built up roller-compacted concrete (RCC). The major goal of this study is to use polymer modification to create extremely high-performance cement-based composites, with a focus on compressive strength and flexural toughness. Other key features, including as workability and water absorption, were also investigated in order to better understand the performance of PMSFRC and PMC matrix.

II.MATERIALS AND METHODOLOGY

Concrete, fine total, coarse total (20 mm), coarse total (10 mm), snared end steel filaments, polymer plastic, super plasticizer, and water were utilized to make steel fiber supported concrete (SFRC) and polymer altered steel fiber built up concrete (PMSFRC). The fineness moduli of fine and coarse totals were 2.872 and 6.97, separately, and the concrete utilized in this review was 53 grade normal Portland concrete (OPC) adjusting to IS: 12269-1987. Steel filaments with snared closes with a high elasticity were utilized. As delineated in Figure 1, they had snared closes and were ordered into clasps of around ten individual filaments utilizing water solvent glue. During the blending system, the grouping brings the inclination for filaments down to roll together. The glue disintegrated in the blending water in around one moment, permitting individual filaments to handily be appropriated more.

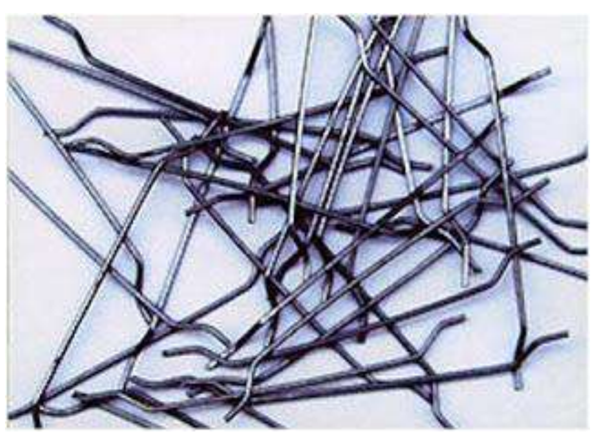


Fig.3 Steel fiber

Table.2 Physical properties of steel fiber

Fiber type	Steel fiber
Length (mm)	30
Diameter(mm)	0.45
Elastic modulus (Gpa)	212
Tensile strength (Mpa)	1200
Density kg/m^3	7800
Shape	End crimped
No. per 100 kg	390

The ideal type of safe haven is commonly accepted to be a snared end that gradually distorts during pull-out. Table 1 shows the actual boundaries of the strands used in the examination. As a polymer, styrene butadiene elastic (SBR) plastic is utilized. This polymer is accessible in a fluid structure that has 40% solids and 60% water.

Table.3 Properties of polymer

Property	Description
Polymer system	Cera polymer latex
Type	Latex
Appearance	Milky white
Setting characteristics	Slow
Viscosity	15 sec
Specific gravity	1.08
Ph.	10.40

The water contained in the polymer has been remembered for the general water content of the blend, i.e., while adding water to the substantial blend, diminish how much water contained in the polymer from the amount of w/c proportion. This is a thermosetting non-epoxy polymer. Table 2 records the properties of this polymer. This super plasticizer is first blended into the blending water, and afterward added to the dry blend concrete.

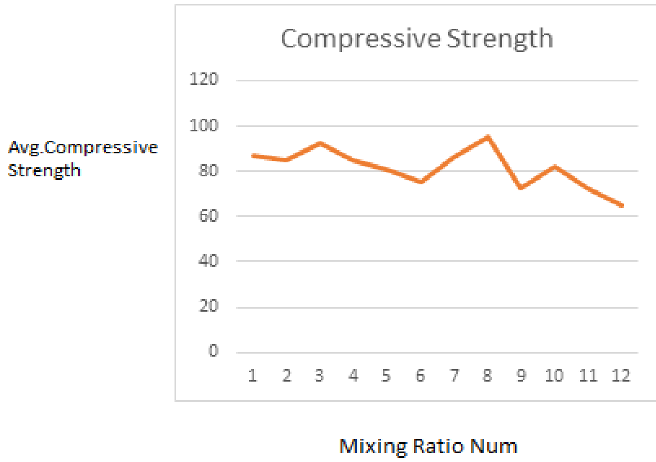
3.1 Compression Test

The pressure test was completed to decide the compressive strength of polymer adjusted steel fiber supported concrete on test examples of 150 mm x 150 mm x 150 mm, as per IS: 10086-1982. A 3000 KN limit pressure testing machine was employed. Figure 2 depicts the basic test setup, whereas Figure 3 depicts the ongoing flexure test of a concrete beam. The specimen's compressive strength is estimated by separating the best burden applied to the example during the test by the cross-sectional region or by applying the formula. Where fcu is the concrete's compressive strength in MPa, Pc is the maximum applied load in KN, and A is the cross-sectional area in mm2.

Fig.4 Compression test on concrete cube in progress

III.RESULTS AND DISCUSSIONS

Superplasticizers and mineral admixtures such as silica fume can now be used to make simple high-strength concrete. However, because the polymer itself, or other associated elements, alter the strength greatly, there is no widely accepted technique for high-strength PMC, and hence empirical testing is required. These parameters include cement-polymer compatibility, polymer type and dose, air-entraining qualities, and so on for the same cement type. Following that, the optimum mix proportions for the high strength PMC were used in other phases of the study programme.



IV.CONCLUSION

Based on different lab test discoveries, the mechanical properties of three sorts of cement, to be specific plain concrete, steel fiber supported cement, and plastic adjusted steel fiber built up, not entirely settled in this review. Polymer latex considerably improves workability. A high-strength PMC can be made with the addition of 15% latex. The compressive strength of concrete increases as the steel fibre content in the concrete increases, reaching its max strength of 1% steel fibre with cement volume. A high water/cement ratio is employed to create the appropriate balance between conditions. Any increase in latex dose above 10% causes compressive strength to drop. PM10- SF1.0 is proves the optimum blend, with good hardening properties; The present mixture would be promising for PM-SFRC structural applications. The insertion of fibre has a significant impact on the arrest, deferral, and proliferation of cracks.

References;

[1] KS Lokesh, Evaluation of Toughness on Varied Thickness of Chopped Strand Mat /PU-foam Sandwich Structures, International Research Journal of Engineering and Technology (IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 09 | September-2018, p-ISSN: 2395-0072

[2]. KS Lokesh, Synthesis and Study on Effect of Thickness on 3-point Bending Strength of Sandwich Composites, International Research Journal of Engineering and Technology (IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 08 | August-2018, p-ISSN: 2395-0072

[3]. KS Lokesh, Preparation and Tensile strength Evaluation of Synthetic fibers Sandwiched with Foam structures. International Research Journal of Engineering and Technology (IRJET), eISSN:2395-0056 Volume: 05 Issue: 09 | September-2018, p-ISSN: 2395-0072

[4]. KS Lokesh, T Pinto, Experimental Study on Effect of Metallic Oxides Mixture on Tribological Behaviour of Aluminium Based Metal Matrix Composites, International Research Journal of Engineering and Technology (IRJET),e-ISSN:2395-0056 Volume: 05 Issue: 06 | June-2018, p-ISSN: 2395-007

[5]. Konur O and Mathews F.L," Effects of the properties of the constituents on the fatigue Performance of Composites: A Review", Composites, 20(4), 1989, pp.317-328.

[6]. Lokesh K.S, Dr.Thomas Pinto, & Ravi S.M. (2017). Evaluation of Mechanical Properties and Wear Characterization of Polymer Composites under Varying Temperature Conditions: A Review. International Journal of Engineering and Information Systems(IJEAIS),1(4),64–68. http://doi.org/10.5281/zenodo.821168

[7]. Lokesh K. S., Bandu Ummaji, Gururaj P., K. Rayappa, Yashavantha J., Effect of Red Mud Particles on Scratch Resistance of Aluminum Based Metal Matrix Composites, American Journal of Aerospace Engineering. Vol. 5, No. 1, 2018, pp. 24-29. doi: 10.11648/j.ajae.20180501.14

[8]. Lokesh KS, "Impact of Modified Thickness on Flexural Modulus of PU-Foam /CSM Glass Fabric Sandwich Panels ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457- 0435, Volume 2 Issue 3, pp. 29-35, July-August 2018.URL: http://ijsrmme.com/IJSRMME182210

[9]. Lokesh K S , Karthik B.Y, Avinash C.G, Ganesh Kamath, Samson Lobo, "Experimental Study on Tribological Characteristics of E-waste filled Fibre Reinforced Plastics ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 2, Issue 1, pp.11-16, .2018URL http://ijsrmme.com/IJSRMME182203 Volume 2 | Issue 2 | March-April 2019 | www.ijsrmme.com

[10]. Lokesh K S, Dr.Thomas Pinto, Mohammed Gowspeer, Effect of E-waste Rubber on Wear Behaviour of Glass fibre Reinforced with Epoxy Composites Pages: 20-25 DOI: 10.7324/IJASRE.2018.32624 DOI URL: http://dx.doi.org/10.7324/IJASRE.2018.32624

[11]. Lokesh KS, "Study on Processing and Axial loading Conditions of Lightweight Materials ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 2 Issue 4, pp. 21-27, September-October-2018.URL: http://ijsrmme.com/IJSRMME18347

[12]. KS Lokesh, T Pinto, Comparative Study on Axial Loading Conditions and Effect of Mineral Filler on CSM and WF Fibres, International Research Journal of Engineering and Technology (IRJET), e-ISSN:2395-0056 Volume: 05 Issue: 10 | October-2018, p-ISSN: 2395-0072

[13]. Lokesh KS, Dr. Thomas Pinto, "Experimental Study on Tensile Effect of Different E-glass Fabric Laminates Reinforced with Potential Adhesives ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 2 Issue 5, pp. 14-22, November-December 2018. URL: http://ijsrmme.com/IJSRMME18253

[14]. Lokesh KS, "Evaluation of Flexural Rigidity of PU - foam Cored Sandwich Structures", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 2 Issue 5, pp. 36-42, November December 2018. URL: http://ijsrmme.com/IJSRMME18255

[15]. Lokesh K S, "Abrasive Study of ELT Rubber Loaded with Fibre Reinforced Plastics", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 2 Issue 5, pp. 43-48, November-December 2018. URL: http://ijsrmme.com/IJSRMME18256

[16]. Lokesh KS, Dr. Thomas Pinto, "Review on Tribological Parameters of Fibre Reinforced Plastics Modified with Mineral Fillers ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 2 Issue 5, pp. 49-56, November-December-2018. URL: http://ijsrmme.com/IJSRMME18257

[17]. Lokesh KS , "Mineral Filler Effect on Tensile Parameters of Randomly Oriented and Woven Fabric Plastic Laminates ",International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457- 0435, Volume 2 Issue 4, pp. 28-33,SeptemberOctober2018. URL: http://ijsrmme.com/IJSRMME18248

[18]. Lokesh K S, "Experimental Study on Effect of Silicon Carbide and Graphite particles on Mechanical Behaviour of Alluminium-6061 Alloys", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN : 2457-0435, Volume 3 Issue 1, pp. 10-17, January-February 2019. URL: http://ijsrmme.com/IJSRMME19311

[19]. Lokesh K S, "Preparation and Mechanical Testing of E-waste Glass Filled Polymer Composites", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 3 Issue 1, pp. 18-23, January-February 2019.URL: http://ijsrmme.com/IJSRMME19312

[20]. Lokesh K. S, Vinayaka Kannantha, International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2000-000X Vol. 1 Issue 2, April – 2017, Pages: 97-100

[21] Pranav S, Pratibha Lokesh K S, Thomas pinto, Arjun Kumar, Chetan.G, Comparative study on tensile behaviour of e - glass (woven & chopped) fibre reinforced with epoxy composites, International Journal of Engineering Sciences & Research Technology, 2017/3, volume-06, issue-03.

[22]. Lokesh K S, Utilization and Mechanical Testing of Scraped Glass Powder Loaded with Gfrp Composites International Conference on Recent Trends in Arts, Science, Engineering and Technology, ISBN: 978-81-939938-3-5

[23] Lokesh K S, "Assessment of Axial Cramp Resistance of Graphene based Aluminium Nano Composites by Stir Casting Technique ", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 3 Issue 2, pp. 01-07, March-April 2019. URL: https://ijsrmme.com/IJSRMME19314

[26] Lokesh K S, Dr. Thomas Pinto, "Examination of Modulus of Rupture of Fibre mat Bonded with Potential Adhesives", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2457-0435, Volume 3 Issue 2, pp. 08-14, March-April 2019. URL: https://ijsrmme.com/IJSRMME19315

[27] Lokesh K S, Determination of Scratch Resistance of Graphene based Nano Composites International Journal of Academic Engineering Research (IJAER) ISSN: 2000-001X Vol. 2 Issue 7, July – 2018, Pages: 20-24

[28] Raghavendra Pai K, Lokesh K S, Veeresh R K, Anandakrishnan Somayaji, Nithin Kumar. (2021). Investigation on performance of DC motor in exhaust application using vibration-based condition monitoring. *PalArch's Journal of Archaeology of Egypt / Egyptology*, *17*(9), 1278 - 1285. Retrieved from https://www.archives.palarch.nl/index.php/jae/article/view/3750 (Original work published November 2, 2020)

[29] Swathi P Shetty Lokesh K S, Jagadeesh, Praveen babu, Research on Combination of Swing Wing with Canard and Tail used in Fighter Aircraft, International Journal of Recent Technology and Engineering (JRTE),volume-08,Issue-02,2019

[30]RaghavendraPai, Vinayaka Kannantha, Naveen Kumar Jagadapura Ramegowda, *and* Lokesh Kanchugaranahally Sriramamurthy "First pass yield improvement in fuel injection pump delivery valve assembly", AIP Conference Proceedings 2080,050002 (2019) https://doi.org/10.1063/1.5092930

[31] Lokesh, K. S. (2019). An Experimental Evaluation of Substrate and Annealing Conditions on Zinc Oxide Thin Films Prepared by Sol-gel Method: On the Influence of Annealing Temperature. GRIN Verlag.

[32] Dr. Thomas Pinto, Lokesh K.S, Bharath Kumar S, Dr. Ramachandra C G3, Effect of E-waste filler on tensile and flexural behavior of E-glass/Epoxy composites, International Journal of Engineering Trends and Technology, 2016/5, volume-02, Issue-05

[33] IC, Chethan, and Lokesh KS. "Fatigue Crack Growth Analysis of a Wing Stiffened Panel." International Journal of Current Trends in Science and Technology 8: 20553-20558.

[34] Lokesh, K.S.; Chetan, I.C.; Thomas, P.U. Influence of graphene on hardness number of Aluminium-7075 based metal matrix composites. Int. J. Innov. Sci. Res. Technol. **2017**, 2.

[35] K. Raghavendra Pai, K.S. Lokesh, D. Shrinivasa Mayya, J.R. Naveen Kumar, Ajit M. Hebbale,,Experimental study on preparation and mechanical characteristics of jute/silk/coco-peat reinforced with epoxy polymers, Materials Today: Proceedings, Volume 46, Part 7, 2021, Pages 2764-2769, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2021.02.511

[36] Naveen Kumar J R, Prasad P, Narayana Hebbar, Savitha M B, Lokesh K. S & Navaneeth Gowda N (2021) A potential application of polyethyleneimine-reduced graphene oxide nanocomposite sensing film coated on interdigitated electrode prepared from copper-clad for carbon dioxide detection, Materials Research Innovations, 25:6, 363-371, DOI: 10.1080/14328917.2020.1826674

[37] Naveen Kumar J R, Prasad P, Narayana Hebbar, Savitha M B, Lokesh K. S & Navaneeth Gowda N (2021) A potential application of polyethyleneimine-reduced graphene oxide nanocomposite sensing film coated on interdigitated electrode prepared from copper-clad for carbon dioxide detection, Materials Research Innovations, 25:6, 363-371, DOI: 10.1080/14328917.2020.1826674

[38] Raghavendra Pai, L. Bangarappa, K.S. Lokesh, D. Shrinivasa Mayya, C.R. Naveen, Thomas Pinto, Hybridization effect on water absorption and flexural properties of E-glass/banana fibre/epoxy composites, Materials Today: Proceedings, Volume 52, Part 3, 2022, Pages 1841-1845, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2021.11.491

[39]LokeshK.Sriramamurthy, SubhasHunasikatti, NaveenKumarJ. Ramegowda, Vinayaka Kannantha, and Raghavendra Pai "Effect of E-waste rubber on mechanical behavior of glass a fiber reinforced with epoxy composites", AIP Conference Proceedings 2080,020003 (2019) https://doi.org/10.1063/1.5092886

[40] K. S. Lokesh, I. C. Chethan, N. Kumar, and V. Kannantha, "Determination of Compressive Strength of Graphene Reinforced with Aluminium-7075 Metal Matrix Composites," International Journal of Mechanical Engineering & Technology, vol. 9, no. 1, pp. 327–335, 2018.

[41] K.S. Lokesh, J.R. Naveen Kumar, Vinayaka Kannantha, Thomas pinto, U. Sampreeth, Experimental evaluation of substrate and annealing conditions on ZnO thin films prepared by sol-gel method, Materials Today: Proceedings, Volume 24, Part 2, 2020, Pages 201-208, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.04.268.

[42] Nithin Kumar, K.S. Lokesh, Vinayaka Kannantha, Raghavendra Pai, Ajit M. Hebbale, Development and experimental investigation of mechanical properties of graphene-based aluminum 6061 alloys, Materials Today: Proceedings, Volume 46, Part 7, 2021, Pages 2421-2424, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2021.01.303