Experimental Study of Reinforced Composite

Rajesh Bhargava[1], Hitesh Khandelwal[2], Nahid Akhtar[3]

[1]*M.Tech Scholar, Department of Mechanical Engineering, LIET, Alwar, Rajasthan, India*
[2,3]*Assistant Professor, Department of Mechanical Engineering, LIET, Alwar, Rajasthan, India*

Abstract **- Experimental Study of Reinforced Composite comprises of the process of fabrication of reinforced composite by introducing aramid fibre and sawdust in the vinyl resin matrix in various proportions, in particular, with different weight fraction. And analysis of the test results of these samples is performed to understand the change in specific mechanical properties in accordance to the change in the fraction of fibre used in the resin.**

Keywords **– Reinforced Composite, Aramid**

I. INTRODUCTION

Composites materials are in used since the age of first development by the human civilization. Composites were used over vide range by the pre-industrialized civilization, from building structure or monuments to the daily usable utensils. With the growth of human civilization, new composite materials also emerged constantly and their applications have found its way in far more better and helpful manner to human needs.

In matrix-based structural composites, the matrix serves two principal purposes viz., binding the reinforcement phases in place and deforming to distribute the stresses among the constituent reinforcement materials under an applied force.

Also, the expectations from matrices are many. They may need to be withstanding temperature variations, be conductors or resistors of electricity, may have moisture sensitivity etc. Also, it offers weight advantages, ease of handling and other merits which may also become applicable depending on the purpose for which the matrices are chosen.

II. FIBRE REINFORCED COMPOSITES

Fibre reinforced composites are most widely used and earliest known reinforced material, as they are known for their nature to satisfy the desired conditions, like they transfer strength to the matrix constituents by influencing and enhancing matrix properties as desired.

Fibres ideal performance depends on several factors like its length, shape, orientation, and composition of the fibres and the mechanical properties of the matrix. The orientation of the fibres in the matrix provides strength to the composite; and the strength is greatest along the longitudinal directional of fibre. But that doesn't mean longitudinal fibres can take the same amount of load irrespective of the direction in which it is applied. Optimum performance from can be obtained if the load is applied along its longitudinal direction. The slightest shift in the angle of loading may drastically reduce the strength of the composite.

For the current research work, reinforced composite of vinyl ester and aramid fibers along with sawdust with different weight fraction were prepared by using hand molding technique. Vinyl resin was mixed with standard hardener MEKP in 4:1 ratio. This mixture was cured for 1 hour at room temperature. After curing, the layer of aramid fibers along with sawdust is laid on the cure vinyl. After making the fabric layer and adding another layer of the vinyl resin, mold is pressed by the flat surface for removing the air bubbles thus, making a sandwich like arrangement.

A series of composite was fabricated with variation in quantity of fabric, as stated below:

Composite C1 = 70% vinyl ester and 25% aramid fiber + 5% sawdust

Composite C2 = 60% vinyl ester and 35% aramid fiber + 5% sawdust

Composite C3 = 50% vinyl ester and 45% aramid fabric + 5% sawdust

The figures below show the test samples C1, C2 and C3, having different proportion of resin and fibre composition, after moulding and cutting them into standard size for various testing:

Figure 1: Test specimens C1 composite.

Figure 2: Test specimens C2 composite.

Figure 3: Test specimens C3 composite.

III. TESTING OF COMPOSITE

The various tests were performed on the given sets of specimens. All the tests were being performed in the NABL Accredited Laboratory. Tables mentioned below illustrates results of various test performs on the test samples.

TABLE 1: TENSILE PROPERTIES OF COMPOSITES.

Composite	Tensile Strength (kN/mm2)	Deflection (mm)
C1	2.22	5.72
C2	3.04	6.01
C3	3.9	7.32

TABLE 2: HARDNESS OF COMPOSITES.

Composite	Hardness (BU)
C1	60
C2	60.5
C3	63.55

TABLE 3: DENSITY OF COMPOSITES.

Composite	Density (kg/mm^3)
C1	1.799
C2	1.733
C3	1.690

TABLE 4: TOUGHNESS OF COMPOSITES.

Composite	Toughness (J)
C1	8
C2	10
C3	16

TABLE 5: FLEXURAL STRENGTH OF COMPOSITES.

Composite	Flexural Strength (N/mm^2)	Deflection (mm)
C1	4.1	25.30
C2	4.5	22.40
C3	4.8	21.69

IV. RESULT AND DISCUSSION

It has been observed that increase in the quantity of fibres (aramid + sawdust) has significantly improved the properties of the reinforced composite material. Although the amount of sawdust has been kept constant, but the aramid fibre has been increased by certain percentage in each of the test specimen i.e. C1, C2 and C3. Thus, the improvement in the properties observed is quite a noteworthy.

V. CONCLUSION

In this research, experimental study of reinforced composite was been formed. The composite was prepared by the hand moulding technique and the basic ingredients were vinyl ester resin, aramid fibre and sawdust. The results obtained are quite impressive. A positive trend has been observed that with the increase in the amount of the aramid fibre and sawdust in the vinyl ester resin, the concerning properties are also get increased (C3 > C2 > C1). Only exemption was in the case of the density where density was getting decreased (C1 > C2 > C3) as the amount of fibres in the resin increased. This might be due to the reason that the sawdust is occupying the volume more as compared to the aramid fibre although its percentage is limited to that of 5 per cent.

REFERENCES

[1]. A. P. Harsha and U. S. Tewari, "Abrasive wear of glass fibre reinforced polysulfone composites," *Indian Journal of Engineering & Materials Sciences*, vol. 9, no. 3, pp. 203–208, 2002.

[2]. N. Chand and B. Das Jhod, "Mechanical, Electrical, and Thermal properties of maleic anhydride modified rice husk filled PVC composites," *BioResources*, vol. 3, no. 4, pp. 1228–1243, 2008.

[3]. N. Chand, S. C. Prajapati, and R. K. Singh, "Development and characterization of sisal nano fibre reinforced polyolefin composites," *Journal of Scientific Research and Reviews*, vol. 1(3), no. 9, pp. 26–32, 2012.

[4]. G. B. Chai and P. Manikandan, "Low velocity impact response of fibre-metal laminates - A review," *Composite Structures*, vol. 107, pp. 363–381, 2014.

[5]. R. Yahaya, S. M. Sapuan, M. Jawaid, Z. Leman, and E. S. Zainudin, "Quasi-static penetration and ballistic properties of kenaf-aramid hybrid composites," *Materials and Design*, vol. 63, pp. 775–782, 2014.

[6]. Y. Swolfs, L. Gorbatikh, and I. Verpoest, "Fibre hybridisation in polymer composites: A review," *Composites Part A: Applied Science and Manufacturing*, vol. 67, pp. 181–200, 2014.

[7]. Z. Sun, X. Hu, and H. Chen, "Effects of aramid-fibre toughening on interfacial fracture toughness of epoxy adhesive joint between carbon-fibre face sheet and aluminium substrate," *International Journal of Adhesion & Adhesives*, vol. 48, pp. 288–294, 2014.

[8]. S. Hussain *et al.*, "Surface modification of aramid fibres by graphene oxide nano-sheets for multiscale polymer composites," *Surface and Coatings Technology*, vol. 258, pp. 458–466, 2014.

[9]. N. P. Sahu, D. K. Khande, G. C. Patel, S. K. Bohidar, and P. K. Sen, "Study on Aramid Fibre and Comparison with Other Composite Materials," *International Journal for Innovative Research in Science & Technology*, vol. 1, no. 7, pp. 303–306, 2014.

[10]. J. H. Song, "Pairing effect and tensile properties of laminated high-performance hybrid composites prepared using carbon/glass and carbon/aramid fibers," *Composites Part B: Engineering*, vol. 79, pp. 61–66, 2015.

[11]. B. Cai and Y. H. Yuan, "Research on performance of aramid fibre composite," *Materials Research Innovations*, vol. 19, no. 10, pp. 30–32, 2015.
[12]. L. Xing, L. Liu, Y. Huang, D. Jiang, B. Jiang, and J. He, "Enhanced interfacial properties of domestic aramid fiber-12 via high energy gamma ray irradiation," *Composites Part B: Engineering*, vol. 69, pp. 50–57, 2015.
[13]. T. Uygunoglu, I. Gunes, and W. Brostow, "Physical and Mechanical Properties of Polymer Composites with High Content of Wastes Including Boron," *Materials Research*, vol. 18, no. 6, pp. 1188–1196, 2015.
[14]. Z. Ge, D. Si, Y. Lan, and M. Shi, "The Effect of Modifying Agents on the Mechanical Properties of Straw Flour/Waste Plastic Composite Materials," *Key Engineering Materials*, vol. 723, pp. 56–61, Dec. 2016.
[15]. X. Qian, H. Wang, D. Zhang, and G. Wen, "High strain rate out-of-plane compression properties of aramid fabric reinforced polyamide composite," *Polymer Testing*, vol. 53, pp. 314–322, Aug. 2016.
[16]. R. Polanský *et al.*, "Development of a measuring system for on-line in situ monitoring of composite materials manufacturing," *Composites Part A: Applied Science and Manufacturing*, vol. 90, pp. 760–770, Nov. 2016.
[17]. C. K. Iu, "Nonlinear analysis for the pre- and post-yield behaviour of a composite structure with the refined plastic hinge approach," *Journal of Constructional Steel Research*, vol. 119, pp. 1–16, Mar. 2016.
[18]. A. Sarı, "Thermal energy storage characteristics of bentonite-based composite PCMs with enhanced thermal conductivity as novel thermal storage building materials," *Energy Conversion and Management*, vol. 117, pp. 132–141, 2016.
[19]. X. Chen, W. Wang, S. Li, and C. Jiao, "Fire safety improvement of para-aramid fiber in thermoplastic polyurethane elastomer," *Journal of Hazardous Materials*, vol. 324, pp. 789–796, 2016.
[20]. R. Singh, R. Kumar, L. Feo, and F. Fraternali, "Friction welding of dissimilar plastic/polymer materials with metal powder reinforcement for engineering applications," *Composites Part B: Engineering*, vol. 101, pp. 77–86, 2016.
[21]. Ö. Y. Bozkurt, A. Erkliğ, and M. Bulut, "Hybridization effect on Charpy Impact behavior of Basalt/Aramid fibre reinforced hybrid composite laminates," *Polymer Composites*, vol. 37, no. 2, 2016.
[22]. S. Badeli, S. Saliani, and A. Carter, "Effect of Short Aramid Fibers on Asphalt Performance," *Substance ÉTS*, 2017.
[23]. N. G. Gonzalez-Canche, E. A. Flores-Johnson, and J. G. Carrillo, "Mechanical characterization of fiber metal laminate based on aramid fiber reinforced polypropylene," *Composite Structures*, vol. 172, pp. 259–266, 2017.
[24]. O. Arnould, D. Siniscalco, A. Bourmaud, A. Le Duigou, and C. Baley, "Better insight into the nano-mechanical properties of flax fibre cell walls," *Industrial Crops and Products*, vol. 97, pp. 224–228, 2017.
[25]. Y. Şahin and P. De Baets, "Tribological behaviour of unidirectional carbon fibre-reinforced epoxy composites," *IOP Conference Series: Materials Science and Engineering*, vol. 174, 2017.
[26]. D. Sheng *et al*., "Low-temperature dyeing of meta-aramid fabrics pretreated with 2-phenoxyethanol," *Coloration Technology*, vol. 133, no. 4, pp. 320–324, 2017.
[27]. I. Zlotnikov, E. Zolotoyabko, and P. Fratzl, "Nano-scale modulus mapping of biological composite materials: Theory and practice," *Progress in Materials Science*, vol. 87, pp. 292–320, Jun. 2017.
[28]. K. Shaker, A. Jabbar, M. Karahan, N. Karahan, and Y. Nawab, "Study of dynamic compressive behaviour of aramid and ultrahigh molecular weight polyethylene composites using Split Hopkinson Pressure Bar," *Journal of Composite Materials*, vol. 51, no. 1, pp. 81–94, Jan. 2017.
[29]. S. Budhe, M. D. Banea, S. de Barros, and L. F. M. da Silva, "An updated review of adhesively bonded joints in composite materials," *International Journal of Adhesion and Adhesives*, vol. 72, pp. 30–42, Jan. 2017.
[30]. J. Pach, D. Pyka, K. Jamroziak, and P. Mayer, "The experimental and numerical analysis of the ballistic resistance of polymer composites," *Composites Part B: Engineering*, vol. 113, pp. 24–30, Mar. 2017.
[31]. A. Majumdar, B. S. Butola, N. Awasthi, I. CHauhan, and P. Hatua, "Improving the Mechanical Propertise of p-Aramid Fabrics and Composites by Developing ZnO Nanostructures," *Polymer Composites*, vol. 38, no. 3, 2017.
[32]. Y. Pan, G. Wu, Z. Huang, X. Wu, Y. Liu, and H. Ye, "Corrosion behaviour of carbon fibre reinforced polymer/magnesium alloy hybrid laminates," *Corrosion Science*, vol. 117, pp. 152–158, 2017.