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Development of particle reinforced composite by plastic and e-waste

A. Kanagaraj
kanagaraj03@gmail.com
Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu

C. Franciskennathamreth
cafranciss1044@gmail.com
Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu

M. Ajithkumar
ajithappz121@gmail.com
Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu

V. Anandh
francisamrith@gmail.com
Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu

R. Nagaraj
cafs1044@gmail.com
Akshaya College of Engineering and Technology, Coimbatore, Tamil Nadu

ABSTRACT

The main aim of this project is to develop Particle reinforced composites. Thermoplastic is taken as matrix material. Thermosetting plastics and E-Waste glass powder of 60μm is taken as particles. The formed structure exhibits high strength, low mass density and less weight compare to wood and steel. Due to its superior performance, the composite reinforced materials are mainly used indoors, frames, the automobile industry, especially for vehicle body applications. In this project particle reinforced Composite formed from Plastics and Electronic wastes. The formed specimen is subjected to tensile, hardness and bend test. It exhibits high tensile and bending strength.

Keywords— *MCC, Surface hardness, Fiber volume ratio*

1. INTRODUCTION

Achieving high strength with low mass density and lighter-weight materials is one of the most important methods of sustainable development, which is of great significance for both energy-saving and environmental care purposes. Nowadays, such high strength and lighter-weight materials for various applications are also required due to harsher energy-saving and emission-reduction standards. One of the most effective ways to achieve weight reduction is the use of alternative lightweight materials called composite materials. Composite materials are ideal for this purpose due to their high specific modulus and strength, as well as good chemical stability. Therefore, the application of composite materials in the automobile industry has a long history, helping to produce eco-friendly and energy-saving vehicles while simultaneously achieving weight loss.

2. PARTICLE COMPOSITE MATERIALS

Particles are used in to increase the modulus of the matrix. To decrease the permeability and also to decrease the ductility. Reinforced materials will be like particles. A particle may either have a dimension or no long dimension Particle composites consist of particles of one material dispersed in a matrix of a second material. Generally, particles are spherical, ellipsoidal, polyhedral, or irregular in shape. Particles are added to a liquid matrix that later solidifies in some process. The particles may be treated or untreated during reinforcement. Particles are used to increase the strength or other properties of inexpensive materials during reinforcement with other matrix materials.

2.1 Types of particle reinforced composite

2.1.1 Large particle reinforced composite: LARGE particles cannot be treated on the atomic or molecular level. Involves large particles that are harder or stiffer than the matrix. The reinforcing particles tend to restrain movement of the matrix phase in the vicinity of each particle matrix. The matrix transfers some of the applied stress to the particles, which bear friction at the load. Bonding at the interface is necessarily important

2.1.2 Dispersion-strengthened particle reinforced composite: Small particles (60 μm). Matrix bears most of the applied load. Particles hinder or impede the motion of Particles of dislocations. Plastic deformation is restricted. It improves the yield and tensile strength. The metal, metallic compound, ceramic particle, whisker or etc., is uniformly dispersed in matrix medium.

Due to its inevitable properties such as improved mechanical strength and high hardness as compared to wood and plastic as investigated

3. PREPARATION

PET bottles, thermosetting plastics and Cathode ray tube from E-wastes have been collected as a matrix material and reinforcement material respectively. Initially, Thermoplastics like PET bottles had crushed by scrubbing machine up to 3mm length in order to produce matrix by injection moulding.

Thermosetting plastic is crushed into 3 mm length for reinforcement. Along with matrix and Thermosetting plastic Cathode ray tube glass powder of 60µm is added which is produced by ball milling.

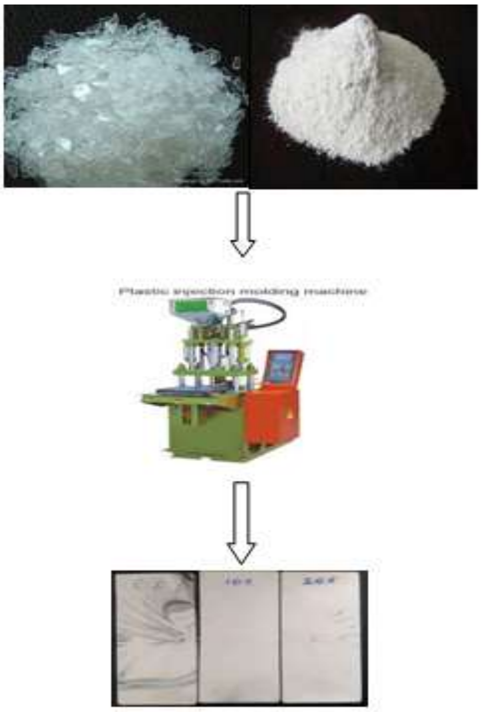


Fig. 1: Matrix: PET bottle scraps, Reinforced materials: E-waste powder

Thermoplastic is taken as matrix material. Thermosetting plastics and E-Waste glass powder are taken as particles. Thermoplastic (PET Bottles), Thermosetting plastics (Switches) and CRT glass powder are mixed in 10% as well as 20%. The mixture is melted at 250^0 C is injected into dying by injection moulding. Finally, the required specimen is formed from plastic and E-waste

4. EXPERIMENTAL PROCEDURE

In this present work plastic and E-waste glass powder of size 200 × 65 × 15 mm was used as work material.

4.1 Bend testing procedure

Bend tests are used to deform the test material by the application of bend load at the midpoint. The applied bend load produces a concave surface. Workpiece made up of plastic and E-waste glass powder of size 200 × 65 × 15 mm is used in order to conduct bend test. The load has been applied to the work material until it fractures. This test will guide us to determine the ductility or resistance to fracture of that material. In this flexure test, the aim is not to load the material until failure but rather to learn the deformation of the specimen for various load conditions. The test samples made by 10% and 20% reinforcement are loaded in a way to create a concave surface at the midpoint with a specified radius of curvature. Bend test is performed until the fracture happened. Bending tests are also popular like a tensile test, compression test, and fatigue tests. In Bend, test particle reinforced specimens 0f 10% and 20% reinforcement materials are allowed to determine the material's ductility, bend strength, fracture strength and resistance to fracture. These characteristics are used to determine peak load to failure the composite materials of 10% and 20% reinforcement.

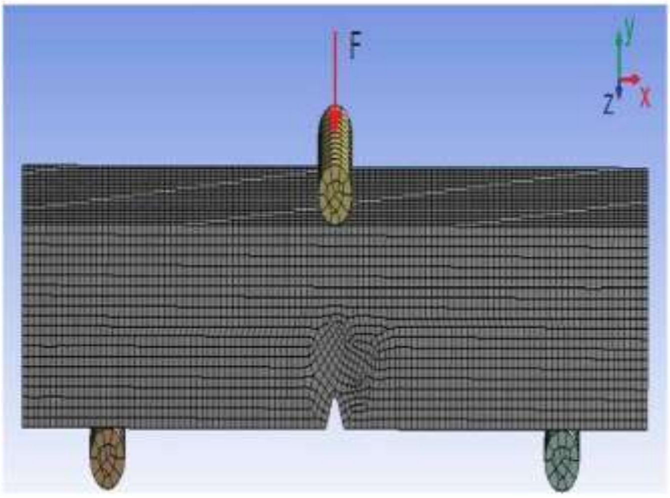
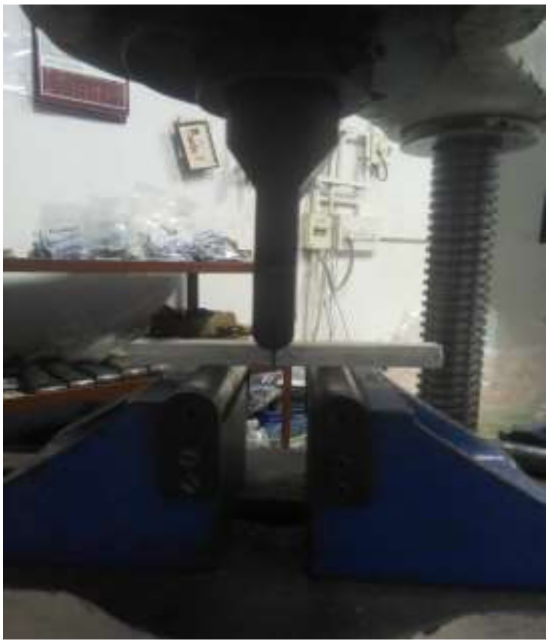


Fig. 2: Bending test procedure



(a)

(b)

Fig. 3: Composite specimen bend test in UTM

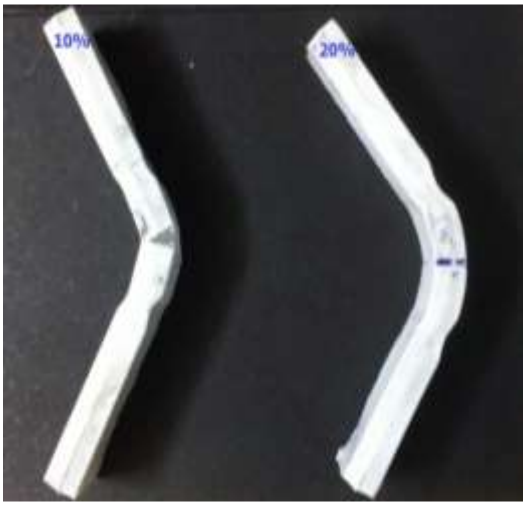


Fig. 4: Specimen after bend test

4.2 Tensile test procedure

Tensile testing is fundamental material science and engineering test in which Workpiece made up of plastic and E-waste glass powder of 10% and 20% reinforcement are subjected to a tensile load until failure. Mechanical Properties like ultimate tensile strength, breaking strength, maximum elongation and reduction are measured by the tensile test.

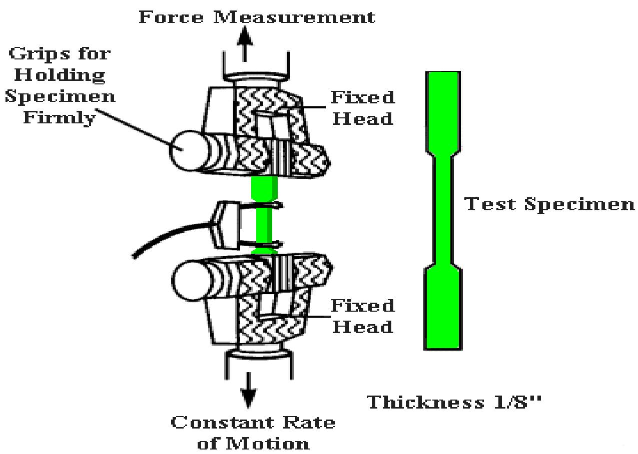


Fig. 5: Tensile test procedure

(a)

(b)

Fig. 6: Composite specimen tensile test in UTM

Fig. 7: Specimen after tensile test

4.3 Bending analysis

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{\tau}{R}$$

Where

σ - Bending strength in $N/m^{2,}$

M - Bending moment in N-m,

Y - Distance from neutral axis in m,

I - Moment of inertia in m^4.

4.4 Bending strength

$$\sigma = \frac{M * Y}{I}$$

Where,

σ - Bending strength in N/m^2,

M - Bending moment in N-m,

Y - Distance from the neutral axis in m.

B - Breath of specimen in m.

4.5 Equivalent young's modulus

$$E_{eq} = \frac{2E1E2}{E1 + E2}$$

Where,

E_1 - Young's modulus of E-waste powder in N/m^2,

E_2 - Young's modulus of Plastic in N/m^2.

4.6 Global stiffness matrix for bending load

*Global force matrix = Global stiffness matrix * deflection matrix*

$$\{F\} = \{K\}*\{U\}$$

$$\begin{Bmatrix} F_{1y} \\ m_1 \\ F_{2y} \\ m_2 \end{Bmatrix} = \frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ 6L & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix}\begin{Bmatrix} v_1 \\ \phi_1 \\ v_2 \\ \phi_2 \end{Bmatrix}$$

4.7 Global stiffness matrix for tensile load

$$\frac{\text{AE}}{\text{l}}\begin{pmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{pmatrix}\begin{Bmatrix} U_1 \\ U_2 \\ U_3 \end{Bmatrix} = \begin{Bmatrix} -Po_1 \\ Po_2 + Pl_1 \\ Pl_2 \end{Bmatrix}$$

5. RESULTS AND DISCUSSION

Table 2: Different reinforcement values

Properties	Composite with 10% reinforcement	Composite with 20% reinforcement
Density(kg/m^3)	817	807
Tensile Strength(N/mm^2)	27.9	29.9
Maximum Bending load(N)	9340	11500
Shear Strength(N/mm^2)	19.8	24.9
Hardness	66	67

Through this project Particle, reinforced composite is developed. Thermoplastic is taken as matrix material. Thermosetting plastics and E-Waste glass powder of 60µm is taken as particles. The formed specimen is subjected to tensile, hardness and bend test. It exhibits high tensile and bending strength. While comparing the 10% reinforced composite with 20% reinforced composite with mechanical properties like tensile strength, bending strength and hardness has been increased with a reduction in mass density Specimens are formed by injection moulding of (200mm X 65mm X 16mm).It has density of 817kg/m^3 and 807 kg/mm^3 10% and 20% respectively. Formed specimens are subjected to a tensile load in a Universal testing machine. The load has been increasing up to its breaking point. Finally, Tensile strength of 27.9 N/mm^2 and 29.9 N/mm^2 has gotten for 10% and 20% reinforcement respectively. Formed specimens are subjected to Bending load in Universal testing machine. The load has been increasing up to its breaking point. Finally, Shear strength of 19.8 N/mm^2 and 24.9 N/mm^2 has gotten for 10% and 20% reinforcement respectively. The maximum tensile load 5440N and 5640N are achieved by the formed composite specimens with 10% and 20% reinforcement respectively. The maximum Bending load 9340N and 11500N are achieved by the formed composite specimens with 10% and 20% reinforcement respectively. The formed composite specimens are subjected to a hardness test. Specimens are achieved 66 and 67 Brinell hardness number for 10% and 20% reinforcement respectively.

By these Experimental results when the reinforcement material ratio increases density, as well as weight, get reduced. Through Tensile and bending test reports, Tensile strength and bending strength has been increased when the reinforcement material ratio increases. By Hardness test report, Hardness has been increasing when the reinforcement material ratio increases. An experimental test of Tensile strength, Bending Strength and hardness value graphs are also indicating the same things as strength has been increased when fibre-volume ratio increased.

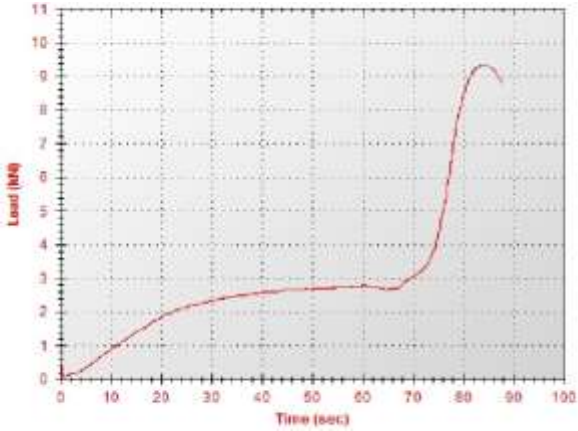


Fig. 8: Bend test with 10/% composition

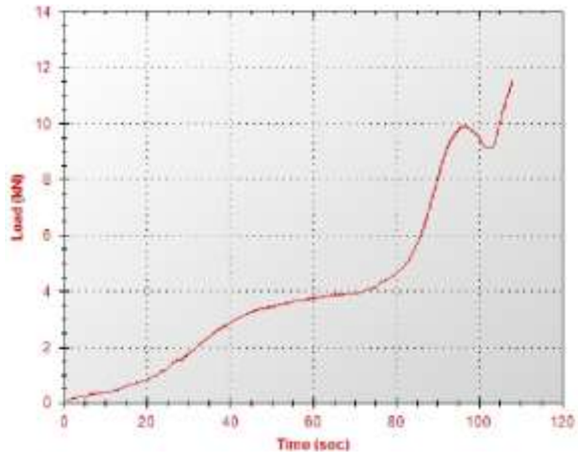


Fig. 9: Bend test with 20/% composition

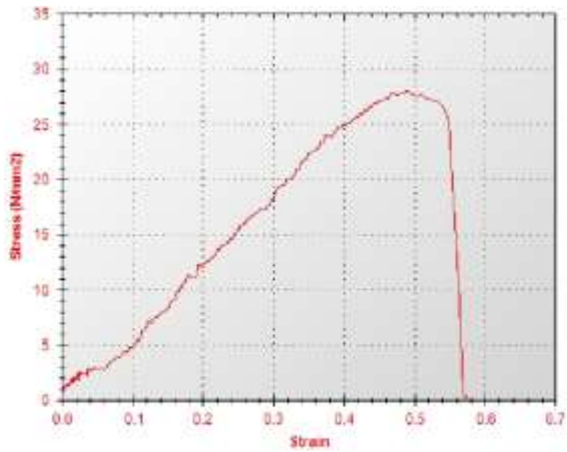


Fig. 10: Tensile test with 10/% composition

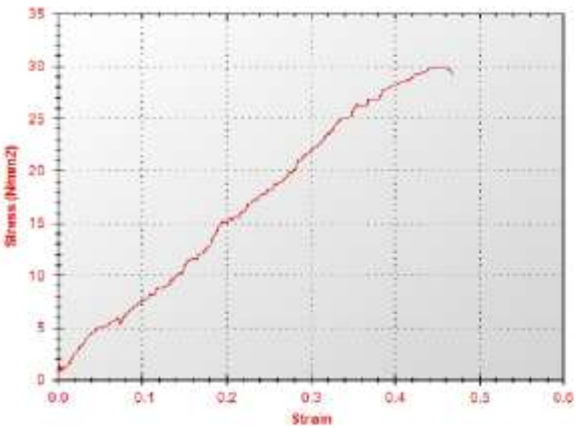


Fig. 11: Tensile test with 20/% composition

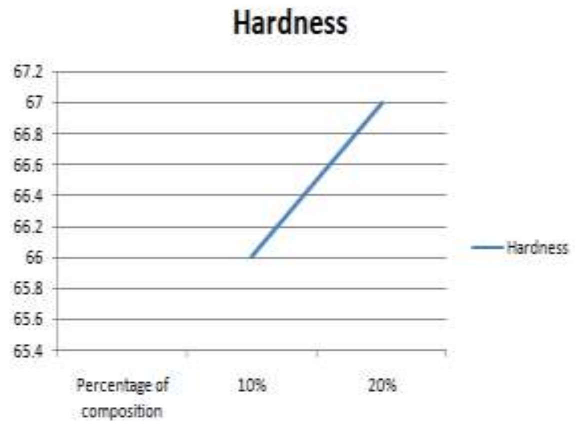


Fig. 12: Hardness

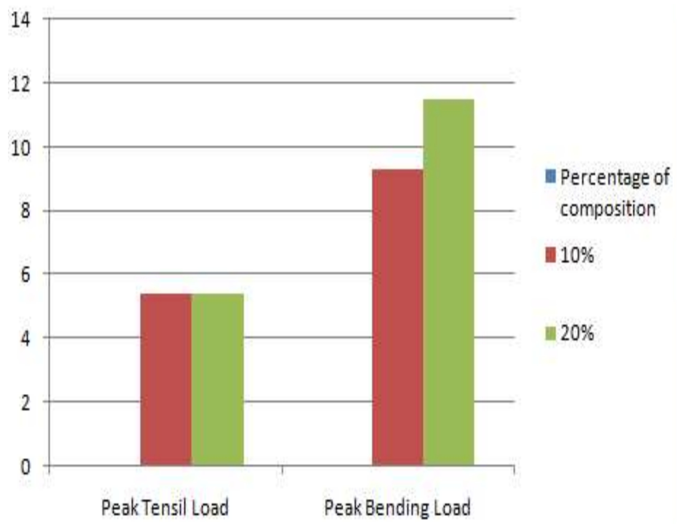
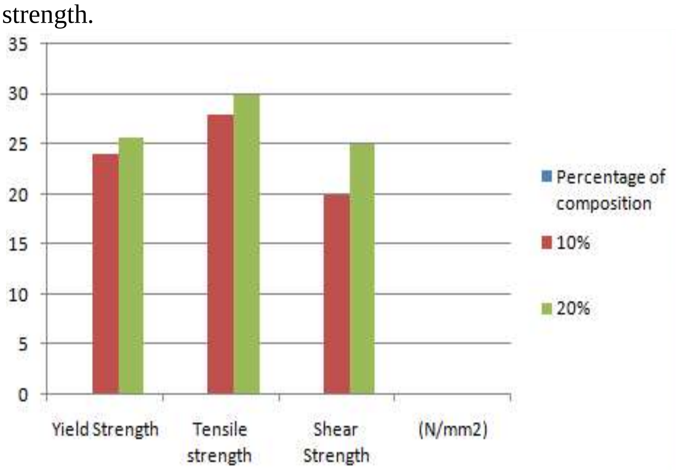


Fig. 13: Peak load

6. CONCLUSION

Through this project Particle, the reinforced composite is developed. Thermoplastic is taken as matrix material. Thermosetting plastics and E-Waste glass powder of 60µm is taken as particles. The formed structure exhibits high strength, low mass density and less weight compare to wood and steel. Due to its superior performance, the composite reinforced materials are mainly used indoors, frames, the automobile industry, especially for vehicle body applications. In this project particle reinforced Composite formed from Plastics and Electronic wastes. The formed specimen is subjected to tensile, hardness and bend test. It exhibits high tensile and bending strength.



Finally, the Tensile strength, Bending strength and Hardness of Plastic and E-Waste glass powder composite has been increased when the fibre-volume ratio is increased.

7. REFERENCES

[1] Marko Hyvarinen and Mikko Ronkanen. "The effect of the use of construction and demolition waste on the mechanical and moisture properties of a wood-plastic composite". From Structural Engineering International Journals. 1992;2(1):7-12. (2011).
[2] Amel Aattache, Rabah Soltani, Abdelkader Mahi. "Investigations for properties improvement of recycled PE polymer particles-reinforced mortars for repair practice". From International Journals of Composites Science & Technology. (2010).
[3] Thanate Ratanawilai, Kampanart Taneerat. "Alternative polymeric matrices for wood-plastic composites: Effects on mechanical properties and resistance to natural weathering". From Composites Science & Technology 1992;44(3):227-255. (2007).
[4] C. Barile,et.al, "Mechanical comparison of new composite materials for aerospace applications. 1987;25(3):371-393, (2012) .
[5] F.Brites, C. Malca,et.al, "Cork Plastic Composite Optimization for 3D Printing Applications". From International journals of Composites & Structures. 1982;15(3):335-350.(2016).
[6] Sibele Piedade Cestari,et.al, "Recycling processes and issues in natural fiber-reinforced polymer composites". From International journals of Composites & Structures. 1989;33(1):41-47.(2010).
[7] Ping Chena, Yuan Wanga, et.al, "Adhesion and erosion properties of epoxy resin composite coatings reinforced with fly ash cenospheres and short glass fibres". From International journals of Composites & Structures. 1999;44(4):263-278.(2006).
[8] Fidanovski, et.al, "Composite materials from fully bio-based thermosetting resins and recycled waste polyethene terephthalate". Journal of Composite Structure. 1996;35(3):263-269.
[9] Xingli Zhang, Xiaolong Hao. "Heat Transfer and Mechanical Properties of Wood-Plastic Composites Filled with Flake Graphite". Journal of Composite Materials.1976;10(4):325-341.
[10] Adijat Omowumi Inyanga, et.al, "Suitability of developed composite materials for meniscal replacement: Mechanical, friction and wear evaluation". Journal of Composite Structure. 1998;42(4):263-269.
[11] Luca Sorelli, et.al, "Characterization of concrete composites with recycled plastic aggregates from postconsumer material streams". Journal of Composite Structure. 1996;35(3):263-269.
[12] Muammar Kaya. "Recovery of metals and nonmetals from electronic waste by physical and chemical recycling processes". Journal of Composite Structure. 1996;35(3):263-269.
[13] Siddharth Patel, et. al, "Study on mechanical properties of environment-friendly Aluminium E-waste Composite with Fly ash and E-glass fibre". Journal of Composite Structure. 1996;35(3):263-269.
[14] Vaibhav Gaikwad, et.al, "The present and future of e-waste plastics recycling". Journal of Composite Structure. 1996;35(3):263-269.(2018)
[15] Mehdi Seghiri, et.al, "The Possibility of Making a Composite Material from Waste Plastic". Journal of Composite Structure. 1996;35(3):263-269.(2017).
[16] Irina Turku, et.al, "Characterization of wood plastic composites manufactured from recycled plastic blends.". Journal of Composite Structure. 1996;35:263-269.(2016).

[17] Timo Karki, et.al, "Durability of wood plastic composites manufactured from recycled plastic". Journal of Composite Structure. 1996;35(3):263-269.(2018).
[18] Deepak Verma, et.al, "Processing and evaluation of mechanical properties of epoxy filled E-glass fibre fly ash hybrid composites". Journal of Composite Structure. 1996;35(3):263-269.
[19] A.F. Fedotov. "Interface model of the influence of particle size on the plastic deformation resistance of particle-reinforced metal-matrix composites". Journal of Composite Structure. 1996;35(3):263-269.
[20] S. Bruna Torres Ferreira, et.al, "Sisal-glass hybrid composites reinforced with silica microparticles". Journal of Composite Structure. 1996;35(3):263-269.
[21] Nguyen Dinh Duc, et. al, "Bending analysis of three-phase polymer composite plates reinforced by glass fibres and titanium oxide particles". Journal of Composite Structure. 1996;35(3):263-269.
[22] J. Lapin, et.al, "Room temperature mechanical behaviour of cast in-situ TiAl matrix composite reinforced with carbide particles". Journal of Composite Structure. (2018).
