Design and Fabrication of Two Wheeler Mudguard using Sisal Natural Fiber

Baskaran.s[#1], Justin Dhiraviyam.F[#2], Sathish.K[#3], Srithar Kumar.S[#4]
[1,2,3]*Assistant Professor, Department of Mechanical Engineering*
Sri Eshwar College of Engineering, Coimbatore, India
[4] *CFD Analyst,Mahindra & Mahindra, Chennai, India*

Abstract

In the current scenario automobile industries focuses on enhancing the strength and reducing the weight of body parts. In two wheelers mudguard is provided to prevent the dirt's and sand particles in tire from entering and damaging other parts. Presently most of which are made from ABS/Polypropylene plastics. They are of high cost and not completely degradable. In my work an attempt has been made to use strong and abundantly available sisal plant fibers as reinforcement in epoxy resin to make low cost, high strength and less weight substitute for mudguards.

Keywords — *ABS, Sisal, Epoxy*

I. INTRODUCTION

Polymer matrix composites using natural fibers as reinforcement have been receiving lots of attention in recent years. Natural fiber based composites made of renewable materials have been used in interior and exterior body parts of vehicles. Further market penetration of green composites will occur only when their production is made cost effective and competitive to present injection molded plastics used on many vehicles. Various attempts have been made to reduce the use of expensive glass, aramid or carbon fibers by preferring low density, cost effective natural fibers over synthetic alternatives. Sisal fiber is one of the most widely used natural fibers. It is extracted from leaves of sisal plant which is native to tropical countries of india, south africa and brazil. It grows wild like fences around the fields, roadways and railway tracks. Boopathi et al [1] extracted the borassus fruit fibers and found its mechanical properties. They further designed and developed two wheeler bumper from borassus fruit fiber reinforced epoxy composites by reducing its weight with enhanced strength. Considering this as primary requirement of automobile engineering field.H.S. Park et al [7] developed a short fiber reinforced plastic front side panel (car fender) for reducing weight in automobile. Design concept and optimization strategy in terms of design for strength, design for manufacturability were also considered.

The fiber reinforced plastic fender gives some advantages such as light weight, low cost, and design flexibility can replace traditional steel fender. Georgios koronis et al [3] made a study that provides a bibliographic review in the broad field of green composites, seeking out for materials with a potential to be applied in the near future on automobile body panels. With technical information of bio polymers and natural reinforcements a database was created with the mechanical performance of several possible components for the prospect green composite. Renewable materials for matrix and reinforcements are screened accordingly in order to identify which hold both adequate strength and stiffness performance along with affordable cost so as to be a promising proposal for green composite. Yan li et al [8] presents a summary of recent developments of sisal fiber and its composites they tested the properties of sisal fiber interface between fiber and matrix, cost, density, specific strength and modulus. K.L Fung et al [2] investigated the processing of sisal fiber reinforced polypropylene composites a pre impregnation technique has been introduced for injection molding of sisal fiber reinforced polypropylene composites. The major advantage of pre-impregnation technique is that the composites can be injection molded with relatively lower temperature. Krishnan jayaraman et al [5] developed a method for manufacturing sisal-polypropylene composites with minimum fiber degradation. common methods for manufacturing natural fiber reinforced thermoplastic composites injection molding and extrusion tend to degrade fibers during processing. Ling sun et al [6] analyzed the structural features of automobile large plastic parts and selection of corresponding shaping modes. They elaborate product design, raw material selection, forming method, structural design on account of manufacturing defects such as weld line and sink mark etc occurring to automobile plastic decorating parts subject to injection molding. Gikuru mwithiga et al [4] produced sisal/epoxy laminates than subjected it to tensile and bending test. The results revealed the tensile strength of the samples were 31-40 Mpa and flexural strength of the laminates ranges from 83.7-113.2 Gpa. N.Saravanakumar, L.Prabhu et al [9] discusses experimental analysis on cutting fluid. N.Sathiseelan, S.Baskaran [10] discusses optimization of welding parameters. G.Gokilakrishnan [11] et al discusses operation of ball valve torque. V.Naveenprabhu [12] et al investigates tube in heat exchanger. A. Elsabbagh [13] et al discussed the fire retardant properties of natural fiber. S. Witayakran [14] discussed the recent usage of natural fiber in automobile industry.

II. SISAL/EPOXY COMPOSITES:

Sisal fiber is extracted from the leaves of sisal plant by soaking the leaves in water for a week than debonding the flushes from fiber by retting method and allowed to get dried. Than the fiber is impregnated in epoxy resin to make sisal/epoxy laminates. This laminate is cut to standard sizes to make specimens for mechanical testing. For impact test as per ASTM standard samples is cut to (66x13x3)mm, for tensile sample dimension is (250x25x3)mm, for flexural sample dimension is (127x13x3). Out of 3 ratios compared 60:40 has better mechanical properties than 65:35 and 70:30.

Density g/cm^3	1.45
Diameter mm	50
Tensile strength Mpa	470
Young's modulus Gpa	9.4

Table 1 mechanical properties of sisal

Cellulose%	67
Lignin %	8
Hemicelluloses %	10
Moisture content %	11

Table 2 chemical composition of sisal

Density g/cm^3	1.2
Tensile strength Mpa	55
Tensile modulus Gpa	2.75
Poisson ratio	0.33
Shrinkage %	1-5

Table 3 properties of epoxy

III. DESIGN AND FABRICATION PROCESS

A. *Design methodology*:

A 3D modelling of two wheeler mudguard is developed using the pro-e software. The following assumptions were taken into account for developing a model. Model of mudguard is depicted in fig 1.

- The mudguard design depends on tyre size i.e it is designed for 2.50 x 18 inch(width x diameter).
- The circumference should not be more than ¼ of the overall circumference of the tyre.(360°full size).
- At least 2.5cm clearance should be maintained between mudguard and tyre.

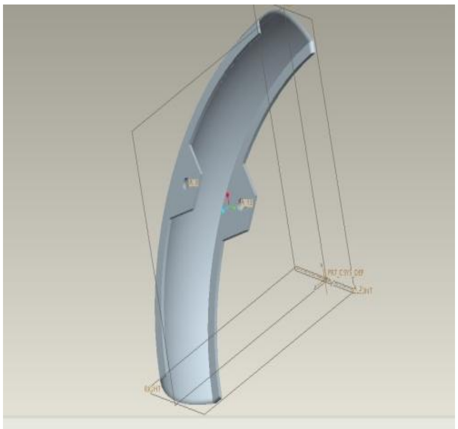

Fig 1.Conceptual model of mudguard

B. *Fabrication:*

Fabrication of mudguard is done with a wooden pattern that is engraved to the shape of the mudguard. The length of fiber used in the mould was limited to 25cms. The epoxy resin with hardener was thoroughly mixed with required fibers in the ratio of 60:40. The fiber resin was allowed to spread uniformly in the male and female moulds up to required thickness. The moulds are meticulously clamped together. The mould was placed in room temperature for 24 hours. Than the mudguard was carefully removed from the mould by uncoupling the male and female moulds. Mould of mudguard is depicted in fig 2.

Fig 2.Wooden mould for fabricating mudguard

Fig 3. A View of Mudguard produced using wooden Dies

IV. RESULTS AND DISCUSSION:

Composite plates were made for three types of ratios and one which offers best result is selected. Among three ratios 60:40 is selected by comparing it with 65:35 and 70:30. Actual weight of composite plate is 300gms. The dimension of the composite sheet is (300x300x3)mm. For 60:40 ratio 60% of epoxy resin is used and 40% of sisal fiber is used along with 10% of araldite hardner.

Ratios	Impact strength in J/mm^2	Flexural strength in Mpa	Tensile strength in N/mm^2
60:40 UT	1.3	247.16	108
65:35 UT	0.3	14.66	5.54
70:30 UT	0.6	86.24	54.62

*UT-Untreated

Table 4. Mechanical properties of sisal/epoxy composites

The graphical representation of results for 60:40 ratio which holds maximum tensile, flexural and impact values are shown below. Tensile test carried out on an untreated sisal/epoxy composite specimen revealed that it can withstand a peak load of 8140N and while dividing it by its cross sectional area of $75mm^2$ a tensile strength of $108N/mm^2$ achieved. Tensile graph is depicted in fig 3. Flexural test is carried out by three point bending method on the specimens cut to ASTM standards with the cross sectional area of $30mm^2$ its results proved it can withstand 343N load and flexural strength of 247.16Mpa is achieved. Flexural graph is depicted in fig 4. Izod impact test conducted on 4 specimens showed the energy lost during the impact as $1.03J/mm^2$. Impact graph is depicted in fig 4.

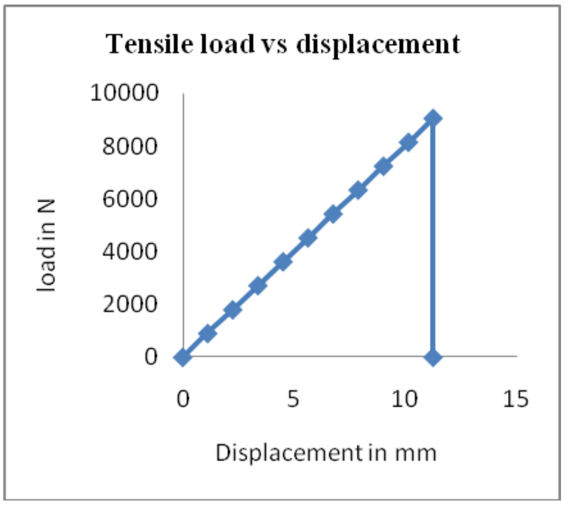

Fig 4. Tensile strength graph

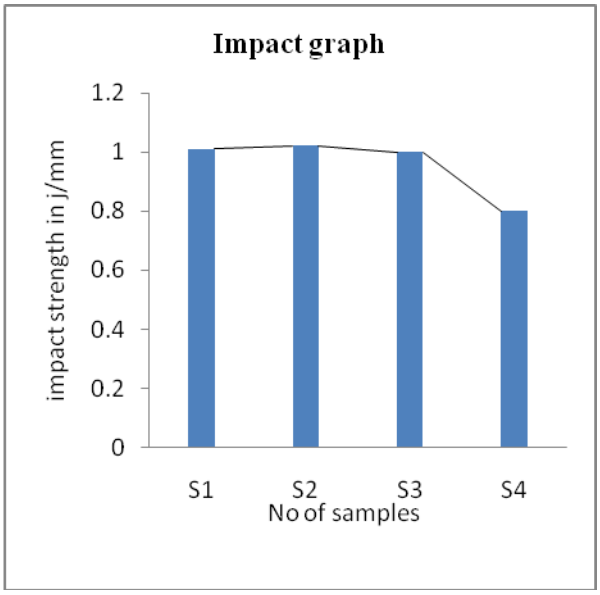

Fig 5. Impact strength graph

The fluctuations in results of impact test which differs from samples are due to the distributions of fiber in the matrix although it is generally assumed fibers are uniformly distributed in matrix and matrix and fiber have a perfect bonding. It is suggested better value from the result is chosen while manufacturing a product considering the result. The three mechanical properties tensile, impact and flexural provides satisfactory results for emphasising its use in two wheeler mudguards. But Technological support and industries producing bio-based products have to be improved to successfully introduce the natural fiber based products to the ocean of automobile markets.

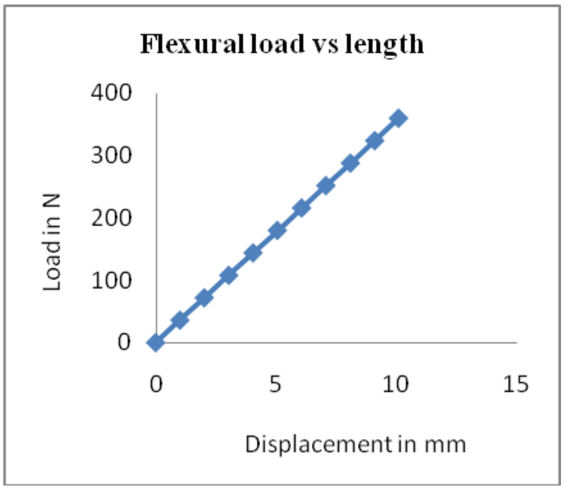

Fig 6. Flexural strength graph

V. CONCLUSION

The application of green composites in automobile body parts seems to be feasible as far as green composites have comparable mechanical performance with synthetic ones. Conversely green composites seem to be rather problematic due to their decomposable nature. The biodegradability issue is one problem that needs to be addressed when aiming 100percent bio-based composite applications, especially when dealing with structural parts of future vehicles. The trend can also be reversed in the sense that the necessity for environmentally conscious solutions can overturn the value chain and put premium price on environmental impact of current solutions. The practicability of natural fiber reinforced composites in automobile application was well proved. The weight of composite mudguard is comparatively low than the weight of the conventional two wheeler mudguard. At the same time strength and resilience of the natural fiber reinforced mudguard is also enhanced.

REFERENCES

[1] L.Boopathi, P.S.Sampath, "conceptual design of two wheeler bumper made from alkali treated borassus fruit fiber reinforced epoxy composites", (2012), European journal of scientific research, vol.79, pp.353-361.

[2] K.L. Fung, X.S. Xing, " An investigation on the processing of sisal reinforced polypropylene composites", (2003), composites science and technology, vol.63,pp.1255-1258.

[3] Georgios korosis, Arlindo silva, "A review of adequate materials for automotive applications",(2012), composites,vol-nil, pp.-nil.

[4] Gikuru mwithiga, janet mutheu mwania, " Influence of sisal fiber content on tensile and bending strength of sisal/epoxy composites", (2006),journal of engineering and applied sciences,vol.4,pp.508-512.

[5] Krishnan jayaraman, "Manufacturing sisal-polypropylene composites with minimum fiber degradation",(2003), composites science and technology, vol.63,pp.367-374.

[6] Ling sun, xiaoming liu, "control analysis and apparent quality of automobile large plastic parts",(2011), procedia engineering,vol.16.pp.438-443.

[7] H.S.Park, X.P.Dang, "Development of short fiber reinforced plastic front side panels for weight reduced automobiles",(2010), journal of automotive technology, vol-nil,pp.nil.

[8] Baskaran, S., & Venkadesh, S. Exergy Analysis In Ic Engine Using Diesel Blends As A Fuel. International Journal of Applied Engineering Research, 10(7), 2015.

[9] Saravanakumar, N., Prabu, L., Karthik, M., & Rajamanickam, A. (2014). Experimental analysis on cutting fluid dispersed with silver nano particles. Journal of Mechanical Science and Technology, 28(2), 645-651.

[10] Sathiseelan, N., and S. Baskaran. "Optimization of welding parameters using plasma arc welding for SS316 material." Optimization 6.1 (2016).

[11] Gokilakrishnan, G., Divya, S., Rajesh, R., & Selvakumar, V. (2014). Operating Torque In Ball Valves-A Review. International Journal for Technological Research in Engineering, 2(4), 311-315.

[12] V.Naveenprabhu, K.Saravanakumar, T.Suresh and M.Suresh, "Experimental investigation on tube-in-tube heat exchanger using nanofluids",(2016), Advances in Natural and applied sciences,Vol.10.pp.272-278.

[13] A. Elsabbagh, L. Steuernagel, J. Ring, "Natural Fibre/PA6 composites with flame retardance properties: Extrusion and characterisation",(2017),Elseiver,Vol 108,pp.325-333.

[14] S. Witayakran, W. Smitthipong, R. Wangpradid, R. Chollakup, P.L. Clouston "Natural Fiber Composites: Review of Recent Automotive Trends", (2016),Journal of material science and technology, Vol 10,pp 210-215.