DESIGN AND ANALYSIS OF BANANA FIBER REINFORCED POLYMER SPUR GEAR MANUFACTURED BY GEAR HOBBING PROCESS

S.Sivaganesan[1], , S.Joseph irudaya raja[2], C.Gnanavel [3] A.Parthiban[4],
Email id: sivaganesanme@gmail.com
[1] Associate Professor, Department of mechanical engineering, VISTAS, Chennai
[2]Assistant Professor, Department of mechanical engineering, VISTAS, Chennai
[3]Assistant Professor, Department of mechanical engineering, VISTAS, Chennai
[4]Associate Professor, Department of mechanical engineering, VISTAS, Chennai

Abstract

The process is done with the combination of different materials such as Polyester resin, Natural fiber, Glass fiber and Silicon carbide. The development of a spur gear and to improve its efficiency and its performance.The composition of these materials has better tensile strength, high tensile modulus, low elongation, low cost, easy availability. These property materials was selected to design and manufacturing spur gear by using gear hobbing process and finally testing the hardness of the spur gear.

Key Words: natural fibre, silicon carbide, *hobbing process, glass fibre, spur gear, Testing of composite*

1. Introduction

Composites are the combinations of two materials in which one of the material is called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other material called the matrix phase..[1]The biodiesel from the vegetable oil (which use for food preparation) increase the cost of food and biodiesestudied the effect of potassium titan ate whiskers filler-reinforced epoxy composite on the tensile and flexural properties and found that the tensile and flexural strength decrease due to the addition of the fillerl, [2] The effect of snail-shell powder on the polypropylene composites was investigated by The results indicated an increase in the tensile, flexural, and impact properties with an increase in the filler content and filler size., [3]studied the mechanical behavior of wood flour-added polypropylene composite and found the addition of filler material in the polypropylene matrix increases the mechanical properties of the composite material.[4] analyzed the effect of fly-ash loading on the mechanical properties of the epoxy resin and concluded that filler material size affect the compressive and impact strength of the composite material, [5] investigated the influence of nano clay on woven coconut sheet/polyester composites on dynamic mechanical properties of composite and found that the addition of nano clay influences on storage and loss modulus of composite material,[6] have used coconut shell powder as filler material in epoxy composite and it was found that incorporation of coconut shell powder increased the tensile strength and modulus with a slight decrease in impact strength, [7] have used coconut shell powder as filler in recycled polypropylene, and Sodium DedecylSulfate (SDS) was used as coupling agent. It revealed that the addition of filler provided an increase in tensile properties, thermal stability, crystalline and lower the water absorption compared to unmodified composites,

2. Materials

2.1 Banana Fibre

Banana plant or plantain plant not only gives the delicious fruit but it also provides textile fiber, the banana fiber. Banana fiber is natural fiber. Natural fibers present important advantages such as low density, appropriate stiffness and mechanical properties and high disposability and renewability. Moreover, they are recyclable and biodegradable. There has been lot of research on use of natural fibers in reinforcements.

Banana fiber, a ligno-cellulosic fiber, obtained from the pseudo-stem of banana plant (Musa sepientum), is a bastfiber with relatively good mechanical properties. Banana plant is a large perennial herb with leaf sheaths that form pseudo stem. Its height can be 10-40 feet (3.0-12.2 meters) surrounding with 8-12 large leaves. The leaves are up to 9 feet long and 2 feet wide (2.7 meters and 0.61 meter)

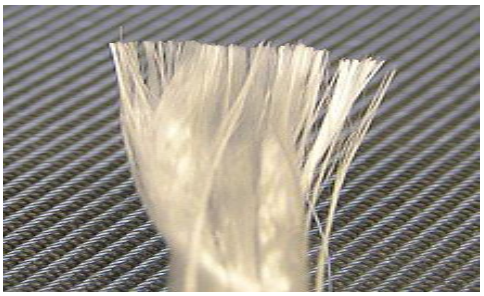
2.3 Polyester Resin

Polyester resins are unsaturated synthetic resins formed by the reaction of dibasic organic acids and polyhydric alcohols. Maleic Anhydride is a commonly used raw material with diacid functionality. Polyester resins are used in sheet moulding compound, bulk moulding compound and the toner of laser printers. Wall panels fabricated from polyester resins reinforced with fiberglass—so-called fiberglass reinforced plastic (FRP)—are typically used in restaurants, kitchens, restrooms and other areas that require washable low-maintenance walls. They are also used extensively in cured-in-place pipe applications.

Departments of Transportation in the USA also specify them for use as overlays on roads and bridges. In this application they are known as PCO Polyester Concrete Overlays. These are usually based on isophthalic acid and cut with styrene at high levels—usually up to 50%.Polyesters are also used in anchor bolt adhesives though epoxy based materials are also used. Many companies have and continue to introduce styrene free systems mainly due to odor issues.

2.3 Glass Fibre

Glass fiber (or **glass fibre**) is a material consisting of numerous extremely fine fibers of glass.Glassmakers throughout history have experimented with glass fibers, but mass manufacture of glass fiber was only made possible with the invention of finer machine tooling. In 1893, Edward Drummond Libbey exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers. Glass fibers can also occur naturally, as Pele's hair.



Glass wool, which is one product called "fiberglass" today, was invented in 1932–1933 by Russell Games Slayter of Owens-Corning, as a material to be used as thermal building insulation.It is marketed under the trade name Fiberglas, which has become a genericized trademark. Glass fiber when used as a thermal insulating material, is specially manufactured with a bonding agent to trap many small air cells, resulting in the characteristically air-filled low-density "glass wool" family of product

2.4Silicon Carbide

Siliconcarbide (SiC), also known as carborundum /kɑːrbəˈrʌndəm/, is a semiconductor containing silicon and carbon. It occurs in nature as the extremely rare mineral moissanite. Synthetic SiC powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907.

SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both. Large single crystals of silicon carbide can be grown by the Lely method and they can be cut into gems known as synthetic moissanite.

3. Composition

a) Gear 1

100% Polyester Resin (Matrix)

b) Gear 2

40% Glass Fiber, 60% Matrix

c) Gear 3

40% Natural Fiber, 60% Matrix

d) Gear 4

20% Natural Fiber, 20% Glass Fiber, 60 % Matrix

e) Gear 5

17.5% Natural Fiber, 17.5% Glass Fiber, 5 % Silicon Carbide, 60% Matrix

4. Testing of Composite Material

4.1 Tensile test:

The test specimen is prepared according to the ASTM D-3039 standard

The length ,width and thickness of the specimen were 135,19 and 3mm

Tensile strength = P/A

4.2 Flexural test:

The flexural specimens were prepared as per the ASTM D790 standard.

The length, width and thickness of the specimen were 100, 13 and 3mm

Flexural Strength = $3PL/2bt^2$

4.3 Impact test

The Impact specimens were prepared as per the ASTM D 256 standard.

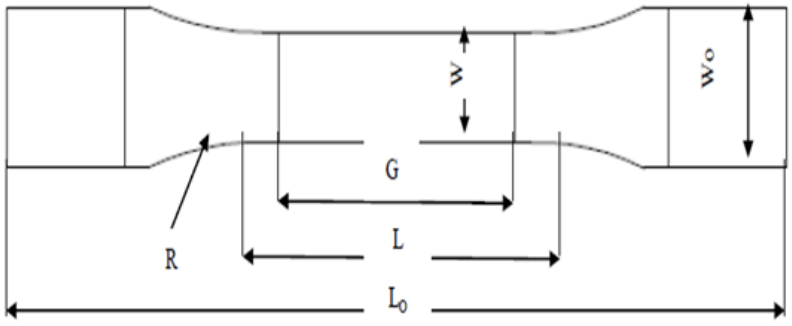
The length, width and thickness of the specimen were 65.5, 13, and 3mm.

Impact = K / A

K- energy absorbed

A- area under the notch

5. Tensile Test – ASTM D638



W - Width of narrow section = 13mm

L - Length of narrow section = 57mm

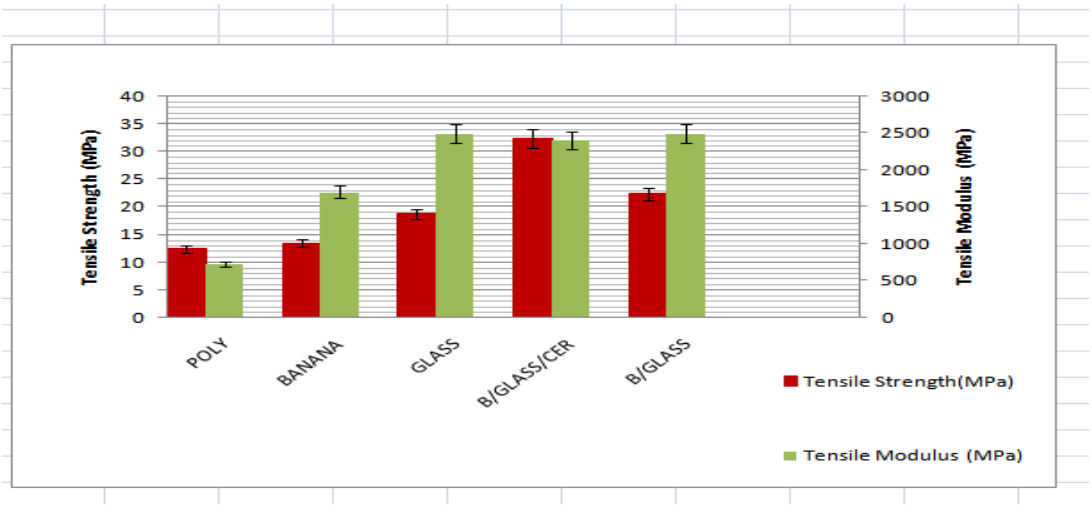
Wo - Width of overall= 19mm

Lo -Length overall= 165mm

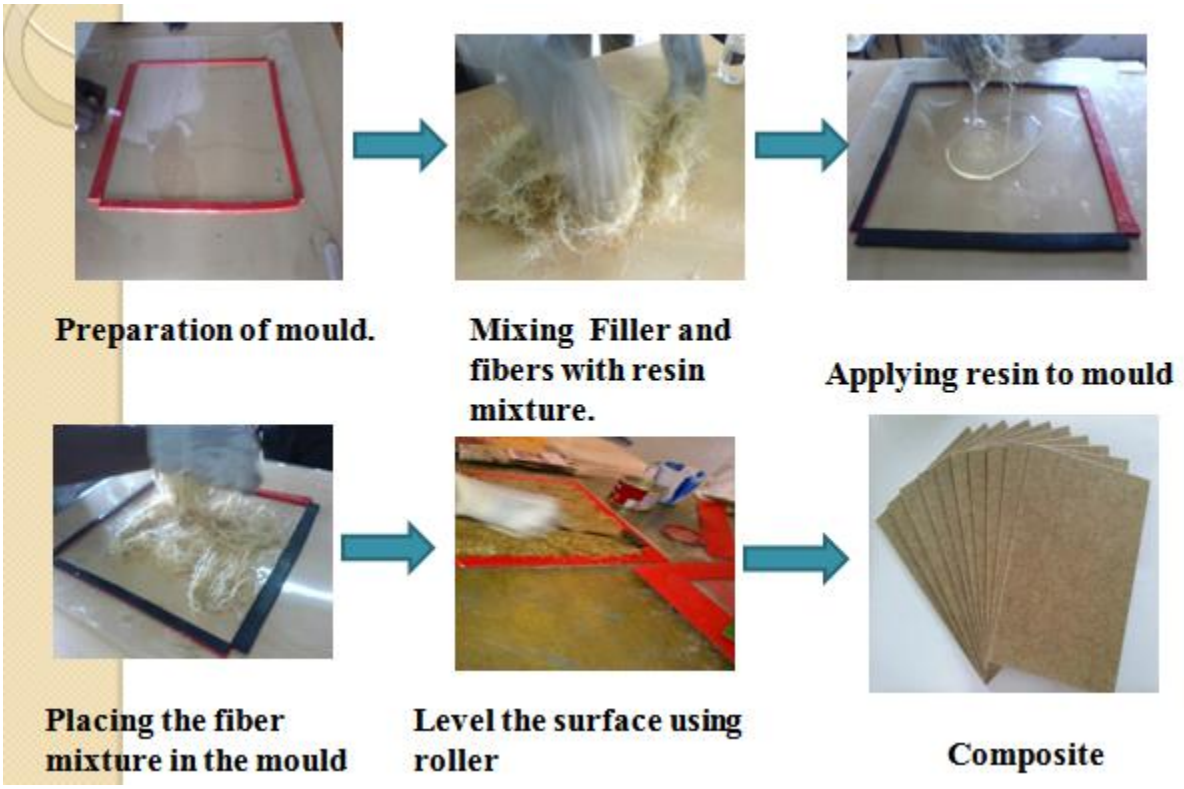
G -Gauge length= 50mm

D -Distance between grips= 115mm

R -Radius =76mm


Tensile Strength (MPa)
Tensile Modulus (MPa)
40
35
30
25
20
15
10
5
0
3000
2500
2000
1500
1000
500
0
POLY
BANANA
GLASS
B/GLASS/CER
B/GLASS
Tensile Strength(MPa)
Tensile Modulus (MPa)

6. Fabrication of Composite



7. Conclusion

The influence of different composition spur gears (polyester resin 100% ,60% matrix + 40 % glass fibre , 60% matrix + 20% glass fibre + 20% natural fibre , 55% matrix + 20 % glass fibre + 20% natural fibre + calcium carbonate) hardness properties are analysed. The maximum hardness properties are found on gear model 4 (55% matrix + 20 % glass fibre + 20% natural fibre + 5 calcium carbonate) is 69 BHN, and the manufacturing of gear reveals that the gear hobbing process suitable for this polymer materials.

References

1. Sudheer et. Al. (2000), “Mechanical properties of potassium titan whiskers fillers reinforced epoxy resin composite”, Journal of minerals and material characterization and engineering, Vol. 11.
2. Onuegbu. et. al. (2003), “The effect of filler content and partical size on the mechanical and end-use properties of snail-shell powder filled polypropylene", Material science and application.
3. Kokta et. al. (2004), “Mechanical behavior of wood flour-added polypropylene composite”, Materials & Design, Vol. 31.
4. Gupta et. al (2004). “Effect of fly-ash loading on the mechanical properties of the epoxy resin”, Journal of minerals and material characterization and engineering, Vol. 9.

5. Ranjini et. al. (2013), “Investigated the influence of nano clay on woven coconut sheet/polyester composites on dynamical mechanical properties of composites",

6. Sarki et. al. (2010). Effect of surface modification of bamboo cellulose fibers on mechanical properties of cellulose/epoxy composites. Composites Part B: Engineering, 51, 28-34.
7. Chun et. al. (2011). Effects of alkali treatment and elevated temperature on the mechanical properties with coconut shell powder as a filler in polypropylene.
8. Mansor M.R., et. al. (2013), "Stiffness Prediction of Hybrid Kenaf/Glass Fiber Reinforced Polypropylene Composites using Rule of Mixtures (ROM) and Rule of Hybrid Mixtures (RoHM)", Journal of Polymer Materials, Vol. 30, No. 3, pp. 321-334.
9. Nayak S.K., et. al. (2013), "Mechanical properties of eco-friendly recycled polymer composites: a comparative study of theoretical and experimental results", International Journal of Plastics Technology, Vol. 17, No. 1, pp. 75-93.
10. Prasad, A. R., & Rao, K. M. (2011). Mechanical properties of natural fibre reinforced polyester composites: Jowar, sisal and bamboo. Materials & Design, 32(8), 4658-4663