

# Experimental Analysis of Madar and Vakka Reinforced Hybrid Polypropylene Composite

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**ABSTRACT:** Natural fibers has much more importance than the synthetic fibers from the few decades. It should be available in every part of the world and they are easily degradable in the environment. The main Moto of this work has to study the behaviour of VAKKA and MADAR natural fiber reinforced hybrid polypropylene composite these are eco-friendly and partially degradable in the environment. Composites having the polypropylene reinforced with fibers are prepared by using injection moulding machine by varying the weight fractions of fibers madar-vakka (0-100%) madar-vakka (25%-75%) madar-vakka(50%-50%) madar-vakka (75%-25%) madar-vakka (100%-0%). The composites are tested for their mechanical properties.

**KEYWORDS:** Composites, Vakka fiber, Madar fiber, Polypropylene, Mechanical properties

## I. INTRODUCTION

Composite materials are replacing traditional materials because of their superior properties such as high strength –to-weight ratio, high mechanical strength and minimum thermal expansion. The development of new materials is on the anvil, and the number is growing day by day. Natural fibre reinforced polymer composite became more attractive due to their high specific strength, light weight, biodegradability and environment friendliness. Natural fibre mixed with synthetic fibre-reinforced polymer composite is finding increased applications. The reinforcing phase of the composites provides the strength and the stiffness, to make them harder, stronger and stiffer than the matrix. The reinforcement is usually in the form of a fibre or a particulate. The length to diameter ratio is known as the aspect ratio, and can vary greatly for fibres because the length of the fibre is much greater than its diameter. Continuous fibres have high aspect ratios, while discontinuous fibres have low aspect ratios, and the orientation of fibre composites normally is perfect, while discontinuous fibre composites are often made into laminates by stacking single sheet of fibres in different orientations to obtain the desired strength and stiffness properties with fibre volume as high as 60 to 70 %. In general, the smaller the diameter of the fibre, the higher its strength, but the cost increases when the diameter becomes smaller. In addition, smaller diameter fibres have greater flexibility, and are more amenable to fabrication processes such as weaving or forming across the radius.

Author Feng [1] et al has reported the structure property connections of kenaf fiber strengthened polypropylene (PP) and its effect co-polymers polypropylene (MAPP) utilized viably to enhance the quality connected the fiber and lattice. The impact of coupling operator on the mechanical properties and element mechanical conduct is reported. Results additionally shown the effect copolymers mixes with coupling specialist have better high temperature module and lower creep consistence than uncoupled frameworks. The crystallization and dissolving conduct of kenaf composites were looked at utilizing differential filtering calorimeter. The author in [2] Abdul Khalil et.al has worked on the oil palm fibre to toughen the otherwise brittle unsaturated polyester resin (USP) in the polymer matrix biofiber composites. In contrast to the conventional method of incorporating the toughening agent in the matrix resin, the method used in the present investigation consisted in treating the biofiber (OPF) with the toughening resin before

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impregnating with USP resin. Accordingly biofiber was first impregnated with toughening resin, acrylonitrile-butadiene-styrene (ABS) to produce a pre-preg. The pre-preg was then impregnated with USP resin containing free radical initiator. The ABS content in the biofiber pre-preg was varied from 5 to 25%. Unsaturated polyester was reinforced with the pre-preg and cured in presence of MEKP to produce ‘‘hybrid composite’’. Hybrid (ABS +USP) composite showed improved mechanical properties (tensile, flexural and impact), density and lowered water absorption as compared to thermoplastic (ABS) composites. Both thermoplastic and hybrid composites (ABS+ USP) at 10% ABS solution showed the highest properties as compared to other fractions (5%, 15%, 20%, and 25%). In [3] Clemons and Sanadi examined the impacts of fiber content, coupling specialist and temperature on the effect execution of fiber -plastic composites. They watched vitality to mast extreme burden (EML) valves for kenaf composites were about portion of those for unfilled PP examples in turned around indent tests at room temperature, however execution was comparative at low temperatures. This examination demonstrated that Izod sway test can expand the data picked on the effect execution of composites produced using polypropylene (PP) strengthened with kenaf fiber. Instead of yielding a solitary vitality esteem, the outcomes demonstrate the state of heap diversion band, which prompts more noteworthy understanding into the conduct of the material. In [4] Chauhan .s.s et. Al has worked on the wood fibre composites they stated that the results shows that the MAPP (maleic anhydride modified polypropylene) reinforced composites exhibits less results compared to the poly propylene reinforced composites. Mechanical properties, measured in tensile, flexural and impact tests, demonstrated that the fibers used in this work act as effective reinforcing agents for PP. With the wood-fiber content in the composite increasing from 10 to 50 wt.%, the tensile strength increased linearly from 30.5 to 44.2 N/mm<sup>2</sup> representing a 45% increase, while the tensile modulus increased by nearly 200%. Flexural strength exhibited an increase of 85% from 49.8 to 91.9 N/mm<sup>2</sup>. The increase in mechanical properties demonstrated that m-TMI-g-PP is an effective compatibilizer for wood-fiber polypropylene composites. In [5] P.Ganeshan, K.Raja has conducted work on the madar fibre and red mud. They make a composite with these two as the reinforcement and polystyrene as the matrix. In this study they stated that the madarfibres has the high strength and exhibits good results like the tensile strength and flexural strength etc. In [6] .N. Ravi Kumar et al has worked on the vakka fibre . In this study they stated that the fibre has the high mechanical properties. They are make a composite with this fibre pp as the matrix and the results states that up to 15% of the fibre addition has exhibit the good tensile and flexural properties and after that the values are reduced . so they finally concluded that the 15% of composition is good for the use. In [7] Smita Mohanty et.al has concerned on the sisal fibre composites reinforced with the MAPP and the PP as matrix. In this study they used as 1 % of MAPP and 21% (volume fraction ) of sisal fibre has added to make a composite. By this the results shows that the addition of this composition has increased the mechanical properties of the composite. Without using the MAPP the strength, flexural strength etc are low compared to the other ones. they are concluded that sisal fibers could reinforce the PP matrix when used in optimal concentration of fibers and coupling agents.

## II. EXPERIMENTAL PROCEDURE

In this we have to discuss about the extraction of fibers and what the mechanical properties to be found as follows are Tensile, Flexural and Impact.

### A .MATERIALS

(1) Polymeric matrix: Polypropylene (M 110) was provided as granules by Haldia Petrochemicals Limited, Kolkata, India. It has melting temperature of 180° C and melt flow index of 11 gm/10 min at 230° C. Its density at the room temperature is 0.9 gm/cm<sup>3</sup>.

(2) Extraction of Vakka fiber: The vakka fibers are extracted from the leaf base of the vakka tree. The dried leaf base are collected manually and soaked in water for 21 days. After that wash the leaf base with fresh water, chopped into desired height for easily extraction of the fiber. Then the chopped pieces are retting with rubber hammer. By this retting the excess are removed from the fibers. Then wash the fibers with clean water and dried in shade to remove the moisture. Then chop the obtained fiber into desired length (3mm).

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(3) Extraction of Madar fiber: The madar fibers are extracted from the bark of the madar tree. The stems are collected manually. The collected ones are dried in shade for two days. After then separate the bark from the stems, by using sharp knife/blade to separate the fiber from the stem. The fibers are collected and chopped into the desired length (3mm).

## B. COMPOSITE FABRICATION:

Before going to fabrication the fibers are free from moisture so keep it in oven for some time. In this (model CIC 12) is used to dry the extracted fibers. The oven has an automatic temperature control unit with an operating range of 0 – 350° C. All raw materials are dried in an oven at a temperature of 80° C for 2 hours to expel the moisture. The specimens are prepared by using injection moulding machine. A 2 ton plastic hydraulic injection moulding machine, model JIM-1HDB by texair plastic limited as shown in fig. First of all pre heat the machine with the desired temperature for some time. In this work we have used polypropylene as the matrix, so set the temperature to 210°c to its melting point. By using weight fractions these fibers are mixed with the polypropylene. The five different weight fractions are madar-vakka (0% - 100%), madar-vakka (25% - 75%), madar-vakka (50% - 50%), madar-vakka (75% - 25%), madar-vakka (100% - 0%). By this all the fibers are divided according to their weight fractions. Then properly mix the fiber with polypropylene pellets and pour into the injection moulding machine. A 2 ton capacity hydraulic machine has applied a force of 1100 kgf/cm<sup>2</sup> for each specimen into the mould, for each weight fraction of fiber all the specimens are fabricated.

## C. CHARACTERIZATION OF COMPOSITE:

(1) Tensile properties: A 2-ton limit electronic tensometer, METM 2000 ER-1 model (plate II-18), supplied by MS microtech pune, is used to determine tensile strength of composites. Its capacity can vary by load cells of 20kg, 200kg, and 2000kg. A load cell of 2000kg is used for testing composites. Self -balanced chuck with grip is used to gauge the thickness and width of composites. The gauge length thickness and width are measured with 0.001 mm smallest count automated micrometer. The electronic tensometer is fitted with weight, extension indicators. It has least count of 0.01 kg and 0.01 mm individually.. Repeat the procedure for all the specimens of weight fractions of the composite. According to the ASTM-D638M standards all the specimens are prepared.

mathematical calculations of tensile strength

$$\text{YOUNGS MODULUS} = \frac{\text{STRESS}}{\text{STRAIN}}$$

$$\text{STRESS} = \frac{P}{A}$$

i.e., P= Load

A=Area (13\*3) mm

$$\text{STRAIN} = \frac{\Delta L}{L}$$

i.e., ΔL=change in length

L= original length



Fig.1 Sample Specimens after Tensile test

(2) Flexural properties: Three point flexural test ASTM-D790M-86 is used to find the flexural properties, the test specimens are having the 98 mm long by 10 mm wide and 4mm thick. Five weight fractions of five sets of specimens are tested. In flexural test the external rollers are 64 mm separated and the specimen are evaluated at a strain rate of 0.2 mm/min.

$$\text{FLEXURAL STRENGTH} = \frac{3PL}{2bt^2}$$

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$$\text{FLEXURAL MODULUS} = \frac{L^3 m}{4bt^2}$$

Where L= length      b = width

t = thickness      p = load

m = slope of the load deflection curve



Fig.2 Sample Specimens of Flexural test

(3) Impact properties: Impact test specimens are prepared as per ASTM D256-97 standards to measure the impact strength and the dimensions are 64 X 12 X 9 mm width. A V-notch provided having an included angle of 45° at the centre of the specimen, and at 90° to the sample axis. The depth of the specimen under the notch is 10.16 ± 0.05 mm. the samples are fractured in plastic impact testing machine supplied by M/S international equipment Mumbai. All the five specimens of each composition are tested and sample specimens are shown in fig.

$$\text{IMPACT STRENGTH} \quad I = \frac{E}{T} \text{ joules / mts}$$

Where E= impact energy in joules recorded on the scale

T= thickness of the sample used



Fig 3 sample specimen after impact test

### III. EXPERIMENTAL RESULTS

**(1)TENSILE PROPERTIES:** The results obtained in the tensile strength with respect to weight fraction of the fibers and it is observed that the maximum tensile strength occurs at the Madar-Vakka (25%-75%) weight fraction of the composite and decreases the further weight fractions but pure madar has increasing the strength not than the combination of both fibers. The tensile strength of the combination is 22.12 MPa as shown in fig 4

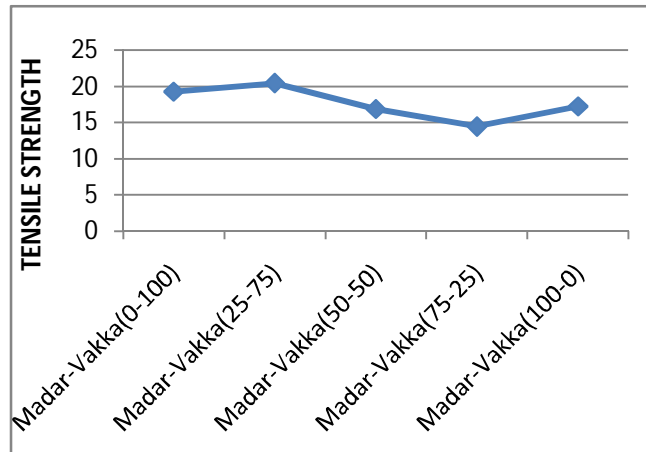


Fig 4 weight fractions vs Tensile strength

Fig 5 shows the tensile modulus which is an indication of load bearing capacity. In this maximum tensile modulus is observed at weight fractions of Madar- Vakka (75% - 25%) are 254.5 MPa. As fiber is the stiffer component in the composite, resistance towards deformation. Due to the fibers interaction with each other is maximum at the obtained combination.

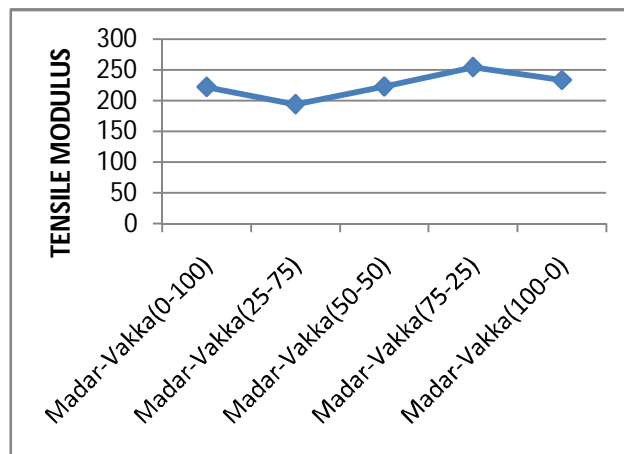


Fig 5 weight fractions vs Tensile modulus

**(2) FLEXURAL PROPERTIES:** The results obtained in the Flexural strength with respect to weight fraction of the fibers and it is observed that the maximum flexural strength occurs at the Madar-Vakka (50%-50%) weight fraction of the composite. The obtained values are 90 Mpa. The reasons for the lower flexural properties at higher fiber fractions are possibly due to the lower fiber to fiber interaction, void and poor dispersion of fiber in the matrix

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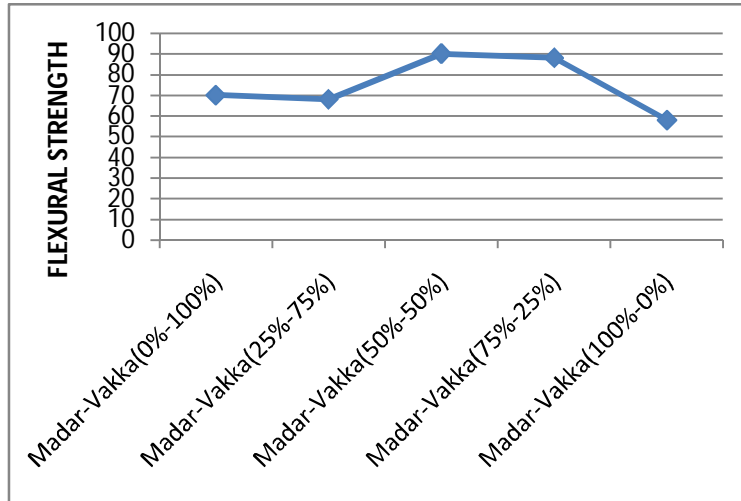


Fig 6 Flexural strength vs weight fraction of fibers

Flexural modulus vs weight fractions of Madar-Vakka hybrid polypropylene composites as shown in fig 7 maximum flexural modulus is observed at weight fractions of Madar- Vakka (25% - 75%) are 1757 Mpa. The modulus has increased at the vakka 75% and madar 25% and then decreases due to the increasing of the fiber percentages.

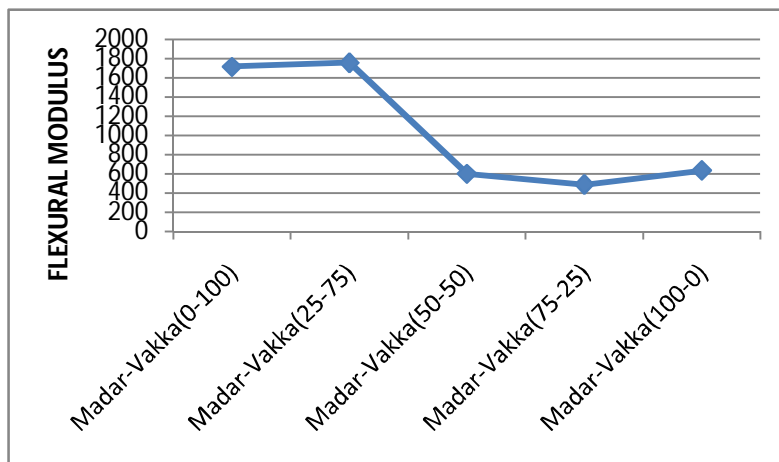


Fig 7 Flexural modulus vs weight fractions of fibers

**(3) IMPACT PROPERTIES:** The fibers play a very important role in the impact resistance of the composite as they interact with the crack formation in the matrix and act as stress transferring medium. The variation of impact strength with fiber loading for composites . the impact strength with respect to weight fractions of the fibers and it is observed that the maximum impact strength occurs at Madar-Vakka (25%-75%) weight fraction of the composite. The obtained values are 75 j/m.



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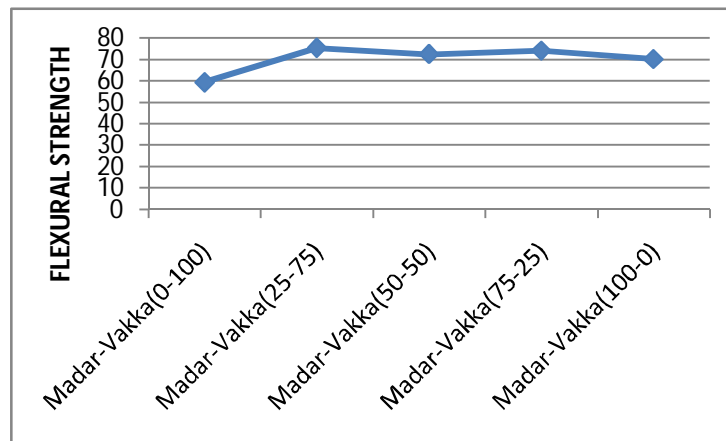


Fig 8 Impact strength vs weight fractions of fibers

## IV.CONCLUSION

The effect of reinforcement of the madar and vakka hybrid polypropylene composite was analysed on the basis of weight fractions of fiber and investigated on the mechanical properties the following conclusions are could be drawn from the experimental result of the study.

- The maximum tensile strength is obtained at the fiber combination of Madar-Vakka (25%-75%) weight fraction of the composite.
- The maximum tensile modulus observed at weight fractions of Madar- Vakka (75% - 25%) .
- The maximum flexural strength occurs at the Madar-Vakka (50%-50%) weight fraction of the composite. In this up to 50% the value increases and then decreases due to its fiber bonding.
- Maximum flexural modulus is observed at weight fractions of Madar- Vakka (25% - 75%) . because of the voids the value are decreased in increasing the fiber percentages.
- The impact strength with respect to weight fractions of the fibers and it is observed that the maximum impact strength occurs at Madar-Vakka (25%-75%) weight fraction of the composite.
- From the obtained results has concluded that the Madar-Vakka (25%-75%) has exhibit better properties compared to the other combination of fiber weight fractions.

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