# Fabrication and Analysis of Ceiling Fan Blades Using Composite Materials

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*Abstract*— Energy crisis has become a major issue in today’s modern scenario. Though wide range of researches is being laid in the areas of alternate energy sources, proper management of the available energy sources will contribute in controlling this energy crisis, particularly in high populous countries such as India. Ceiling fan being one of the vital electric appliance, consumes considerable electric power in most domestic and Industrial application. Compared to existing ceiling fan blade, the composite blade saves 31% of power, and reduces the cost by 28%.
***Keywords:*** Ceiling Fan Blades, Composite Materials

## I. INTRODUCTION

A ceiling fan is a device suspended from the ceiling, which employs hub-mounted rotating blades to provide the air flow. The ceiling fan blades are usually made up of aluminum, steel, wood, etc. The ceiling fans have become a common appliance both in domestic and industrial applications. The power consumption in these conventional fans is more due to the increased weight of the fan blades. Energy crisis and less availability of natural resources is the major challenge faced in today’s scenario. Less power consumption, being the main focus of all electrical appliances companies, selection of better material and effective manufacturing processes, can reduce both the power consumption and the manufacturing cost. Composites are compound materials, differ from alloys in the fact that individual components retain their characteristics but are so incorporated into composites so as to take advantages only of attributes, not that characteristics of short comings, to obtain improved materials. Composite materials (also called composition materials or shortened to composites) are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure.

At present aluminum is widely deployed in blade manufacturing mainly due to the advantages such as less density compared to steel, corrosion resistance and aesthetic look. Though aluminum has wide advantages when compared to steel, it stays back in certain properties such as less strength to weight ratio, paint coating etc. Composites have become a better replacement for conventional steel with adequate improvement of mechanical properties and their reduced weight. This work employs the fabrication of glass fiber reinforced composite fan blade and the replacement of aluminum blades with these composite blades. The power consumption, weight and cost savings of both the conventional and the composite blade fan is compared experimentally. Though a variety of resins and fibers are available, considering the manufacturing easiness and the mechanical aspects epoxy resin and E- glass fiber is employed in the fabrication work. Epoxy resin is almost totally transparent when cured.

## II. LITERATURE SURVEY

A preliminary comparative study of basalt and E-glass woven fabric reinforced composites was performed. The fabrics were characterized by the same weave pattern and the laminates tested by the same fiber volume fraction. Results of the flexural and interlinear characterization are reported. Basalt fiber composites showed higher flexural modulus and apparent interlinear shear strength (ILSS) in comparison with E-glass ones but also a lower flexural strength and similar electrical properties. With this fiber volume fraction, scanning electron microscopy (SEM) analysis of the fractured surfaces enabled a better understanding both of the failure modes involved and of points of concern. Nevertheless, the results of this study seem promising in view of a full exploitation of basalt fibers as reinforcement in polymer matrix composites (PMCs).The results of this preliminary investigation show there is scopefor extensive use of basalt fibers as an alternative to glass fibres’asreinforcement in polymer composites. In particular, flexural modulus an inter laminar properties are promising, while dielectric behaviour in the frequency range 10 kHz–1 MHz is almost identical. Areas of concern would regard the presence of a premature failurein compression, which does not allow exploiting the material to its full potential. In this regard, the low fiber volume fraction, themedium strength of the interface and the type of flexural test (three-point) could have played an important role. This could beassessed by applying different stress distribution, e.g. performing four-point bending tests and using higher fibre contents. These represent on going issues. The growth of industrial applications of these laminates would benefit from the investigation and use of both optimized sizing and manufacturing process of fabrics along with the proper choice of the most suitable mix of basalt rocks.

The effect of basalt fibre production technology on the mechanical properties of fibre (strength, electricity modulus, and ultimate deformation) is considered depending on the geometrical parameters of monofilaments. The service properties and stability of products made of basalt fibre are determined not only by the chemical composition of the initial material, but also by filament production technology. The studies were performed on basalt mono filaments produced in gas furnaces from melts: roving 9.5–10.5m in diameter produced by the continuous (spinneret) method; filaments up to 13m in diameter produced by the spinneret method with subsequent air blowing at normal temperature (duplex process).

To study the specific mechanical properties of the filaments produced by the continuous methods, three types of weakly twisted fibre (roving) were tested. Thus, by means of extending the duration of basalt melting in order to fully complete the processes of verification, degassing, and homogenization, it is possible not only to diminish the spread in the elastic-strength properties of discrete filaments, but also to raise their average level to the level of strength properties in continuous filaments. The use of hot air in blowing probably decreases the internal residual stresses and stabilizes the structure of fibres, which can contribute to increasing their strength and decreasing the spread in their physic mechanical properties. In this case it is possible to increase the elasticity modulus of a discrete filament to the level typical of continuous basalt fibres (90GPa), since the obtained preliminary results demonstrated that the existent differences in elastic properties of discrete and continuous fibres' are slight and statistically insignificant.

## III. EXPERIMENTAL STUDY

The existing aluminum fan blade is studied to read its various design aspects such as length, thickness, width, aero dynamic design, etc. The difficulties while manufacturing as the pressure, surroundings is determined by making a few specimens of the blade. Epoxy resin (LY556), hardener (HY951), cotton cloth fiber is bought from sivam traders, Rasipuram.

### *A. Raw Materials*

Epoxy resin and Cotton cloth fiber is used. Hardener is mixed with the resin to provide high viscous solution. The raw materials employed here are mixed in a definite ratio, considering the design and strength aspects of the composite fan blade. Also wax is applied in the mould to make the mould free from sticking onto the composite layer formed by this process.

### *B. Design of Composite Fan Blade*

The design of the existing aluminum fan blade is taken as the design for the new composite fan blade. The aero dynamic design and other design parameters are taken same as the existing one.

### *C. Fabrication of Composite Blade*

The number layers of fiber required is first determined by finding the thickness of the fiber which is found to be 1mm. Allowances are provided to the mould trimmed to the required accurate size. The fibers are cut to the required size. In the hand layup technique, first wax is applied over the mould. The thickness required for the composite blade is built by applying a series of fiber glass layers and liquid resin layers. A roller is used to squeeze the excess resin and create uniform distribution of the resin throughout the fiber surfaces. Homogeneous wetting of the fiber is obtained by the Raw materials Grade LY556 HY951 cotton cloth fiber. Existing fan blade is used as the mould. In this process, since temperatures with less pressure, it is easier to fabricate. Liquid resin is applied to the mould and then the glass fiber is placed on the top.

A roller is used to with the resin. Until suitable thickness for cement layer is applied. It allows the user to optimize the part by placing different types of fabric and mat materials. Since the reinforcement layer is placed manually, it is known as hand layup process. It is labour intensive but requires only a less capital. layup technique The number layers of fiber required is first determined by finding the thickness of the fiber which is found to be 1mm. Allowances are provided to the mould so that they could be trimmed to the required accurate size. The fibers are cut to the first wax is applied over the he thickness required for the composite blade is built glass layers and liquid resin A roller is used to squeeze the excess resin and create uniform distribution of the resin throughout the fiber surfaces. Homogeneous wetting of the fiber is obtained by the squeezing action of the roller. The part is then cooled at room temperature and a little pressure and once it is solidified, it is removed from the mould.

### *D. Weight Comparison*

The weight of the existing fan blade and the composite fan blade were determined using an electronic weighing machine. The weights of the blades were tested individually a mean values of the three blades are considered for the weight comparison.

*1) Aluminium Blade:*

Weight of aluminium blade (1 unit) = 245gm Weight of aluminium blades (3×245) = 735gm

*2) Composite Blade:*

Weight of composite blade (1 unit) = 186 gm Total weight of composite blades (3×189) = 567gm Percentage saving in weight Reduction = 56gm.saving in weight = 22.8 %

From the weight determined in both the cases, it is clear that the replacement of aluminum blade by composite blade has reduced 24% of weight.

### *E. Existing Blade Specifications;*

Manufacturer: Crompton greaves
Model: Popular AL series
Rated power: 70 watts
Rated speed: 800 rpm
Minimum air delivery: 330 $m^3$/min
Existing blade weight (three blades): 0.735 Kg
Material: Aluminium
Density of aluminum: 2.7 gm/cc.

## IV. PROBLEM IDENTIFICATION

Based on the literature presented in the previous chapter; It is found that some research are carried out synthetic fiber on basalt fiber, they found out only mechanical properties of fiber. There is a lot of scope to characterize the mechanical behavior of chopped basalt fiber composites. So it is decided to carry out research if the above topic and analyze the following mechanical properties like.

- Tensile Test
- Bending Test

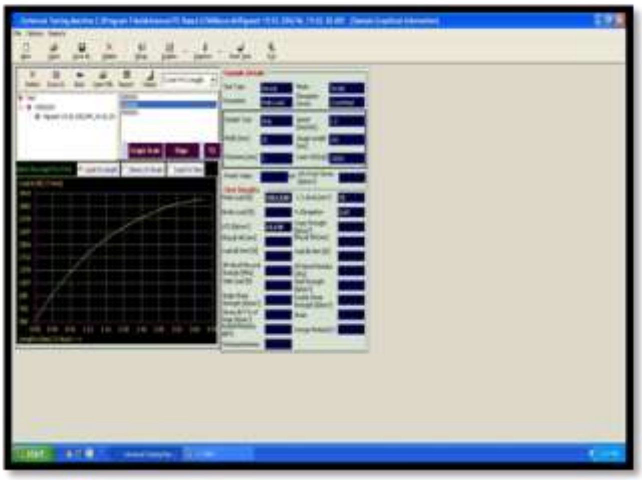

## V. CALCULATIONS

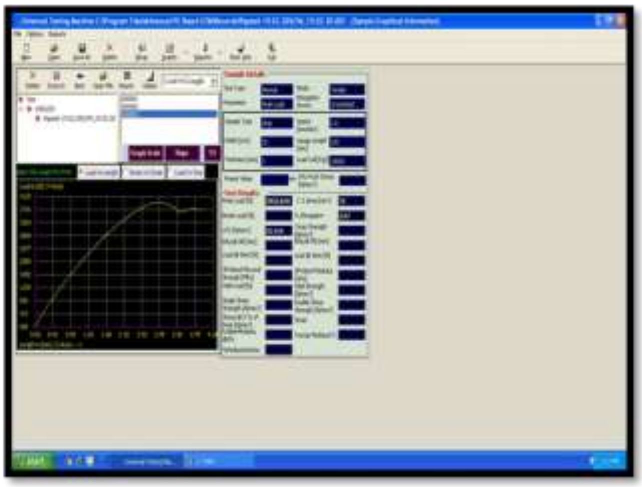
%Weight reduction = (Weight of Steel Blade – Weight of Composite Blade)/Weight of Steel Blade

= (0.735-0.567)/0.735

=0.228

=22.8%.





## VI. CONCLUSION

Design, fabrication and testing of existing and composite fan blade (using cotton cloth fiber material) are completed and also composite blade is tested and compared with existing blade. In this project the composite blade has been designed and fabricated. This composite blade has more strength over existing fan blade. The existing fan blade weighs about 245grams whereas the weight of composite fan blade is 189grams, which is 22.8% lesser than existing blade. It is tested that the power consumed by the existing blade (0.052units) is more when compared to composite blade (0.037units). So when we use composite fan means we can reduce 30% of power consumed by the existing ceiling fan. Cost of composite ceiling fan blade is Rs. 279/- which is 44% less than existing aluminium blade. The strength of the composite blade also high when we compared with aluminium blade. From the study, it is concluded that the cotton cloth fiber material is a suitable material for manufacturing the composite ceiling fan blade.

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