# Modeling and Analysis of Automobile Door Panel Using Natural Fibre Composites

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***Abstract:—***The production of synthetic fibre depends mainly on fossil fuels and needs nearly ten times more energy as compared to natural fibre. As a result the pollutant gas emissions to the environment from synthetic fibre production are significantly higher than that from natural fibre production. Also the fibres produced are not biodegradable, which makes the disposal difficult.
This paperis focussed on the design and structural analysis of the car door internal panel by replacing polypropylene with banana and mango fibre reinforced composite. Structural analysis is done with different load and the result is studied. Final analysis results of natural fibre are compared with synthetic fibres and found natural fibres are better option than synthetic fibres. The car door internal panel and dashboard are done using modelling software CATIA V5R20 and analysed using Ansys workbench.

***IndexTerms*–Naturalfibre reinforced composites, modelling in the software CATIA V5R20, meshing and analysis in ansys workbench, results comparison, car interior panel, banana fibre.**

## I. INTRODUCTION

### 1.1 Composites-

A composite material is one that is made from two or more constituent materials with significantly different physical or chemical properties, which when combined at a microscopic level produce a material with characteristics different from the individual components.Natural fibres- Fibres can be described as hair-like materials that are continuous filaments or discrete elongated pieces in nature. Natural fibres are those that are obtained from vegetables, animals, or minerals in the form of hair-like materials, most of which can be spun into filaments, thread, or rope. They are mostly used as reinforcements in composites. Natural fibres obtained from vegetables contain cellulose and a polymer of glucose bound to lignin with varying amounts of other natural materials in it.[2]

### 1.2 Natural fibres-

Natural fibres areproduced by plants, animals, and geological processes. They can be used as components for composite materials, where the orientation of fibres impacts the properties of elements. Natural fibres can also be matted into sheets to make products such as paper, felt or fabric. Natural fibres are basically classified on the basis of origin of source, into three types

- PlantFibres
- MineralFibres
- Animal Fibres

**1.2.1 Plant Fibres:**Plant fibres mainly consist of cellulose like cotton, jute, bamboo, flax, ramie, hemp, coir and sisal. Cellulose fibres have a wide range of applications.

Bananafibre- Natural fibres show many advantages such as low density, low cost, environmental friendly, bio-degradable and high specific mechanical performance. Banana is available in most part of India, and banana fibre availability is more. The chemical composition of banana fibre is cellulose, hemicellulose, and lignin. It is a highly strong fibre. It is light weight. The hydrogen bonds and other linkages provide the necessary strength and stiffness to the fibres. The density of banana fibre is 1300 kg/m3, tensile strength is around 355 MPa, young's modulus is 33.8GPa and elongation at break is 5.3%. It has a strong moisture absorption quality; it absorbs as well as release moisture very fast. The fibres can be extracted when required. Utilization of banana stem fibre not only benefit the environment, but it will also reduce the overall resource consumption while sustaining national economic growth and introduction of green technology in automobiles. The banana fibre is obtained from the stem of a banana tree. After banana is taken from the tree the whole tree is of waste especially the stem which is the major part of the tree. The stem of the banana tree is in the form of layers. The strength of the fibre varies according to the layer position, as the layers goes towards the centre the strength starts to decrease. Hence, the outer layer has more strength compared to the inner layer. The outer layers are dried for few weeks to take out the moisture present in the stem layers. The dried fibres are twisted for removal of more moisture as well as to reduce the size of the fibre. The thickness of the twisted fibre obtained will be around 1.8mm to 2.1 mm, this fibre is made into a yarn. The fibre yarn is then woven to make sheets.

The banana sheets are used for the project because of all the above mentioned properties.

Mango fibres- Mango is an abundantly available fruit consumed by people in several parts of world Mango fibre is also another natural fibre which has a better strength, environmental friendly, and also is bio-degradable. Mango fibre is extracted out of mango endocarp (mango seeds) after drying the seeds in sunlight for 2-3 days to remove the water content and then they are powered for use as filler. Mango seeds play a major role for the material strength. The major properties that mango seed composites have are high strength to weight ratio, less weight, low economic cost and on top of that it is a waste product. Once the mango is consumed the seeds are thrown to waste. These waste seeds can be used for manufacturing of composite materials. It can be used as particles or can be powdered and mixed with the binders. Mango seed powder can be used as a filler in manufacturing natural fibre composites.[1]

## II. LITERATURE REVIEW

This section of the paper provides the brief background about natural fibres .

Bharath Raj et.al. Carried out experiment on natural fibre reinforced composites using banana and mango in epoxy resin.The experiment yielded good mechanical properties of banana fibre with mango particulates. We used these results in our work. [1]

C.Lakshman et.al. have carried out a research on "Mechanical Performance and Analysis of Banana Fibre Reinforced Epoxy Composites"- A composite is made up of at least two elements out of which one is the binding material, also called matrix and the other is the reinforcement material.[3]

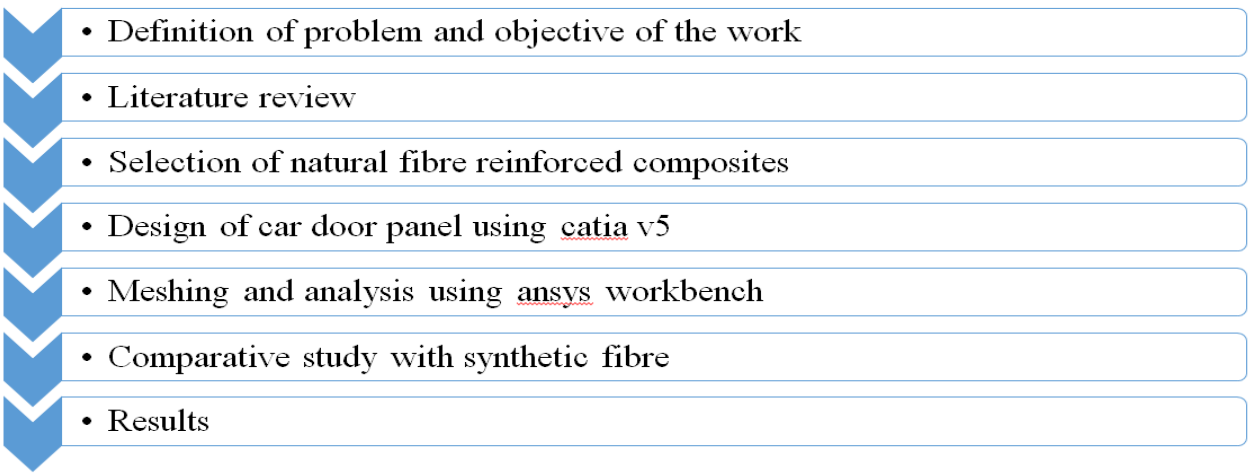
M. Raghuveer et.al. have carried out an experiment on "Design and impact analysis of a car door". According to the study The side impact door should have the ability to absorb as much deformational energy as possible without breaking. Steel is still the most widely used material for beam members, but the steel increases the total weight of the car.[3]

Eskezia E et.al. experimented on "Finite Element Analysis of Internal Door Panel of a Car by Considering Bamboo fibre Reinforced Epoxy Composite"- The internal door panel of an automobile contributes to the overall functionality and ergonomics of the ride, such as: armrests, various switches, lights, electronic systems like the window controls and locking mechanism. Composite materials made of natural fibres and polymer matrix provides synergistic properties, improving their strength and durability.[2]

## III. METHODOLOGY

The production of synthetic fibre depends mainly on fossil fuels and needs nearly ten times more energy as compared to natural fibre. As a result the pollutant gas emissions to the environment from synthetic fibre production are significantly higher than that from natural fibre production. Also the polymers produced are not biodegradable, which makes the disposal difficult. Hence the focus is shifting towards natural fibre composites. The following methodology is followed:

**Chart 3.1:** Methodology chart



**IV. Design using catia v5**

Door panel drawing-

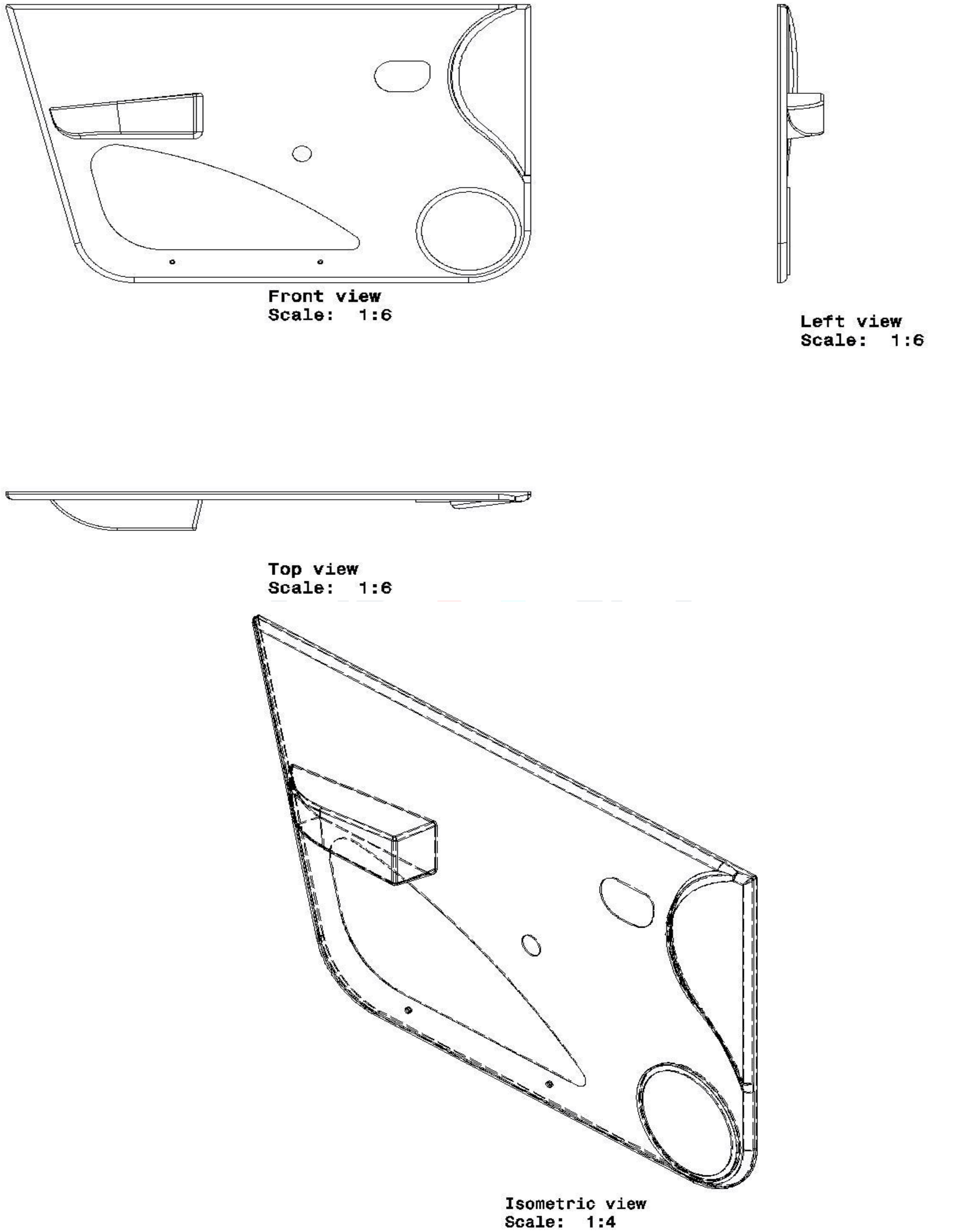



**Fig 4.1**: Projected views of door panel

## V. MESHING AND ANALYSIS

Meshing and analysis of the above designs was done using ansys workbench 16.0. Number of plies was 4 with orientation of 0°, 45°, -45°, 0°. Number of elements in the mesh is 11364 for each layer.

Boundary conditions-

The internal door panel has several areas where constraints are applied as follows:

- Upper part resting on the metal frame structure blocking the movement on y-direction ($U_2$).
- In screw mounted areas movement is blocked on all three directions ($U_1$, $U_2$, and $U_3$).

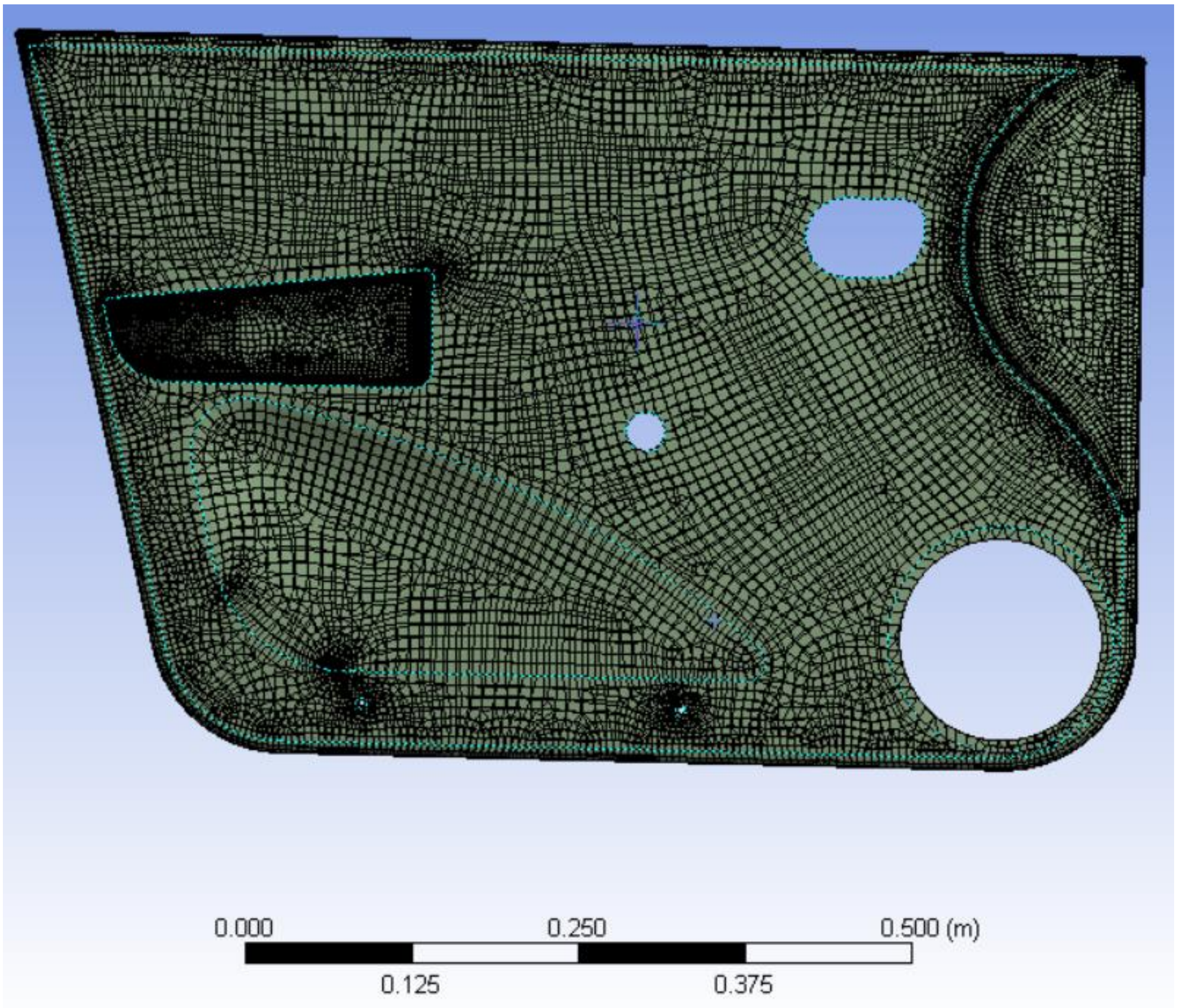



**Fig 5.1**: Meshing of door panel

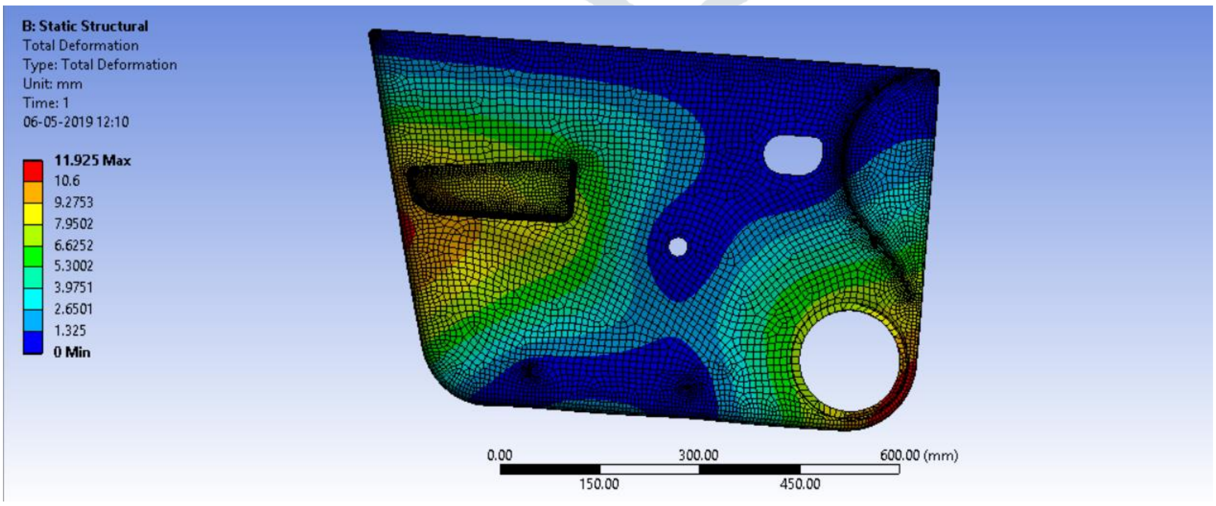



**Fig 5.2**: Analysis of banana fibre reinforced composite door panel

## VI. RESULTS AND DISCUSSION

**Table 6.1:** Properties comparison of polypropylene and banana fibre compositefrom experimental results

| Properties | Polypropylene | Banana fibre composite |
|---|---|---|
| Tensile strength(Mpa) | 740 | 914 |
| Young's modulus(Mpa) | 1100 | 669.2 |
| Poisson's ratio | 0.42 | 0.38 |
| Density(kg/m$^3$) | 904 | 950 |
| Hardness number | 65 | 62 |

**Table 6.2:**Resultsobtained from Ansys

| | EQUIVALENT STRESS(MPa) | DISPLACEMENT(mm) | WEIGHT(Kg) |
|---|---|---|---|
| Polypropylene | 44.13 | 4.8 | 1.45 |
| Banana fibre composite | 17.41 | 11.925 | 0.8706 |

## VII. CONCLUSION

In conclusion, banana fibre with mango particulates shows mechanical properties close to polypropylene and can replace it. By changing the orientation and number of plies we can obtain better results. The resin used in this work is epoxy which can be replaced with natural resins to make it completely bio degradable. The weight of the interior panel was reduced by 39.98 % hence the vehicle weight reduces and efficiency increases.

## REFERENCES

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