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Design and analysis of plate made by composite material for thermal applications using Ansys

Raj Mishra, Er. Kriti Srivastava, Dr. Nitesh Kumar Dixit,
[1]Student, Assistant Professor, Assistant Professor
[1,2,3] Dept. of Mechanical Engineering
[1,2,3] Institute of Engineering and Technology,
Dr. Rammanohar Lohiya Avadh University, Ayodhya 224001

Abstract:The areas covered in this study are linked to the manufacturing and evaluation of composite plates. The first phase of the project comprises research of composite plates as well as an evaluation of the effect of plate activities on the environment. The second section goes into further depth on the research methodologies used, as well as the influence of the composite plate's thermal assessment on the reduction of heat losses in the building. The fundamental objective of this thesis is to provide an overview of the assessment of a composite laminate plate that has been subjected to thermal inquiry. It was necessary to use a total of 5 layers of material in the composite plate of material, which included Epoxy Woven wet 230 UD, Epoxy glass fiber, and Epoxy resin.

Keywords–Composite plate, Thermal analysis, FEM, Ansys, Temperature drop.

I. Introduction

In composites, there are two kinds of material combinations: one that can be characterized as a refurbishment phase and the other that can be defined as a matrix stage and is included in the other product, which is referred to as the matrix stage, in the form of fibre sheets or pellets. Composites are divided into two stages: the refurbishment stage and the matrix step. Most significantly, the matrix is responsible for transmitting stress between reinforcing fibers and protecting them from mechanical and/or environmental deterioration, whilst the fibers/particles are used to improve mechanical qualities such as strength and stiffness by being included in a composite. The scientific community defines a synergistic combination as any combination of two or more microscopic components that are physically and chemically distinct from one another yet are intra-soluble in one another, as opposed to any other combination. The objective is to make full use of all of a product's best attributes while being entirely unfettered by the limitations of the material used.

Composite technologies have increasingly supplanted plastic components in both lightweight and high-strength constructions, as seen by their increasing use in aerospace and defense applications. The use of composites in these applications is primarily motivated by the need for high strength and tensile strength at high temperatures, as well as high breaking strength and strength. In general, the reinforcing components of a low-density system are stiff, but the framework is frequently ductile or weak in character, according to the definition. Due to the interaction between frame strength and matrix strength when a composite is properly designed and built, it achieves a unique set of qualities that no other conventional material can match. Among the most essential things to consider when it comes to strength are the kind of fiber and/or quantity of fiber used, as well as the output and type of resin used.

II. polymer composite matrix

Matrix tissues are the polymers that are most often employed in medical applications because of their strength and flexibility. Due to a combination of two factors, this has occurred. Although polymers have a variety of structural uses, their mechanical properties are often insufficient when compared to the high strength and stiffness of metals and ceramics, respectively. In order to address these issues, it may be necessary to strengthen additional polymer materials. Polymer matrix composites may not be necessary to be subjected to high pressures or temperatures if this is determined to be the case. Composites are also a viable choice for equipment that contains a silicone matrix as a structural component. Therefore, the research and growth of polymer composite materials for structural applications has seen considerable surge in recent years. As a result of the fact that composites have better aggregate characteristics than polymers, polymer mixes are employed in the manufacture of these materials. Elastic modules are substantially larger in size than sterile polymers, and they are also significantly less brittle than ceramics. Composite polymers are often divided into two categories depending on the presence of a reinforcing element in the polymer matrix. (Figure 1.1).

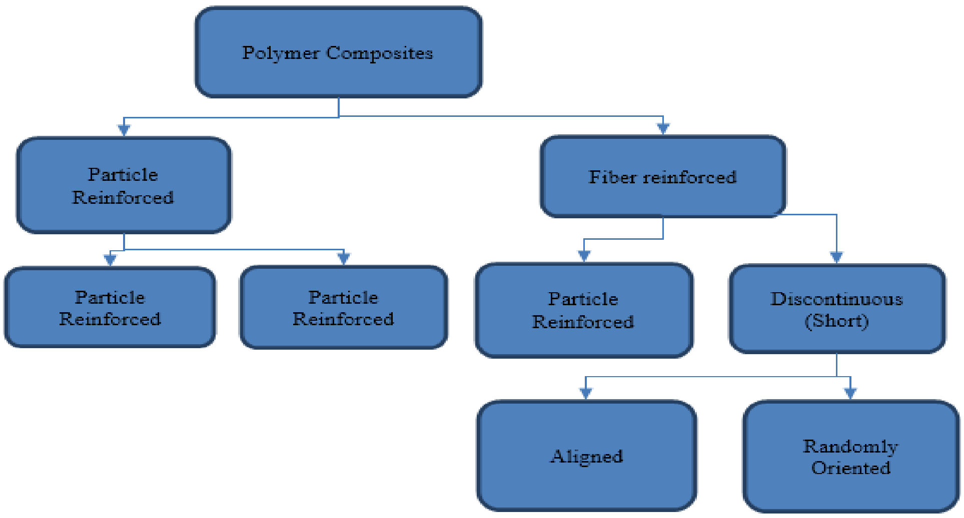

Figure 1: Composite classification depending on the form of reinforcement

III. ANALYSIS OF COMPOSITE PLATEBY FINITE ELEMENT ANALYSIS (FEA)

The Finite Element Technique, which is used to simplify a differential or integral condition, is an example of a numerical approach. It's been connected to a range of physical issues, even those in which the relevant differential conditions are easily accessible. The anticipation of piecewise consistent capacity for the arrangement, as well as the acquisition of the capabilities' characteristics in a way that lowers arrangement error, are essential to the method. A wide range of physical occurrences in building and research may be expressed in terms of partially differential situations. Because these situations are so complicated, it's practically impossible to reduce them using traditional logical approaches for self-assertive forms. The finite element method (FEM) is a computational methodology for approximating partial differential equation solutions (PDE). The FEM employs a capacity/premises-based method to deal with the PDE. Fundamental equations (FE) are frequently utilized to solve static and dynamic issues in a variety of fields, including solid and liquid mechanics, electromagnetics, biomechanics, and so on. The Finite Element Technique (FEM) is a discrete component approach that uses discrete components to provide an estimated arrangement of the governing differential condition. The discrete component conditions are used to create the final condition of the FEM framework. The ability to isolate the framework condition into constrained components and apply component conditions in such a manner that the combined components resemble the original system is a key premise of FEM.

IV. DESIGN AND ANALYSIS OF COMPOSITE PLATE

Epoxy Woven wet 230 UD, Epoxy glass fibre, and Epoxy resin were used to make composite plate models. The materials used to make the four layers of the wall sample are listed below. Each of the four pieces has a different material makeup. FEA stands for finite element analysis in practice, and it is best understood while dealing with real-world situations. FEA is widely used in the automobile sector. It's a common tool for configuring builds in the product development process. Understanding the principles of FEA and design methodologies, as well as exhibiting systems, inherent faults, and their influence on the nature of the outputs, is crucial to making FEA a useful design tool. FEA as a computer approach is also used in engineering problem analyses.

a. Modeling of composite Model

By integrating three kinds of composite materials with various material compositions, Ansys designed a composite plate sample with the goal of minimizing heat losses. The block's length and breadth are both 24 cm. The top and bottom levels are each 8 cm thick, while the center layer is 4 cm thick. The Ansys design of a composite plate sample is shown in Figure 1.

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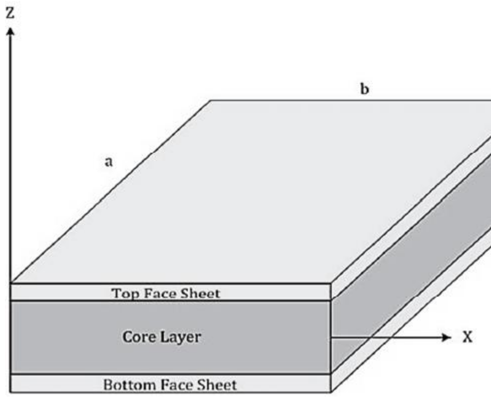

Figure 2: Model of composite plate

a. Applying boundary conditions

After developing a composite plate model with four layers, the applied air convection temperature is 22 degrees Celsius, and the lowest layer is chosen for testing maximum or minimum heat transfer and thermal stresses at 200 degrees Celsius.

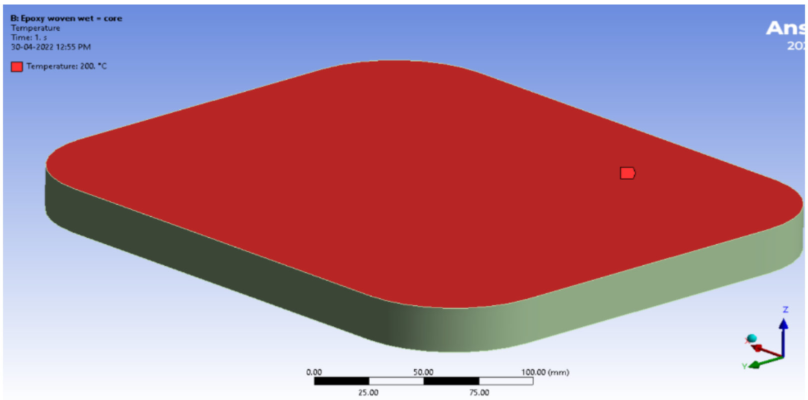

Figure 3: Applying Boundary conditions of Composite plate

V. RESEARCH METHODOLOGY

The methodology section describes the study's overall strategy and approach. This covers the research's universe, sample, data and data sources, study variables, and analytical methodology. The following are the specifics;

Process for designing Thermal test analysis in Ansys ACP

Performed impact analysis of composite material plate for study while selecting 3 types of material for composition of plate and 0^0, 45^0 stack angles selected.

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VI. RESULTS AND DISCUSSION

A thermal study of a composite material plate is carried out. Epoxy materials were utilised, along with epoxy carbon weave wet, epoxy resin, and epoxy fibre glass materials, and a 3D model was created in Ansys for simulation study of composite material plates for heat examination. This research was carried out to look at the failure of composite plates.

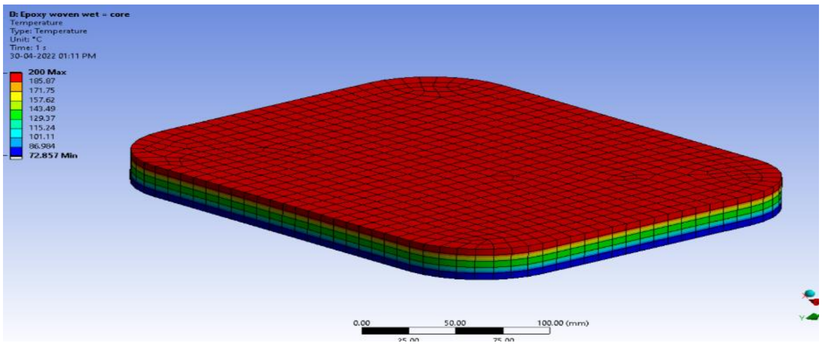

Figure: Temperature on Epoxy woven wet material composite plate

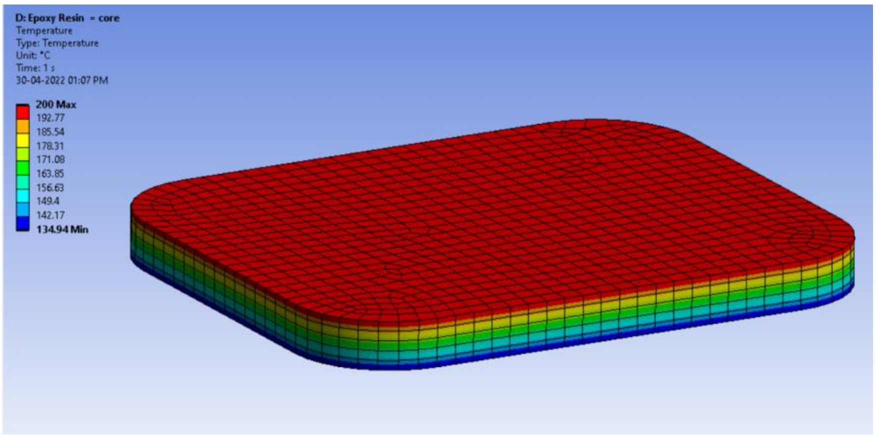

Figure: Temperature on Epoxy Resin material composite plate

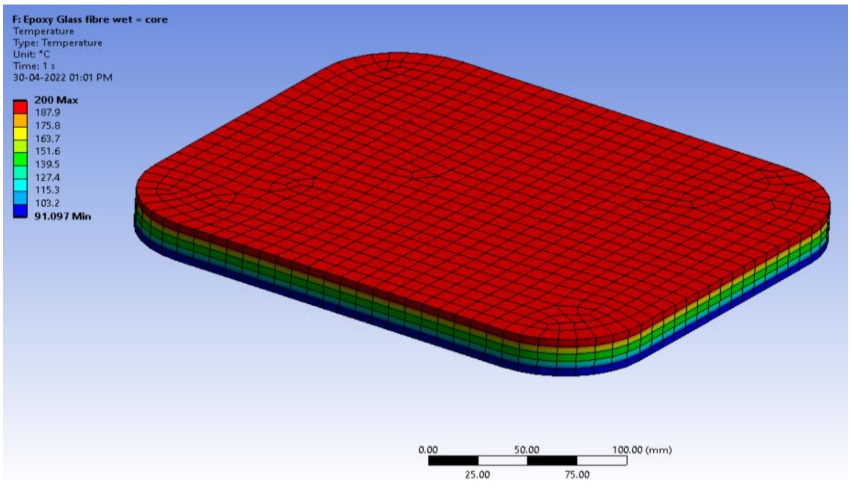

Figure: Temperature on Epoxy Glass fibre material composite plate

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Table 5.2: Output of thermal analysis of composite plate

Output Parameters	**Epoxy carbon woven wet**	**Epoxy Resin**	**Epoxy Fiber Glass**
Temperature Drop	72.85	134.94	91.09
Total heat flux(w/mm2)	0.0002543	0.0005647	0.0003455

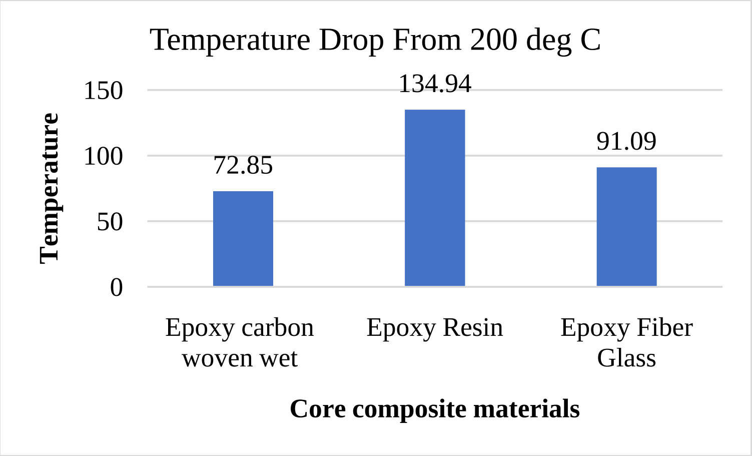

Figure 4: Temperature drop on Composite plate

As shown in Figure 4, the Epoxy carbon woven wet material had the lowest temperature or temperature decrease. We may claim that we have superior outcomes in composite plates with Epoxy Resin in terms of minimizing heat loss since the maximum temperature found on the outer layer in Epoxy resin material.

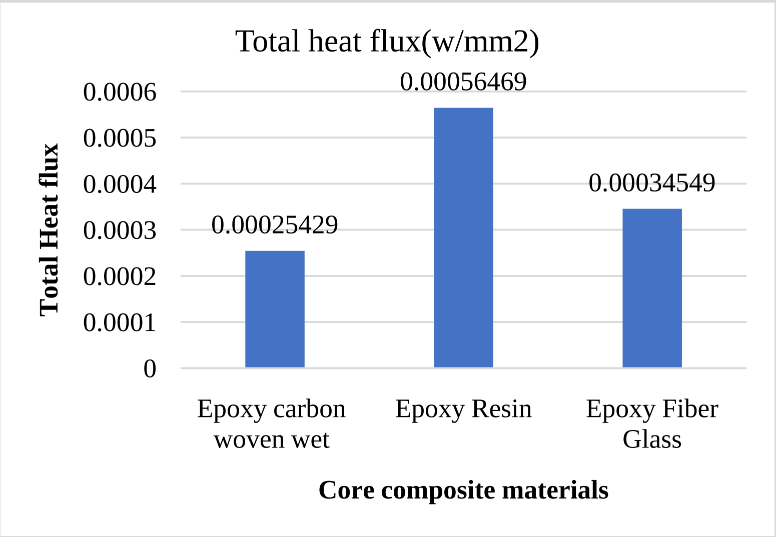

Figure 5: Total Heat Flux of Composite plate

As shown in Figure 5, the maximum total heat flux was found on the Epoxy resin composition of the plate, while the minimum total heat flux was found on the Epoxy carbon woven wet, indicating that the minimum heat flux indicates the least amount of heat loss, implying that Epoxy woven wet performs better against heat loss in composite plates.

VII. CONCLUSION

Our goal is to get a better understanding of internal and exterior thermal behaviour by identifying the thermal conductivity characteristics of composite constructions.
The findings presented in this chapter are based on data acquired via simulated study of composite plates.
We utilised 5 layers in the design of the composite plate, using one material and a second core material. After designing a composite plate in the ACP module, link it to an explicit dynamic for impact analysis to investigate plate behaviour.s

- In the design of composite plate using both upper layer of Epoxy Woven wet material having maximum temperature applied on top side 200 degree celsius then other side temperature found 72.85 0C. which is lower than the 200 0C
- In the design of a composite plate employing both upper layers of Epoxy Resin material with a maximum temperature of 200 degrees Celsius on the top side, the temperature on the other side was discovered to be 134.94 degrees Celsius, which is lower than the 200 degrees Celsius.
- The highest temperature applied on the top side of the composite plate was 200 degrees Celsius, whereas the temperature on the other side was 91.09 degrees Celsius, which is lower than the 200 degrees Celsius.
- Using thermal research, we discovered that the Epoxy carbon woven wet material has a minimum temperature or temperature decrease. We may claim that we have superior outcomes in composite plates with Epoxy Resin in terms of heat loss reduction since the maximum temperature was observed on the outer layer in Epoxy resin material.
- In stress analysis, the highest total heat flux was observed on the Epoxy resin composition of the plate, followed by the lowest total heat flux on the Epoxy carbon woven wet plate.

VIII. FUTURE WORKS

- To explain the confusion caused by the impacts of bi-axial glass fibre composites, researchers evaluated the behaviour of uni-directional glass fibre composites in three-dimensional thermal conductivity.

- Setting up thermal conductivity over the whole temperature range of a room Temperature at maximum operating temperature.

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