MODAL ANALYSIS OF ELECTRICAL MOTOR CASING

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Abstract. Getting analytical and mathematical solutions for issues involving difficult geometries, loading and material properties, it is usually unacceptable. Analytical solutions that are given by a location in a body. This analytical solution usually needs standard or partial differential equations that are not obtained. Hence there is the need to rely on numerical strategies, like finite component strategies for acceptable solutions. Most sensible issues involve sophisticated domains (both material and material constitution), hundreds and non-linearities that forbid the event of analytical solutions exploitation numerical strategies. A numerical method, with the arrival of computer, is often used for the investigation and analysis of the results of varied parameters of the system on analyzed. It is price effective and saves time and material resources compared to the multitude of physical experiments required to realize a similar level of understanding. The ability of numerical strategies and electronic computation, make incorporation of all relevant options during a mathematical model of a physical method not attainable without fear concerning its solutions by precise means. Those who are fast to use a computer program rather than think about the problem to be analyzed may find it difficult to interpret the input file to the computer program, a decent understanding of the underlying theory of the matter still as numerical methodology is needed.

Key Words: Electrical motor casing, FEA, Model Analysis, Modeling, Ansys

1. Introduction

ANSYS is a general purpose finite element modeling package for numerical determination of a large sort of mechanical problems which issues include: static/dynamic structural analysis (both linear and non-linear), heat transfer and fluid problems, moreover as acoustic and electro-magnetic problems. ANSYS is general finite element analysis (FEA) software package [13]. Finite element analysis may be a numerical method for deconstructing a complex system into terribly tiny items (of user-designated size) called as elements. The software package implements equations that govern the behaviour of those parts and solves all, making a comprehensive clarification of the action of the system acts as a full. These results then are given in tabulated or graphical forms. This type of study is generally used for the planning and optimization of a system too advanced to for investigation by hand [11,16]. Systems that will work into this class are too advanced because of their pure mathematics, scale, or governing equations. ANSYS has the customary FEA teaching tool inside the engineering and science colleges. ANSYS provides economical methods to explore the performance of products or processes in very virtual surroundings [22]. This kind of development is termed virtual prototyping. With virtual prototyping techniques, users reiterate varied situations for optimizing the product long before
production is started. This permits a discount within the level of risk, and within the price of ineffective styles.

The varied nature of ANSYS provides a method to confirm that users are ready to see the impact of a style on the total behavior of a product, be it electromagnetic, thermal, and mechanical, etc. In general, a finite element solution is also broken into the subsequent three stages [17-19]. This can be a general guideline that may be used for fitting any finite element analysis. investigated the results of flexural and compressive properties of kenaf combined with silicon dioxide nano particles in epoxy composites. The filler material utilized in this work was silicon dioxide Nano particles were used for boosting the standard of kenaf reinforced composite. The composites were using the vacuum infusion method within which kenaf mats were set in. The silicon dioxide nano particles square measure was distributed into epoxy glue employing a homogenizer at 3000 rpm for 10 minutes before being infused into fibres. A big mechanical property with the inclusion of silicon dioxide nano particles was seen. Composites with 2% vol. silica recorded worth of 43.8 MPa and 3.05 GPa for flexural strength and flexural modulus and 40 MPa and 1.15 GPa for compressive strength and compressive modulus severally. studied the kenaf matrix composites reinforced with natural fibres and their mechanical properties. Here, the geo polymer composite was based on fly ash and reinforced with short natural fibres such as coconut, sisal, raffia and cotton. They concluded that the composite with coconut, sisal had mechanical properties but a composite with raffia had only poor properties. SEM images, showed the natural polymers as less coherent than the artificial ones. It is the best alternative for Portland cement[2]investigate the reasons that explained the use of flax and hemp as the designer’s first choice. They found higher specific stiffness than glass fibre composites in tension and plate bending, higher vibration damping capacity in those composites. They examined the technical aspects such as mechanical properties and non-technical aspects such as feel, touch, colour and texture of the fibres and their influence on the daily purposes and the designer’s choice of selecting these fibres. conducted experiments to understand the tribological characteristics of oil palm and kenaf fibre with epoxy glue as medium and comparisons. Pin on disk check was administered to see the wear behavior. A pin with sample of diameter 10 mm was out through with an appropriate machining method. A dry sliding check was performed using the pin on disc tribometer. Check parameters like weight proportion of fibre, load, sliding speed and temperature range were taken as operational parameters. The result showed the rise in temperature resulted in slashed coefficient of friction and magnified wear rate for each of the composite. The wear rates for each of the fibres exhibited a higher performance through increase in the fibre composition. SEM was done and therefore the result showed the composites having blow holes, small cracks, fibre retreat and a few regions deboning were discovered. administered various mechanical tests in various natural fibres and found that the hybrid composites had better mechanical properties and alternate material for various automobile and defense applications was also seen. investigated the impact of kenaf with different yarn sizes and their mechanical properties. The kenaf fibre was fancied via pultrusion process. Mechanical tests like tensile, compression and flexural were administered and comparisons were made with different forms of kenaf yarn tex. Pultruded composites showed better mechanical properties created with smaller tex range in comparison to a large tex range, attributable to it, that helped providing higher wetting of fibre throughout production of composites and consequently helped extension of its properties. SEM analysis was done and therefore the result showed poor wetting of kenaf fibre recorded lower properties of kenaf yarn larger tex range than the smaller tex range. investigated the low velocity impact properties of flax composites which showed the longevity and safety of the composites. Two composite matrix flax-epoxy and flax-MAPP were tested and compared. The energy absorbed by the flax-MAPP was seen as 50% higher than the flax-epoxy. The flax-epoxy resulted in a palpable decrease in properties after impact. Also the use of ductile thermoplastic matrix results in decreased impact area. fabricated natural fibre and aluminium sheet hybrid composites. The composites were fabricated using the vacuum assisted resin transfer molding (VARTM) process. This hybrid composite had a high electromagnetic shielding. The introduction of aluminium sheets had no effect on the mechanical properties of the hybrid composites. The results obtained from the internal bond tests showed the interfacial bonds as
investigated the effect of mechanical properties on hemp fibres and unidirectional fibre/epoxy composites. These effects were studied when the hemp fibres were oxidized of lignin by laccase. The oxidized fibres were taken for a study of mechanical properties such as tensile stress, thermal resistance, etc. From the results, they concluded that there was an increase in tensile stress, stiffness and thermal resistance of the laccase treated fibres. There was no cross linking by laccase seen. This increase in properties was due to the catalyzed polymerization of lignin in hemp fibres. investigated the geometric optimization and compression design of natural fibre composite structural channel sections. It was carried out by the inclusion of geometric stiffeners which restricted the development of local buckling, creating less slender channel sections with greater compression strength. Compression strengths were compared with steel and timber wall stud strengths. They concluded that the developed composite was suitable for residential building applications. The combined plain channel and stiffened channel experimental data covers a broad range of section slenderness values.

2. Modeling

Throughout the history of our industrial society, many innovations are seen proprietary and whole new technologies have evolved. May be the only development that has compact production of a lot of quickly and considerably than any previous technology is that the information processing system. Computers are being employed more and more for each style with particularization of engineering elements within the drawing workplace. Computer Aided Design (CAD) is outlined because the application of computers and graphics package to assist or enhance the products design from conceptualization to documentation. CAD is most commonly associated with the use of an interactive computer graphics system, referred to as CAD system. CAD design systems are powerful tools and are within the mechanical design and geometric modeling of product and elements. There are many reasons for employing a CAD system to support the engineering style function:

- To increase the productivity and quality.
- To uniform design standards and have a manufacturing knowledge base.
- To reduce inaccuracies caused by hand-copying of drawings and variation between drawings.

Computer Aided Manufacturing (CAM) stands out due to the effective use of engineering in producing designing and management. CAM is most closely related to functions in production engineering, like methods and production designing, machining, scheduling, management, internal control, and Numerical Control (NC) part programming. CAD and CAM are usually combined CAD/CAM systems.

This arrangement permits the transfer of data from the planning stage into the stage of coming up with the manufacture of a product, without the requirement to reenter the data on part geometry manually. The info developed throughout CAD is stored; then it is processed any, by CAM into mandatory knowledge and directions for operative and dominant production machinery, material handling instrumentation, and automatic testing and review for product quality.

3. Modeling of Electrical Motor Casing

The modeling of the electrical motor is done in 3D and it is shown in figure 1.
4. Methodology

Methodology is the systematic, theoretical analysis of the ways applied to a field of study. It includes the theoretical analysis of the body of ways and principles related to a branch of information. Typically, it encompasses ideas like paradigm, theoretical model, phases and quantitative or qualitative techniques. A methodology does not take off to produce solutions - it is therefore, not constant as a technique. Instead, methodology offers the theoretical underpinning for understanding that method, set of ways, or supposed “best practices” may be applied to specific case, for instance, to shrewdly select a result. The methodology is that the general analysis strategy that outlines the means during which analysis is to be undertaken and among different things, identifies the ways to be employed in it. These ways, delineated within the methodology, outline the means that or modes of information assortment sometimes, however a selected result is to be calculated. Once correct to a study of methodology, such processes represent a constructive generic framework and will so be weakened into sub-processes, combined or their sequence modified.

5. FEA Analysis

In FEA analysis we can do many analyses for the fabricated composite material. Here the below mentioned three cases are done in FEA analysis.

5.1. Modal Analysis (To find the stiffness of the material)
   a) Case A - Hemp
   b) Case B - Flax
   c) Case C - Hemp + Flax
6. Boundary Condition

The boundary condition of fixed support, rotational velocity, displacement and fixed mass is shown in figure

![Figure 2. Boundary condition](image)

For Modal Analysis **motor housing base** is constrained as a **fixed support**, i.e., there is no translation movement in X, Y and Z directions. To replace rotor coil, a point mass load is added to the assembly. Rotor shaft Z - translation has been constrained.

Also no separation added (Face-Face) between contact faces. In this pair, one part is acting as contact body and other one is target body. Motor housing base is constrained as a fixed support, i.e., there is no translation movement in X, Y and Z directions. To replace rotor coil, a point mass load is added to the assembly. Rotor shaft Z - translation has been constrained by applying rotational velocity from 200 to 1200 rpm. Figure 3, 4, 5 and 6 shows the bonded contact for the electrical motor.

![Figure 3. End cover flange to motor housing](image)
7. Modal Analysis

Modal Analysis is mostly dispensed to seek out natural frequency of the system and completely different mode shapes at different Eigen values [12,14]. In this work, totally different modes and Eigen values square measure calculates and premeditated between mode shapes versus natural frequencies [15,20,
This shows the stiffness and rigidity of the material toward totally different modes. Using Modal analysis it can be captured the first 10 natural frequencies and related mode shape of each frequency for the 3 cases. Figure 7 shows the modal analysis results for case A. Each figure represents the frequency of each mode and displacement related to the frequency. Due to rotational velocity the model is exhibiting rotational vibration.

Figure 7. Modal analysis for 10 modes for case A
Table 1 shows the value of modal analysis for case A, B and C. According to this table Case C is having more natural frequency than other 2 cases.

| Modes | Case -A  | Case -B  | Case -C  |
|-------|----------|----------|----------|
| 1     | 30.959   | 45.103   | 49.496   |
| 2     | 55.867   | 79.428   | 86.464   |
| 3     | 242.63   | 306.88   | 327.84   |
| 4     | 261.22   | 330.73   | 351.68   |
| 5     | 369.71   | 496.33   | 515.18   |
| 6     | 606.56   | 747.08   | 753.8    |
| 7     | 672.56   | 751.02   | 791.26   |
| 8     | 728.32   | 907.61   | 911.07   |
| 9     | 754.32   | 910.27   | 931.84   |
| 10    | 880.19   | 986.57   | 1021     |

Figure 8 shows the relation between modes and damped frequency. Based on modal analysis results Case C (Hybrid Hemp - Flax fibre) has additional stiffness (due to high natural frequency) while compared to other two cases.

Conclusion

In this analysis, a study for three totally different composite materials particularly Hemp fibre, Flax fibre and Hybrid of Hemp and Flax fibre for Finite Element Analysis of electrical motor casing has been carried out. The motor casing should be rigid and better in stiffness to resist operative vibrations.

3D modelling of motor casing is built using Parametric Creo one among the fine 3D modelling software. These 3 materials are applied to motor casing as a material properties of the model and three types of analysis namely, Modal Analysis, Rotor Dynamics and Structural Transient Analysis carried out to check the stiffness, reliability towards operative frequency and durability of motor casing.

As determined from modal analysis Case C (Hybrid Hemp Flax fibre) has better stiffness compared to two different fibres as shown in graph fig 7 (Modes vs Damped Frequency).
Campbell diagram was premeditated between frequencies vs speed of the motor for predicting critical speed. The operative frequency and operative speed do not match with the critical speed and frequency.

Model analysis was performed for finding the vibrational stability of the composite materials and observation Case C shows low deflection and equivalent stresses compared to different fibres. Force vs deflection curve and stress vs strain curve are premeditated to indicate the stiffness of the materials and energy vs deflection curve premeditate show of the strain energy observed, when deformation happens. As determined from all above studies Case C has higher stiffness and strength compare from different two fibres.

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