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Design And Analysis Of Composite Propeller Blade For Aircraft

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Abstract: In this project, the work basically deals with the modelling and analysis of the propeller blade of an aircraft for its strength. A propeller blade is complex 3D model geometry. This requires high end modelling CAD software is used for generating the blade model in SOLID WORKS. This paper consists of brief details about Fiber Reinforced Plastic materials and the advantages of using composite propeller over the conventional metallic propeller blade.
This project focus on the metal and composite strength analysis of the propeller blade carried out by using the finite element analysis. By using ANSYS software static and fluent analysis were carried out for isotropic material , In this work two different types of propellers i.e., Aluminium, E-glass, and carbon fibre, were studied using FEA techniques.

Keywords: Lightweight Composite Design,3D CADModeling, Finite Element Analysis (FEA),Computational Fluid Dynamics (CFD),Stress Distribution Analysis, Solid works ,Catia V5,Aerodynamic Performance, ANSYS.

I. INTRODUCTION

1.1Because of the high cost of oil, there has been a recent emphasis on the need to design environmentally friendly aircraft with increased fuel efficiency. Three to five percent of global carbon dioxide emissions come from aircraft, and the aviation industry is the sector with the highest emissions overall. The amount of carbon oxide emitted into the high-altitude atmosphere is larger than the amount of oxide released by all of the world's vehicles combined. In order to enhance the rethink propeller fuel as rotating wing,

1.2WORKING OF AIRCRAFT PROPRLLER

A propeller is a device that transforms the rotational energy produced by a motor or any other mechanical device into a source of propulsion power. An aircraft's propellers are a necessary component since without them, it cannot fly.

1.3 A PROPELLER IS A WING WITH A TWIST

The propeller's wing-like cross-section design results in reduced air pressure on one side and increased air pressure on the other.

PROPELLERS AND PITCH

The angle that the wing forms with the oncoming air stream is known as the angle of attack. The angle a propeller blade makes with the rotational plane is known as its pitch angle. Its wing nearly always attacks at the same angle the whole length. However, because of the propeller blade's twist, the pitch and angle change as it goes. Propellers with adjustable pitch allow the entire blade to be altered while in flight, resulting in optimal performance at varying air speeds. It's like trying to flip a bicycle or car. Similar to how airplane propellers shoot airborne, boat propellers generate thrust in the water. Typically, the propeller blade requires the assistance of

II. LITERATURE REVIEW

2.1 LITERATURE SURVEY

Using a transition-sensitive turbulence modeling for CFD study, Wang et al. examined the performance of marine propellers. A 1% turbulence intensity was used for each of the research situations, and the advance ratio (J) ranged from 0.0 to 1.60. Large laminar and transition flow zones were discovered, thus the transition sensitive turbulence model was included in the investigation. By incorporating the transitional analysis, the analysis offers a way to reduce the difference between the CFD and the experimental data. In comparison to the conventional k-ω SST turbulence model, the study demonstrates that the outcomes increase propeller prediction accuracy.

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Benini conducted research on the methods that may be used to assess propeller blade performance, such as the completely three-dimensional numerical RANS computation and the combined momentum-blade element theory (CMBET). The Wageningen B3-50 propeller blade was examined numerically using the commercial CFD program FLUENT. The cylindrical area upstream and downstream of the propeller is designated as the flow domain. For the meshing, the flow domain has about 800,000 nodes. For the matching intake and outlet flow domains, velocity inlet and pressure-outlet were used, respectively. For the investigation, the inlet values varied, and the static relative pressure was 0. Throughout the investigation, the conventional k-ε turbulence model was utilized. The outcome demonstrates that the numerical approach, with 5% advance ratio, yields dependable findings.

Using ANSYS FLUENT with RANS, Seo et al. conducted a CFD study on a meshing approach to forecast the ship propeller's performance. The stationary and rotating regions comprise the two parts that define the flow domain for the analysis. The stationary region's flow domain is defined as 10D upstream and 27D downstream from the blade center, while the rotating section diameter is fixed at 20D. In the meantime, 0.28D is assigned upstream and downstream for the rotating zone, and 1.2D surrounds the propeller blade. displays the domain of flow. There are 1.43 million unstructured meshes in total, which are split up between 538,530 tetrahedron and 756,000 hexahedron cells. The inlet flow is adjusted using on the inlet border.

Through their harmonic analysis, Y.S. Rao and B.S. Reddy [2] demonstrate that composite propeller blades are safe in the event of resonance events. In the case of composite, vibration fault can also be controlled because of its greater dampening effect. They have used the Ansys software to compare the harmonic analysis of S2 Glass fabric/Epoxy and aluminum metal. Their findings indicate that the composite case's maximum displacement is 0.08192, significantly less than the 0.1784 of the aluminum propeller blade.

Inter laminar shear stress for composite materials with varying number of layers was observed by M.A. Khan et al. [3] and indicates strong bonding between the layers. Composite material has 80.5% higher natural frequency than aluminum propeller, according to Eigan value research. They demonstrated that the composite was made up of distinct layers in their static analysis.

Ganesh et al. [4] had done static and modal analysis for aluminium propeller and composite (carbon reinforced plastics) propeller. From their analysis it shows blade deflection in case composite propeller is very less compare to aluminium. Besides that they also observed the stress strain variation for the strength analysis.

Using the finite element method, K.B. Yeo et al.[5] made some predictions regarding the stress distribution surrounding a propeller blade. A hydrodynamic examination of stainless steel and wagenigen B Series 3 bladed propellers was conducted. Stress is created when rotational speed increases, and it crosses the 3000 rpm mark after that. N.V. Dashpande, K.M. Pandey, and Pritam Majumder Journal of Basic and Applied Engineering Research, Volume 3, Issue 3, January–March 2016, p-ISSN: 2350-0077; e-ISSN: 2350-0255 There is a 272 critical stress and failure probability.

A model for the CFD simulation-based measurement of hydrodynamic force and momentum was proposed by E.A. De Barros and J.L.D. Dantas [6]. The experimental data is compared with their projected value. While experimental results show a wake coefficient of 0.22, their calculated results indicate a wake coefficient of 0.36.

W.Y. San et al. [7] provided a numerical prediction for the underwater structure's propeller-excited acoustic response based on CFD, FEM, and BEM. By using a boundary condition in the Refined Integral Algorithm and pointing the CHIEF points normal toward the interior field, a unique solution was produced. Using QUAD8 as a boundary element, the global mesh refinement approach calculates the field point. Error refining has reached a maximum level of 10-4. The sphere RIA's BEM model is used to calculate the HIE integral. The open water characteristic of the 4381 propeller was studied using CFD, and the experimental and achieved results were compared. To obtain propeller variation of thrust and torque, a "sub marine + propeller" system was simulated using CFD. SST turbulence model created to monitor undersea boundary flow details.

The performance parameters of flexible propellers based on various fabrication methods were compared by B. G. Paik et al. [8]. Three cutter carbon/epoxy and glass/epoxy models were evaluated in MOERI's medium-sized cavitation tunnel. Because they lower the blade's pitch angle, the thrust generated by the blade and the advance ratio variation are what give the propeller its flexibility. The relationship between sound pressure and the generated thrust as determined by an acoustic noise measurement test. TiO2 is used as a tracer particle in a tailoring technique for efficient control. Particle image velocimetry (PIV) was used to observe the influence of blade flexibility on propeller wake.

A paddle-powered underwater hexapod robot concept was presented by C. Georgaides et al. [9]. Characterizing the forces produced by the paddle vibrating in the water was the primary goal. A paddle trajectory built on a cubic spline was created in response. Here, the amount of water replaced by the paddle determines the thrust produced based on the estimation of the input. A setup experiment is carried out to measure thrust. The Lab VIEW application is used to control the paddle and collect experimental results. A few assumptions include the vehicle traveling within a stationary body with constant attributes, translation motion based on Newton's equation, and rotational motion based on Euler's equation. To have a deeper understanding of 3ds max®, an animation and graphic software.

The propulsion system of an oscillating flexible plate with the combined action of pitch rotation and heave translation was experimentally studied by O. Barannyk et al. [10]. The caudal region of a fish serves as incentive, and the goal is

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achieved by conducting numerous experiments at various submersion depths and measuring force. A hydrodynamic oscillating propulsion is represented by a flat rectangular plate with blunt leading and tailing that is used as a propulsion system. The frequency and amplitude of pitch and heave are considered as parameters of sinusoidal motion. Part of the flexibility composed of polydiethylsiloxane (PDMS). Two Parker HV23 stepper motors produce sinusoidal motion. LabView code was utilized to measure force and frequency using a 3 axis load cell and a 16 bit digital data acquisition board table. MatLab additionally.

A. Mazumder and H.H. Asada [11] conducted research on a spheroidal appendage-free underwater vehicle for many purposes, including nuclear reactor inspection. Their primary focus was on developing a highly stable control system and a small, multi-DOF propulsion system. In order to do that, a nonlinear hydrodynamic model is created, and its controllability and stability are examined through the use of a special bidirectional centrifugal pump that produces four-directional flows and a water jet with a Coanda effect valve. A robot prototype was created based on the analytical data, and it was utilized to develop the PD controller.

For UUV propellers, T. I. Fossen and M. Blanke [12] propose a nonlinear output feedback controller. The estimated axial flow velocity feedback is used to do this. The simulation explains a more accurate result when using a single propeller. Here, the Lyapunov stability theory is used. Two Global Exponential Stability Theorems (GES) were established under the assumption that the propeller revolution and the axial flow velocity have the same signs. The predicted result compensates for the disturbance caused by the axial flow velocity on thrust and torque, which is significant from a number of perspectives.

The stress concentration impact resulting from penetrations in a deep diving submersible's pressure hull and its structural design was examined by C. Y. Hsu et al. [13]. For that reason, the author uses the FEM methodology of Hibbitt and Karlsson to explore shallow cylindrical shells and analyzes the failure mechanisms and curvature effect on spherical deep diving vehicles under external pressure. The distribution of stress at various curved angles of a circular hole aids in the creation of design data.

For the study of elastro-plastic behaviour of material Von Mise's Yield criteria are used. Meshing is done by 9 nodes doubly curved thin shell element and considers 5 DOF.

The underwater vehicle designed by M. A. MacIver et al. [14] is based on the propulsion strategy, body design principle, and sensory system of a weakly electrified fish. Here, they generate trajectories using an idealized ellipsoidal body model, Kirchhoff's equation, and an optimal control technique. A UV was equipped with artificial electrosensors, creating an omnidirectional sensing volume.

T. F. Miller et al. [15] presented the idea of a morphing hull for an underwater vehicle and talked about its advantages, particularly in terms of speed, endurance, and range. In order to maintain the expandable energy between the pressure hull and flexible hull, an annulus is created. The benefits of reducing the drag profile, improving the vehicle range, and changing the effectiveness can be obtained by maintaining the flexible hull form while adjusting the outer hull diameter morphing. Power usage consequently decreases as well. Morphing is the process of raising the truss and decreasing the outer hull diameter by sliding the truss along the axial direction in the inner pressure hull. A MatLab-created mathematical model based on the fuel that UUVs should carry.

A marine propeller with an energy-saving Wake-adapted fixed guide vane was created by L. X. Hou et al. [17]. This suggestion was based on the surface panel method (SPM) and propeller vortex theory (PVT). The primary component of the propeller's design is the hydrodynamic interaction between the propeller and the FGV. Instead of using a single propeller, this design increases thrust by 8.7% and 8.3% propulsive efficiency.

T. Pechan and A. Sescu [18] conducted an experimental investigation on the noise produced by surface flaws in propellers in a variety of fields. Numerous types of acoustic studies have been conducted under varying situations, taking into consideration different propeller blade imperfections. Their testing revealed that surface imperfections had little to no impact on acoustic properties. And much more work may be done in the future by installing more microphones at different locations.

An experimental examination on the noise caused by surface imperfections in propellers in various fields was carried out by T. Pechan and A. Sescu [18]. Various acoustic experiments have been carried out under varied conditions, accounting for variable propeller blade defects. Their experiments showed that surface flaws had very little effect on the acoustic characteristics. Furthermore, by placing additional microphones in other locations, a great deal more work might be done in the future.

The optimization of marine propellers from a multi-objective perspective was completed by S. Mirjalili et al. [20]. Here, a variety of experiments were conducted taking into account different structural parameter and operating condition factors. Maximizing efficiency and optimizing cavitations is the key goal. According to their findings, both improvements were successful with a propeller that had five or six blades and a rotating speed of 170 to 180 RPM.

S. Gaggero et al. [21] Design through the application of BEM and optimization algorithms of a contracted and tip loaded propellers. The design approach is based on a parametric description of the propeller blade, derived from the usual design table by using B-Spline parametric curves, and an in-house developed Panel Method/Boundary Element Method (BEM)

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aimed to evaluate the performance (including citations) of the propellers selected by a genetic optimization algorithm. The result obtained from their result was validated with experimental work.

For the most current application, M.M. Bleiziffer et al. [22] created a revolutionary design method by precisely calculating the lift of arbitrary hydrofoils in cascades for a maritime propeller. Here are a few propeller designs that RANS CFD simulated. Two-dimensional thin hydrofoils were produced using the panel approach to calculate the surrounding flow field. The current study showed how accurate estimates about the flow around the blade sections could enhance propeller performances.

A. Bhattacharyya et al.'s study [23] used a duct propeller to observe the scale effect for a propeller with changeable pitch that was designed with a distinct duct. this is accomplished by using three distinct ducts and resolving a CFD simulation.They came to the conclusion that propeller torque drops between 3 to 4% at full scale compared to model scale. Based on merit coefficient, several duct propeller performances are compared.

In their experiment, X. Weng et al.[24] used an underwater structure to evaluate the acoustic response resulting from mechanical excitation. They take into consideration a cylindrical shell with an interior bulkhead composed of a FGM core coated in an absorbent substance for this purpose. Acoustic analysis is done using the Helmholtz integral formulation and the boundary element method. The shell is sealed with a circular bulkhead and a truncated conical shell. The interior of the shell was composed of metal. The model's construction resembles the hull of a submarine. A basic nonlinear geometric equation was established because of the conical shape. The displacement equation and boundary condition are applied to the motion equations. It has been noted from the material property and structural study that stiffness changes as the volume fraction exponent changes and as the

N. A.Hussain et al. [25] investigated on under water glider modelling for analysis of net buoyancy, depth and pitch angle control. For that they chose a ballast tank sub system considering ballast rate is the main input and find the three outputs. This is done by MatLab system identification tool box TM. The simulation and output results are compared and based on the obtained information USM underwater glider prototype control system designed and optimized. Besides that stabilization and robust analysis of the glider also done. H.M.T

Khalled et al. [26] talked about the flash-less cold forging process optimization and thermal study of the AUV propeller hub, which was simulated using FEM. Using Al as a model material, the deformation is examined using the rigid plastic finite element method, with the premise that the material satisfies the von Misses yield requirements. Here, a model is developed using SOLID WORKS SP472007 program and simulated in the STL format using DEFORM-F3 3D software. The primary goal of the paper is to eliminate the flash, which is accomplished by running the simulation again with the hexahedron taken into account as a meshing element. Here, thermal analysis and the temperature distribution technique are used to confirm optimization. A 100-ton C-type forging machine was utilized for the experiment, and the outcomes were compared to a simulation.

Two control systems were described by L. Moreira and C. G. Soares [27] using two different methods (the H2 and Hα methods).This is done in order to regulate its lateral position and path. The outcomes of both models were compared and examined within their respective domains in order to observe the sensitivity of sensor noise and reject disturbances.

The failure analysis of a marine propeller's blade fastening bolts under varying stress conditions was examined by Z. Zhenqian et al. [28]. Here, a gradient in hydrogen concentration promotes hydrogen diffusion, and stress concentration is also evaluated by experiment and FEM analysis. Based on the FEM analysis, the bolt's roof surface experienced the maximum stress of 1016 MPa, which is where the crack development initiated.

Dubbioso G. and others [29] Analyze a marine propeller's performance as it operates in an oblique flow by using the Reynolds averaged Navier-Stokes equations numerically. Analysis was done with two distinct loading circumstances and varying incidence angles (10–30°), and related propeller performance characteristics under idealized off-design conditions were noted. The findings indicate that in a typical off-design situation of ship operation (manoeuvring), there is a 20% and 40% increase in thrust and torque, respectively.

A miniature autonomous surface vehicle (ASV) was created by G. Ferri et al. [30] to monitor coastal water quality, specifically the content of heavy metals and hydrocarbons, using a specially designed, miniaturized sensor. This apparatus was able to gather water samples at a depth of 50 meters and analyze them afterwards. The optimization process uses the catamaran solution because of its inherent shape stability and reduced drafting. Carbon fiber is employed in construction while being mindful of the guarantee. The three-layer HydronNet ASV navigation system was created.

A parametric identification and sensitivity analysis for AUV in diving plane were covered by X. U. Feng et al. [31]. Sensitivity is determined via a straightforward computation of viscous hydrodynamic derivatives. This is accomplished by creating a mathematical model using the LS-SVM approach. There has been a simulation of the zigzag kind based on a mathematical model. The numerical simulation and sensibility analysis have been performed by utilizing dominant sensitive and co-efficient. The motion characteristic of the AUV is given by the coordinate system. This study makes the assumption that the flow field is infinitely deep and unbounded, and it ignores environmental disturbance. The fourth-order Runge-Kutta algorithm is employed in simulated maneuvering. A model is rebuilt based on the simulation results, compared to the original model, and naturally applied for maneuvering research.

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In order to understand the behavior of a non-axisymmetric nose submarine model during pitch maneuvers, Saeidinezhad et al. [32] looked into experimental studies on the model. Using a model length of -10˚≤α≤ 27˚ and a pitch angle of ɫ≤α, this is done in a wind tunnel with Reynolds number 6.6 x 106. Pitch angle changes are associated with changes in the drag and lift coefficients. Smoke flow visualization test is used to measure flow separation and cross flow vortices around the submarine model at different pitch angles. Aerodynamic force and moment are recorded, and the model is made using aluminum and wood using a CNC machine.

IV. Method

MATERIALS AND METHODS

3.1 ALUMINIUM ALLOY 7075

Numerous applications can benefit from the aluminum alloys of the 7000 family. Manufacturers and end users place a high importance on grade 7075's resilience and low weight. It is a robust, machinable aluminum alloy with several applications in the aviation, aerospace, and automotive sectors.

3.2 CARBON FIBER

Glass fiber is the "driving force" of the industry in fiber products. It is versatile and highly competitive with materials s uch as wood, metal and stone. Liquid glass products are durable, lightweight, electricity-free and have very low raw material costs.

3.3 E-GLASS FIBER

The mechanical characteristics of fiberglass are similar to those of other fibers, such carbon and polymers. Even though it isn't as robust as carbon fiber, its cost in composites is far lower. Consequently, glass fiber serves as a reinforcing agent in a variety of polymer goods, resulting in the creation of glass-reinforced plastic (GRP), sometimes referred to as "glass laminate," an extremely strong and comparatively light fiber reinforced composite (FRP) material. GRP is employed structurally because of its strength and comparatively light weight; unlike glass wool, it contains little to no air or gas, making it denser and a worse thermal insulator.

3.4 MATERIALS' MECHANICAL PROPERTIES

MATERIALS	MODULUS OF YOUNG (Mpa)	TENSILE STRENGTH(Mpa)	POISSON'S RATIO	DENSITY(kg/mm^3)
ALUMINIUM 7075	71700	280	0.33	0.00000028
CARBON FIBER	70000	3900	0.30	0.00000020
E-GLASS FIBER	76000	3455	0.31	0.000000258

Table 2- Mechanical properties of materials

3.5 FACTOR: PROPELLER DESIGN EFFICIENCY

THE NUMBER BADES

There Must Be A Trade-Off Because Adding More Blades Would Actually Make The Propeller Less Efficient. However, Having More Blades Improves Thrust Distribution And Keeps The Propeller Balanced.

The diameter

The Propeller's Efficiency Is Significantly Impacted By Its Diameter. Greater Thrust And Power May Be Produced On A Bigger Volume Of Liquid Via Larger Propellers. But Most Designs Have Diameter Restrictions, Thus Optimization Needs To Happen Somewhere Else.

VELOCITY OF FLOW

Another Crucial Factor To Take Into Account Is The Expected Flow Rate Of The Fluid, Whether It Be Water Or Air. The Pitch Distribution Of The System Is Determined By This Force And Rotational Speed (RPM). At Axial Speed, Large Propeller Designs May Lose Some Of Their Efficiency. Designs With A Pitch To Diameter Ratio Of 1:1 Are The Most Efficient.

FLOW DENSITY

If the fluid's real density has no bearing on the system's effectiveness, it does have an impact on early design stages when it comes to defining the shape and size. Because the liquid has a lower density than water, an air propeller used in drones and airplanes, for instance, has a greater surface area than its water counterpart.

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3.5.1 3D SOLIDWORKS 2023 FOR AIRCRAFT

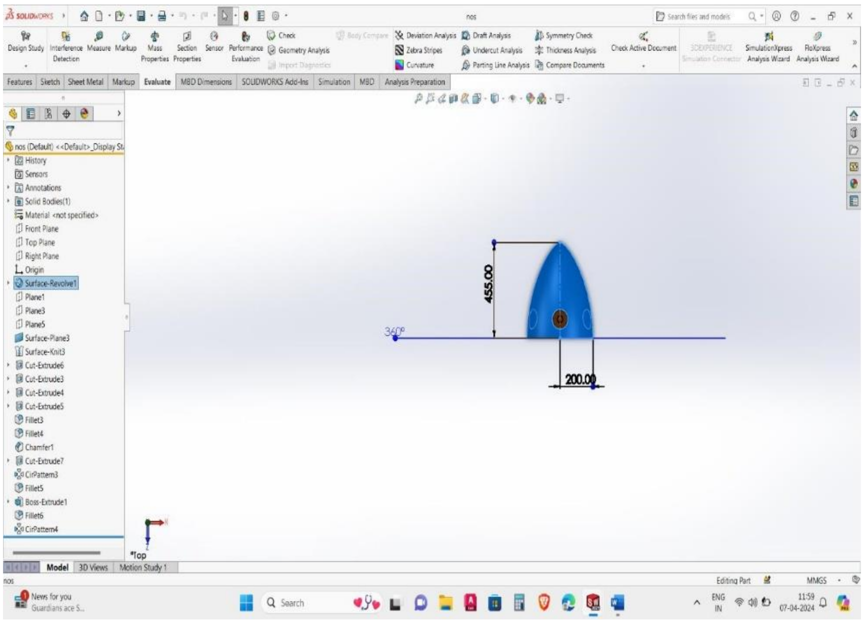

Figure 3.1 *3d Solidworks Model for aircraft blade*

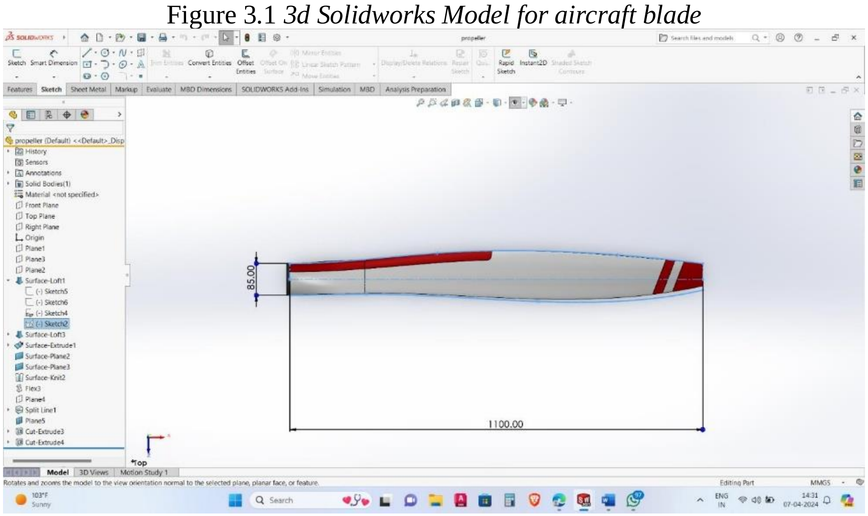

Figure 3.2 *Blade front view*

Draw a circle in the sketch and use the command Surface spin Next, create the sketch using the command fig utilize shaft as a guide.
Then draw the sketch as shown and take a different plane, draw the same sketch with a different angle and use a multipart solid. Use a circular pattern in that you use a complete crown.
3.5.2 3D SOLIDWORKS MODEL FOR AIRCRAFT

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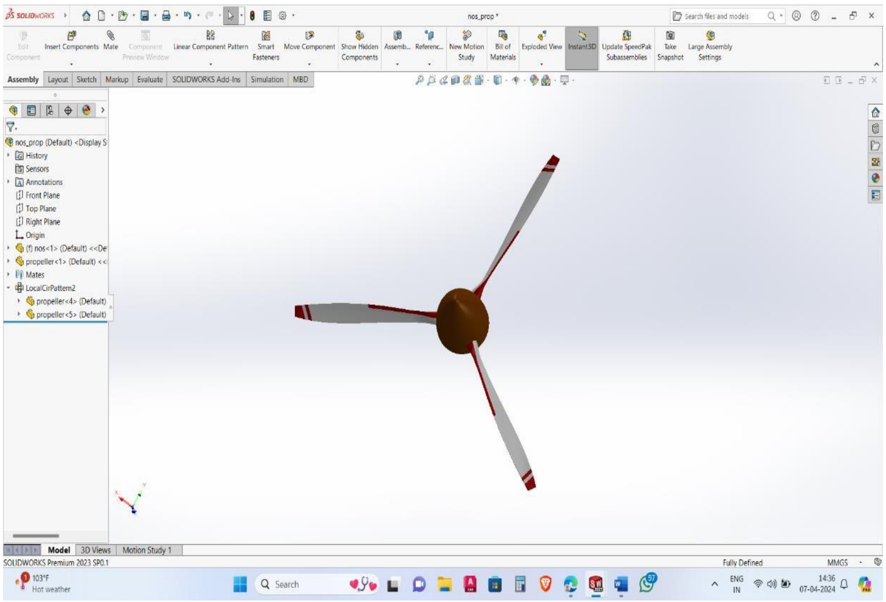

Figure 3.3 *Assembly*

3.5.2 2D SOLIDWORKS MODEL FOR AIRCRAFT

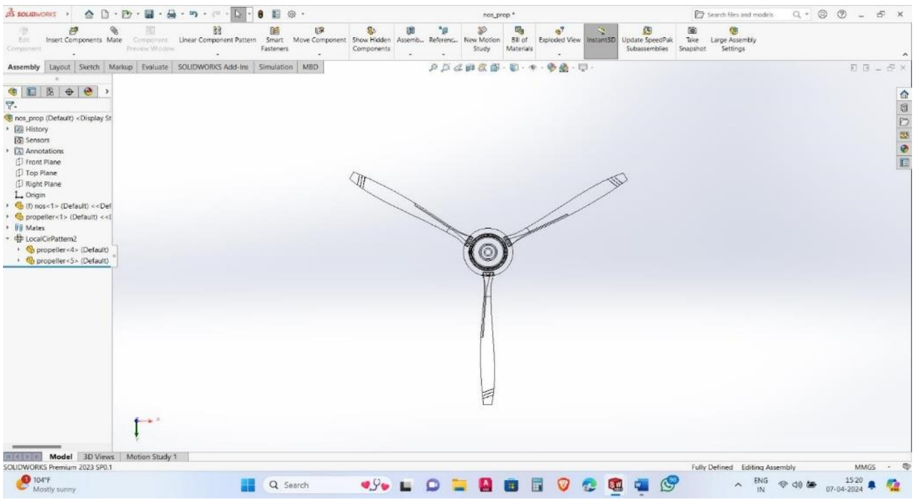

Figure 3.4 *Solidworks model for 2d aircraft blade*

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6 ANSYS SOFTWARE

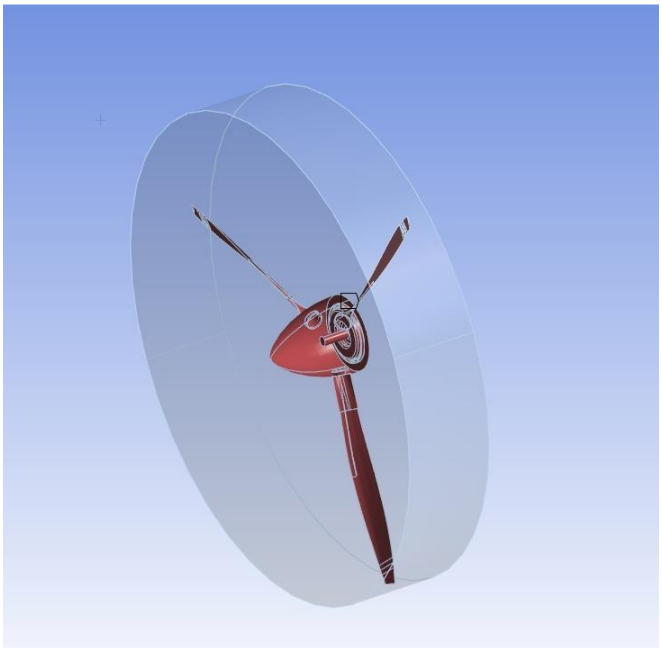

FIGURE 3.5 *ANSYS WORKBENCH 14*

ANSYS Is The Name Of The Software Used For Computer-Aided Engineering, Or Engineering Simulation. Its Gear Case Evaluation, Which Has Many Gears And Contains Thermal, Static, Dynamic, And Fatigue Details, Is Meant To Improve The Product. In 1970, Dr. John A. Swanson Founded Swanson Analysis Systems, Inc., Or CHASSIS. Its Main Objective Was Redirected To Developing And Disseminating Limited-Detail Building Physics Software Capable Of Simulating Stationary, Dynamic, And Thermal Issues Along With Heat Transport Difficulties. SASI's Commercial Growth Occurred With The Increase In Demand For Technology And Computer Production. The Agency Had Grown By 10 To 20 Percent Annually When It Was Acquired In 1994. The Industry-Leading Software Package From SASI, ANSYS®, Was Acquired By The New Owners Along With ANSYS, Inc. As Its Flagship Product.

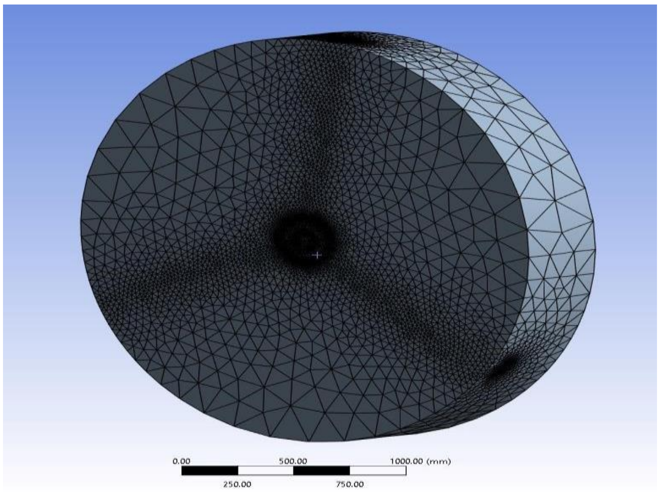

FIGURE 3.8 *MESHING OF PROPELLER BLADE*

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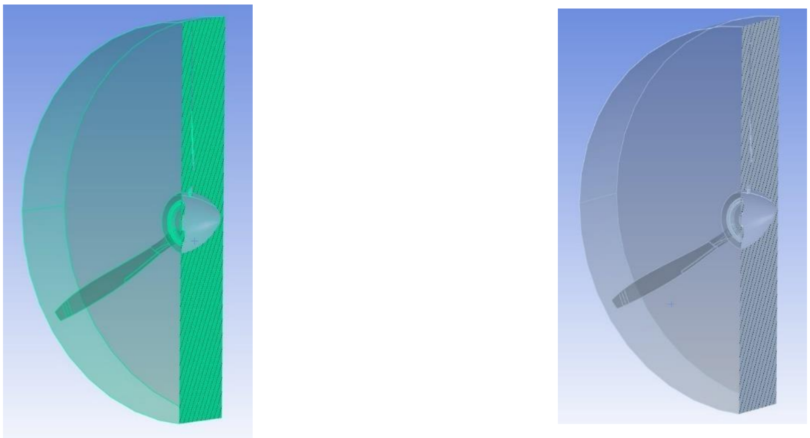

FIGURE 3.9 *CROSS SECTION-MESHING OF PROPELLER BLADE*

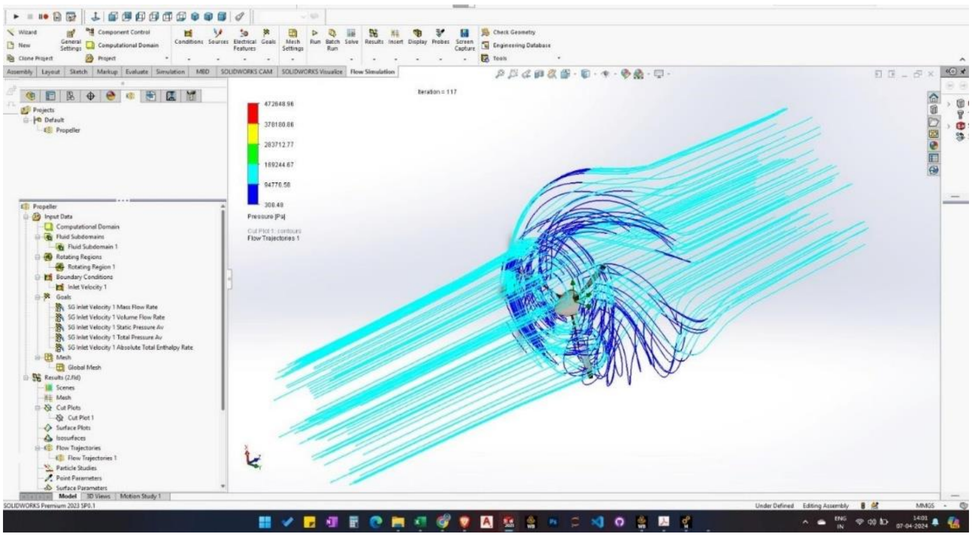

FIGURE 3.10 *FLOW TRAJECTORIES OF PROPELLER*

V. RESULTS

3.8 RESULTS

NAME	UNIT	VALUE	PROGESS	CRITERIA	DELTA	USE convergence
SG Inlet Velocity 1 Mass flow Rate	Kg/s	56.8715	100	0.832897556	0.756676151	On
SG Inlet Velocity 1 Volume flow Rate	m ^ 3/s	49.5312	100	0.41635752	0.000502074011	On
SG Inlet Velocity 1 Static Pressure Av	Pa	97274.90	100	2270.98748	2171.94132	On
SG Inlet Velocity 1 Total Pressure Av	Pa	105853.81	100	2429.56576	2353.80851	On

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SG Inlet Velocity 1 Absolute Total Enthalpy Rate	W	1.736e+07	100	254181.368	231336.258	On

TABLE 5 *Fluent analysis Results*

VI. LIMITATIONS AND FUTURE RESEARCH

The present study is limited to the numerical design and analysis of an aircraft propeller blade using **SolidWorks** and **ANSYS** software. Only three materials—**Aluminium Alloy 7075, Carbon Fiber, and E-Glass Fiber**—were considered for comparison under static structural and CFD analysis. The investigation was performed under predefined boundary conditions and operating parameters, which may not fully represent actual flight environments. Dynamic loading, fatigue behavior, vibration characteristics, impact resistance, thermal effects, and manufacturing defects were not considered in this study. In addition, the simulation results were not validated through experimental testing or wind tunnel investigations, which may affect the accuracy of the predicted performance.

Future research can focus on validating the numerical results through experimental testing and prototype fabrication. Advanced analyses such as **fatigue, modal, harmonic, transient dynamic, and thermal analysis** can be carried out to evaluate long-term performance under realistic operating conditions. Optimization techniques using **genetic algorithms, topology optimization, and artificial intelligence** may be applied to improve blade geometry, reduce weight, and increase efficiency. Further studies can also investigate advanced composite materials such as **Kevlar, Basalt Fiber, and Hybrid Carbon-Glass composites**. Considering varying flight speeds, environmental conditions, and noise reduction techniques will contribute to the development of lightweight, high-performance, and energy-efficient aircraft propeller blades for future aerospace applications.

IX. CONCLUSION

In order to successfully tolerate varying speeds, structural analysis and fluid analysis employ a composite structure made of carbon fiber and E-glass fiber. Finite element analysis was used to do structural analysis in order to assess the suggested structure.

Based on a static analysis of the propeller blade, it can be observed that the stress value decreases as the propeller speed increases (to 7000 rpm) and is less than that of carbon fiber, E-glass, and aluminum alloy. Since carbon epoxy is a composite substance, it is stronger.

The stress value for three layers with orthotropic material is less than the findings of the static analysis, according to the linear analysis of layers.Thus, it may be said that propeller blades for airplanes can be made of laminated composite materials.

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