Modelling and Analysis of SUKHOI FGFA and Introduction of composite materials to SUKHOI FGFA

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Abstract. This paper talks about the modal and flow analysis done on the aircraft with composite materials. We are using steel, carbon fibre and Bucky paper. This will give a brief description and contrast between the three composite materials on sukhoi fgfa. Carbon fibre reinforced composites (CFRPs) are light weight, have high strength and modulus, which make them qualified candidates for numerous automotive and aerospace industries. However one of the major technical challenges for these materials in aircraft structures, in terms of aircraft safety and durability, is lightning strike protection (LSP). This is due to the inadequate electrical properties of normal CFRPs. Although, CFRPs have relatively good in-plane electrical conductivity compared to neat epoxy resin, they lack metal-like high conductivity for LSP applications. To solve this issue, metal materials such as copper or aluminium mesh are attached to carbon fibre composites in the aircraft structure. This solution is not satisfactory due to heavy weight of metals and the occurrence of galvanic corrosion between metals and CFRPs. On other hand carbon nano tubes (CNTs) possess great potential for enhancing high-performance and multifunctional properties of composites and exhibit incredible mechanical, electrical and thermal properties, which can replace the metal mesh materials.

1. Introduction
Carbon fibre fortified composites (CFRPs) are light weight, have high quality and modulus, which make them qualified possibility for various car and aviation businesses. Be that as it may one of the significant specialized difficulties for these materials in plane structures, as far as air ship security and strength, is lightning strike assurance (LSP). This is because of the deficient electrical properties of ordinary CFRPs. In spite of the fact that, CFRPs have generally great in-plane electrical conductivity contrasted with perfect epoxy gum, they need metal-like high conductivity for LSP applications. To explain this issue, metal materials, for example, copper or aluminium work are joined to carbon fibre composites in the aircraft structure. This arrangement is not acceptable because of overwhelming mass of metals and composites

This examination researches the utilization of carbon nanotubes to upgrade composite conductivity for potential metal material substitution and investigates their essential flow conveying limit. Amid testing, the specimens were presented to high temperatures with electrical current-instigated warm warming in environment condition. High electrical streams created Joule warming causing warm debasement at more than 600°C (fundamental disappointment system). Miniaturized scale basic changes of the specimens after electrical current warming were watched utilizing SEM and EDS examinations. The outcome indicates tar dissipation at the example score range and nucleation of Fe and Ti particles.
2. Background and Significance
The auxiliary parts of numerous flying machine stages (fuselage, wings, and so forth.) are transitioning from metal materials to carbon fibre strengthened composites (CFRPs) due to lighter weight (weight decrease up to 80% contrasted with conventional planes). Different points of interest such as decreasing the quantity of parts are gotten by utilizing the CFRPs and its advances. Be that as it may, lightning strike insurance (LSP) is a noteworthy test because of lacking conductivity of CFRCs and current conveying ability.

2.1 LITERATURE REVIEW

2.1.1 Materials Properties
In this report, we will first independently audit their electrical properties and current-conveying limit. At long last, we will concentrate on the buckypaper's present conveying limit correlation and auxiliary changes of various perfect CNT buckypapers. Furthermore, the progressing examines and tests on the impact of the lighting strikes on CFRP boards will be audited.

2.1.2 Carbon nano tube's atomic structure
The revelation of the carbon nano tube holds astounding potential for materials applications. Carbon nano tubes are worked from sp2 carbon iota’s (which are 33% more grounded than the sp3 structure of precious stone), comprise of honeycomb cross sections, are a consistent structure, and are generally separated to single-walled carbon nano tube (SWCNT) and multi-walled carbon nano tube(MWCNT). Run of the mill metals, for example, copper lead around 2 million electrons for each second through the wire's ~3 millimetre (0.12 inch) cross segment. In examination, single walled carbon nano tubes direct about 2 trillion electrons for every second through the ~3 nanometre(0.00000012 inch) nanotube particle measurement ( 109 A/cm2).

![Figure.1 different forms of carbon based materials](image)

2.1.3 Permeation limit
To give the conductive way through a composite material, a three dimensional network of conductive filler particles is required; this circumstance is called permeation. Percolation threshold can be portrayed by a sharp drop of electrical resistance. Many models have been created to characterize the conditions. Some consider that the permeation limit is dependent from the filler's shape, size or angle proportion; be that as it may, different speculations consider the dependency on the introduction of limitedly thick sticks. Permeation limit can be characterized as critical filler volume content, where a system is shaped in conductive polymer mixes.
This wonder likewise brings about various weight rate of fillers relying upon the processing strategies and kind of nanoparticles.

3. Electrical Properties of MWCNTs
It is trusted that the conductivity in MWCNTs occur along the individual layers, with little interlayer coupling. As indicated by Moon et al the aggregate current limit of individual MWCNTs is, when all is said in done, bigger than that of a SWCNT. Figure 2 demonstrates the I-V charts of three MWCNTs at three distinct lengths. According to these diagrams, the shorter the MWCNT and the bigger the breadth, the higher the conductivity is as connected voltage are expanded.

4. External flow analysis using ANSYS FLUENT
With a specific end goal to ascertain the weight appropriations on the aircraft, a fluent model of the UAV was created. This was done essentially by model to ANSYS FLUENT stage which is the pre-processor for the stream examination.

4.1 Creating the GEOMETRY and FLOW DOMAIN: The ANSYS workbench stage gives better bi-directional associations than all significant CAD frameworks, capable geometry change and creation instruments with ANSYS Design modeler, propelled fitting advancements in ANSYS coinciding, and simple move and customize exchange of information and results to share between applications. This intelligent procedure is the primary pre-preparing stage. The goal is to deliver a cross section for contribution to the material science pre-processor. Prior to a cross section can be created, a shut model strong is needed. The geometry and lattice can be made in the Meshing application network creation instruments.

4.2 MESHING: A limited volume and thickness cross section is produced utilizing unstructured tetrahedral cells as a part of the zone nearly encompassing the flying machine, to take into account the complexities of the geometry, alongside a kaleidoscopic limit layer network 6 cells thick on the
airplane's wetted surface. Organized hexahedral cells are then used to characterize the remaining stream space.

4.3 PARAMETRICAL STUDIES
The geometry is modelled using the Uni Graphics (UGNX). This UG model is imported to ANSYS FLUENT as shown in figure. Here the model is extended for fluid domain. Subsequently acquired results at these conditions are taken into account for external flow analysis.

4.3.1 FOR STEEL 430:
- Poisson's ratio: 0.30
- Young's modulus: 208
- Tensile strength: 0.400

![Analysis results for steel 430](image)

Figure 3: Analysis results for steel 430

4.3.2 FOR SINGLE WALL NANOTUBE
- Poisson's ratio:
  1.) Arm chair: 0.16
2. Chiral: 0.18
3. Zig-zag: 0.19
Young's modulus: 1054.00
Tensile strength: 150.00

Figure 4: Stress analysis for single wall nanotube

4.3.3 FOR MULTIWALL NANOTUBE:
Poisson's ratio: 0.19
Young's modulus: 1200
Tensile strength: 150.00
4.3.4. MATERIAL PROPERTIES

Material: Air at 25 C
Material Description = Air at 25 C and 1 atm (dry)
Material Group = Air Data, Constant Property Gases
Thermodynamic State = Gas

Properties:
- EQUATION OF STATE:
  Density = 1.185 [k/m³]
  Molar Mass = 28.96 [kg /kmol]
- SPECIFIC HEAT CAPACITY:
  Specific Heat Capacity = 1.0044E+03 [J/ kg K]
  Specific Heat Type = Constant Pressure
  Reference Temperature = 25 [C]
- DYNAMIC VISCOSITY:
  Dynamic Viscosity = 1.831E-05 [kg/m s]
- THERMAL CONDUCTIVITY:
  Thermal Conductivity = 2.61E-02 [W/m K]
4.3.5 BOUNDARY CONDITIONS

The various boundary conditions used for simulation are given below:

**INLET:** This primary inlet is given as INLET boundary condition. In this boundary, the fluid can flow in only one direction i.e. the fluid can only enter into the boundary. It cannot flow in opposite direction.

At this boundary, the following initial conditions are given.

- Boundary Type = INLET
- Location = INLET
- Normal Speed = 400 [m/s]

**OPENING:** In opening boundary condition, the fluid can both enter and leave the boundary.

**WALL:** The assumption is that on the rigid surface, the fluid is stuck to the wall due to viscosity. So it is called “no-slip condition” and it required the solid and adjacent fluid surface which isn’t having a velocity related to each of the others. Therefore, the wall boundary conditions are given for the engine and plane.

**OUTLET:** At the outlet of the domain, the boundary condition is given as OUTLET. Here, the fluid can only leave the boundary. Fluid cannot enter through the boundary.

4.3.6 SOLVER INPUTS: Many numerical schemes are available for solving a fluid flow problem. Based on the physics of the problem, the suitable method is chosen. Here the turbulence model k-epsilon is used.

4.3.7 POST – PROCESSING RESULT:

**FLUENT RESULTS**
5. Conclusion
To explore the utilization of carbon nanotubes to improve conductivity of composites for potential metal material substitution and their fundamental current conveying limit properties, tests, including buckypaper composites (C1-24%, C1-33%, C1-38% and C2) and CNT upgraded CFRP composites (C3,C4,C5), were presented to high current conditions noticeable all around. After introduction, tests produced high temperatures because of the Joule warming. The fundamental disappointment component is warm corruption. The HCC test demonstrated that specimens were harmed by sudden consuming at a blaze purpose of 600°C in barometrical condition, while an IR camera was utilized to screen temperatures and in-situ resistance estimations were taken. Be that as it may, for tests C3, C4, C5, no resistance esteems were checked because of the high conductivity of carbonfibers.

This composite material utilization in the sukhoi FGFA would not just expand the speed and the electric properties like electric conductivity and different viewpoints, It likewise enhances the warm resistivity and the resistance towards the regular fiascos resembles helping thunder and the a standout amongst the most essential point in this use of Bucky paper is, it makes the airplane more stealthier than some other contender stealth's around the globe.
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