Modelling and Analysis of Aircraft Fuselage Semi monocoque Structure

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Abstract - The structural integrity and performance of an aircraft fuselage are critical factors in aerospace engineering. This project focuses on the modelling and analysis of a semi-monocoque aircraft fuselage structure, a widely used design due to its high strength-to-weight ratio and efficient load distribution. The study involves creating a finite element model (FEM) of the fuselage to simulate real-world loading conditions, including aerodynamic forces, internal pressurization, and structural stresses.

Various materials and geometries are considered to optimize weight, strength, and durability. Advanced simulation techniques such as ANSYS&CATIA, FEA, are employed for stress analysis, deformation studies, and failure predictions. The results provide insights into the structural behavior of semi-monocoque fuselages, aiding in weight reduction, fuel efficiency, and overall aircraft performance improvements. This research contributes to the advancement of aerospace design methodologies by ensuring safety, reliability, and cost-effectiveness in modern aircraft structures.

Key Words : fuselage aircraft ,ansys,monocoque,semi - monocoque

1.INTRODUCTION:

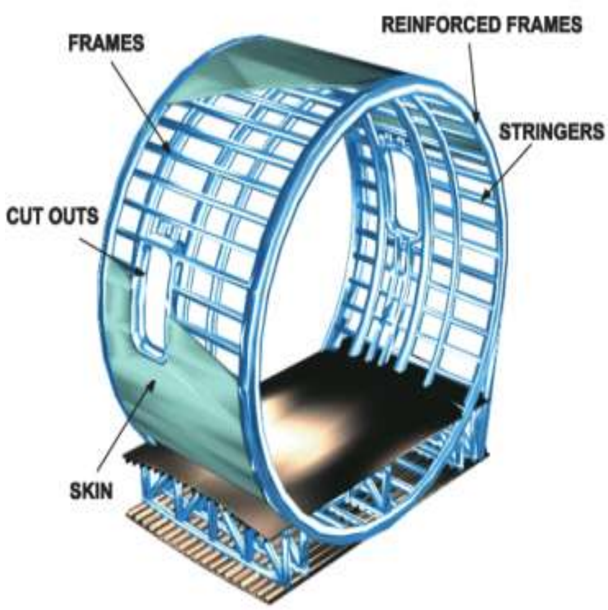
The fuselage, or body of the airplane, is a long hollow tube which holds all the pieces of an airplane together. The fuselage is hollow to reduce weight. As with most other parts of the airplane, the shape of the fuselage is normally determined by the mission of the aircraft. A supersonic fighter plane has a very slender, streamlined fuselage to reduce the drag associated with high speed flight. An airliner has a wider fuselage to carry the maximum number of passengers. On an airliner, the pilots sit in a cockpit at the front of the fuselage. Passengers and cargo are carried in the rear of the fuselage and the fuel is usually stored in the wings. For a fighter plane, the cockpit is normally on top of the

fuselage,weapons are carried on the wings, and the engines and fuel are placed at the rear of the fuselage

1.1 SEMIMONOCOQUE:

The term semi-monocoque refers to a stressed shell structure that is similar to a true monocoque, but which derives at least some of its strength from conventional reinforcement. Semi-monocoque construction is used for, among other things, aircraft fuselages, car bodies and motorcycle frames. Sectioned fuselage showing frames, stringers and skin all made of aluminium. This is the preferred method of constructing an all-aluminium fuselage. First, a series of frames in the shape of the fuselage cross sections are held in position on a rigid fixture. These frames are then joined with lightweight longitudinal elements called stringers. These are in turn covered with a skin of sheet aluminium, attached by riveting or by bonding with special adhesives. The fixture is then disassembled and removed from the completed fuselage shell, which is then fitted out with wiring, controls, and interior equipment such as seats and luggage bins. Most modern large aircraft are built using this technique, but use several large sections constructed in this fashion which are then joined with fasteners to form the complete fuselage. As the accuracy of the final product is determined largely by the costly fixture, this form is suitable for series production, where a large number of identical aircraft are to be produced.

Fig: 1.semimonocoque structure



1.2 FUSELAGE:

The fuselage is an aircraft's main body section. It holds crew, passengers, and cargo. In single-engine aircraft, it will usually contain an engine, as well, although in some

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amphibious aircraft the single engine is mounted on a pylon attached to the fuselage, which in turn is used as a floating hull. The fuselage is the main part of the plane, located centrally to the entire aircraft. The fuselage, which is basically a large, hollow tube that tapers at the back, is the component where the passengers and baggage are held and to which the wings and empennage are attached.

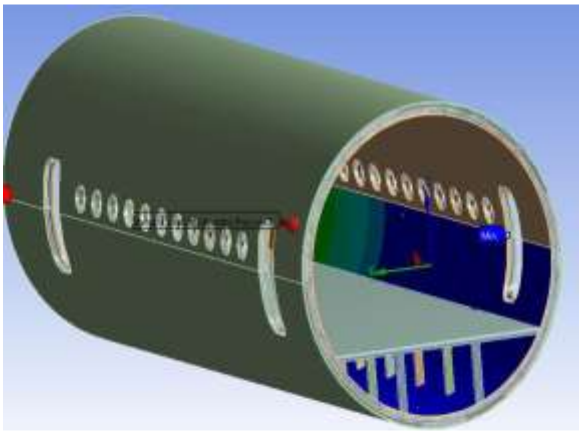

Fig: 2.fuselage structure

2. DESIGIN OF FUSE LAGE:

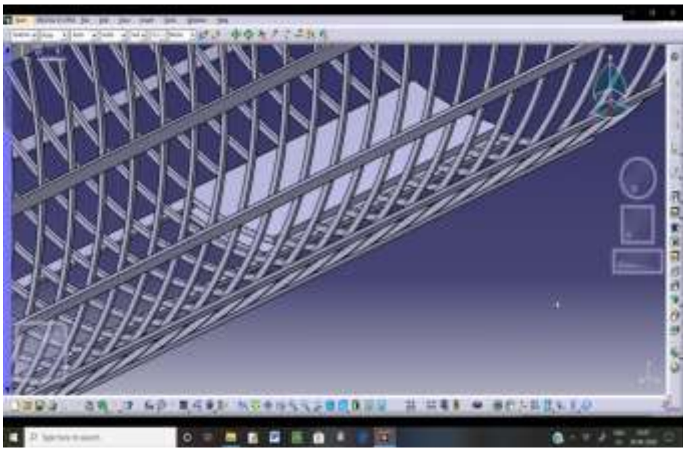

Fig: 3. Design view of fuselage in Catia

3. MATERIAL:

3.1Carbon Fiber Reinforced polymer composite:

Deformation of single individual part at a pressure of 69.252Mpa.

Outer shell	35.603	0
Support sheet	30.824	23.425
Frame	30.854	0.16952
Inner sheet	30.773	0.0055312
Foot	29.098	0.15304
Beam	29.102	15.946

Table: 1. Deformation values of Carbon Fiber

Equivalent stress:

Outer shell	4077.2	64.025
Support sheet	1665.9	653.46
Frame	80365	12.198
Inner sheet	4846.8	46.947
Foot	561.99	20.416
Beam	985.55	5.4919

Table:2.equivalent stress

Equivalent elastic strain:

5. CONCLUSION :

The main aim of this project is to minimize weight and increase performance. To reduce weight material optimization is done. The analysis of model was done with two different material properties using finite element analysis. The study finite element analysis of stresses of dissimilar materials was performed with the software ANSYS. The finite element method is an efficient technique in analysing stresses.

After material optimization the structure is substituted to static and conditions by comparing results, the modified design Carbon fiber Reniforced polymer has given best results compared to other material. Furthermore, the analysis can be carried studying for failures criteria of composite material. On a little longer timeline affecting future composite fuselage construction is sensor and technologies related to structural health monitoring (SHM). This is a very large field with growing interest by many OEM‟s in many applications by many industries, including aerospace, automotive, and power generation.

With the increasing fuel costs and environmental lobbying, commercial flying is under sustained pressure to improve performance, and weight reduction is a key factor in the equation. Beyond the day-to-day operating costs, the aircraft maintenance programs can be simplified by component count reduction and corrosion reduction. The competitive nature of the aircraft construction business ensures that any opportunity to reduce operating costs is explored and exploited wherever possible.

For example it is great to have a cable that‟s 69% lighter weight, but you have to be able to produce this in a format and in a cost that can be broadly used by aircraft engineers. Partners in composite excellence are the source for quality composites solutions that meet exacting aerospace requirements. We have to realize that all companies are an intelligent partner involved in and invested in better composite aviation world.

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