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*Research Article*

# Fabrication of Carbon Fiber Fuselage for Unmanned Aerial Vehicle

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***Abstract***

*Unmanned Aerial Vehicles (UAVs) are extensively used in today's world. With varied applications of UAV, the Design and Fabrication thus receive utmost importance in order to achieve a stable and successful flight. Nowadays there are a plethora of materials available with different characteristics. Some Materials like carbon fiber need to be cured before they can be used. This paper explains one of the fabrication process used to produce an airfoil shaped Fuselage made entirely out of carbon Fiber.*

***Keywords:*** *Carbon-fiber, epoxy, Fabrication, Fuselage, Mould, UAV*

## 1. Introduction

The Fuselage is one of the most critical components in the UAV. It houses all the systems including the flight control, flight power Source, Propulsion etc. Therefore, the Fuselage has to be a sturdy and robust piece of equipment. It should withstand all forces even in the event of crash and protect the Avionics, Engine etc. Carbon-Fiber is one of the most widely used materials in the world. This notorious piece of material is famous for the strength to weight ratio it provides. However, unlike some of the other materials Carbon-Fiber cannot be directly used on to the UAV. It has to be cured and thus molded into the shape of the Fuselage.

## 2. Fuselage

Fuselage is a UAV's main body section that houses the avionics, an Engine (in case of single engine UAV), Imaging system etc. With the development of Composites, fabrication techniques have changed over time. Earlier aircrafts were made by using Geodesic construction and used plywood. However, Plywood cannot be compared to the characteristics that modern day composites provide. Carbon Fiber is one of the widely available and widely used composite. A modern day example would be the prominent Boeing 787-Dreamliner which uses composites in its fabrication. Each 787 contains almost 35 Metric tons of carbon-Fiber reinforced polymer (CFRP). Carbon Fiber Composites have a higher strength to weight ratio compared to conventional aircraft materials. This would mean less weight of the UAV and thus more fuel efficiency.


**Fig.1** Composites used in Boeing 787 Dreamliner

Given below is the comparison of Strength to weight ratio comparison between a few materials

**Table 1** Comparison between Strength to Weight ratio of certain composites

| | Fiber strength | Laminate strength | Density of laminate grams/cc | Strength-to-weight |
|---|---|---|---|---|
| E Glass | 3450 | 1500 | 2.66 | 564 |
| Carbon Fiber | 4127 | 1600 | 1.58 | 1013 |
| Kevlar | 2757 | 1430 | 1.44 | 993 |
| Epoxy | N/A | 12-40 | 1-1.15 | 28 |

## 3. Fabrication Method

Carbon Fiber can be cured in a number of ways. However, to keep it simple and cost effective the wet lay-up method is chosen First, A mould is made of the shape required by the fuselage. The mould is usually made up of Stainless Steel. For better understanding a

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specific fuselage design has been considered. This fuselage was designed for a UAV with 2m wingspan. The shape of the Fuselage follows the shape of Wright 6 Airfoil. The fuselage is to be made of single layer of bidirectional carbon fiber.

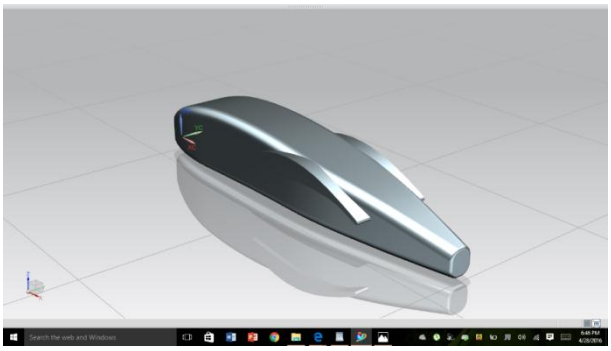

**Fig.2** CAD Model of Fuselage

In order to obtain intricate shapes, the mould is designed on CAD and then brought into life with the help of a CNC Machine

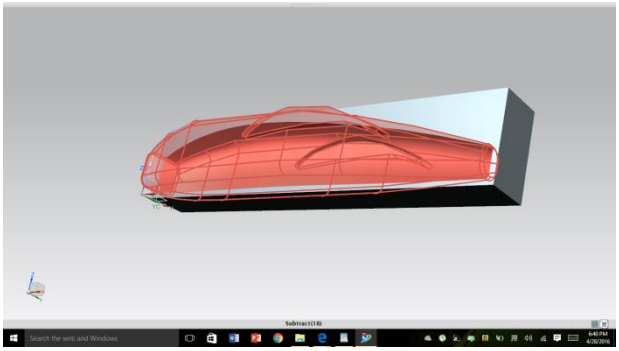

**Fig.3** CAD Model of Fuselage Mould

Once the Moulds are ready, a thin layer of wax is applied to the mould. This will protect the carbon fiber from sticking to the mould once it's cured and hardened. Now a single layer of bidirectional carbon Fiber cloth is laid down in the mould. Once the cloth is properly set, a mixture of Epoxy-Resin is then applied with the help of a roller.

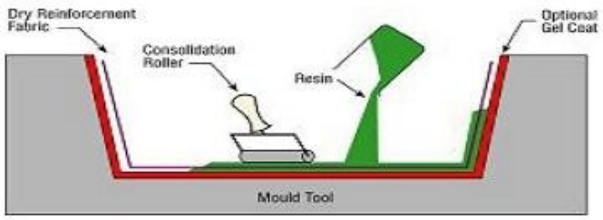


**Fig.4** Wet Layup Process

However, utmost care has to be taken while doing the above procedure since handling of carbon fiber strands can lead to itching or irritation to the skin. Thus, protective gear is suggested. This Epoxy-Resin is a mixture of the resin and hardener in a specific ratio. This is set to dry .However a vacuum may be used in order to make the cloth stick to the mould. This cures the Carbon Fiber and a hardened version of the cloth is now obtained.

## 4. Reinforcement

After around 8 hours of drying, that cloth of carbon fiber is moulded into a beautiful and intricate shape of the airfoil. However, the obtained model, is not the final version. Because of the intricate shape, the Fuselage could have certain spots where the strength is less. Thus, these spots are then reinforced with strips of carbon fiber. Also even with the material characteristics of Carbon Fiber, the fuselage could go through a lot of shape changes on application of force. In order to provide extra resistance we provide support by using Lite Ply Formers. These formers follow the shape of the airfoil and are placed at specific distance inside the fuselage, thus forming a kind of skeleton, thus giving the fuselage rigidity .These formers are designed on CAD and then Laser Cut on Lite Ply. A practical setup of the same has been shown below:

**Fig.5** Practical setup of Formers in the Mould

## Conclusions

After analyzing the curing processes for Carbon Fiber, the Wet Lay-up Method is found to be one of the simplest and cost effective method of curing carbon fiber. The Equipment and skill needed is less as compared to the other processes. This particular processes was tested and the results obtained were phenomenal. Even after certain deliberate crashes, the fuselage remained sturdy and none of the Avionics were damaged.

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