# Design, Fabrication and Analysis of Radio Controlled Aircraft Steering Seat Base and Arm

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*Abstract*— Radio control aircraft should be lower weight to fly but it's also strong enough to endure the loads they experience during flight. Designing is one of demanding works in RC aircraft designed project. Design such as structure, accurate evaluation of loads is important. Design the structure of the front wheel steering seat base and arm. Theoretical Design of steering arm and base by using Theoretical data of RC aircraft and materials take poly lactic acid and carbon fibre poly lactic acid. Analysis of steering arm and base in ANYSIS software by using materials data and load conditions. Then Modelling of Radio control aircraft front wheel steering seat base and arm in CATIA software. Manufacturing the designed objective 3D Printing Machine using poly lactic acid and Carbon Fibber poly lactic acid plastic materials.

***Keywords:*** ANYSIS Software, Radio Control Aircraft, Design, Fabrication

## I. INTRODUCTION

### A. *Radio Controlled Aircraft:*

Radio controlled aircraft is a small flying plane that is controlled remotely by an operator on the ground using a hand held radio transmitter. The transmitter is communicating with a recover within the aircraft that sends signal s to servomechanism.

Full scale aircraft designs from every ear of aviation from the "Pioneer Era" and World war s start, through to the 21stcentury, have been as modelled as radio control scale model aircraft. Various scale sizes of RC aircraft have been built in the decades since modern digital proportional, miniaturized RC gear.

Radio controlled aircraft is used for Defence purposes, with their primary tasks being intelligence gathering reconnaissance. An Unmanned Aerial vehicle (UAV), also known as a Drone. It is usually not recommended for human pilot. Remotely controlled target Drone aircraft were used to train gun crews.

Fig. 1: Radio Controlled Aircraft

### B. *Radio controlled aircraft front wheel steering:*

A steering system in Radio controlled aircraft for aircraft while ground borne with remote control modes. In the remote mode signal command controller operates both rudder and differential brakes of the main landing gear system. Steering commands can now be initiated remote operator via receiver and processer

#### 1) *Tri-Cycle Type Landing Gear:*

The most commonly used landing gear arrangement is the tricycle-type landing gear. It is comprised of main gear and nose gear. In this type of Gears, the main gears are mounted below the wings. COG is exactly in between the nose wheel nose Gear and main Gear.

On light aircraft, the nose gear is directed through mechanical linkage to the rudder pedals. Heavy aircraft typically utilize hydraulic power to steer the nose gear. Control is achieved through an independent tiller in the flight deck. The main gear on a tricycle-type landing gear arrangement is attached to reinforced wing structure or fuselage structure. The number and location of wheels on the main gear vary. Many main gears have two or more wheels.

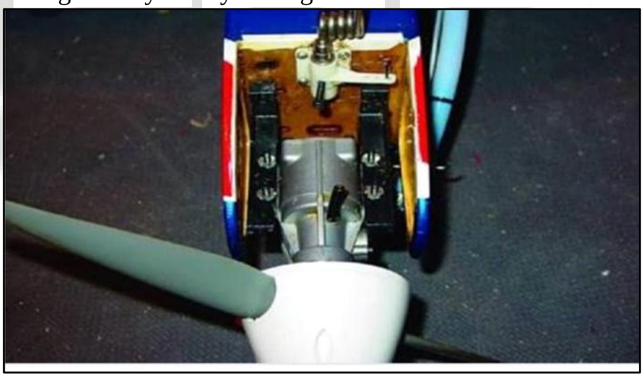

Fig. 2: RC Aircraft Front Wheel Steering Part

#### 2) *Introduction to Rapid Prototyping:*

A CAD model is constructed, and then converted to STL format. The resolution can be set to minimize stair stepping The RP machine processes the STL file by creating sliced layers of the model. The first layer of the physical model is created. The model is then lowered by the thickness of the next layer, and the process is repeated until completion of the model. The model and any supports are removed.

a) Numerical Analysis:

There are many different CAD packages capable of producing an STL file. For rapid prototyping it is essential that parts are complete and have continuity, i.e. the part to be built must be represented as closed surfaces that unambiguously define an enclosed volume. The standard file format for rapid prototyping is called STL (Standard Triangulation Language), where the shape of the object is defined by a mesh of tiny triangles laid over the surfaces. The triangles must meet up exactly with each other, without gaps or overlaps, if the object is to be built successfully. The "slice files" which are used to build each individual layer are calculated from the STL file, and if there are any gaps between the triangles, then the edges of the slices are not properly defined.

When creating an STL file from CAD, the resolution (also known as Tolerance, Chord Height or Facet Deviation) can be specified. Under-faceted STL files will affect the accuracy and may affect the appearance of the part.

Improvements in rapid prototyping technology allow very accurate slice thicknesses, also was 50 microns, to be achieved. As layers are of finite thickness, small degrees of errors can be tolerated within the Z axis. The final build process requires emerging of multiple STL files to produce the final build file and the building of the component can begin

*3) Fused Depositionmodeling:*

In this project we are using FDM technology which is one of the most widely used rapid prototyping systems in the world. FDM is today the second most common commercial layered manufacturing system. The main reasons of its increasing popularity and use have been its reliability, safe and simple fabrication process, low cost of material and the availability of a variety of thermoplastics. Ever since the first FDM system was launched in early 1990s, the Strategy's Inc. USA has been marketing improved FDM systems on a regular basis. However, research has also been going on in universities and research institutions around the world to increase its applications, to develop new materials and to improve the FDM process. The FDM method forms three dimensional objects from computer generated solid or surface models like in a typical RP process. Models can also be derived from computer tomography scans, magnetic resonance imaging scans or model data created from 3D object digitizing systems.

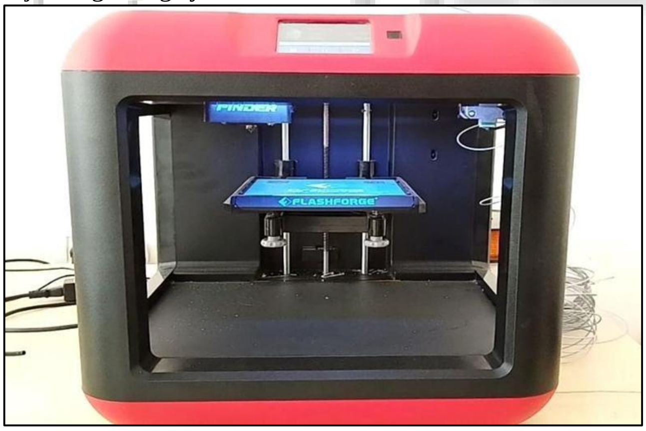


Fig. 1.3: flash forge printer

Summary of investigation: amid of numerous researchers carried out enormous amount of work on rapid prototyping. However, considerably very minimal work was carried out on Radio controlled air craft arm of the steering seat base. Paul marks et al. [1] conducted experiments on FDM. The solid models from various resources are converted into STL format files or other format files, which mostly come along with the FDM machines. Slicing procedures are implemented before the deposition. A lot of research is focused on slicing algorithms and attempting to reduce the stair-case effects and anisotropy of the final physical models. Jamieson found that RP systems need for both tessellated and sliced data from CAD models to be input into RP machines and shown that direct slicing can be beneficial in terms of files size and in eliminating the need to slice a tessellated equivalent model. Their work also has shown that the accuracy can be enhanced, especially on rounded or tubular designs, which also benefits from reduced processing time before the build process starts. Aman Sharmais [2] explained about 3d printing needs in manufacturing industry. They also explained about advantages of 3d printing machine and Disadvantages of 3d printing applications also explained in journal. they give full explanations about the working of 3d printing and types of 3d printers in Additive Manufacturing is a process of joining materials to make objects from three-dimensional model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies. As a new tool in the entrepreneurial toolbox, additive manufacturing system use computer- aided design models and 3D scanning systems for production. Wu H et al. [3] Micro air vehicle: Configuration, analysis, fabrication and test. This paper speaks of two electrically powered MAV with wingspans of 380 and 360mm. The aerodynamics of several airfoil sections at low chord Reynolds numbers are theoretically analyzed. The methods and materials of developing MAV have also been discussed. The materials used in this work are balsa wood, Styrofoam, plywood, transparent skin, carbon fibre, Kevlar. A comparison among these has been carried out on the basis of weight, strength, stiffness, ease of fabrication and resulting. flight performance such as flying stability, payload capacity and manoeuvrability. Styrofoam has been used as airfoil because of ease of fabrication. Plywood has been used in engine mountings keeping in mind the strength. Balsa wood has been used in the fabrication of fixed tail fins and elevens, since these are light and easy to fabricate. include Resin Transfer Moulding (RTM), proper layup, wet layup and convolute winding .John K Borchardt [4] Unmanned aerial vehicles spur composite use. Keeping flight time of the UAV's in mind, the UAV's are making use of light but durable materials. New composites that are being developed make use of high molecular weight polyethylene, S glass, E glass, agamid, quartz, bimaleimide and graphite fibbers reinforcing epoxy, polyester, vinyl ester, and phenol and polyimide resins. The composite processing methods are finished by oven or auto clave curing. The present UVA's have got their aero foil fabricated from aluminum to keep their weight at minimum. Using composites reduces the weight of the UAV by15% to 45%. Thermosetting plastics are preferred rather than the thermoplastics. The thermosetting resins readily impregnate fibbers and helps in the manufacturing of complex shaped parts. Epoxies are the most common thermo sets used in the application of UAV's. Mohammad Aswan et al. [5] explained about Landing gear is a vital structural unit of an aircraft which enables to take off and land safely on the ground and also explained about Tail wheel-type Landing Gear, Tandem Landing Gear. Retractable landing gear stows in fuselage or wing compartments while in flight. Once in these wheel wells, gear is out of the slipstream and do not cause parasites drag. Small Aircraft Retraction System As the speed of a light aircraft increases, there reaches a point where the parasite drags created by the landing gear in the wind is greater than the induced drag caused by the added weight of a retractable landing gear system. Large Aircraft Retraction System is nearly always powered by hydraulics. Typically, the hydraulic pump is driven off of the engine accessory drive. Auxiliary electric hydraulic pumps are also common. And also explained Nose wheel steering system is most aircraft is steerable from the flight deck via a nose wheel steering system. This allows the aircraft to be directed during ground operation. A few simple aircraft have nose wheel assemblies that caster. Among materials being introduced in the aerospace industry, the carbon fibber reinforced plastics (CFRP) have a place of privilege because of their exceptional stiffness-to-mass ratio. However, the polymer-based matrix is vulnerable to damages by environmental conditions. This work exposes the experimental results of several accelerated environmental ageing protocols on CFRP panels. The main concern is to justify or reject by statistical means that a significant degradation of mechanical properties does occur over the time, and to establish a basic model to quantify the effects of different environmental factors of the composite ageing. The results considered here are the elastic properties evaluated over several weeks of accelerated artificial ageing. The stiffness degradation of the samples subjected to the aforementioned ageing protocols is statistically described by a non-linear multi-factorial model inspired by the Design of Experiments (DoE) theory.

## II. MATHEMATICAL MODELLING

Design of radio-controlled aircraft front wheel steering seat base and arm on loads and stress:
Basically, two types of forces applied on the front wheel steering they are:

- Static Force
- Dynamic Force

Static force is considered wind force and the dynamic force is considered steering working condition.

### A. *Static Force:*

Static force is nothing but the wind load and it is calculated by using wind pressure and wind attracted area of the front side of the RC aircraft i.e, rudder area and drag co efficient of rudder ($C_d$).

Wind load $F = A \times p \times C_d$ (1)

One can estimate the wind load acting on steering arm using Eq. 1.

Shear stress induced in steering seat base:

Shear stress $\tau, \frac{\text{Shear load}}{\text{area of cross section applied on load}}$ (2)

One can estimate the shear stress induced in steering seat base using Eq.2.

### B. *Dynamic Loads on Steering Arm:*

Force applied on arm F = arm length × torque of the servo gear motor Arm (3)

One can estimate the Force applied on Arm using Eq.3

Crushing stress = crushing force / crushing area (4)

The crushing stress can be estimated by Eq.4.

$\text{Tensile stress}(\sigma t) = \frac{\text{Tensile load on the steering rod}}{\text{streering rod area}}$ (5)

One can estimate the tensile stress induced in steering rod using Eq.5.

### C. *Failure of arm intension across the weaker section:*

$F = (\pi/4\,(D_1^2 - D_1) \times t) \times \sigma_t$ (6)

One can estimate the Failure of arm intention across the weaker section using Eq.6.

## III. MODELLING AND ANALYSIS

Analysis of RC aircraft steering seat base and arm static loads by using ANSYS software:
Package Used: ANSYS 15.0 Workbench

### A. *Design of component using Poly Lactic Acid [PLA]:*

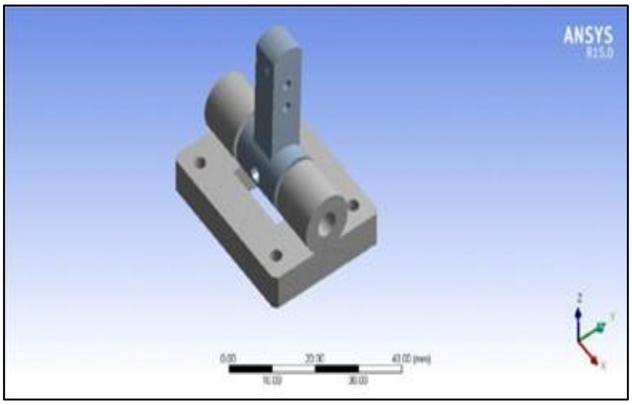


Fig. 3.1: Modelled Steering Seat Base and Arm Assembly for PLA

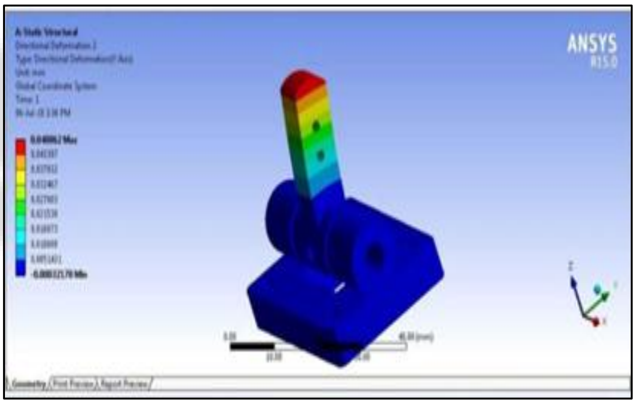


Fig. 3.2: Directional Deformation

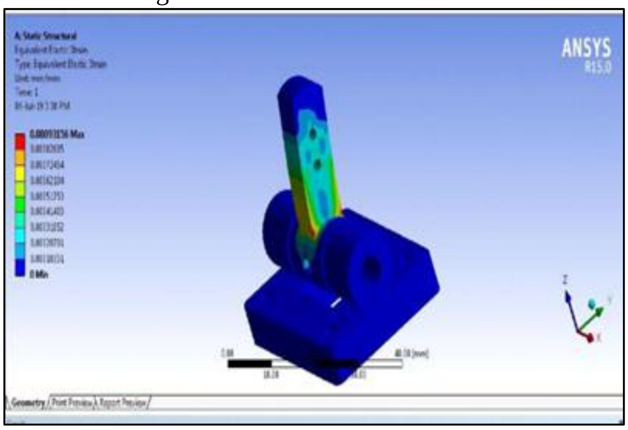


Fig. 3.3: Equivalent strain

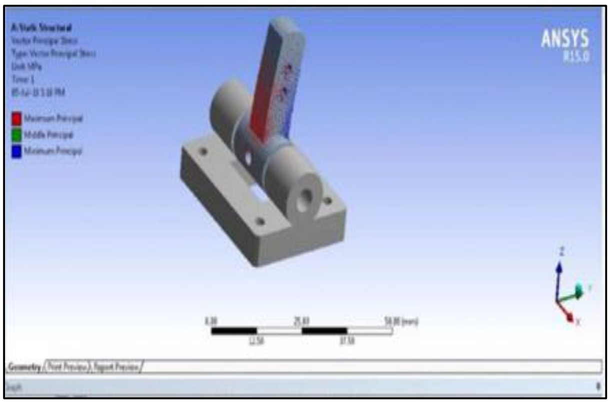


Fig. 3.4: Vector Principle Stress

### *B. Design of Component using Carbone Fibre Ploy Lactic Acid:*

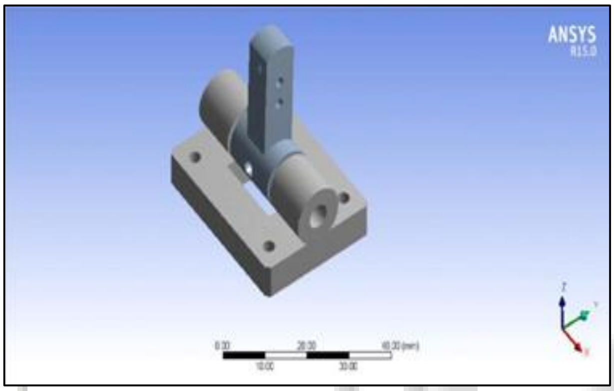


Fig. 3.5: Modelled Steering Seat Base and Arm Assembly for CF PLA

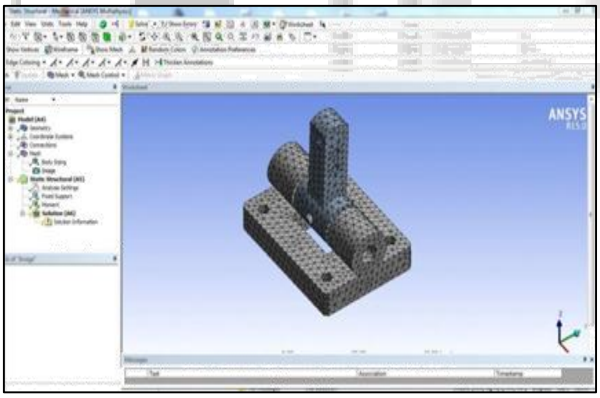

Fig. 3.6: Meshing of Steering Seat Base and Arm

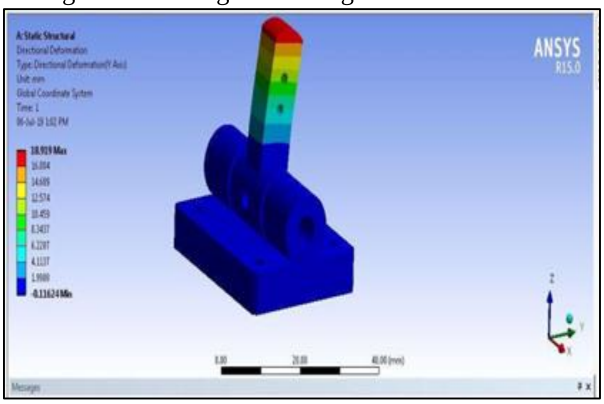


Fig. 3.7: Directional deformation

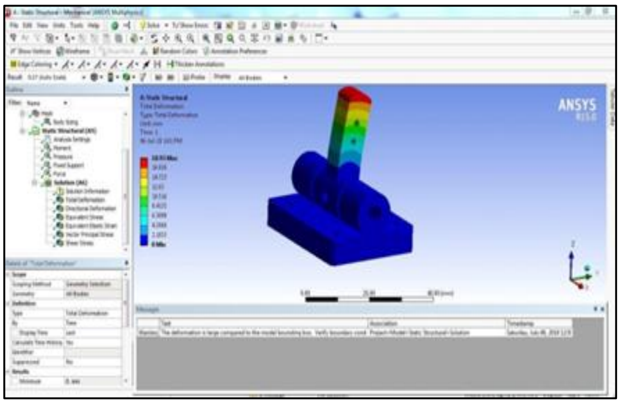

Fig. 3.8: Total Deformation

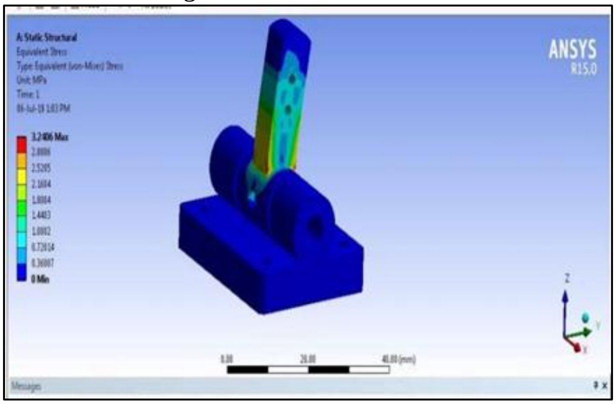


Fig. 3.9: Equivalent Stress

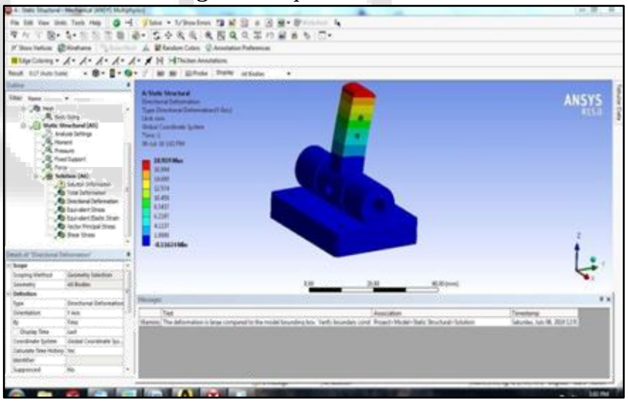

Fig. 3.10: Equivalent Strain

## IV. MODELLING OF RADIO AIRCRAFT STEERING SEAT BASE AND ARM

### *A. Modeling of Steering Seat Base and Arm*

Package Used: Catia Software.

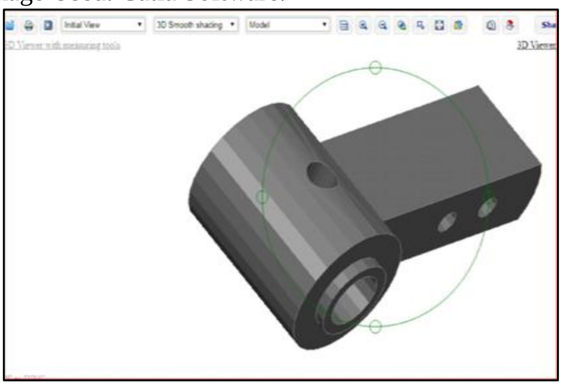

Fig. 4.1: STL Format File of Arm

 

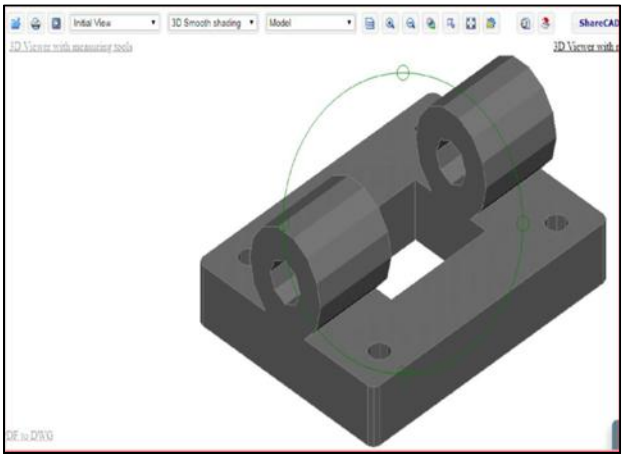

Fig. 4.2: STL Format File of Steering Seat Base

### *B. 3D Printed Radio Controlled Steering Seat Base And Arm Using Polylactic Acid [PLA] And Carbon Fiber Poly Lactic Acid [CFPLA]:*

#### *1) Using Manufacturing Unit: FDM Type 3D Printer*

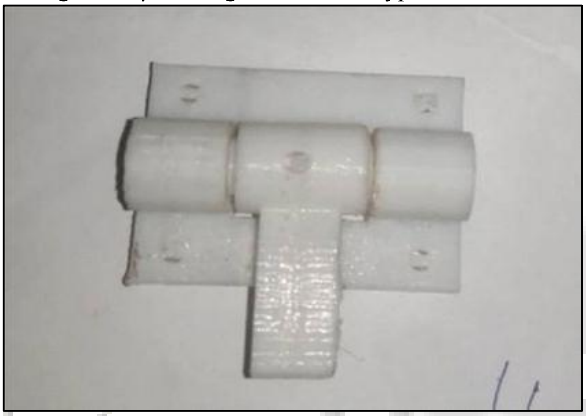

Fig. 4.3: Fabricated seat base and arm by using PLA

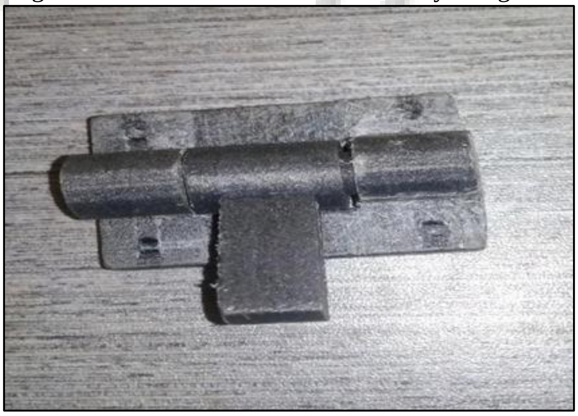

Fig. 4.4: Fabricated seat base and arm by using CFPLA

## V. RESULTS

### *A. Static Forces:*

Wind Load F = 0.0567 N
Shear Stress induced in Steering Seat Base = $7.043 \times e^{-4}$

### *B. Dynamic Forces:*

Forces applied on arm F = 15.4 N
Crushing Stress = 0.2015N/mm$^2$
Tensile Stress Induced in Steering Rod = 0.784N /mm$^2$
Failure of ARM intension across The Weaker Section F = 52.55N

### *C. Frication Force:*

Frication Force of PLA FPLA = 6.6N
Frication Force of CFPLA FCFPLA = 7.7N

## VI. CONCLUSIONS

Based on the results presented above, the following conclusions can be expressed

1) Designed radio-controlled aircraft front wheel steering seat base and arm loading conditions and their failure sections of weaker area of arm and their stress and strain values.
2) Analysis of loads acting on the RC aircraft steering system.
3) Also comparing material properties of suitable for steering arm material.

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