

## Design of Wing in Catia V5

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### ABSTRACT

The objective of the project was to design the wing section of an aircraft in Catia V5. The wing was designed in Catia using various methods, techniques and modules. Wing structure is made of various airfoil shapes such as NACA 4, 5 and 6 series airfoils. In our case, NACA 4 series airfoil was used namely NACA 2412.

### Keywords

Wing section, 3D modeling in Catia V5, Spars, Stringers and Ribs

### 1. INTRODUCTION

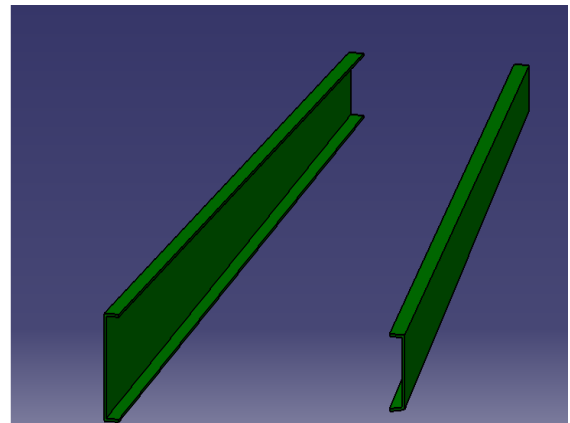
Wing is the most important part of the aircraft, which produces the lift due to the pressure difference generated on the upper and the lower surface. The wing has different types of structural components such as Spars, Stringers, Ribs and Skin which are necessary for the strength of the wing. The main function of these is to distribute the payload and the forces which act on the aircraft wing including shear forces, tensile forces and direct forces.

#### 1.1 Basic definition of wing parts

##### 1.1.1 Spar

Longitudinal member in the wing. Generally wing having two spars called Front spar (located at 30% of wing chord from leading edge) and Rear spar (located at 65% of wing chord from the leading edge). Generally Spar having I cross-section, because I section having maximum moment of inertia, hence highest strength, for the same weight. Spar webs takes Torsional load (i.e. shear stresses) and spar flanges takes bending loads (i.e. bending stresses).

**Material:** - AL7075

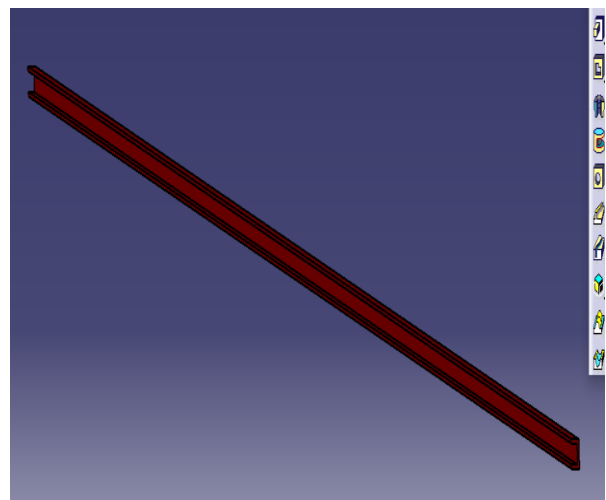


Spar

##### 1.1.2 Stringer

Used for bending loads. Generally having Z, L, T, channel and small wings having rectangular cross-sections because of easy attachment to the skin and space and weight advantage.

**Material:** - AL7075

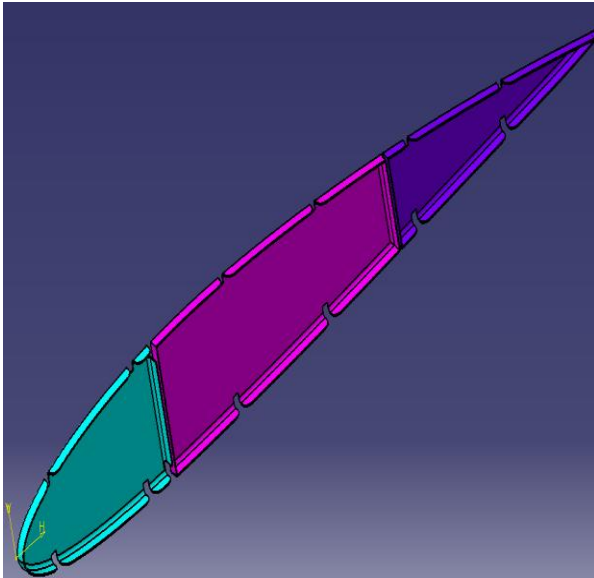


Stringer

### 1.1.3 Ribs

The dimensions of ribs are governed by their span-wise location in the wing (i.e. Airfoil shape) and by the loads they are required to support. Used for maintain the Airfoil shape throughout the wing section. They also act with the skin in resisting the distributed aerodynamic pressure loads. They distribute concentration loads (e.g. undercarriage and additional wing store loads) into the structure.

**Material:** - AL7075

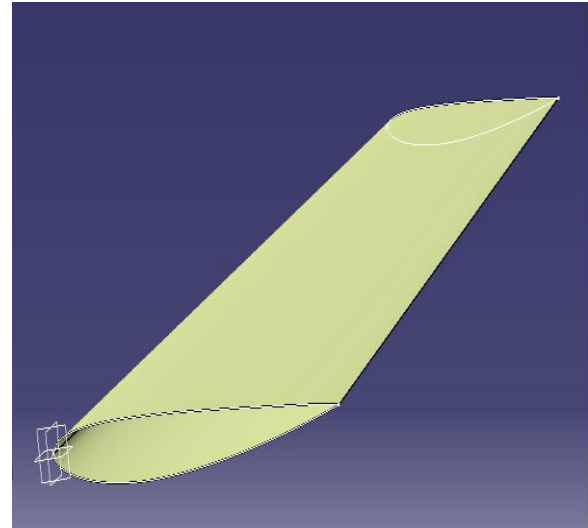


Rib

### 1.1.4 Skin

The outer cover of the wing structure is skin. The primary function of the wing skin is to form an impermeable surface for supporting the aerodynamic pressure distribution from which the lifting capacity of the wing is desired. Skin is efficient for resisting shear and tensile loads. Skin buckles under comparatively low compressive loads. Stringers are attached to the skin and ribs thereby dividing the skin into panels and increasing the buckling stresses.

**Material:** - AL7075 (upper skin) & AL2024 (lower skin)

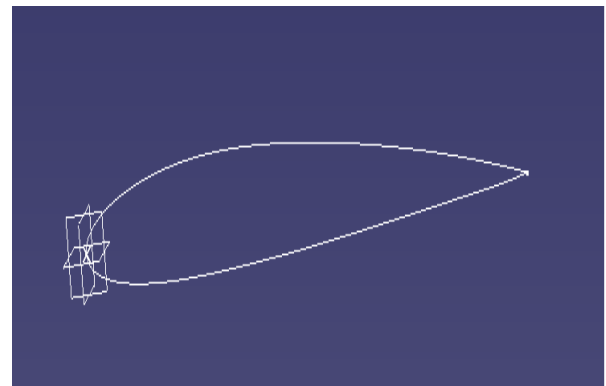


Skin

## 2. DESIGN OF THE MODEL PARTS

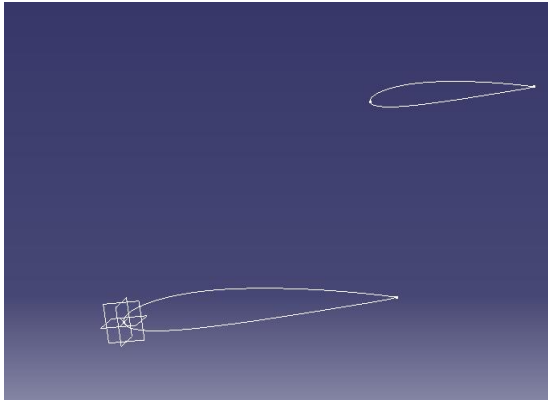
### Construction of Airfoil in Catia V5:-

- Import the points of Airfoil (NACA 2412) in Catia V5 from MS Excel.
- Join all the points using spline (Generative shape design) starting from Trailing edge.
- Scale the airfoil in YZ plane and XZ plane of ratio 1000 using scaling command.

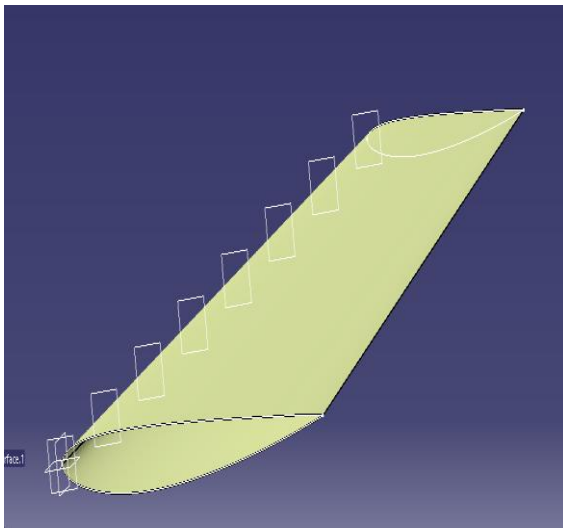


2.1 NACA Airfoil 2412

- Rescale the airfoil in YZ plane and XZ Plane of taper ratio of 0.6 using scaling and shift that airfoil in XY plane at a distance of 3000mm using translate command.

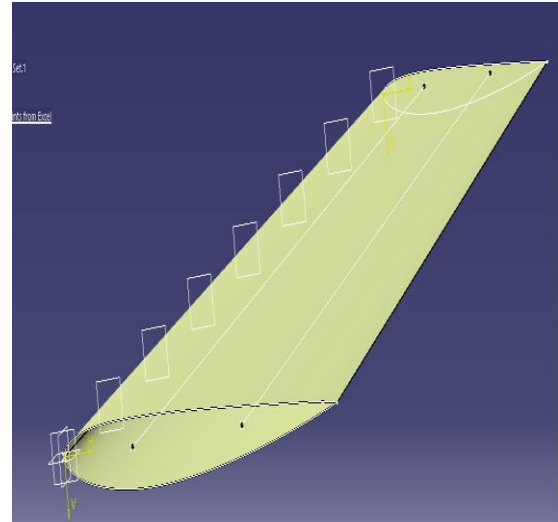


- Select the Multi-section surface command for wing skin by selecting both the airfoils.
- Offset the plane in the z direction at a distance of 3000mm and select planes between command to put the no. of instances (6) between the reference plane and offset plane.



## Construction of Spar in Catia V5:-

- Spars are located at 25% and 65% of wing chord from leading edge.
- Constraint the points at a distance of 250mm and 650mm in scaled airfoil and at a distance of 150mm and 390mm in translate airfoil.
- Select the line to join the constraint points.



- Draw the rectangle of breadth 20mm and coincide one side of rectangle at the point which is at 25% of wing chord ie.250mm from the leading edge.
- Pad the rectangle up to the last plane taking the reference as line of spar.
- Select the split command to remove the rectangle which is out of surface taking reference as multi-section surface and direction inside.
- Select three adjacent sides and use shell command in order to get 'C' cross-section.
- Similar procedure for the other spar.

## Construction of Stringer in Catia V5:-

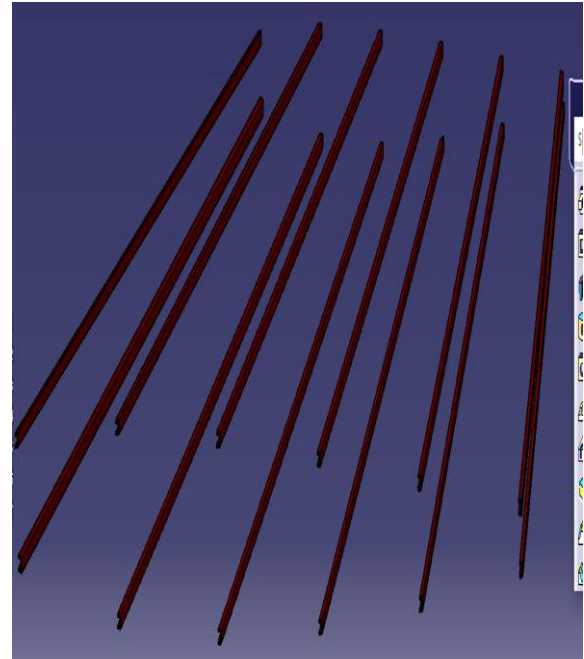
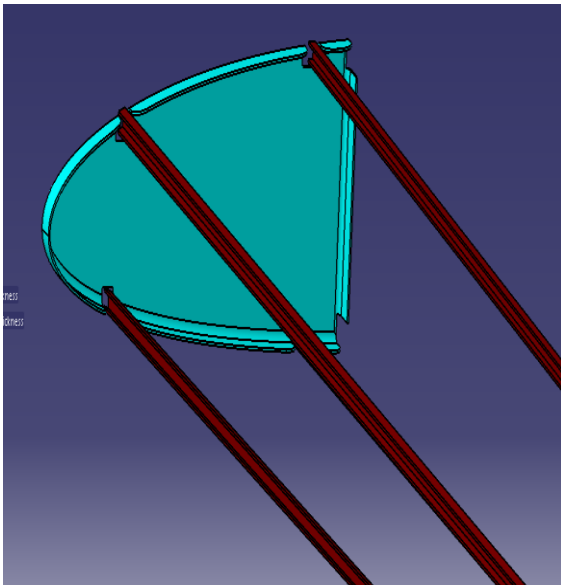
- Select the project 3D elements command to select the airfoil.
- Select the equidistant points command to put the points on the airfoil at equal distance and take care none of the point intersect the spar.
- Similar procedure for the other.
- Select the line to join the points taking support as multi-section surface.
- Select the offset command to shift the airfoil 8mm inside the surface by taking the direction inside the surface.
- Select the extrude command to shift the airfoil 1mm outward in z direction so that all the body remain inside the surface.
- Use the Join command to join the offset and extrude.
- Similar procedures on the other side first extrude and then join.
- Draw the rectangle of breadth 5mm and coincide one side of rectangle with that stringer point.
- Use the rib command taking profile as rectangle, Centre curve as stringer line and reference as multi-section surface.
- Select the split command and split it twice, first taking reference as multi-section surface so that

upper part remove and second taking reference as offset surface.

- Select three adjacent sides and use shell command in order to get 'C' cross-section.
- Similar procedure for all the stringers.
- Draw and constraint the sides of rectangle with stringer 'C' cross-section keeping distance as 2mm.
- Use the sweep command taking profile as sketch and curve as stringer line.
- Similar procedure on all stringers.
- Use the Join command to join all the sweep profile.

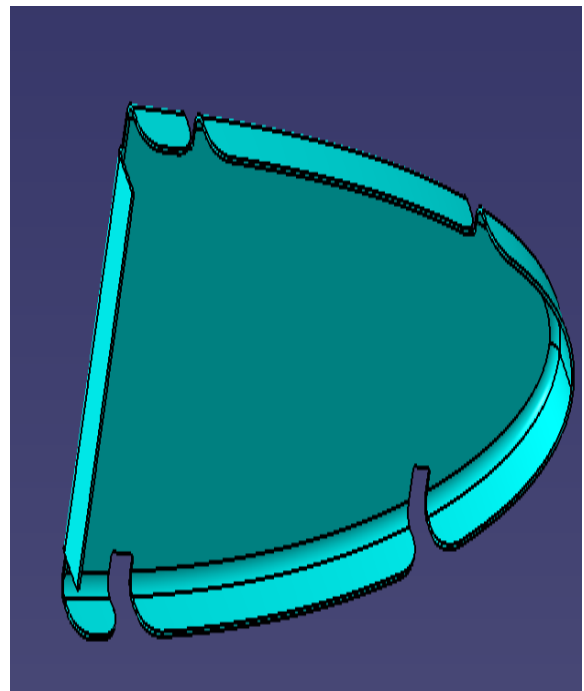
## Construction of Rib in Catia V5:-

- Rib divided into 3 parts i.e. LE rib, mid rib and TE rib.
- Draw the rectangle over the whole surface of any dimension.
- Use the pad command and then split it twice i.e. first with reference to multi-section surface so that the outer part remove and second with reference to spar side face so that only LE rib left.
- Edge fillets the outer part of rib of radius 5mm.
- Shell the inner part of rib of thickness 1.2mm.
- Split the join profile of sweep to get the appropriate shape for stringer to fit in rib.

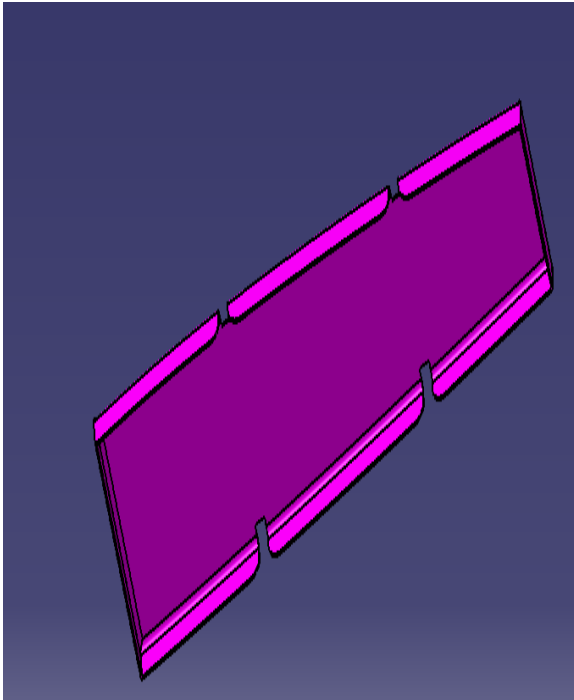


Stringers

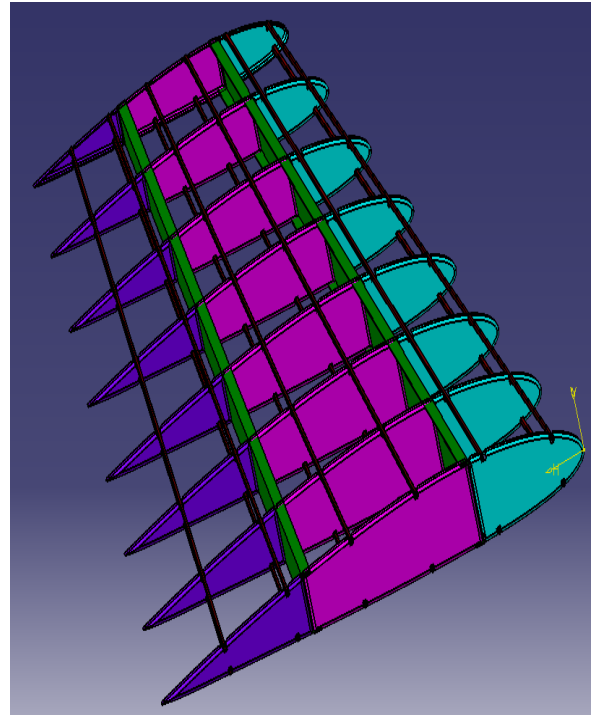
- Similar procedure for middle as well as Trailing edge rib.



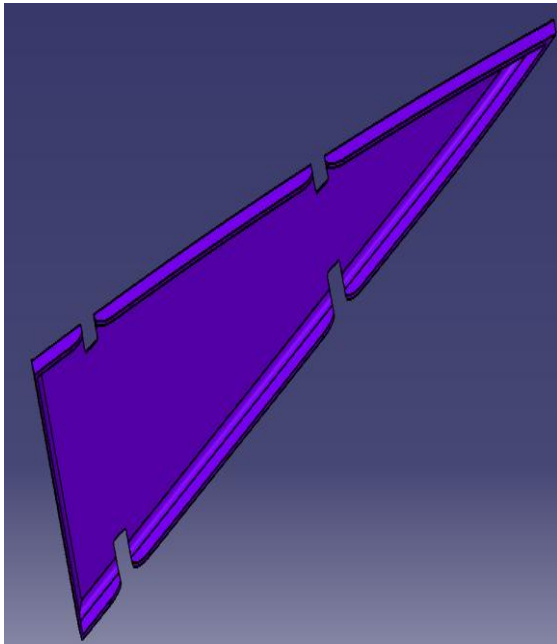
Leading Edge Rib



Middle Edge Rib



Wing Structure



Leading Edge Rib

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