Aircraft Wing Box Cad Modelling and Design

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Abstract- *The plain Wing Box of a two setter conventional aircraft is modelled with the help of Catia. This is exported to other software/tools, in order to be subjected to analysis of its torsional strength, stress/bending moment distribution, shear, etc. on the component parts of the wing box.The wing box structural validation is done using a coupled computational flow chart in Ansys software. This to ensure that the wing box structure is capable of withstanding the extreme cases of lift load/drag load during take-off and nose dive condition. And also, to with stand the mass of the wing load (due to fuels) on the ground. It is also important to note that when we speak of the structural strength of the wing box, we also refer to its bending/torsional strength. The Study is to be carried in different comparison cases, in other to obtain a better structural result.The function of stringers and spars, the longitudinal stiffeners in the wing. The designing of spars in a wing is also shown with the help of screenshots in CATIA V5 software. Load representative of an aircraft will be considered in this study.*

I. INTRODUCTION

The model of the conventional wing box for half span the full wing, is done using the Catia software. Its dimension was obtained from the previous aircraft design project on two-seater conventional aircraft which is also in the references list. A circular cross section was considered/modelled first for its stringers. So that in subsequent analysis, a different cross section can be considered and compared with the circular one, for better structural strength.

II. PARAMETERS

Wing Sweep (L.E.) = 8.6°
Half Span, bwing/2 = 8.217/2 = 4.1085m Root Chord, Croot = 1. 677m
Tip Chord, Ctip = 0.6708m
Front Spar is located 15% of chord length from L.E. Rear Spar is located 70% of chord length from L.E. 9 webbed rib with 410.67m spacing between each.

Circular stringers with 0.03m diameter. Stringers and its location on the cover surface at root chord (same ratio forthe tip chord) are:
8 stringers on the bottom cover (between the two spars) with spacing of 0.10121m from the front spar.
8 stringers on the top cover (between the two spars) with spacing of 0.10145m from the front spar.
4 stringers on the L.E. cover with spacing of 0.10145m from the front spar Airfoil NACA 4415.

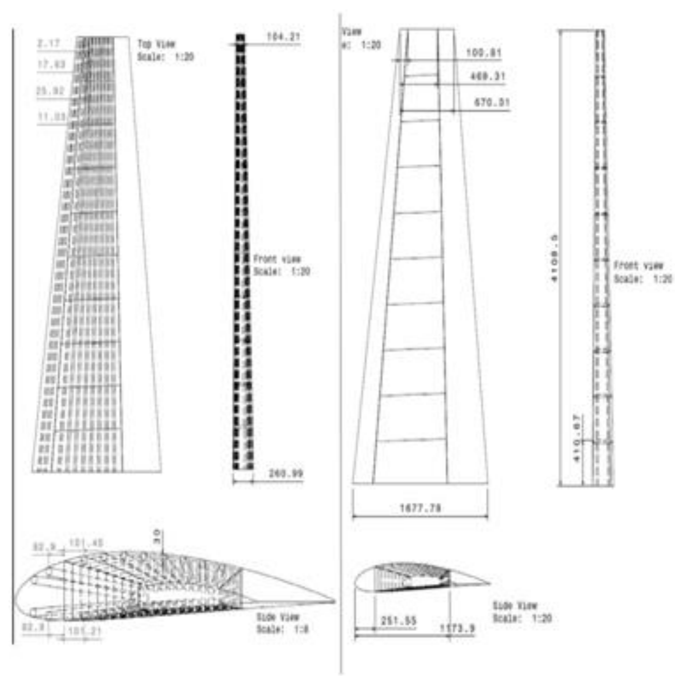

Figure .1 Model Dimensions

III. PROCEDURE

- Open Catia V5
- Go to airfoil tool website, search and plot NACA 4415 for chord length of 1. 677m and 0.6708m. Save both as .csv file.
- Open the first (root airfoil coordinate) .csv file in excel. Copy the x, y, z coordinate to ‘GSD_PointSplineLoftFromExcel.xls’, and run the micro to plot the airfoil spline and curve in Catia automatically.

- Repeat the above step for the second (tip airfoil coordinate) .csv file, but first edit it by adding 4.1085m to its z-coordinate and 0.1512m to its x-coordinate (obtained by 4.1085*tan(8.6°))
- After the curves have been plotted I Catia. Using wireframe and surface design, extrude the root airfoil to the tip one (since it is a simple wing geometry with no kink, guide lines are neglected).
- Make two points for both root and tip chord line at 15% and 70% chord length.
- Extrude these lines to form the front and rear spar, up-to the cover surface.
- Draw 9 lines normal (perpendicular) to the rear spar up-to the front spar with equal spacing of 0.41067m
- Extrude these lines up-to the cover surface to form the webbed ribs.
- Sketch circles (18 circles) of 0.030m diameter both at the root and tip airfoil and make the constrained tangentially to airfoils. And make guide lines to join the circles spanwise sequentially at the tangential point.
- Use sweep feature to generate the tube-like stringer on the cover surface.
- Make and draft of the wing box with and without stringers, rendered iso view and other wireframe view with appropriate dimensions for top, front and side views.
- Save work and create a new part work
- The new part project is created by copy the old one. This is modified to produce a partially webbed rib, using the fill feature to an external (rib edges) and internal (Circular sections as shown below) boundary. This circles are tangential to an offset of 30mm from the rib edge. The spacing between the are set using dependency formula as relation. This formula is dependent on the rib size:

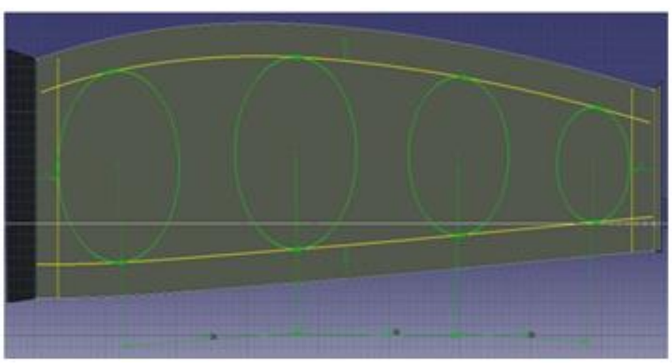

Figure.2 geometry for internal circular boundary of the rib

- Another partially webbed rib of circumscribed quadrilateral internal boundary is modelled, with the following geometry shown below. The quadrilaterals are tangential to the inertial circular boundary to make the comparative study between them, a relative value. But this is still constrained by the offset of the top and bottom edge of the rib. A corner of 10□ arch is used to sharp the quadrilateral. Each constrain is created with a formula to help its replicability on all ribs.

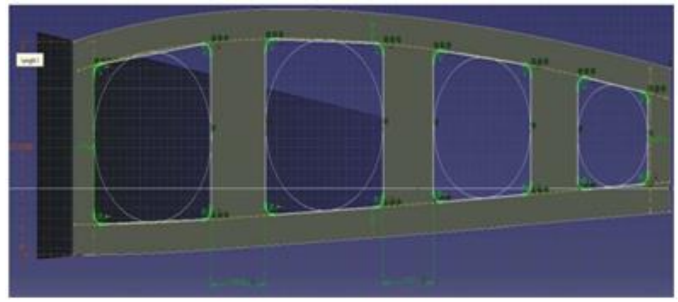

Figure3.Geometry for internal circumscribed quadrilateral boundary of the rib

- Saveworkandexit

IV. MODELLED RESULT (RENDERED VIEW):

Themodelledmodelsaresavedseparatelyas.igsfileformatfortheinitialnon-parametriccomparison.

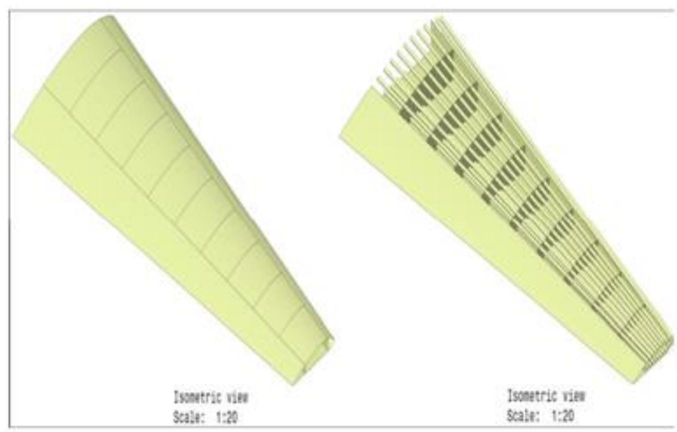

Figure 4. Wing-box model (rendered view)

V. CONCLUSION

The preliminary CAD design is done with the help of Catia V5 software. This modelled is initially done to analyze the importance of stringers. In subsequent modelling the fuel tank will also be included with some adjustment to the wing box geometry.

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BIOGRAPHIES

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