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Preliminary Designing of Wing Brace Brackets for an Amphibious Aircraft

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ABSTRACT

In this paper we describe how to design and analyze the stresses and loads on a particular brackets holding the braces supporting the wing over a float in an amphibious aircraft. This is done to ensure optical and structural stability. The rear brace is connected via a bracket to the rear wing spar and to a rib along x axis. The front brace is connected via a bracket to the front spar and the same rib. The brackets include a hinge below the lower wing surface, where the brace is connected. The designing of front and rear bracket in the wings is also shown with the help of screenshots of brackets designed in CATIA V5 software. It includes the design of front attachment bracket, rear attachment bracket, front brace, rear brace .Calculation of loads, moments and stresses acting on brackets will be considered under this study which are to be done with method of sections. The calculations will be shown with the help of screenshots taken in MS Excel sheets.

KEYWORDS

Brackets, use of brackets in aircraft, braces, attachment of brackets to wings, Aluminum alloy, Structural stability in wings, method of sections, moment and stress analysis, CATIA screenshots, MS Excel screenshots.

1. INTRODUCTION

For some optical and structural reasons the wing should be supported with two braces per side to the floats. The rear brace is connected via a bracket to the rear wing spar and to a rib along x axis. The front brace is connected via a bracket to the front spar and the same rib. The brackets include a hinge below the lower wing surface, where the brace is connected. Both braces are brought together at one single lower point, which is connected to the float with a quick release pin. After releasing the pin the braces should be able to be turned in the upper hinges and fixed on the lower wing surface. The attachment bracket on the float side is not part of this design task.

2. BRACKET DESIGN

Attachment Bracket design

The brackets are attached to the spar and the rib via screws, rivets or bonding.

- Bearing stress and minimum hole distances in spars have to be considered.
- Center line of brace, spar and rib should intersect at one point.
- Material is aluminium alloy (NAW 6061) properly protected against corrosion.
- Aerodynamic drag should be minimized (no CFD analysis required).
- Double shear connection.

3. BRACE DESIGN

The Shape of braces should be aerodynamic. There should not be any moments included in braces .The material should be aluminium to prevent corrosion .They have to be adjustable along the axis .They should have buckling bending computation to compression, aerodynamic load and inertia loads.

4. GENERAL REQUIREMENTS

Salt water operation has to be considered according to protect corrosion. Only above named materials should be used .Computation is done using excel. Designing is done according to following load cases:

Loadcase	Load in front strut along strut axis (N)	Load in rear strut along strut axis (N)	Inertia load factor (g)	Aircraft speed (kn)
A1 (RE30)	24050	18800	3.8	96
D (RE31)	14640	24300	3.8	140
F (RE32)	-5444	25730	1.9	79
G (RE33)	-21300	1587	-1.9	96
E(RE34)	-22630	6980	-1.9	79

5. Aluminium Alloy (NAW 6061)

Properties:

- Versatile heat treatable extruded alloy
- Has medium to high strength capabilities.
- Applications in A/C and aerospace components, marine fittings, transport.
- Medium to high strength.
- Good toughness.
- Good surface finish.
- Excellent corrosion resistance to atmospheric conditions.
- Good corrosion resistance to sea water.
- Can be anodized.
- Good weld ability and workability.
- Widely available.

Typical composition:

COMPONENTS	AMOUNT (wt %)
Aluminium	**Balance**
Magnesium	**0.8 – 1.2**
Silicon	**0.4 – 0.8**
Iron	**Max. 0.7**
Copper	**0.15 – 0.40**
Zinc	**Max. 0.25**
Titanium	**Max. 0.15**
Manganese	**Max. 0.15**
Chromium	**0.04 – 0.35**
Others	**0.05**

6. Method of sections

- The method of sections involves analytically cutting the truss into sections and solving for static equilibrium for each section.
- The sections are obtained by cutting through some of the members of truss to expose the force inside the members.
- In the method of joints, we are dealing with static equilibrium at a point. This limits the static equilibrium equations to just the two force equations. A section has finite size and this means you can also use moment equations to solve the problem. This allows solving for up to three unknown forces at a time.
- Since the method of sections allows solving for up to three unknown forces at a time, you should choose sections that involve cutting through no more than three members at a time.
- When a member force points towards the joint it is attached to, the member is in compression. If that force points away from the joint it is attached to, the member is in tension.

7. CATIA V5 MODEL

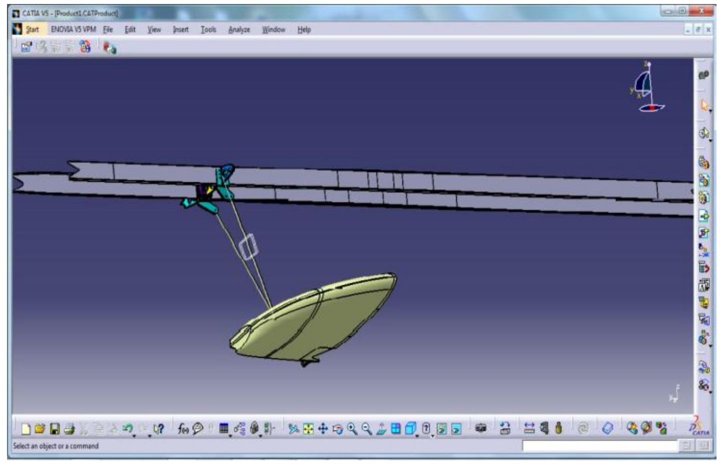

Figure 1 bracket with spar and float

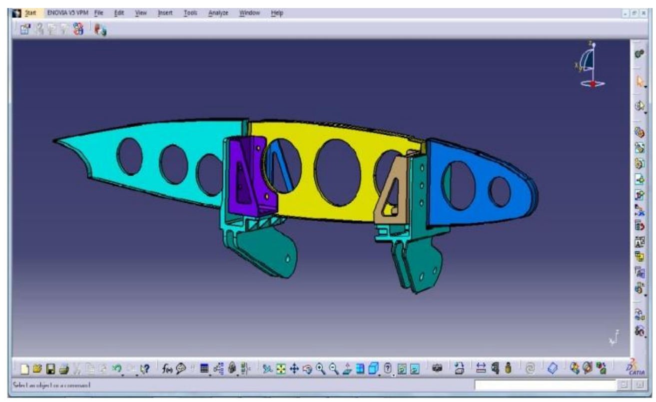

Figure 2 position of bracket on rib

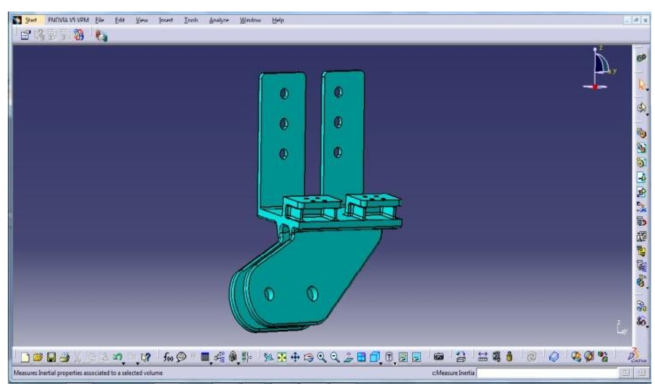

Figure 3 lower part of bracket

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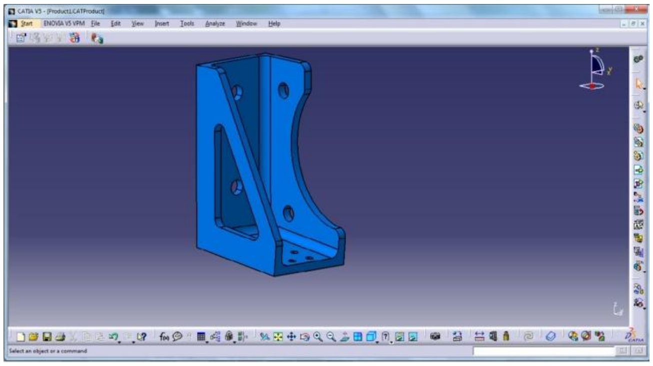

Figure 4 upper part of bracket

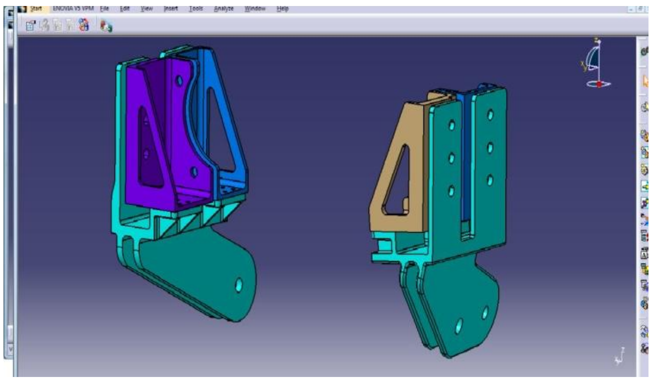

Figure 5 front and rear bracket

8. CONCLUSION
Detail designing will be carried out as per the method of sections.

Formulae used:

- X component of force (force is given)
  Fx = force*cos(α) where α is angle between direction of force and x axis
  Y component of force
  Fy=force*cos(β) where β is the angle between direction of force and y axis
  Z component of force
  Fz =force*cos(γ) where γ is the angle between direction of force and z axis
- Moments
  M= force*l where l is the perpendicular distance
  As the moments are calculated for different force components therefore resulting moment Mr can be calculated by
  Mr = (Mx + My)1/2
- Inertia
  I = (bd3)/12
  Where b and d are d length and breadth of the cross section of which inertia is to b calculated
- Stress = My/I
  Where M is the resulting moment
  Y is half the length d used in inertia (d/2)
  I is inertia

To calculate the above properties the model is divided into various sections and then the values are calculated for the sections respectively. Each section may be defined as different structural component like cantilever beam, simply supported beam, column etc based on its orientation, load carrying capability or degree of freedom. Hence, the formulae to be used depend on structure of the section. And therefore we will lead to the thorough designing of the bracket. The calculations will be done with the help of Microsoft excel. Different load cases will b taken into consideration (load cases shown in a table at page 1).

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