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Design and Analysis of Electrical Unloaded Bracket of An Aircraft

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Abstract

Aircraft design strategy is constantly changing taking safety, weight and cost into consideration. The manufactures are most interested to find the way to make product to meet these three requirements. Unloaded brackets are extensively used for holding cables bundles in aircraft fuselage. It is found that, presently several conventional clamping methods are used for holding he ducts and wire bundles individually. Here, its targeting to optimize Z-Unloaded bracket in both material and profile aspect. Joint strength optimization can be carried out using, hand calculation methodology, where material strength can be obtained using structural analysis tool. The bracket thus designed should have sufficient strength, low weight and easy to manufacture and to be integrated with primary or secondary structural parts.

Keywords

Aircraft brackets, unloaded brackets, Z-bracket etc

Introduction

1. Brackets: A bracket is a small fitting or support used to attach system parts as duct, bundle, cable, and blanket keeping them intended positions. Generally, the brackets are made of steel sheet strip slit and are cut to size before configured to the required shape by bending operation. The brackets are heat-treated to obtain the desired surface properties.

Types of brackets:

A-Bracket is attached directly to the primary structure with permanent fasteners;

B-Bracket is a removable bracket attached on to A-Brackets or directly on to the structure;

C-Bracket is attached to either A or B ones; usually they are glued on to the A and B brackets.

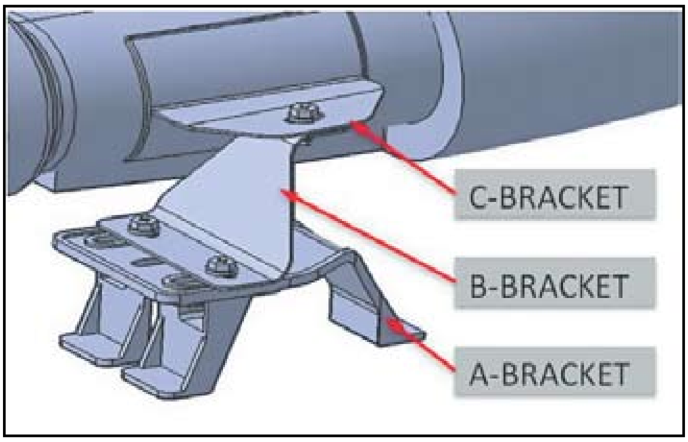

Fig. 1.2

II. Materials

2.1. Aluminium alloy 2024 is an aluminium alloy, with copper as the primary alloying element. It is used in applications requiring high strength to weight ratio, as well as good fatigue resistance. Due to its high strength and fatigue resistance, 2024 is widely used in aircraft structures, especially wing and fuselage structures under tension. It has an ultimate tensile strength of 210–140 MPa (30–21 ksi), and maximum yield strength of no more than 97 MPa (14,000 psi).

2.2. Titanium alloy 6Al-2Sn-4Zr-2Mo grade is a near alpha alloy known for its exceptional creep resistance, strength, and sturdiness, and is often used in a duplex annealed state. Due to its heat resistant nature and durability, 6-2-4-2 titanium materials are most commonly used in the engineering of aircraft and turbine engines (discs, blades, and impellers), airframe components, and high performance automotive valves. Ti 6-2-4-2 comes in a variety of standard specifications including AMS 4919, AMS 4975 and more.

III. Developing tools

1. Modeling in CATIA:

Catia is a multi-platform software suite for computer-aided design (CAD), computer-aided manufacturing (CAM),computer-aided engineering (CAE), PLM and 3D, developed by the French company Dassault Systèmes. CATIA enables the creation of 3D parts, from 3D sketches, sheet metal, composites, molded, forged or tooling parts up to the definition of mechanical assemblies. The software provides advanced technologies for mechanical surfacing & BIW. It provides tools to complete product definition, including functional tolerances as well as kinematics definition.

In the case of Aerospace engineering an additional module named the aerospace sheet metal design offers the user combine the capabilities of generative sheet metal design and generative surface design. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches (blueprints).

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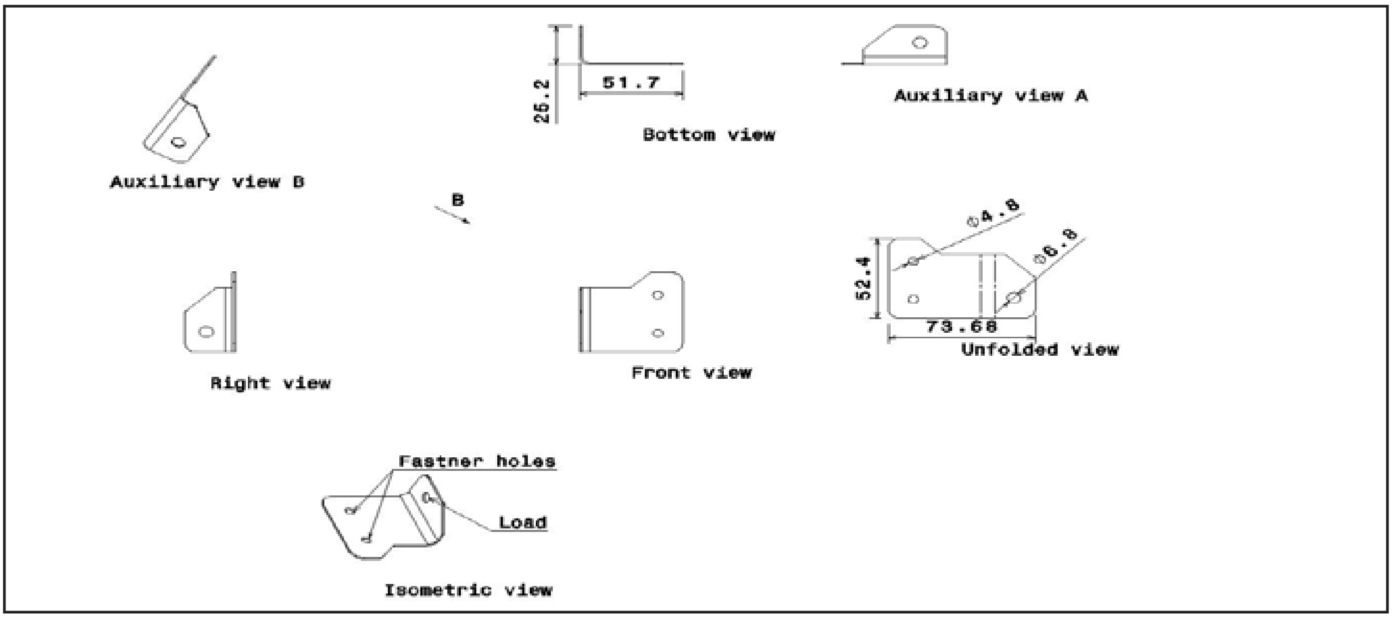


2. Analysis in Msc Patran and Nastran

This is based on sophisticated numerical methods, the most prominent being the Finite Element Method. Nonlinear FE problems may be solved with built-in implicit numerical techniques. Engineers use MSC Nastran to ensure structural systems have the necessary strength, stiffness, and life to preclude failure (excess stresses, resonance, buckling, or detrimental deformations) that may compromise structural function and safety. Manufacturers leverage MSC Patran and Nastran's unique multidisciplinary approach to structural analysis at various points in the product development process.
For doing the analysis in patran, first the pre created model in Catia is to be imported into the software.

3. Material Properties

Two materials are used for designing of the bracket and their properties are

material	Ultimate tensile stress	Ultimate shear stress	density	Poisson's ratio
Al 2024	448	280	2.78	0.32
Ti 6-2-4-2	893	550	4.56	0.33

4. Meshing Method

Free mesh with smart element sizing is adopted to automatically and flexible mesh the model. compared to the mapped mesh, which is restricted to only quadrilateral (area) or only hexahedron (volume) elements, free mesh has no restrictions in terms of element shapes.
Boundary conditions and loads:
in patran the load cases can be done in any user defined way. all the translations and rotations can be kept constrained in all directions and multiple forces (loads) can be applied as required.

IV. Results and discussions

4.1. Aluminum alloy 2024 Msc. Patran & Nastran and hand calculation values of Bracket

Aluminium 2024	Analytical values			Hand calculation values		
Thickness/load direction	X	y	z	x	y	z
2.2	229	87.4	114	229.0560281	44.27390791	84.48377964
2.0	355	106	138	276.9104892	53.22128852	101.9545744
1.8	**439**	**109**	**164**	**341.5610984**	**65.27302279**	**125.5397618**
1.6	562	170	246	431.9059357	82.06407563	158.4739039

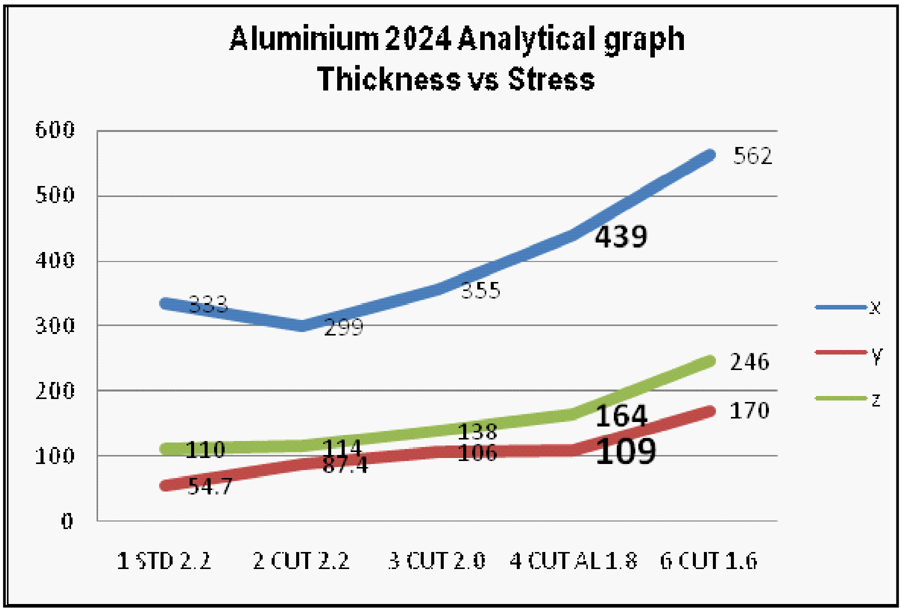
Aluminum alloy 2024, as the material gave the desired results in software analysis. the Ultimate Tensile Stress and Ultimate Shear Stress of the material is of 448 n/mm2 and 280 n/mm2 respectively, for the thickness of 1.8 mm the bracket gave the UTS and USS of 439 n/mm2 and 109 n/mm2 which is a desired value. And at 1.6 mm thickness the bracket failed in analysis.

4.2. Titanium alloy 6Al-2Sn-4Zr-2Mo Msc. Patran & Nastran and hand calculation values of bracket

Titanium 6Al-2Sn-4Zr-2Mo	Analytical values			Hand calculation values		
Thickness/load direction	x	y	z	x	y	z
2.2	354	109	159	229.0560281	44.27390791	84.48377964
2.0	298	89.2	133	276.9104892	53.22128852	101.9545744
1.8	538	134	198	341.5610984	65.27302279	125.5397618

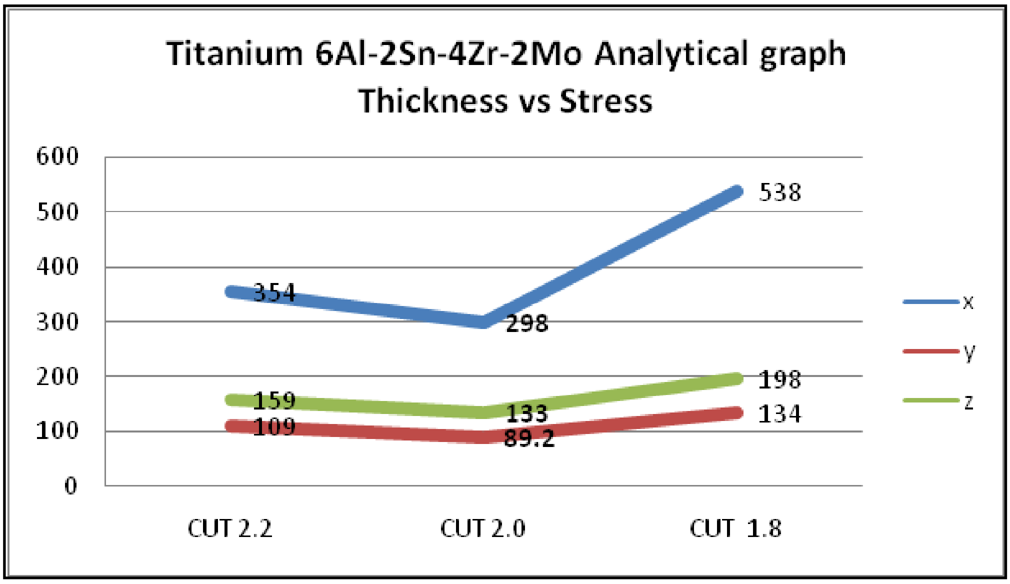
Titanium material vales are not as desired as Aluminum. from 2.2mm to 2.0mm thickness the tensile stress and shear stress values got decreased, but for 1.8 mm thickness the tensile stress and shear stress values got increased.

4.3. Aluminum alloy 2024 Msc. Patran & Nastran values graph



from the graph the derised value is obtained at 1.8mm thickness.

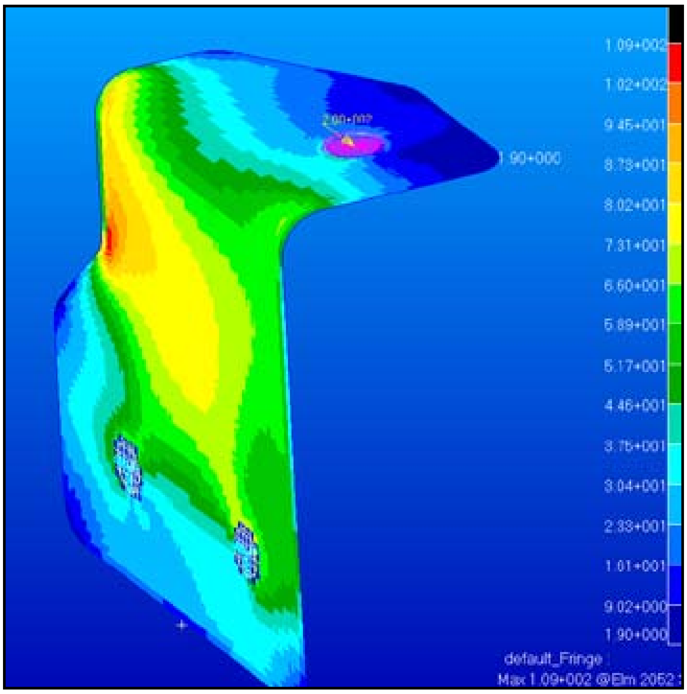
4.4. Titanium 6Al-2Sn-4Zr-2Mo Msc. Patran & Nastran values graph

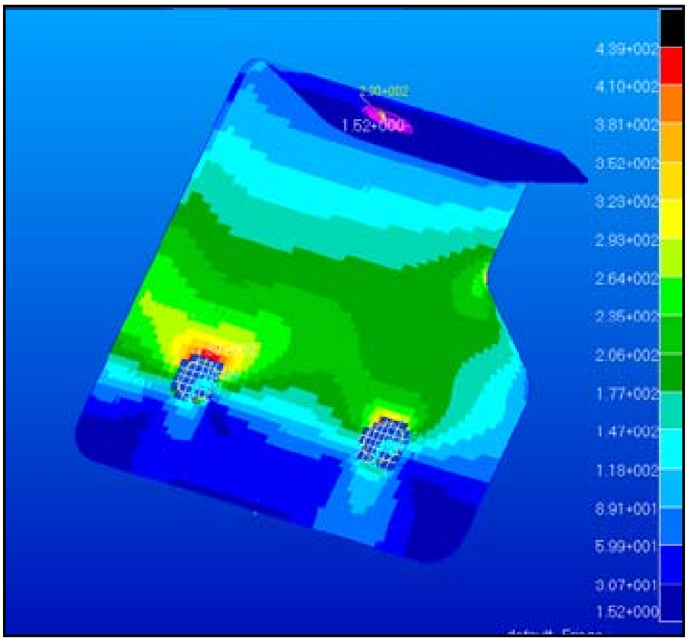


from the graph the values got increased after 2.0mm thickness

4.5. MSC.Patran & Nastran analysis

X direction and Y direction loads for 1.8 mm thickness Aluminium 2024 bracket





from the images we can see that the bracket when load applied in x direction has the maximum stress value near the fastener location and in y direction has the maximum stress value above the fastener location near the fillet corner.

V. Conclusion

ATA-92 bracket of Aluminum 2024 alloy is modified with 4 different thickness values, i.e: 2.2mm, 2.0mm, 1.8mm, 1.6mm. from the study, following observations were made. Ultimate stress values at 1.8mm thickness and for Al2024 are more desired compared to other thicknesses and material loading. The Optimal thickness of the bracket is 1.8mm and the material is Aluminum 2024. the maximum tensile value is 439 N/mm2 and maximum shear value is 109 N/mm2.

As the project is about finding an optimal bracket with cost, safety and weight reduction, the thickness considered is 1.8mm. The cost of aluminum alloy 2024 is 300 per kg where titanium is 3000 per kg, hence al 2024 is considered as the optimum material for the bracket manufacturing. as per the safety of the bracket, at the thickness 1.8mm and of material 2024 the final stress values are lesser than the stress values of the material.

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