

Design and Fabrication of Composite Drill and Trim Jig for I/R Holes of Tip Assembly Door

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ABSTRACT

In the recent technologies composites plays the vital role in the aircraft manufacturing field. Composites are made of two or more dissimilar materials which can be made as per our requirement and even contour shape also. To provide repeatability and accuracy, easy repairable and cost saving composite tools are being preferred. When compared to metallic tools, fabrication of composite tools and its serviceability is better. Especially aircraft components like tip assembly door is having critical contour shape and the drilling of holes in parts having such contour is very difficult. So the selection of tool shall be the right one to make the part as per the engineering requirement.

INTRODUCTION

The I/R holes is nothing but the Interchangeability (I) and Replaceability(R). Aircraft parts are either identified by Interchangeability or Replaceability. Interchangeability is defined as the parts which are fabricated from the controlled tool which is derived from master gauge. Replaceability is the parts which are fabricated from the controlled tool but the only difference is these parts can be reworked as per the fitment requirement. For the better fitment of mating parts, engineering requirements such as flushness, holes alignment, gap and step between door and structure. To meet these requirement the better tool shall be chosen and drilling shall be done from that tool. Though the part is having contour the tool made of composite is easier than the metallic tool. In composites also many types such as glass, carbon etc. Glass fiber is being chosen for easy convenience of fabrication or layup process.

1.1 SCOPE OF THE PROJECT

This project is the design and fabrication of composite drill and trim jig for the I/R holes of tip assembly door. Though the tip assembly door is having critical contour shape and for the drilling of holes in those contour parts composite tools will provide the best results.

1.2 PROBLEM DEFINITION

I/R holes drilled from composite tools will provide best fit check when compared to the holes drilled from the metallic tools. More over composite tools can be repaired and reused easily than the metallic tools.

1.3 OBJECTIVE OF THE PROJECT

The fit check includes the flushness of the torqued screw, gap between the door and the tip assembly structure, holes of the door and structure shall match. To meet these criteria the holes on the door shall meet the engineering requirement. By meeting these requirements the aerodynamics is also satisfied so that the air flow is also flown as per the design.

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

The earliest man made composite materials were straw and mud combined to form bricks for building construction. Wattle and daub is one of the oldest man-made composite materials, at over 6000 years old. Concrete is also a composite material and is used more than any other man-made material in the world. The first artificial fibre reinforced plastic was bakelite which dates to 1907. One of the most common and familiar composite is fiberglass, in which small glass fiber are embedded within a polymeric material (normally an epoxy or polyester). The glass

fiber is relatively strong and stiff (but also brittle), whereas the polymer is ductile. Thus the resulting fiberglass is relatively stiff, strong, flexible and ductile.

2.2 LITERATURE SURVEY

Originating from early agricultural societies and being almost forgotten after centuries, a true revival started of using lightweight composite structures for many technical solutions during the second half of the 20th century. After being solely used for their electromagnetic properties (insulators and radar-domes), using composites to improve the structural performance of spacecraft and military aircraft became popular in the last two decades of the previous century. First at any costs, with development of improved materials with increasing costs, nowadays cost reduction during manufacturing and operation are the main technology drivers. Latest development is the use of composites to protect man against fire and impact and a tendency to a more environmental friendly design, leading to the reintroduction of natural fibres in the composite technology. Increasingly nowadays, the success of composites in applications, by volume and by numbers, can be ranked by accessibility and reproducibility of the applied manufacturing techniques.

MATERIAL SELECTION

The composite material used for the fabrication of drill and trim jig is glass fiber and at the end of the composite tool is having mild steel for the flat surface.

3.1 FIBER SPECIFICATION

Material type- Glass Fiber

Thickness-0.3mm



3.1.1 Properties and uses

Material	E, GPa	σ_b , GPa	ρ , kg/m ³	E/ ρ , MJ/kg	σ_b/ρ , MJ/kg	cost, \$/kg
S-glass	85.5	4.5	2,490	34.3	1.8	22-33

Table 1-S Glass Material properties

Here E is the modulus of elasticity, σ_b is the tensile strength, and ρ is the density.

- Used on aircraft parts that do not have to carry heavy loads.
- Principally used for interior parts such as window surrounds, Leading Edge, Trailing Edge panels, fairings etc.

3.1.2 Composition

The glass fiber is made of various types of glass depending upon the fiberglass use. These glasses all contain silica with various amounts of oxides of calcium, magnesium and sometimes boron.

PROBLEM STATEMENT

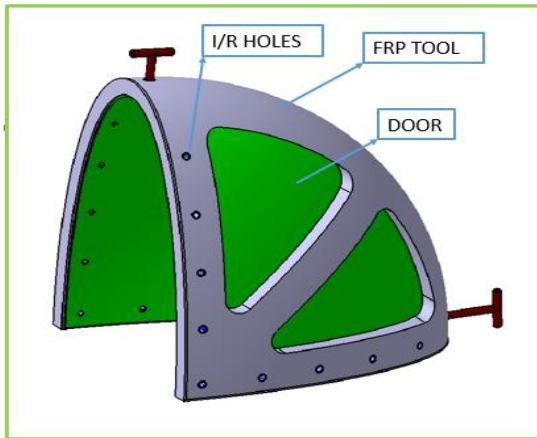
The tip assembly door is having critical contour shape as per the aerodynamics and similarly as the tip assembly structure. If these two parts are assembled with screws and there are many factors to be satisfied. If any of the parameter hasn't met then the part shall not be used for the fitment.

4.1 DESIGN OF COMPOSITE JIG OR TOOL:

Though the door is having critical contour the composite tool or the jig shall be designed similarly as per the door. The only criteria is for designing the tool is the door should butt with the tool without any gap and enter easily.

4.2 Design requirements

- Engineering requirement such as pitch, hole diameter, profile.



Note: All dimensions are in inches and hole numbers are numbered from upper side nose to lower side nose.

CONCLUSIONS

- The composite glass fiber tool is providing repeatable fit check report which is meeting the engineering requirement.
- Moreover the tool may be repaired easily and reused without affecting the contour of the tool when compared to metallic tool.

FUTURE SCOPE OF WORK

The study can be further taken to alternate fixture for holding door by toggle clamps in-lieu of C-Clamps.

REFERENCES

1. Arden L. Bement, “Composite Manufacturing technology”, National Institute of Standards and technology. Chicago, USA.
2. Mechanics of composite materials, R Jones.

4.3 MATERIAL PROPERTIES

Fiber glass is composed of Silicon-di-oxide, Aluminium oxide, Magnesium oxide.

DESIGN METHODOLOGY

5.1 INTRODUCTION TO CATIA

Catia (computer aided three-dimensional interactive application) is a multi-platform cad/cam/cae commercial software suite developed by the French company dassault systems. Written in the c++programming language, catia is the cornerstone of the dassault systems product lifecycle management software suite.

5.1.1 Scope of application

CATIA provides a suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate complex innovative shapes. From subdivision, styling, and Class A surfaces to mechanical functional surfaces.

RESULTS AND DISCUSSIONS

6.1 FIT CHECK RESULT:

HOLE NO	FLUSHNESS	GAP	STEP
1	0.003"	0.045"	0.020"
2	0.002"	0.068"	0.016"
3	0.003"	0.074"	0.022"
4	0.003"	0.062"	0.017"
5	0.003"	0.054"	0.014"
6	0.002"	0.060"	0.022"

Table 2-Fit check result