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Stress analysis of splice joint in an aircraft fuselage with prediction of fatigue life to crack initiation

Venkatesh Deshpande[1], Pratik Phadnis[2], S. P. Avadhani[3]

[1]Assistant Professor, Department of Mechanical Engineering, KLS Gogte institute of Technology, Belagavi, Karnataka, India
[2]Assistant Professor, Department of Mechanical Engineering, KLS Gogte institute of Technology, Belagavi, Karnataka, India
[3]Assistant Professor, Department of Mechanical Engineering, KLS Gogte institute of Technology, Belagavi, Karnataka, India

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Abstract - *stress analysis of a splice joint in a transport aircraft is studied in the current paper. Splice joint panel consists of skin plates, doubler plat.e Alloy of Aluminium 2024-T351 is considered for all the structural elements of the panel. We will be carrying out 2D Finite Element Analysis of splice joint. At the rivet locations Distribution of fasteners loads and local stress field. For a crack to initiate splice joint is one of the critical location. At maximum stress location prediction of fatigue life for crack initiation will be studied*

Key Words: **fuselage, splice joint, , crack propagation, finite element analysis**.

1.INTRODUCTION

A method of joining two members end to end is called Splice joint, If the material length is not sufficient then we opt for Splice joint. . As an alternate to Lap joint and Butt joint the Splice joint can be used. For shear flows span wise the splices are designed. In the majority of cases chord wise loads are small and can be ignored. Due to cabin pressurization the skin splices of longitudinal are designed for Hoops tension loading but It is required to consider local shear loads. Some times Skin and attachment both should be considered for analysis. Fastener hole-out efficiency is to be be maintained at 75 to 80 percent if a lower skin is designed to lower margin of safety.

2. OBJECTIVE:

The dissertation works objective will be stress analysis of splice joint in aircraft fuselage along prediction of fatigue life to crack initiation. . For a study typical splice joint panel consisting of skin plates, doubler plate is considered. For structural analysis of a panel Aluminium alloy 2024-T351 material is considered. On a splice joint panel a two-dimensional finite element-analysis will be carried out.

3. METHODOLOGY

In aerospace design, fatigue analysis is routinely used to minimize the fatigue accidents, as every component added important to aircraft. Therefore minimization of fatigue has played a significant role in aircraft industry.

4. DESIGN METHODOLOGY

Linear Static Analysis:

CATIA V4 is used for the geometric modeling of the structure for the linear static analysis of the splice joint panel. Then abstraction of mid faces can be done. . For preprocessor the model is impoted , where MSC Patran V7 is used. Using MSC Patran a finite element model is created. For a model all the element properties, boundary conditions and loads are applied . For solving purpose MSC/.Nastran is used. After solving the model, it is again imported to MSC Patran for post processing. The results are obtained using MSC Patran and are plotted

1st phase: Stress analysis
2nd phase: fatigue analysis

5. Geometry:

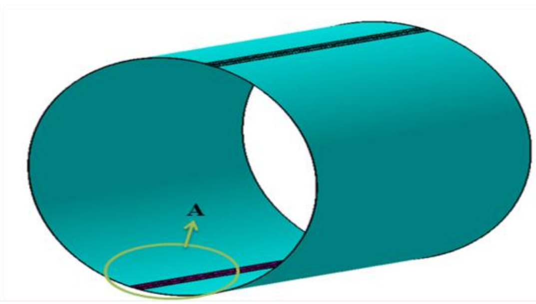

Fig-1: Geometric model of fuselage segment contains butt joint

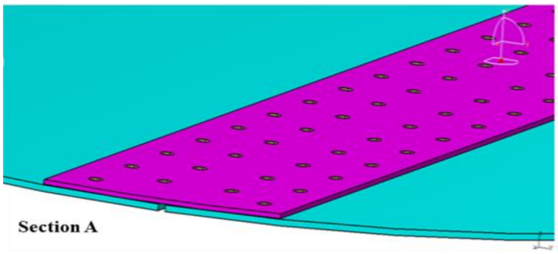

Fig-2: Close-up view of geometric model for section A contains butt joint

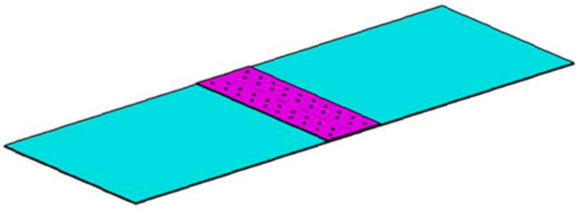

Fig-3: Geometric model of splice joint flat panel.

6. Meshing

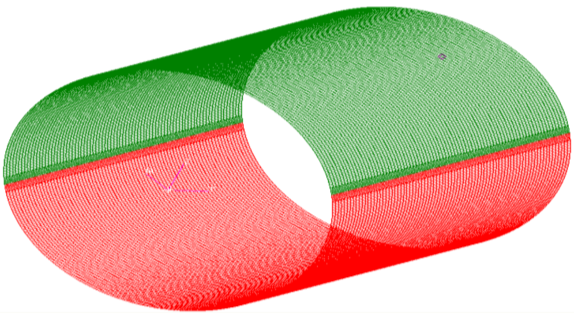

Fig-4: Meshed group of fuselage segment consisting of skin part

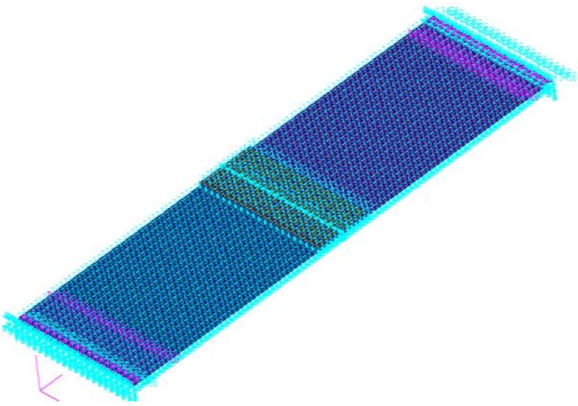

Fig-5: Global FE model of splice joint panel with loads and Boundary Conditions

7. RESULTS AND DISCUSSIONS:

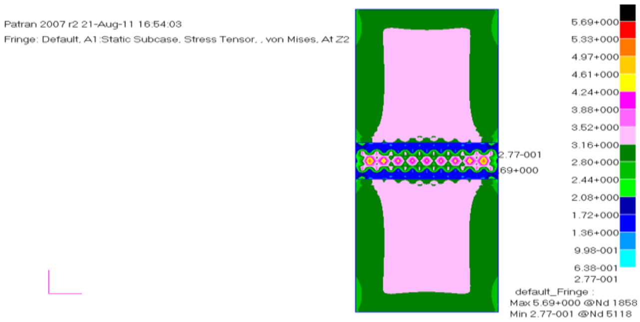

Fig-6: At thickness Z2 the static stress for von mises stress contour at doubler side.

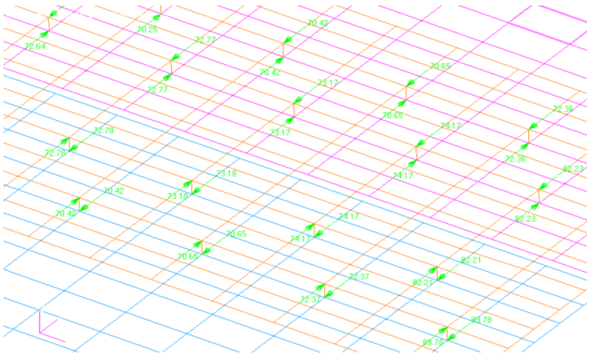

Fig-7: Free body loads taken by rivets

Table 1: Displacement and Von Mises stresses for different pressure values

- The stress contour and displacement contour as

Pressure in PSI	Pressure in kg/mm²	Maximum Von mises stresses in kg/mm² at position		Displace ment in mm
		Z1	Z2	
6	0.00422	10.8	18.1	3.02
6.5	0.00457	11.7	19.5	3.27
7	0.00493	12.7	21.1	3.53
7.5	0.00528	13.6	22.6	3.78
8	0.00563	14.5	24.1	4.03
8.5	0.00598	15.4	25.6	4.28
9	0.00633	16.3	27.1	4.53

shown in above figures. It shows the static stresses distribution of von mises stress tensor and the static displacement variation.

- The both skin part and doubler part of fuselage segment under goes tensile stresses under pressure loading and it's deforming elastically.
- From result contour, the stress at rivet hole in the skin part is more and it under the condition of elastic straining.
- The maximum von-Mises stress for load case of 9PSI at position Z_2 is 27.1 kg/mm^2

  The Maximum Von-mises stresses at node id 47731 are observed from different pressure cycles.

8. REFERENCES

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