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Stress Analysis and Fatigue Life Estimation of Undercarriage Uplock Hook

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Abstract - This project work deals with the static analysis and fatigue analysis of the uplock hook which is the most critical component of the uplock assembly. CAD model of the uplock hook is created using CATIA V5R20. Then static analysis and fatigue analysis is carried out using ANSYS 17. From the static stress analysis results, it is observed that the maximum stress developed in the uplock hook is lesser than the component material allowable. Fatigue analysis shows that the components are meeting the fatigue life requirement of the aircraft operations.

Keywords – Uplock hook, Stress Analysis, Static Analysis, Fatigue Analysis.

I. INTRODUCTION

The undercarriage or landing gear is the structure that supports an aircraft on the ground during landing and allows it to taxi, turning, towing etc. Modern aircraft uses the retractable landing gear, which extends during landing and retracts after take-off. Uplock allows the landing gear to lock and unlock during retraction and extension operation during take-off and landing. In the retracted and extended condition, landing gear is held in locked and unlocked position by uplock mechanism which consists of uplock lever, uplock hook, springs, cover plates, hydraulic assembly and some other components. Uplock is subjected to the loads during the extension (upload) and retraction (download) operation of the landing gear. The uplock is designed for the upload and download which will be acting during extension and retraction operations respectively.

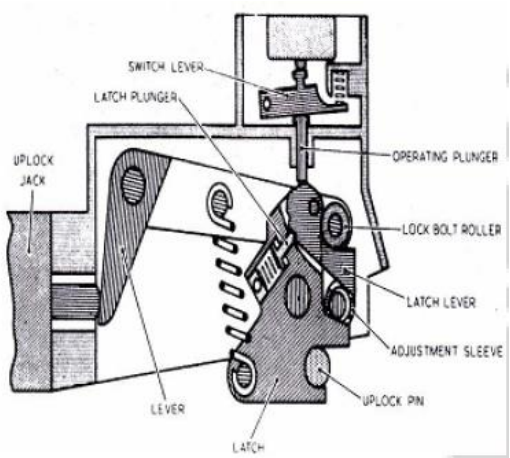

Fig 1. Uplock Mechanism in Locked Condition

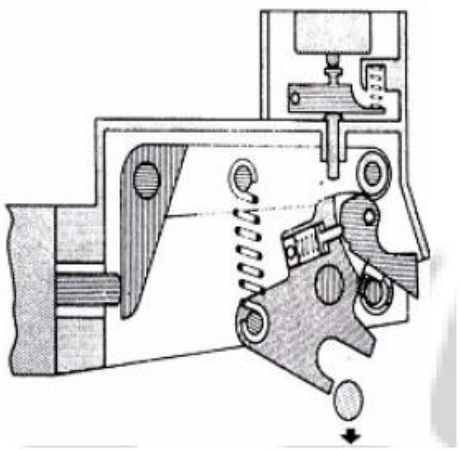

Fig 2. Uplock Mechanism in Unlocked Condition

II. DESIGN

During retraction and extension, landing gear is held in locked and unlocked position by uplock mechanism. Uplock lever and uplock hook is the most critical parts in the uplock mechanism. Uplock lever transfers the force from the hydraulic jack to the uplock hook during locking and unlocking of the landing gear. Uplock hook holds the roller which is attached to the landing gear to keep the landing gear in retracted position whereas roller which is attached to the landing gear leaves the hook during extended position. CAD model of the Uplock hook is designed using CATIA V5R20.

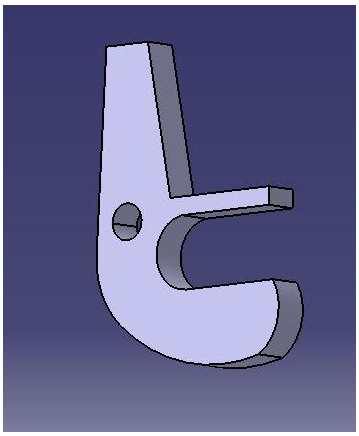

Fig 3. CAD Model of Uplock Hook

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III. STATIC ANALYSIS

A. *Meshing, Boundary and Loading Coditions*

Meshing:

ANSYS is used to do meshing in the uplock lever design. There are several types of mesh pattern, some of them are triangle, quadrilateral, tetra and hexa. In this design hex-dominant mesh and refinement technique is used.

Boundary Conditions:

A – Allowed to rotate only about x-axis, all other transitional and rotational motions are arrested.
B – Arrested in x, y, z direction translational motion.

Loading Condition:

During retraction, weight of the landing gear acts downward on the hook which is the download condition. During extension, due to the weight of the landing gear some load acts upward on the hook which is the upload condition. On comparing both download and upload condition, the maximum load acts in the download condition. When uplock roller is locked by the hook attached to the uplock lever, therefore compression force of 22650 N acts on the uplock hook.

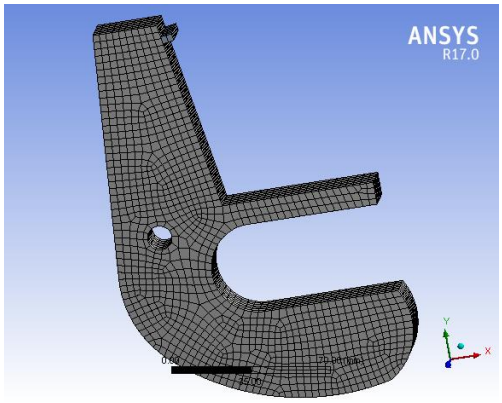

Fig 4. Meshing of Uplock Hook

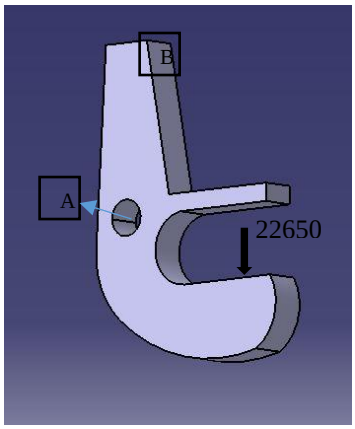

Fig 5. Boundary & Loading Condition of Uplock Hook

B. *Material Selection*

Table I. Material Selection & Material Properties

Component	Uplock Hook
Material	NCM Steel
Young's Modulus	210 GPa
Poisson's Ratio	0.3
Ultimate Tensile Strength	1250 MPa
Density	7.8599E-06 kg/mm^3

C. *Stress Distribution*

Static stress analysis is done for the uplock hook with download acting on it. From the analysis, it is observed that the maximum stress developed in the uplock hook is lesser than the component material allowable (1250 MPa).

Table II. Stress Analysis

Maximum Principal Stress	439 MPa
Equivalent Von-Mises Stress	554 MPa
Normal Stress	401 MPa

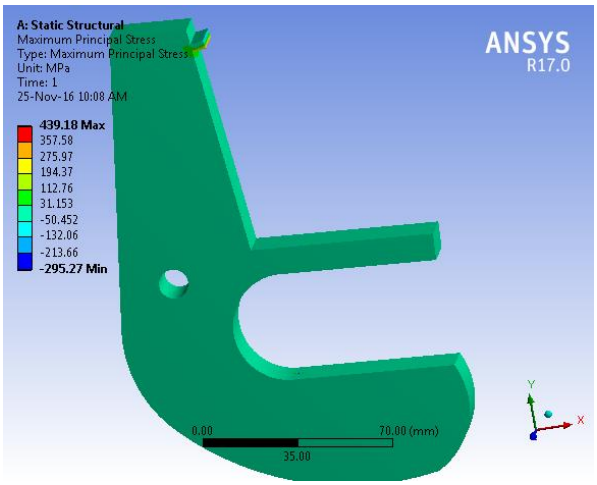

Fig 6. Maximum Principal Stress

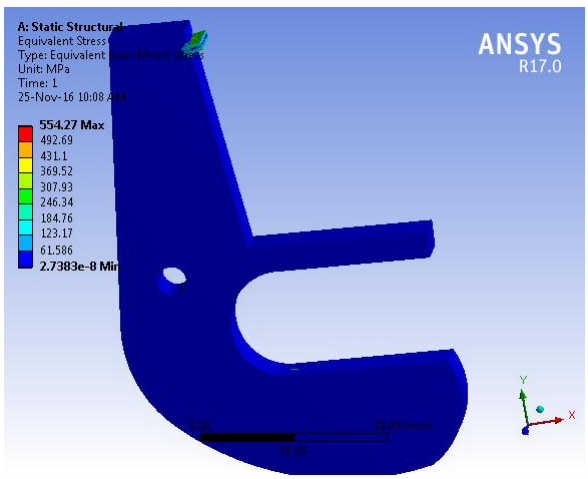

Fig 7. Equivalent Von - Mises Stress

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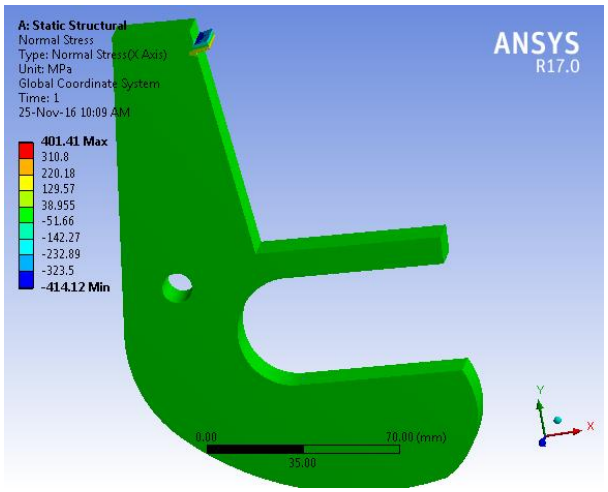

Fig 8. Normal Stress

IV. FATIGUE ANALYSIS

A. Fatigue Life for Uplock Lever

Fatigue analysis for uplock hook is done by considering the maximum principal stress developed during download condition.

From fatigue analysis, it is found that fatigue life of uplock hook is 1103 cycles during download condition which meets the fatigue life requirement (1000 cycles) of the aircraft operations.

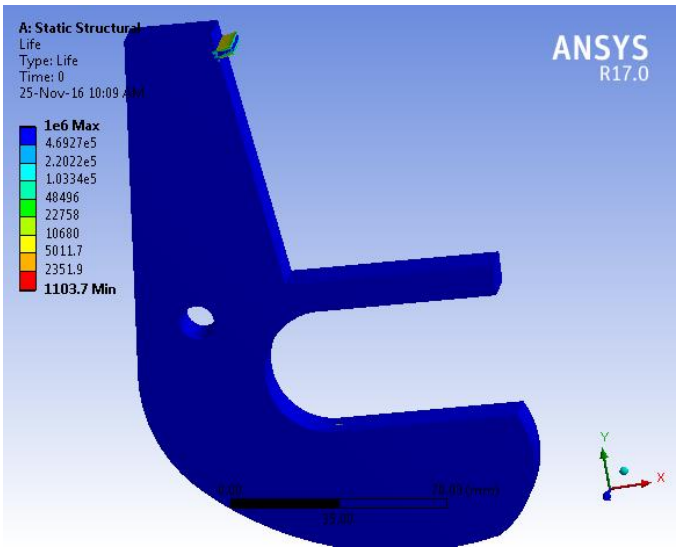

Fig 9. Fatigue Life

V. CONCLUSION

This paper work presents a computational design of uplock hook for static and fatigue analysis. The dimensions of the proposed model are obtained by the strength of material approach and then the static analysis is done and fatigue life is estimated. For this analysis and estimation, finite element analysis tool is used. Static stress analysis for the uplock hook is carried out to found the maximum principal stress developed which is less than the material allowable limit. Therefore, proposed design of Uplock hook is safe. Fatigue analysis is carried out to find the fatigue life of uplock hook which meets the fatigue life requirement.

VI. FUTURE SCOPE

Design and Analysis will be carried for remaining parts of undercarriage Uplock assembly. Optimization of the design for the reduction of stress concentration and to provide good adequate structural strength.

VII. REFERENCES

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