FATIGUE LIFE ESTIMATION ON LANDING GEAR

Nehru. K [1], Guhan. G [2], Rajasekar. G [3], Premnath. A[4], Srinath. N [5]
[1]Assistant Professor, [2][3][4][5]UG Scholar,
Department of Aeronautical Engineering, SNS College of Technology, Coimbatore, India

ABSTRACT

This paper boarder around the nose landing gear static structural analysis and calculating the fatigue life estimation by various loading condition. The nose landing gear is one of the most primary and important structural component of any aircraft. Landing gear is a crucial part and has been found with increasing failure due to fatigue loading conditions. The nose wheel landing gear is made up of structural steel material and has a good structural composition and physical properties. Therefore, this paper deals with the static structural and fatigue life analysis of nose wheel landing gear. Here the design is made using CATIA V5 software and the fatigue life analysis is carried using ANSYS 16.1 software. Finally, an effort has been made in this paper to investigate the induced stresses and calculated the fatigue lifetime of the nose wheel landing gear.

Keywords: ANSYS, CATIA, Fatigue, Nose landing gear,

I. INTRODUCTION

The nose landing gear is the primary landing gear which is present in nose region of the aircraft .The nose landing gear has a braking system inside the gear bay to decelerate the tires during retraction but has as main functions to increase the maneuverability of the aircraft and to support the nose of the aircraft during ground operations. Furthermore, the nose landing gear construction includes a system that damps shimmy, which is an effect that causes the nose gear to point in the direction which is not equal to the moving- direction. Landing Gear Analysis Aircraft use landing gears ever since the first flight was made.

In the beginning of the twentieth century landing gears were simplistic, had no wheels and were not retractable. During the Second World War, landing gears were developed; became retractable and the configuration changed. Because of the increasing aircraft dimensions and weight more developed gears were needed. Nowadays, all commercial aircraft use complex landing gear systems that are retractable. All landing gears serve the same purpose.

- During landing, the landing gear must absorb the landing shock.
- During taxi, the nose gear is steerable to maneuver on the ground.

- To reduce drag, the landing gear is made extendable and retractable.
- After the touchdown, the aircraft decelerates by the use of brake systems.
- All landing gear system components must meet several regulations to guarantee safety aircraft operations.

PURPOSES

Landing gears come in different types and dimensions, but they all have the same purposes:

- Absorbing the landing pulse
- Maneuvering on the ground
- Safety aircraft operations

Absorbing the Landing Pulse

When an aircraft touches down, the vertical velocity has to be totally reduced. The landing gear of modern aircraft absorbs the landing pulse and thereby reduces the aircraft vertical speed to zero.

Maneuvering on the Ground

The landing gear provides the possibility to maneuver on the ground. The engines enable acceleration or deceleration of the aircraft and the brake landing gear components decelerate the wheels.

Safety Aircraft Operations

The aircraft fuselage is supported by the landing gear, whereby the aircraft's fuselage is distributed on the ground. The landing gear also protects the aircraft fuselage and prevents aircraft damage with creating a space between the fuselage and the ground.

II. METHODOLOGY

The following flow chart is used as the methodology to find the fatigue life calculation for the Landing gear and it is given below

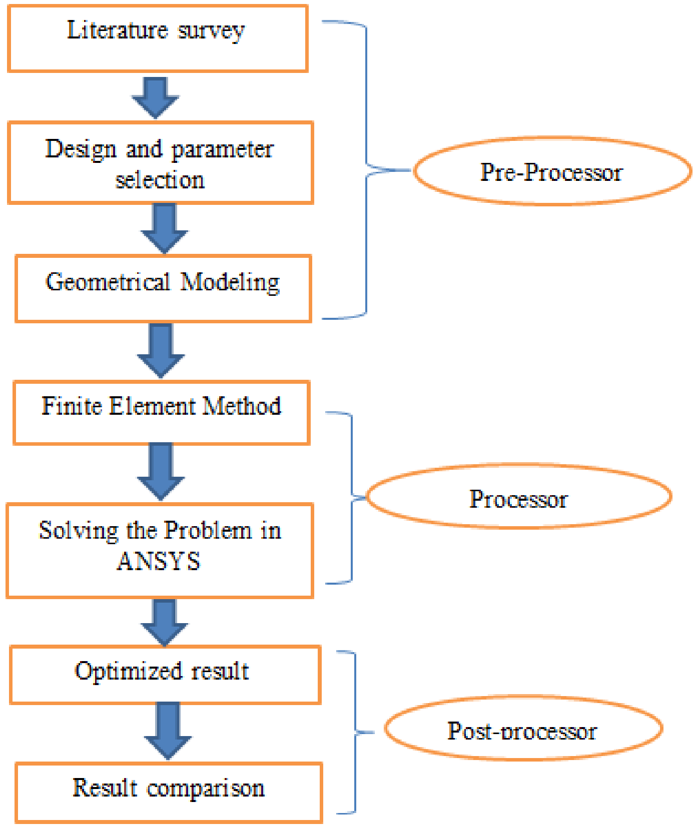

Fig: 2.1 Flow chart

III. DESCRIPTION OF NOSE WHEEL LANDING GEAR.

The main reference for the design of the nose wheel landing gear is taken from the Cessna 152 aircraft. The primary design considerations for the nose wheel landing gear are given below.

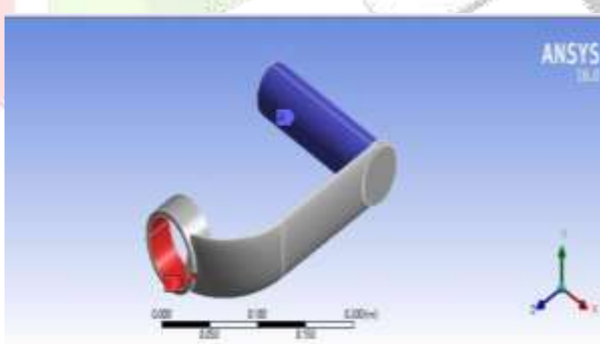

Fig: 3.1 landing gear CATIA Model

Table 1: Design consideration

S.No	Description	Value

1	Base axle length	150 mm
2	Axle diameter	45 mm
3	Axle head diameter	50 mm
4	Strut height	220 mm
5	Strut width	70 mm
6	Strut head inner diameter	60 mm
7	Strut head outer diameter	70 mm
8	Number of struts joined	1 No's

MATERIAL DATA

The material used for our project is structural steel. The material properties of the structural steel is given below

Table 2: Material details

S. No	Description	Value
1	**Elastic modulus**	$20 * 10^9$ N/mm^2
2	**Poisson's ratio**	**0. 3**
3	**Minimum tensile strength**	$13 * 10^6$ N/mm^2
4	**Minimum yield strength**	$19 * 10^6$ N/mm^2

IV RESULT AND DISCUSSIONS

A. STRESS ANALYSIS :

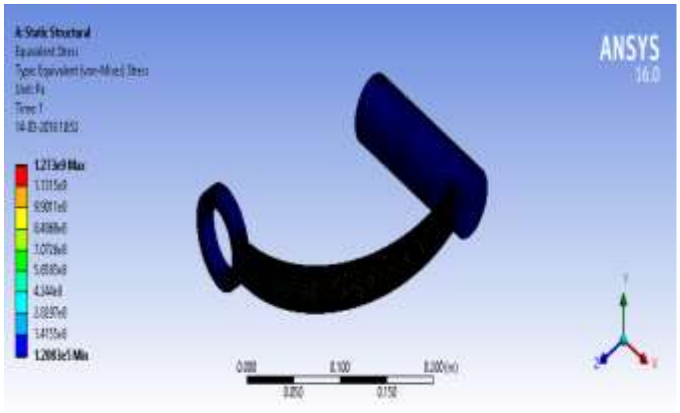

Fig 4.1: Stress Analysis

B. STRAIN ANALYSIS :

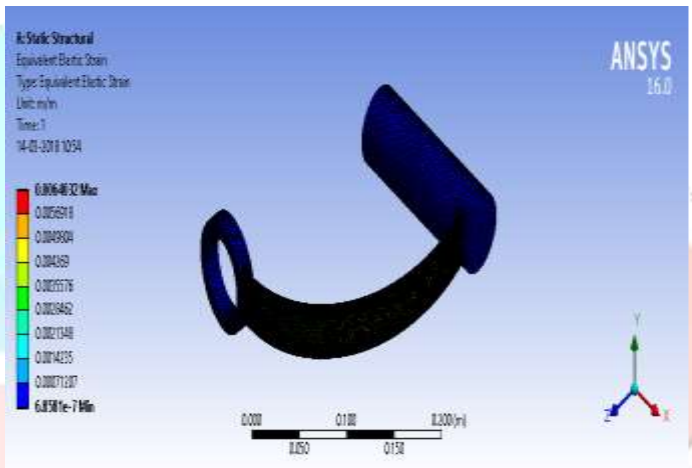

Fig 4.2: Strain Analysis

C. FATIGUE LIFE ESTIMATION

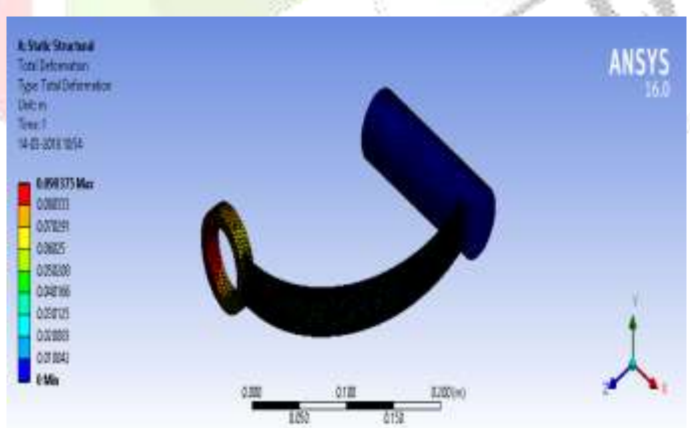

Fig 4.3: Total Deformation

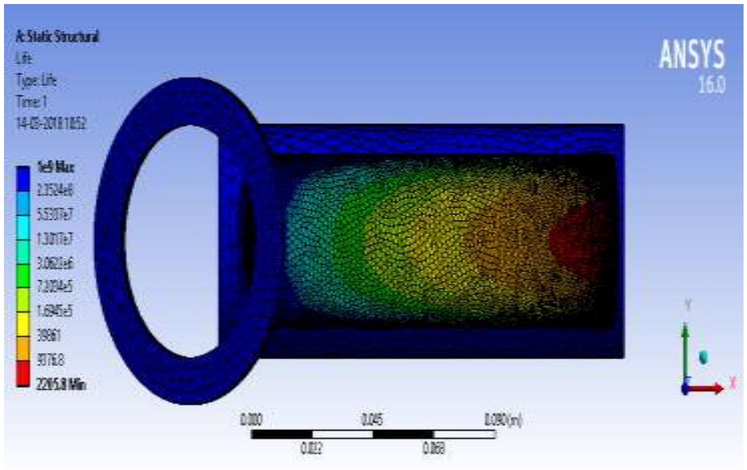

Fig 4.4: Fatigue Life Estimation

From the above results calculated we are getting the life cycle values for the nose wheel landing gear as 2205.8 cycles minimum and 1e9 cycles maximum.

V CONCLUSION

From the results gathered from the above analysis we come to a conclusion that the maximum fatigue structural damage will happen in the inner mid portion of the landing gear strut with a minimum life cycle of about 2205.8 cycles. This result can be further optimized with variable design consideration and by using different type of analysis methods.

REFERENCES

[1]. Ravi Kumar (oct – 2013)," Design and analysis of main landing gear structure of a transport aircraft and fatigue life estimation for the critical" in International Journal of Mechanical and Production Engineering, ISSN: 2320-2092, Volume- 1, Issue- 4, Oct-2013.

[2]. Raees Fida Swati, "Design and Structural Analysis of Weight Optimized Main Landing Gears for UAV under Impact Loading" from Article in Journal of Space Technology · July 2014, vol -4, no 1 july 2014.

[3]. Pu-Woei Chen1, (Feb -2012), "Composites structures and fatigue life analysis" in Advanced Materials Research Vols 476-478 (2012) pp 406-412.

[4]. Ibrahim Doruk (Sep - 2010) "occurrences of locking block failure in the semi-automatic shotgun bolts at a shotgun factory "in Scientific Research and Essays Vol. 5(20), pp. 3134-3140, 18 October 2010, ISSN 1992-2248.

[5]. Praveen Joel P (April- 2014) "Conceptual design phase of aircraft the integration of undercarriage system" in IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. III (Mar- Apr. 2014), PP 67-74.

[6]. Nikhil H P1 (May - 2015) "The undercarriage or landing gear of an aircraft structure" in IJRET: International Journal of Research in Engineering and Technology, eISSN: 2319-1163, pISSN: 2321-7308.

[7]. Raviteja B1 (Oct - 2015) "Nose landing gear support bracket assembly and its function maintain the stability of the landing gear during the movements" in IJSRD - International Journal for Scientific Research & Development, Vol. 3, Issue 10, 2015 , ISSN -2321-0613.

Nehru. K, "Design and Optimization of the Effect of Base Bleed on Thrust of A Truncated Spike Nozzle", International Journal of Engineering Science and Computing, September 2017 Volume 7 Issue No.9, p 14807.

Nehru. K, "Low Cycle Fatigue Analysis of Gas Turbine Blade", National Journal on Advances in Building Sciences and Mechanics Vol.6, No.1.

[8]. E.A. Ossa (April - 2005) "Analysis and investigation of the causes of the failure of the main landing gear of a Cessna402B civil aircraft" in Engineering Failure Analysis 13 (2006) 1177–1183 33

[9]. Haitao Wang (Mar -2008) "A mathematical model is developed to control aircraft vibrations caused by runway excitation using an active landing gear system" in Journal of Sound and Vibration 317 (2008) 50–66.