DESIGN, DEVELOPMENT & ANALYSIS ON LANDING GEAR OF LIGHT WEIGHT FIGHTER AIRCRAFT

1Mr. K.S Naidu, 2HARI KRISHNA YADAV VEERLA
MASTER OF TECHNOLOGY Aeronautical Engineering Department MLR Institute of Technology, Hyderabad
1Asst.Professor of AERO DEPARTMENT, MLR Institute of Technology, Hyderabad
2Student, Aeronautical Engineering Department, MLR Institute of Technology, Hyderabad.

***Abstract*—** Another aircraft major component that is needed to be designed is landing gear (undercarriage). The landing gear is the structure that supports an aircraft on the ground and allows it to taxi, take-off, and land. In fact, landing gear design tends to have several interferences with the aircraft structural design. In this book, the structural design aspects of landing gear are not addressed; but, those design parameters which strongly impact the aircraft configuration design and aircraft aerodynamics will be discussed. In addition, some aspects of landing gear such as shock absorber, retraction mechanism and brakes are assumed as non-aeronautical issues and may be determined by a mechanical engineer. Thus, those pure mechanical parameters will not be considered in this chapter either.

The first job of an aircraft designer in the landing gear design process is to select the landing gear configuration. Landing gear functions may be performed through the application of various landing gear types and configurations. Landing gear design requirements are parts of the aircraft general design requirements including cost, aircraft performance, aircraft stability, aircraft control, maintainability, producibility and operational considerations.

The project describes the Design, Development & Analysis calculations performed on Landing gear of a light weight fighter aircraft after the material change from metal to composites. Stress calculations of each and every component, if performed manually will become herculean task for the stress engineer. Instead, FEA software can be used to perform these calculations immediately and effectively. For our purpose, we are using the commonly approved 'Hyper mesh as a solver and Ansys for pre-processing & post-processing. During the analysis, primarily a Landing gear important components are selected from the complete landing gear modeled and the stress values are obtained. The same model is then analyzed for the understanding of the stress levels. The residual strength of the Landing gear is obtained and the different stress capability of the design is studied.

Keywords—CATIA V5 R20,Landing Gear, Ansys 5.7 & 12.0 ,Top down Assembly approach and Stress

I. INTRODUCTION

The landing gear of an aircraft supports it during ground maneuvering operations, by providing a suitable suspension system and also cushions the landing impact. It features a shock strut which dissipates the kinetic energy associated with the vertical velocity on landing and provides ease and stability for ground maneuvering's. To put it down roughly, an a/c touches down with vertical velocity of about 2 to 3 m/s, and the vertical impact load is contained within 2 to 3 times the static reaction by having suitable energy absorbing and dissipating means in the landing gear. Some gears have to undergo sequenced shape change, such as retraction or planing in order to fit in the wheel well when retracted. Another example is shrinking of the shock strut during retraction in order to clear the gear into the wheel well. Another example is shrinking of the shock strut during retraction in order to clear the gear into the wheel well. The main landing gear is one of the most critical components of an aircraft, capable of reacting the largest local loads on the airplane. It is a primary source of shock attenuation at landing. It controls the rate of compression extension and prevents damage to the vehicle by controlling load application rates and peak values. Thus utmost care must be taken while designing a main landing gear. It should be able to take 90% of the weight of the aircraft while standing. The Landing gear is the principal support for the airplane when parked, taxing, taking off or landing. The most common landing gear consists of wheels, however airplanes can be equipped with floats for landing on water or skis for landing on snow. The gear configuration consists of two main gears attached in the wing box and the nose gear which attaches to the fuselage nose. The main gear is a trailing link design which is typical for design.

II. PROJECT METHODOLOGY

A. Literature Survey

Aircraft structure is the most obvious example where functional requirements demand light weight and, therefore, high operating stresses. An efficient structural component must have three primary attributes; namely, the ability to perform its intended function, adequate service life, and the capability of being produced at reasonable cost. Attention is now focused on propagation of crack. The review summarizes the previous effort on the 'Damage tolerance assessment of stiffened structures in the Landing Gear.

B. Mathematical formulation

When the aircraft lands at normal sink rate, maximum amount of energy has to be absorbed by the main landing gear, which undergoes large deformations and rotations. This necessitates a rigorous non-linear finite element analysis of the main landing gear to predict its behavior prior to manufacturing a prototype.

Steering torque= 450000Kg-mm
For Al maximum bending stress= 45 Kg/mm2
Maximum Shearing stress =45X0.66%= 30 Kg/mm2
Moment Arm= 304 mm
Load= 450000/304 =1480Kg
Toggle Length=260mm
Reaction offset= 100mm
Reaction R1 &R2= 260X1480.2632 = 3848.6 Kg
M=1480X23=34040Kgmm
I=50X12X12X12/12=7200
Z=7200/6=1200
Bending stress=28.36 Kg/mm2 OK
For 24= 29.6 Kg/mm2
For 25 distance m=37000
Bending stress= 37000/1200=30 Kg/mm2 OK
Shear stress=3848/8.5X12X2=18.9 OK

Functional Specifications

Part Name	Main Landing Gear
Function	To absorb the shock (kinetic energy of the vertical velocity on landing)
Sinking speed	2.5 to 3 m/sec
Landing ‘g’ permitted Max. Vertical Weight	2.5 g (3 g max.) 560 Kg
Efficiency	0.5
Aesthetics rate	Very high
Functional Properties	High toughness, high strength, corrosion resistant.
Material	Which can store the greatest elastic potential energy per unit mass / volume without failing

III THESIS DESCRIPTION

- It should be able to take 90% of the weight of the aircraft while standing.
- At minimum sinking speed of 3 m/sec it should be able to take 80% of the takeoff weight.

Design Considerations

- Landing Gear should locate near the center gravity (CG) of the plane
- CG location are depended on aircraft configuration, loading, fuel state.
- Maximum strength
- Minimum weight
- High reliability
- Overall aircraft integration
- Low cost
- Airfield compatibility

σb = 6 M / t2
Where,
M = Bending moment,
t = thickness of the wall

C. Abbreviations and Acronyms

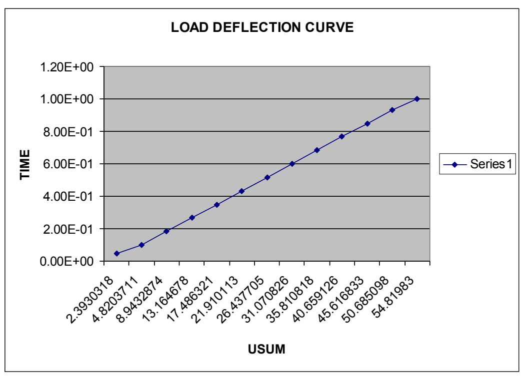
a/c: Aircraft.
PMC: polymer matrix composites
MMC: metal matrix composites
CMC: ceramic matrix composites
NTSB: National Transportation Safety Board
CG: Center of Gravity
FEM: Finite Element Method
FEA: Finite Element Analysis
CATIA: Computer Aided Three-dimensional Interactive Application.

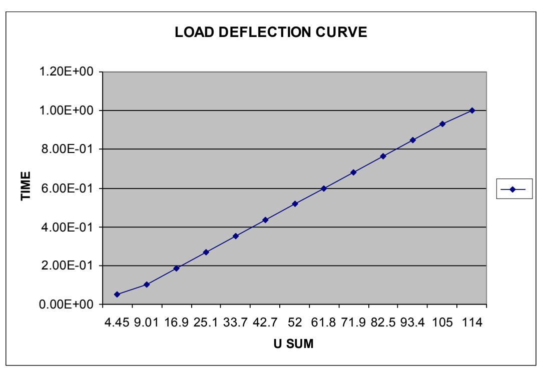
D. Units

The units used in the analysis are as given in below table.

Type	Units
Force	N
Moment	N-mm
Stress	MPa
Displacement	mm

E. *Analysis*





Load Cure information at two landing conditions

III. Thesis Discussions & Conclusions

Discussion

- It was observed that at a maximum designed load of 5600 N (maximum take-off weight), design is quite safe with unidirectional fiber arrangement as well as with bi-directional fiber arrangement.
- Maximum stresses are occurring at the curved region where supports are attached to the landing gear. And it has been found that all stresses values are well within the limits, quite lesser than allowable stresses values for the chosen material.

- Failure indexes are lower than one with maximum stress failure criteria as well as for Tsai-Wu failure criteria. Thus with both the arrangement, it satisfies all the design requirements at the maximum design load of 5600 N.
- It can be observed that at twice of the design load, landing gear is showing highly non-linear characteristics with both fiber arrangements. Failure criteria index is more than one using unidirectional fiber arrangement. Using bi-directional layer orientations, at a load level of 11200 N failure indexes are lower than one.

Conclusion

The findings from the above investigation are as follows.

- The development study has shown that composite main landing gear is as good as any advanced metallic landing gear, in their performance.
- This development shows that application of GFRP / EPOXY material makes it possible to reduce the weight of the landing gear without any reduction in load carrying capacity and stiffness resulting in 13th times lesser weight than the metallic landing gear.

References

[1] T. Niezgoda , J. Malachowski and W. Kowalski" Selection of dynamics characteristics for landing gear with the use of numerical model" INTERNATIONAL DESIGN CONFERENCE - DESIGN 2002 Dubrovnik, May 14 - 17, 2002.

[2] Anil kumar.Matta1, G.Vijay Kumar1, R.Vijay Kumar2" Design Optimisation Of Landing Gear's Leg For An Un-Manned Aerial Vehicle" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue4, JulyAugust 2012, pp.2069-2075.

[3] Shichun Zhao ; Sch. of Aeronaut., Northwestern Polytech. Univ., Xi''an, China ; Weimin Cui ; Tianxiang Yu ; Bifeng Song "Aircraft Landing Gear Simulation Using Multidomain Modeling Technology" Information Technology, Computer Engineering and Management Sciences (ICM), 2011 International Conference on (Volume:1) Date of Conference: 24-25 Sept. 2011 Page(s):279 - 281 Conference Location :Nanjing, Jiangsu.

[4]Amit Goyal;Dr.H.V.Lakshminarayan"Design ,analysis and simulation of a composite main landing gears for a light aircraft"Coventry university postgraduate study centre MSRSAS,Banglore.

[5] Clark, S.K., Dodge, R. N. and Nybakken, G. H., "Dynamic properties of aircraft tires", Journal of Aircraft, Vol.11, No.3,1974