Failure Analysis of Landing gear of the Aircraft through Finite Element Method

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Abstract-*Landing gear is an important part of an aircraft which helps in landing and takeoff of an airplane. Landing of aircraft may be roughly or smoothly hence different loads acts upon it they are drag load, vertical load and side load etc so the landing gear must be designed in such a way that it must withstand these loads in static and dynamic conditions. The aim of this project is to create a 3d model of the landing gear in CATIA software and subject it to ANYSY to determine the variation in the displacement and von misses stress behavior for three different materials (SAE 1035 steel, 7075-76 Aluminium alloy, Ti-6Al-4V Titanium alloy) which is subjected to static loading for the same loading condition and plot the results and suggest the suitable material.*

Key words: landing gear, displacement, von misses stress.

1. INTRODUCTION:

Landing gear also known as undercarriage of an aircraft is a structure and is as important as other components of an aircraft. Since aviation has become important means of transportation system, design of landing gear has become important. According to reports, the rate of aircraft failure during takeoff and landing is summed to be 55% while remaining 45% of failure during flight [1]. The landing gear supports the aircraft weight while it is at rest and takeoff without affecting other elements of an aircraft [2]. Controlling of compression /extension rate and preventing the self damages due to different loading conditions is the main function of landing gears [2]. Landing gear selection depends on design of an aircraft and its intended use [3].

1.1 Landing gear configurations:

Different gear configurations are in use [3], they are,
a. Tailwheel type landing gear
b. Single wheel
c. Bicycle landing gear
d. Tricycle landing gear
e. Quadra cycle landing gear
f. Multi bogey landing gear

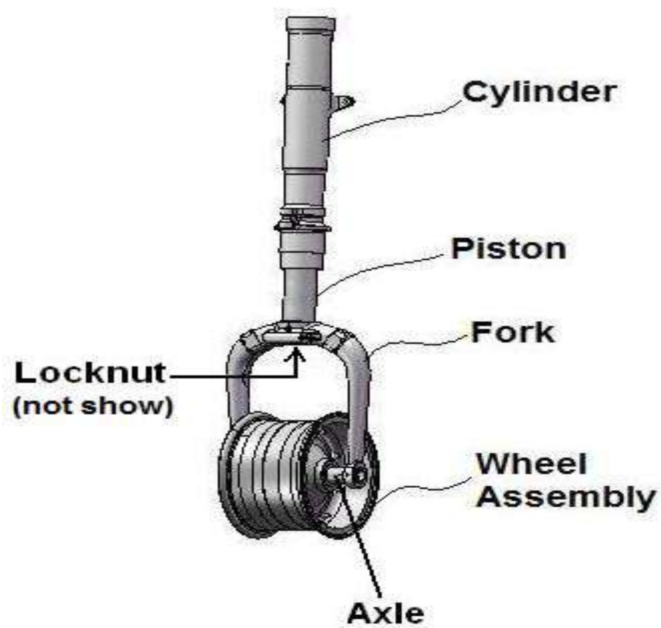


Figure no 1: Parts of landing gear

2. METHODOLOGY:

Method adopted to carry out the project is

- Create model of landing gear using CATIA V5 tool
- Import the draft to ANSYS
- Static Analysis to find out stress (von-misses) and total deformation using ANSYS.

3. MATERIALS AND PROPERTIES:

In the current work analysis of landing gear unit, 3 different materials are selected and the best suitable material has been suggested. The materials selected for our studies are

- SAE 1035 steel
- 7075-76 Aluminum alloy
- Ti-6Al-4V Titanium alloy

Some of the Physical properties of these alloys are tabulated below [4].

Property	Ti-6Al-4V	7075-76 Aluminum	SAE 1035 Steel
Density in g/cm^3	4.43	2.81	7.87
Young's modulus in Giga Pascal	113.8	70.69	196
Co-efficient of thermal expansion in μC^{-1}	8.5	23.6	11.9
Temperature in ^0C	20	20	20
Poisson's Ratio	0.372	0.33	0.29
Yield tensile strength in Mega Pascal	870	503	550
Ultimate tensile strength in Mega Pascal	960	572	620

Table no1: Physical Properties.

4. DESIGN AND ANALYSIS OF LANDING GEAR UNIT:

4.1 3d Design and drafting of Landing gear

Figure no 2: 3d view of Landing gear

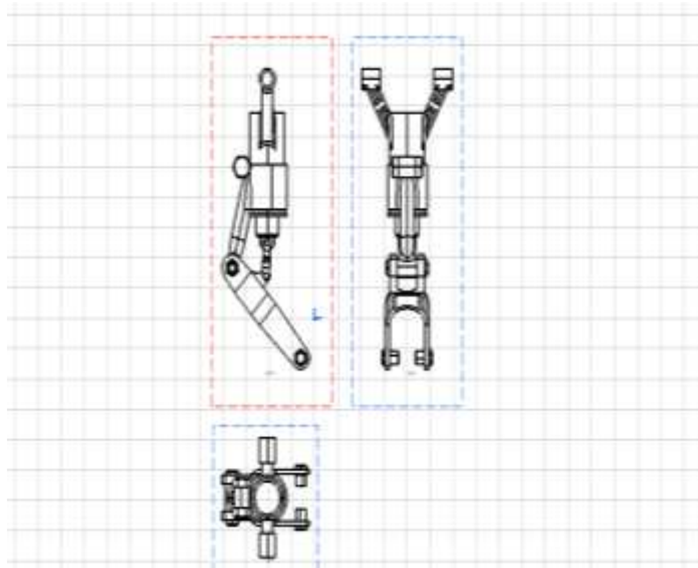


Figure no 3: 2d Drafting of Landing gear

4.2 Structural Analysis of Landing gear

The structural analysis is carried out using ANSYS workbench. The computed results are interpreted and solution for best material for landing gear is been suggested.

4.2.1 Boundary conditions

Considering maximum take-off weight into account, a static load of 80850N applied on to both sides. The nose landing gear experiences 5% of total take of weight (440000 kgs) which computes to 220000 kgs.

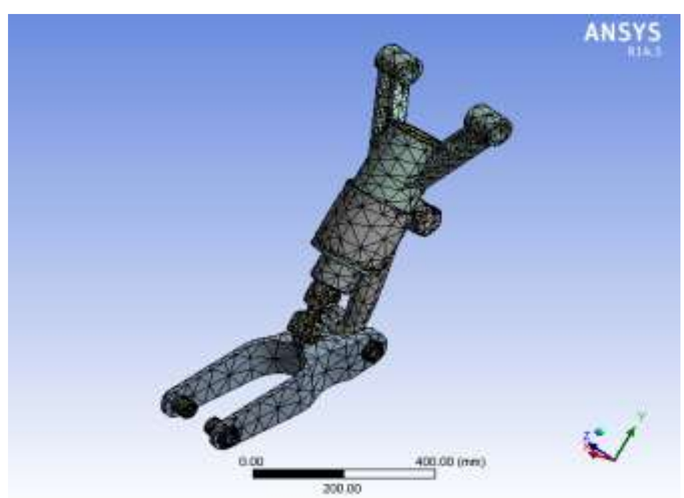


Figure no 4: Meshed form of landing gear

4.2.2 Static Structural analysis for 7075-76Al

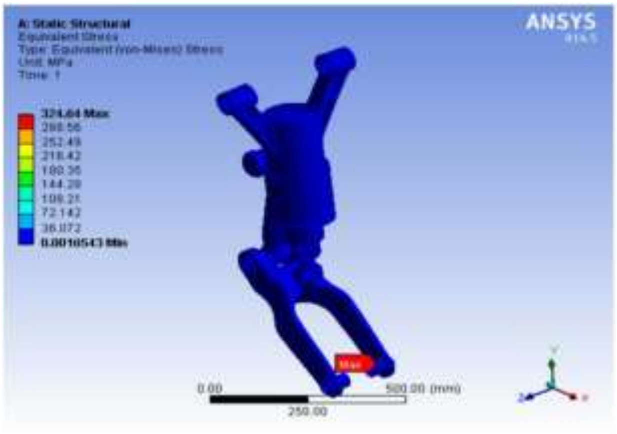


Figure no 5: Stress analysis of 7075-76Al alloy

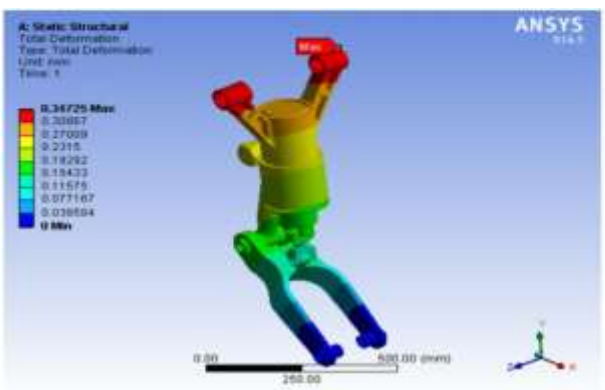


Figure no 6: Total deformation of 7075-76 Al alloy

4.2.3 Static Structural analysis for Ti-6Al-4V

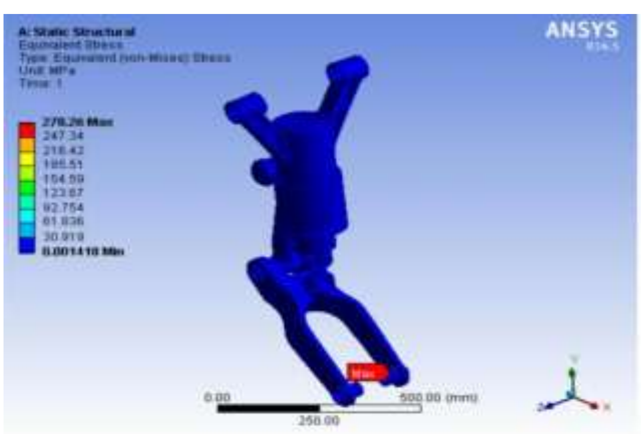


Figure no7: Stress analysis of Ti-6Al-4V

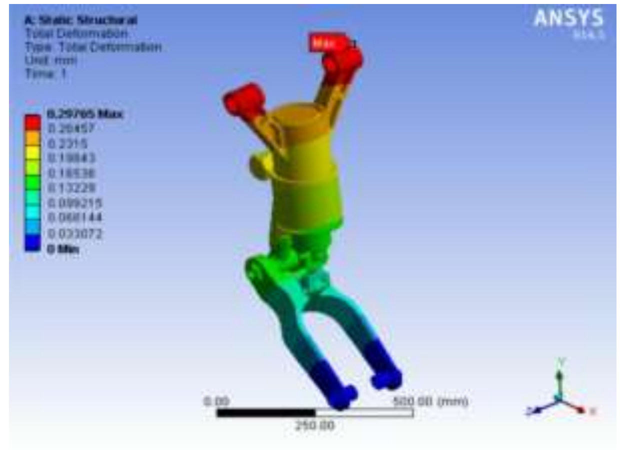


Figure no 8: Total deformation of Ti-6Al-4V

4.2.4 Static Structural analysis for SAE 1035 steel

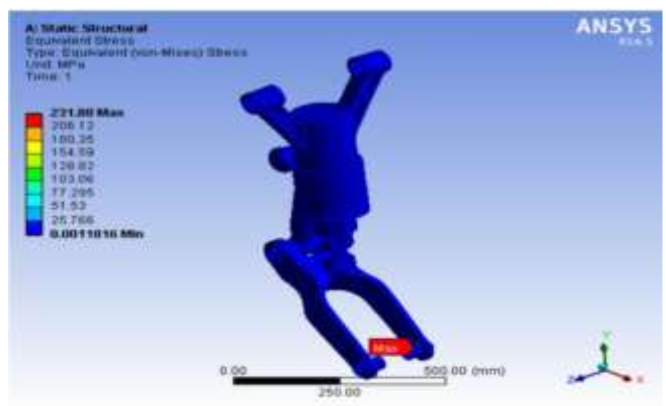


Figure no 9: Stress analysis of SAE 1035 steel

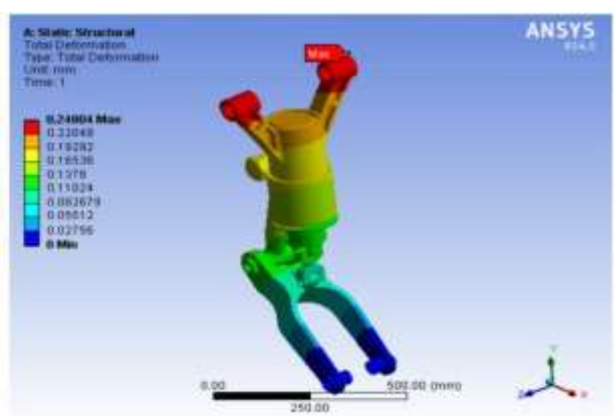


Figure no 10: Total deformation of SAE 1035 Steel.

5. RESULTS AND GRAPHS

5.1 Results:

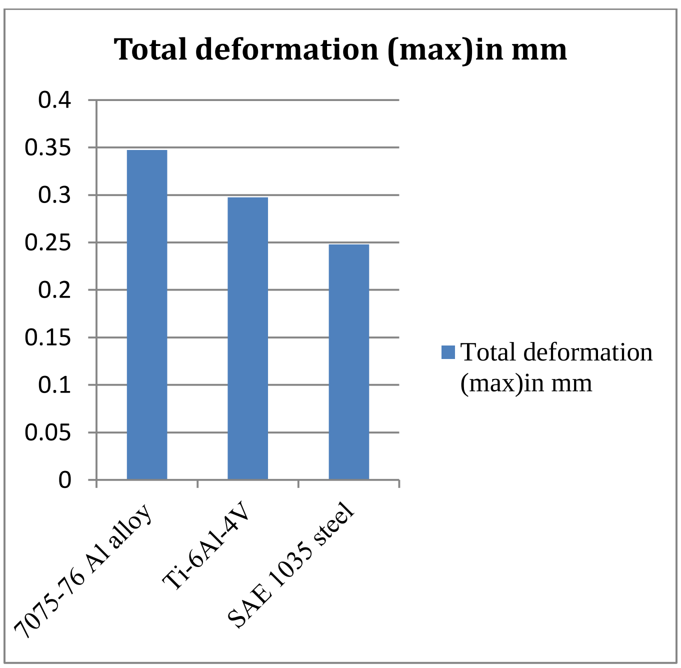
The observed results from ANSYS workbench for three different material under same load conditions, their corresponding stress (von-misses) and total deformation of materials are tabulated below

Sl no.	Material	Total deformation (max) in mm	Stress (max) in MPa.
1	7075-76 Al alloy	0.34725	324.64
2	Ti-6Al-4V	0.29765	278.26
3	SAE 1035 steel	0.24804	231.88

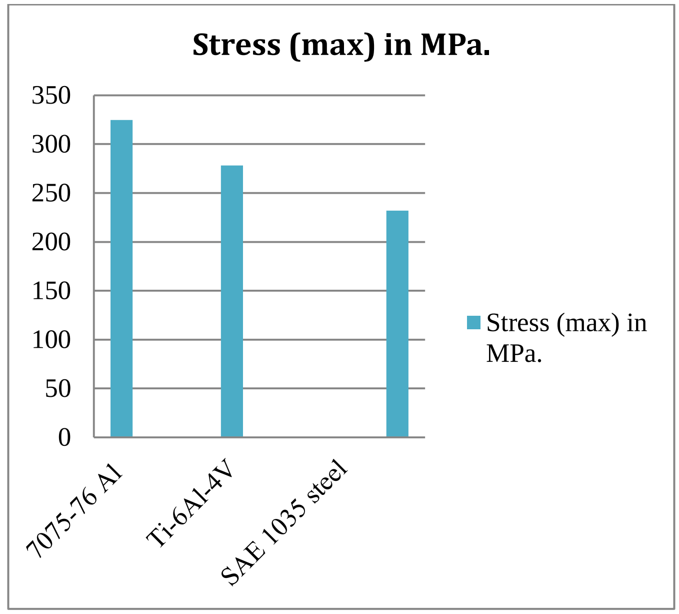
Table no 2: Comparison of stress and total deformation of materials under same loading conditions

5.2 Graphs:

The total deformation (max) of all the three alloys are plotted and found that 7075-76 Al alloy has 0.34725 mm, Ti-6Al-4V has 0.29765mm and SAE 1035 steel has 0.24804 mm.



Graph 1: Comparison of maximum total deformation of different materials



Graph 2: Comparison of Stress (max)

The stress (max) of all the three alloys are plotted and found that 7075-76 Al alloy has 324.64 Mpa, Ti-6Al-4V has 278.26 Mpa and SAE 1035 steel has 231.88 Mpa

6. CONCLUSION

The landing gear unit is designed using the CATIA V5 and the same is considered to evaluate or validate the structural behavior of the three different materials viz.SAE 1035 steel, Ti-6Al-4V and 7075-76Al alloy. By considering parameters like deformation of material under applied load and stress concentration one can analyze the structural behavior of these materials. Figure 5, 7 and 9 indicates the stress analysis of 7075-76Al, Ti-6Al-4V and SAE 1035 steel respectively. It is observed from these figures that, SAE 1035 steel has less stress concentration (231.88 MPa) than other two materials. Figure 6, 8 and 16 shows the deformation of material under load conditions for 7075-76Al, Ti-6Al-4V and SAE 1035 steel respectively. Among the 3 different materials, the less deformation of material is observed in SAE 1035 steel (0.24804 mm) when compared with other two materials.

Hence it can conclude that, the use of SAE 1035 steel over other material is preferable since it undergoes less deformation when the load is applied on it and it also experiences less stress. The SAE 1035 Steel is best suitable for any kind of landing since the aircraft doesn't always land smoothly sometime it will take a rough landing too.

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