"DESIGN AND STATIC MODAL ANALYSIS OF AIRCRAFT NOSE LANDING GEAR WITH VARIOUS MATERIALS USING FINITE ELEMENT METHOD"

[1]M.Tech Student, Department Of Mechanical Engineering, Helapuri Institute Of Technology And Science Eluru, Andhra Pradesh.
[2]Assistant Professor, Head Of The Department, Department Of Mechanical Engineering, Helapuri Institute Of Technology And Science Eluru, Andhra Pradesh.
[3]Asst Professor(C) Department of Civil Engineering, JNTU Kakinada ,UCEK, Kakinada, East Godavari District, Andhra Pradesh, India, 533003
[1] JUJJUVARAPU V S VISWESARA RAO [2]Mr. K. SIVARAJU [3]THANETI LILLY RANI

ABSTRACT

An aircraft landing gear system must absorb the kinetic energy produced by a landing impact and excitations caused by the aircraft travelling over an uneven runway surface. This is the necessary requirement of a successfully designed landing system. The oleo-pneumatic shock is the most common type of shock absorber landing gear system used in aircrafts. It dissipates the kinetic energy produced by impacts arising when an airplane lands at high speed but also offers a comfortable ride to passengers when the airplane taxies at low speed. The objective of this project is to determine the stress, displacement,strain,shear stress of a nose gear using the different materials like Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 of an aircraft during landing using structural finite element analysis. The landing gear was first modeled using Catia software and then imported into Ansys software perform a static and modal analysis. The apply the working forces on Nose landing gear were taken the boundary conditions. finally concluded the which material is the suitable for landing gear based on the stress , displacement ,strain, shear stress values in static analysis and Total deformation in modal analysis.

Key words: Nose landing gear, Igs, different materials, Ansys, CATIAV5.

1INTRODUCTION OF NOSE LANDING GEAR:

The purpose of the landing gear in an aircraft is to provide a suspension system during taxi, take-off and landing. It is designed to absorb and dissipate the kinetic energy of landing impact, thereby reducing the impact loads transmitted to the airframe. Aircrafts are one of the greatest invention of human as it is a highly complex product. Having such a vehicle is very useful for easy and comfortable travels across the world. Aircrafts are used in multiple ways, they are use in commercial purpose as well as military purpose. It mainly reduces time of travel and provide luxury to the passengers also the making and using of aircrafts provided lots of employability options. An aircraft has lots of sub systems and components which are used in together to make it operable. Some of the main parts are fuselage, landing gears, cockpit, wings, engine, ailerons, rudder etc. all the parts were made keeping in mind that the product have to fly deep in sky so weight, stresses, deformation etc are taking in consideration before manufacturing the parts. Keeping these things in mind a design of each component and system was made and material selection has to be done wisely. To make an aircraft tough, strong, and light now a days, design and analysis were done in softwares.

FIGURE 1 PARTS OF LANDING GEAR

Before manufacturing every component and sub system were designed and analyzed to get better results and it is much easier to be rectified. The landing gear system is one of the most crucial system of an aircraft as it supports the craft when it is not flying, allowing it to take off, land, and taxi without damage. Wheels are typically used but skids, skis, floats or a combination of these and other elements can be deployed depending both on the surface and on whether the craft only operates vertically (VTOL) or is able to taxi along the surface. Faster aircraft usually have retractable undercarriages, which folds away during flight to reduce air resistance or drag. Aircraft landing gear usually includes wheels equipped with simple shock absorbers, or more advanced air/oil oleo struts, for runway and rough terrain landing. Some aircraft are equipped with skis for snow or floats for water, and/or skids or pontoons (helicopters). The undercarriage is a relatively heavy part of the vehicle; it can be as much as 7% of the take-off weight, but more typically is 4–5%.

1.2 TRICYCLE TYPE LANDING GEAR

The most commonly used landing gear arrangement is the tricycle-type landing gear. It is comprised of main gear and nose gear

1.2.1MAIN LANDING GEAR

The main gear on a tricycle-type landing gear arrangement is attached to reinforced wing structure or fuselage structure. The number and location of wheels on the main gear vary. Many main gear have two or more wheels

FIGURE 2 **Different parts of landing gear**

1.2.2NOSE LANDING GEAR

The nose gear of a few aircraft with tricycle-type landing gear is not controllable. It simply casters as steering is accomplished with differential braking during taxi. However, nearly all aircraft have steerable nose gear. On light aircraft, the nose gear is directed through mechanical linkage to the rudder pedals. Heavy aircraft typically utilize hydraulic power to steer the nose gear. Control is achieved through an independent tiller in the flight deck. The purpose of the landing gear in an aircraft is to provide a suspension system during taxi, take-off and landing. It is designed to absorb and dissipate the kinetic energy of landing impact, thereby reducing the impact loads transmitted to the airframe.

1.3 FUNCTIONS OF LANDING GEARS

Landing gear provides following functions for an aircraft:

- Provides ground support i.e. bears weight of the aircraft on the ground.
- Facilitates rolling of the aircraft during landing, take-off, taxing and towing operations.
- Absorbs shocks during landing, take-off, taxing and towing and saves the air frame structures.
- Withstands side loads of cross-wind
- Provide facility for steering action
- Provides facilities for braking action
- Provides facilities for anti-skidding

2. LITERATURE REVIEW

The survey of writing devoted to the most commonly applied landing gear system, for example, landing gears furnished with hydraulic pneumatic shock absorbers. Exploring the literature, particularly consideration will be paid to the manner by which the dynamic properties of wheel, shock absorber and airplane structures are considered, and to the manner by which the heaps due the arrival impacts are determined. V. d. Neut et.al.isan exceptionally broad examination in the field of balanced landing sway stacks and is committed specifically to the issue of characterizing basic stacking cases for nose wheel landing gears. Ferrium m54 material examination the tire- safeguard blend of the nose wheel landing gear is spoken to by a direct spring, however for the fundamental wheel landing gear the safeguard damping attributes are spoken to by speed squared damping powers. The unstrung mass is dismissed while haggle safeguard spring qualities are spoken to by direct springs. Further, the drop test translation issue of how to consider static lift powers is as of nowperceived. Concerning the explanatory way to deal with the issue in the USA, as a matter of first importance crafted by E. G. Keller ought to be referenced. This examination plans in a fitting manner the conditions of movement of haggle safeguard, and computes the vertical arrival gear heaps of an unbending airplane. It is depicted how in a versatile structure the increasing velocities must be determined when the arrival gear powers are known as a component oftime. Jerzy Malachowsk his examination on the best strategies for airplanes' arrival gears configuration just as the assessment of the apparatus' condition during usage period and conceivable outcomes of broadening its strength are the subject of various investigations, including the ones by driving overall flight organizations and national logical focuses. It is confirmed in these examinations that numerical investigation of the quality of the development components of the analyzed airplane's part (next to test research) is a vital phase of appropriate approach of aeronautics research, specifically in programming and reliability assessment and improvement of strategies for expanding strength if there should arise an occurrence of arrangements previously used inpractice. Yang he led venture on FW-11 coordinated between Aviation Industry Corporation of China (AVIC) and Cranfield University. His gathering structured another reasonable plan and its objective is to build up a flying wing business carrier. As a piece of AVIC 'MSc program, the FW11 venture is built by three stages: reasonable plan stage, fundamental structure stage, and detail configuration stage. The creator was engaged with the theoretical plan stage which was partitioned into three stages: determination of prerequisites, structure a customary airplane as pattern airplane and structure FW-11 contrasting and the gauge airplane. The fundamental target of this proposal was to construct a lot of conclusion, anticipation and wellbeing the board strategies which are appropriate for the airplane arrival gear expansion and withdrawal control framework. FMEA and FTA for the framework were led. From the FHA, every one of the cataclysmic occasions of the arrival gear augmentation/withdrawal control framework was distinguished. The engineering of the standard based master framework, the procurement of far reaching space master information is in the most significant factor. Amit Goyal he directed this venture in MSRIT School of Advanced Studies (SAS), INDIA. He present a methodology for "Plan Analysis; of a Nose Landing Gear of an Aircraft" made of cutting edge composites materials utilizing progressed CAE apparatuses and strategies. Above all else, useful determination of the part has been indicated. General standards of composite structure were followed in showing up at appropriate plans. In the plan stage utilizing the FEA instrument ANSYS 5.7, beginning structure shape and divider development, picking an appropriate component type, loadings, imperatives, materials and conduct demonstrating has been finished. Different constants and cover boundaries were utilized to characterize the component. In terms of design procedure, the landing gear is the last aircraft major component which is designed. In another word, all major components (such as wing, tail, fuselage, and propulsion system) must be designed prior to the design of landing gear. Furthermore, the aircraft most aft center of gravity (cg) and the most forward cg must be known for landing gear design. In some instances, the landing gear design may drive the aircraft designer to change the aircraft configuration to satisfy landing gear design requirements. A significant number of the association had attempted to explain the static issues like clasping, twisting and so forth. According to architects of Virginia tech, thestructure of the new landing gear must be as basic as could be expected under the circumstances, since intricacy drives up the cost quicker than weight. In any case, weight additionally gives off an impression of being conversely corresponding to the degree of multifaceted nature. With the decrease in the multifaceted nature level, e.g., the quantity of supports, basic individuals are compelled to withstand a higher burden, which in term builds the basic load because of an expansion in cross-sectional region. Along these lines, a parity must be reached among straightforwardness and weight, and this must be practiced through parametric investigations of various landing gearsetup. Titanium and titanium composites have demonstrated their value throughout the decades. They are in fact prevalent for different applications including aviation enterprises and marine gear. They are additionally used in business items because of their cost viability. Titanium amalgams have extraordinary static quality, exhaustion quality and break strength. Besides, titanium compounds have supplanted steel-based segments like edges and joints which requires more quality, in this manner decreasing the generalweight. ViniciusA. R. Henriques examined some striking properties of titanium, to be specific, composite similarity and warmth opposition. TIMETAL 834 is castable, and henceforth require insignificant tooling. It additionally has great weldability with all the current welding methods for titanium, notwithstanding great forgeability. It is being utilized as edges in aeroengines. Another compound of titanium, Ti-7Al-4Mo which is for the most part utilized as blower cutting edges, have higher quality and creep opposition than Ti6Al-4V. Aluminum, which is the most industrially utilized alpha stabilizeris added to titanium. It adds to expand the rigidity and creep quality alongside extra bit of leeway of low thickness. Molybdenum is a beta stabilizer, which gives the upside of lower miss happening and makes it heat treatable. Material of the safeguard swagger assumes an essential job in giving solidarity to the entire setting down rigging get together of the airplane. In this paper external chamber of the safeguard is broke down for three distinctive titanium combinations to think about the outcomes. The materialutilizedinlandingapparatusoughttobelightweightandhavetheoptiontoingest stuns. The goal is to contrast other two titanium amalgams and the normally utilized Ti-6Al-4V. All the investigation identified with this paper is done in ANSYS 19.2. D. Joseph Manuel,Titanium and Titanium Matrix Composites Over the years, titanium metal grid composites (Titanium 10V-2Fe-3V) have been thought of and grown further for use in airplane motor and airframe applications. For airframes, the high explicit modulus of Titanium has been the catalyst as it can decrease as much as 600 pounds in airplane. Ti 10V2Fe-3Al is otherwise called Ti10-2-3. This is a close beta compound utilized in applications requiring high quality (in the 180,000 tractable extents). Titanium10-2-3 joins the best incredible of any business titanium with phenomenal high-quality durability, profound hardenability, flexibility, crack, sturdiness and high cycle exhaustion quality. Dr. V. Jaya Prasad, Stress analysis plays significant role to discover structural safety and respectability of assemblies. The past estimation of stress helps with finding proper material and geometrical measurements. While comparison the results of the referenced materials, Titanium 10V-2Fe-3Al has the high factor of safety, and therefore minimal estimation of greatest pressure created and deflection. The design of lightlanding gear by conducting auxiliary examination and structure advancement was broke down by EssamAlbahkali and Mohammed Alqhtani by leading investigations on landing gear utilizing sway investigation...Review of literature survey on various types of landing gears shows that arrival gear is examined for security of the structure and exertion was made to recognize the shortcomings happening in them. Anyway there is constrained writing accessible on regular landing gear made of ASM7075-T6 material. present study deals with the structural analysis and optimization of landing gear's leg made of ASM7075-T6 material and the investigation was done utilizing ANSYS (Version 13)

3.PROJECT OVERVIEW

3.1 NEED FOR THE STUDY:

As a step toward gaining a better understanding of the construction of the landing gear. This study was designed to analyze the structural analysis of landing gear for different materials. The study investigates the best suitable material for the landing gear construction by examining the stress, deformation, strain, shear stress developed due to loading conditions and find out the frequencies in modal analysis due to the deformation.

3.2 OBJECTIVES OF THE WORK

- To model the Nose landing gears two designsin using CATIA software and analysis using the Ansys15.0
- To perform structural analysis for examining the stresses, deflections, shear stress, strain developed in structure at design load conditions.
- To reduce the weight of the structure using optimization process using with different materials.
- Finally concluded the suitable materials of the landing gear in these materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340

3.3 METHODOLOGY

The analysis of landing gear will be done for different materials. The landing gear with different alloys will be tested by applying a force during the landing under structural analysis in ANSYS 16.2. Then the total deformation, Vonmisses stress, shear stress and strain were calculated for different alloys after applying the boundary conditions.

3.4 PROBLEM IDENTIFICATION:

Improper material leads to the failure steel material are heavy weight and easily formed corrosion Titanium alloy are the high strength materials in this project choose the steel, aluminum ,titanium materials compared the all materials finally concluded the suitable materials due to the titanium is the less stress ,strains, shear stresses . From the literature, it is observed that significant amount of research work has been conducted in the area of landing gear. It has been established that there is a need to overcome problems associated with conflicting requirements such as strength and stiffness of landing gear, and at the same time able to withstand the weight impact of the aircraft and avoid the structural damage while landing. Researchers have proposed suitable materials such as aluminum, titanium, Mg, etc. that are able to withstand the weight impact of the aircraft.

3.5 LEAD SPECIFICATIONS OF SUBSONIC CIVIL TRANSPORT AIRCRAFT:-

The specification of aircraft is taken from the aircraft manual book. Based on the specifications mentioned landing gear is designed. Detailed procedure for designing the landing gear is illustrated below:

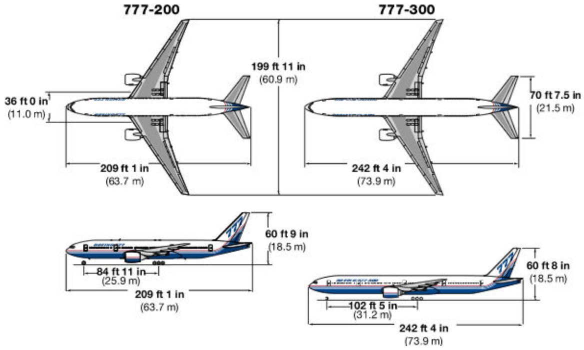

FIGURE 3 AIRCRAFT SPECIFICATION

Maximum takeoff weight = 18,000 kg,
Diameter of the Propeller = 3.8 m
Wing: Span (S) = 60 m2 ,
NACA 6 series Aspect Ratio (AR) = 12,
Forward CG= 18% of mean Aerodynamic chord
After CG= 30%of Mean aerodynamic chord
Distance b/w main gear and forward CG= 1.916m
Distance b/w main Gear and after CG = 1.827m

LOAD CALCULATION:-

Load on nose gear:

Fn = 0.15 × W
= 2700 kg
= 26487 N

Load on Main gear:

Fm = 0.85 × W
= 15,300 kg
= 150093 N

3.6 Material properties:

MATERIAL PROPERTIES	Density Kg/m^3	Possions Ratio µ	Youngs modulus Mpa	Ultimate Tensile strength (Mpa)
TI 10 AL 2FE 3V	4659	0.32	110000	1260
TI 6AL 4V	4500	0.32	110000	900
STRUCTURAL STEEL	7800	0.3	205000	850
TI 8AL 1Mo 1V	4620	0.32	137000	930
ALLOY STEEL 4340	7350	0.28	200000	560

4 DESIGN CONCEPT OF LANDING GEAR

The concept design starts with a study of all design specifications and airworthiness regulations. A concept is then evolved while meeting the functional and regulatory requirements. Major design drivers are performance, safety, cost,time frame, technology and resources. The landing gear location is arrived at and type of landing gear is selected. The landing gear geometry is defined along with kinematics. Steering concepts are also identified in this phase. The ground loads are estimated using dynamic simulations for material selection and preliminary sizing of components. The actuation mechanisms and loads are also worked out in this phase. Various tradeoff studies are performed to enhance weight, volume and cost. Based on these trade-off studies a best concept is selected.

4.1 SHOCK STRUT (UPPER OUTER CYLINDER):

Go to the sketcher workbench select xy plane create the half of the view as per the below dimensions now go to the part design workbench in sketch based features apply shaft option apply angle is 360 degrees again go to the sketcher create the top side hinge shape as per the dimensions apply pad in part design workbench again go to the sketcher workbench create the bottom link as per dimensions.

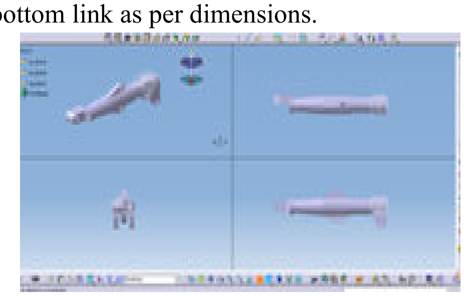

FIGURE 4 SHOCK STRUT DESIGNED IN CATIA

4.2 SHOCK STRUCT LOWER INNER CYLINDER (PISTON):

Go to the sketcher workbench create the circle now go the part design workbench apply pad now go to the yz plane create the circle apply pad as per dimensions now again go to the sketcher create the circle and small circle axle holder as shown the below figures

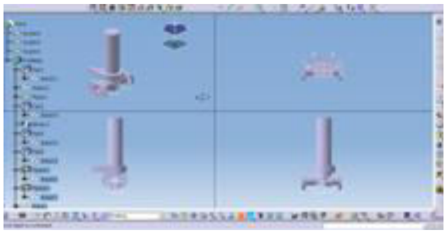

FIGURE 5 LOWER INNER DESIGNED IN CATIA

4.3 AXLE SHAFT:

Go to the sketcher workbench create the half of the axle shaft with dimension after go to the part design workbench apply shaft option as shown below figures

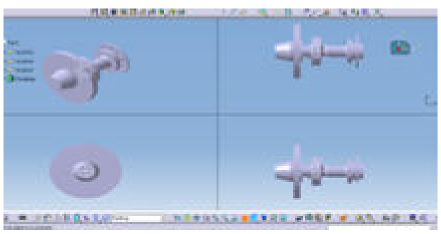

FIGURE 6 AXLE SHAFT DESIGNED IN CATIA

4.4 DISC HUB:

Go to the sketcher workbench create the two circles as per the dimensions now go to the pad option apply thickness is 20mm again go to the sketcher workbench create the small circles now go to the circular pattern option now go to the create the cylinders as per the dimension as shown below figures.

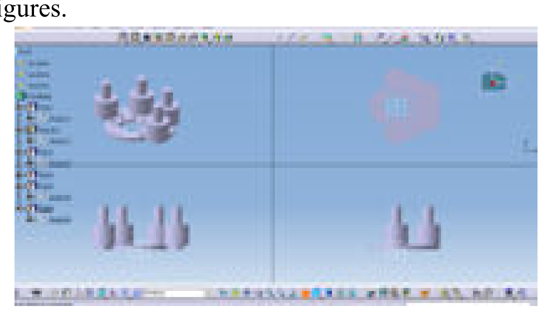

FIGURE 7 DISC HUB

4.5 LINK :

Create the two circle in sketcher workbench thickness is 35 and radius of the link outer hinge in 35mm angle is 60 now go to the part design work bench apply pad is 48mm.

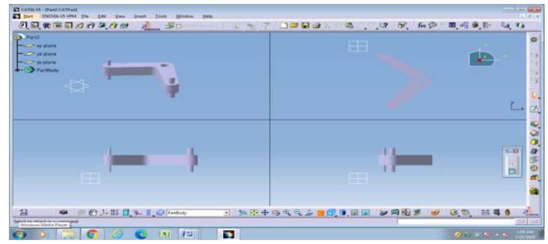

FIGURE 8 LINK DESIGNED IN CATIA

4.6 ASSEMBLY ALL PARTS IN ASSEMBLY WORKBENCH:

After created the parts now go to the assembly workbench go to the existing workbench first upper cylinder fix the part using constraints tool bar now go to the existing component with position imported all parts lower cylinder, axle, disc, bolts, link as shown below figures

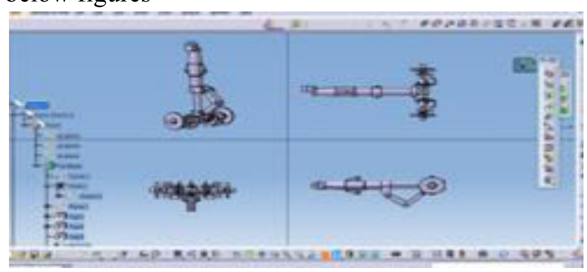

FIGURE 9 ASSEMBLY OF NOSE LANDING GEAR

5 ANALYSIS PROCEDURE IN ANSYS:

Designed component in catia workbench after imported into ansys workbench now select the steady state thermal analysis .

1.ENGINEEERING MATERIALS (MATERIAL PROPERTIES).
2.CREATE OR IMPORT GEOMENTRY.
3.MODEL(APPLY MESHING).
4.SET UP(BOUNDARY CONDITIONS)
5.SOLUTION
6.RESULTS

5.1 STATIC STRUCTURAL ANALYSIS

The static structural analysis calculates the stresses, displacements, strains, and forces in structures caused by a load that does not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that the loads and the structure's response are assumed to change slowly with respect to time. A static structural load can be performed using the ANSYS WORKBENCH solver.

The types of loading that can be applied in a static analysis include.

5.2 MODAL ANAYSIS:

In modal analysis free natural vibration frequencies of roll cage frame was found out for the first 6 modes keeping the suspension members and the attached member of the mounts constrained. All the modes that were found out were rigid body mode. Vibrations can also be induced due to the bumps or road but as their intensity would be low it is not considered. Although the bumps and vibration due to reciprocating engine.

5.3MESHING AND BOUNDARY CONDITIONS:

In order to get accurate results, it is required to have smaller aspect ratios and hence tetrahedron meshing is used for outer cylinder as it provides aspect ratio close to unity. It provides a greater number of elements in the mesh. Therefore, a patch conforming method is utilized to generate Tetrahedron meshing to carry out the calculations. A total of 49344 Nodes and 25340 elements were generated.

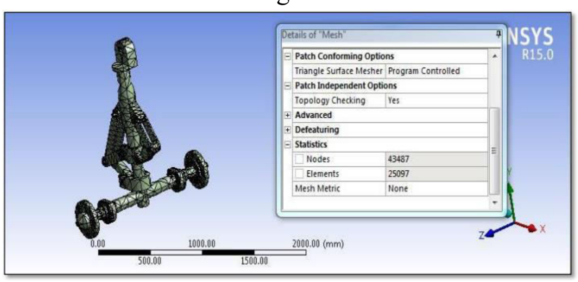

FIGURE 10 MESH : NODES: 43487, ELEMENTS: 25097

5.4 BOUNDARY CONDITIONS:

Two boundary conditions are applied. First, fixed support at the bottom end of the component. Second, a force of 26487 at face at top end as shown below figure.

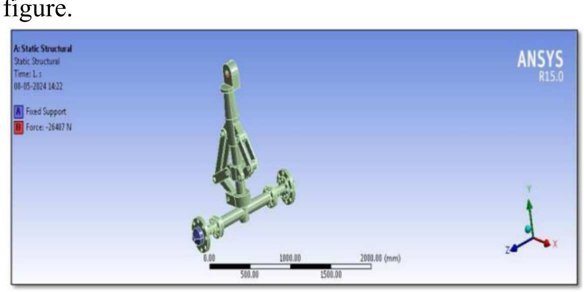

FIGURE 11 BOUNDARY CONDITION: FORCE: 26487N

6 RESULTS AND DISCUSSIONS

Aircrafts are one of the greatest invention of human as it is a highly complex product. Having such a vehicle is very useful for easy and comfortable travels across the worldDesign and Static modal analysis of landing gear using catia and Ansys using various material Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 Mesh: Nodes: 43487, Elements: 25097, Boundary condition: Force: 26487N The solution phase deals with the solution of the problem according to the problem definitions. All the tedious work of formulating and assembling of matrices are done by the computer and finally Von-misses stresses, strains, total deformation, shear stress are given as output.

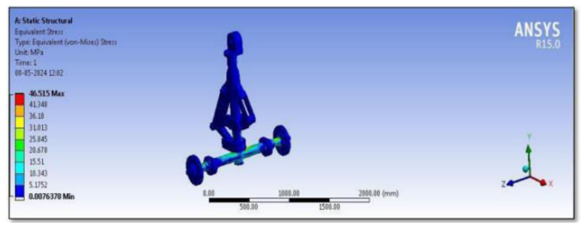

FIGURE 12 VON-MISSES STRESS OF STRUCTURAL STEEL MATERIAL

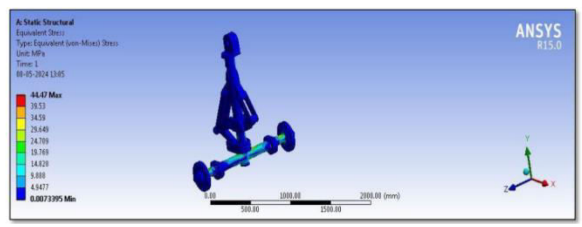

FIGURE 13 TOTAL DEFORMATION OF TI 10AL-2FE-3V MATERIAL

7 GRAPHS: The Static structural analysis of Different materials done and results are obtained for Equivalent (Von-Misses) stress. These results are plotted graphically and a comparison is made between these Materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V,AISI 4340 results with various Materials. Finally Least Von-misses stress is TI10AL2FE3V 44.47 Mpa as shown below graphs.

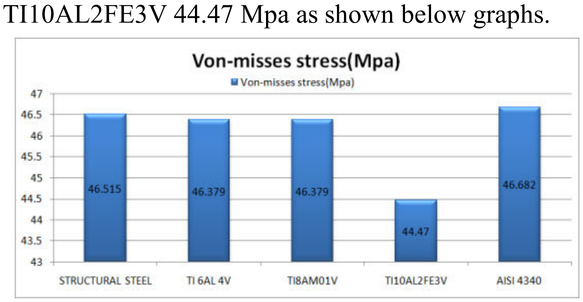

FIGURE 14VONMISSES STRESS GRAPH

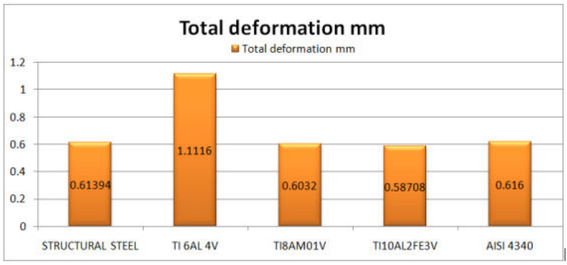

FIGURE 15 TOTAL DEFORMATION GRAPH

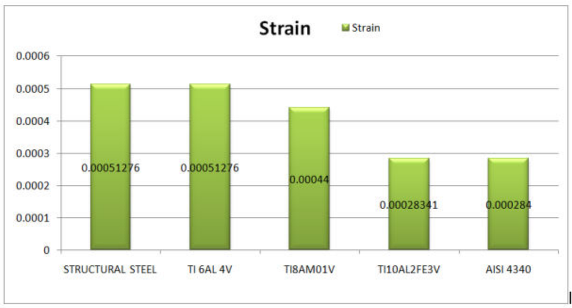

FIGURE 16 STRAIN GRAPH

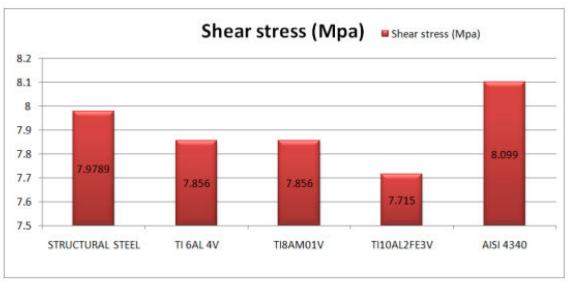

FIGURE 17 SHEAR STRESS GRAPH

8 CONCLUSION

The Aircraft landing gear is modelled and assembled using CATIA V5. The assembled CAD model has been considered to perform structural analysis by finite element approach using the ANSYS package. In general the accuracy of the solution depends on the mesh quality. Each component has been checked for its mesh quality to ensure the solution accuracy. Stress analysis plays important role to find structural safety and integrity of assemblies. The previous estimation of stress helps to find appropriate material and geometrical dimensions. considered to evaluate or validate the structural conduct of the 5 different materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 By considering parameters like von-misses stresses, Strain, deformation, shear stresses of material under implemented load. It is determined results in static analysis from above figures that, Ti 10Al 2Fe 3v, has less von-misses stress, Total deformation, shear stress, Strain obtained .

1. These results are plotted graphically and a comparison is made between these Materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V,AISI 4340 results with various Materials. Finally Least Von-misses stress is TI10AL2FE3V 44.47 Mpa as shown below graphs.
2. These results are plotted graphically and a comparison is made between these Materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 results with various Materials. Finally Least Shear stress is TI10AL2FE3V 7.715 Mpa as shown below graphs.
3. These results are plotted graphically and a comparison is made between these Materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 results with various Materials. Finally Least Total deformation is TI10AL2FE3V 0.58708mm as shown below graphs.
4. These results are plotted graphically and a comparison is made between these Materials Structural steel, Ti6AL4V, Ti8AM01V, TI10AL2FE3V, AISI 4340 results with various Materials. Finally Least Strain is TI10AL2FE3V 0.00028341 as shown below graphs.
5. The process determines a system's natural frequencies, damping factors, and mode shapes Mode 1 Frequency :19.946Hz Total deformation 3.5304mm, Frequency 19.946 Hz Total deformation :3.5304, Frequency 84.52 Hz and Total deformation 1.717mm
6. Finally concluded the TI10AL2FE3V Material is the best This alloy has particular aggregate of splendid hot-die forgeability and extraordinary excessive energy durability and deep hardenability. This is best appropriate cloth for any kind of landing for the reason that aircraft first-class effects in static analysis.

REFERENCES

[1] M. Imran, S. A. R. M, M. Haneef, P. G. Student, M. Engineering, and G. College, “Static and Dynamic Response Analysis for Landing Gear of Test Air Crafts,” vol. 3, no. 5, 2014.

[2] P. Kabade and R. Lingannavar, “Design and analysis of landing equipment lug attachment in an airframe,” vol. 2, no. 10, pp. 5358–5370, 2013.

[3] S. R. Basavaraddi, “Design and Analysis of Main

Landing Gear Structure of a Transport Aircraft and Fatigue Life Estimation," no. July, pp. 10–14, 2013.
[4] A. V Gaikwad, R. U. Sambhe, and P. S. Ghawade, "Modeling and Analysis of Aircraft Landing Gear : Experimental Approach,"vol. 2, no. 7, pp. 2–five, 2013.
[5] K. Shahapurkar and R. B. G, "Stress Analysis of an Aircraft Wing with a Landing Gear Opening Cutout of the Bottom Skin," vol. 2, no. 5, pp. 406–412, 2014.
[6] T. Global and L. Gear, "Introduction to Landing Gear."
[7] Praveen Joel P and Dr. Vijayan R, "Design and Stress Analysis of Nose Landing Gear Barrel (NLGB) of a typical naval trainer plane," IOSR J. Mech. Civ. Eng., vol. Eleven, no. 2, pp. 67–seventy four, 2014.
[8] A. Rajesh and B.T.Abhay, "Design and Analysis Aircraft Nose and Nose Landing Gear," Int. J. Eng. Sci., pp. 2319– 1813, 2015. [9] S. R. Basavaraddi, K. Manonmani, and P. M. Swami, "Stress and Fatigue Analysis of Landing Gear Axle of a," pp. 224–228, 2015.
[10] M. Public, S. Performance, M. Civil, S. Performance, D. An, C. Service, H. Sector, and L. Government, "1 Introduction 1.1," Framework, pp. 1–seventy eight, 1997.
[11] M. Susarla and S. Harshavardhan, "Structural Analysis of the Drag Strut and Dynamic analysis of Aircraft Landing Gear," pp. 1–8.
[12] Mohammed Imran, Shabbir Ahmed R.M and Dr. Mohamed Haneef, "Static and dynamic response evaluation for landing equipment of test aircrafts", IJIRSET, vol. Three, difficulty five, may also 2014.
[13] Rajesh A, Abhay B T, "Design and Analysis Aircraft Nose and Nose Landing Gear", IJES, vol.4, trouble 10, pp 74-80, 2015.
[14] Avi Gulati, Divam Gupta and Prabhansh Varshney, "Assembly of Landing Gear in Catia v5", IJAME, vol. Three- no.1, February, 2016.
[15] James N. Daniels," A Method for Landing Gear Modeling and Simulation With Experimental Validation ",NASA Contractor Report 201601,1996
[16] Russell C. Hibbeler, Engineering Mechanics: Statics, 12th Edition, Prentice Hall, 2009
[17] Green W. L., Aircraft Hydraulic Systems: An Introduction to the Analysis of Systems and Components, Wiley, 1986.
[18] Ying XING, 2012. The Strength Analysis Of The Diagonal Stay Of Aircraft Landing Gear Based on ANSYS
[19] Babu, N.S., Modal Analysis of a Typical Landing Gear Oleo Strut, International Journal of Recent Trends in Engineering and Research
[20] Daniels, J.N., 1996. A technique for touchdown tools modeling and simulation with experimental validation
[21] Alex, I.I.I.M., 2016. Design and Analysis of Modified Oleo Strut ShockAbsorber System in Aircraft Landing Gear. Nternational Journal of TechnoChem Research, 2(02), p 106- 109
[22] Ossa, E.A., 2006. Failure analysis of a civil aircraft touchdown equipment. Engineering Failure Analysis, 13(7), p 1177- 1183 [12]Lee, H.C., Hwang, Y.H. And Kim, T.G., 2003. Failure analysis of nostril touchdown gear meeting. Engineering Failure Analysis, 10(1), p seventy seven-84
[23] Lei, Z., Hongzhou, J. And Hongren, L., 2008. Objectoriented landing gear version in a PC-primarily based flight simulator. Simulation Modelling Practice and Theory, sixteen(9), p 1514-1532
[24] Infante, V., Fernandes, L., Freitas, M. And Baptista, R., 2017. Failure analysis of a nose landing equipment fork. Engineering Failure Analysis, eighty two, p 554-565
[25] Xiangjun, K., Ningning, L., Chunsheng, L., Xianbo, X., Bo, L. And Bing, X., 2015. Landing gear ground load measurement and verification test for a massive passenger jet. Procedia Engineering, 99, p 1426-1433
[26] Inagaki, I., Takechi, T., Shirai, Y. And Ariyasu, N., 2014. Application and capabilities of titanium for the aerospace enterprise. Nippon steel & sumitomo metallic technical report, 106.