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# OPTIMIZATION AND ANALYSIS OF AIRCRAFT WHEEL HUB AND DEVELOPMENT OF PROTOTYPE-MODEL

**G SATYA VARAPRASAD[1], V V RAMAKRISHNA[2],**

[1]M.Tech, student, Department of Mechanical Engineering, PYDAH College of Engineering, Kakinada

[2] Assistant Professor& HOD, Department of Mechanical Engineering, PYDAH College of Engineering, Kakinada

**Abstract**

Design work related to the implementation of new aerospace elements requires the use of 3D-CAD modelling techniques and rapid prototyping, which makes it possible to significantly accelerate the deployment of new solutions.

In this project, one of the rapid prototyping techniques, meanwhile the task is to reduce the stress concentration in the Wheel Hub due to body weight of aircraft and other loads on the wheel hub. For design of the wheel hub solid works is used. It is analyzed by using the ANSYS. While analyzing the stress, stress concentration is found in the fixed regions (location of its bolts). The stress concentration is checked in three ways and selecting the one which gives the optimum stress concentration. The three ways are Design modification, Material changing without design modifications, material changing with design modification. From these three ways we will find out optimum changes in stress concentration. Here existing material were chosen to be al-alloy, and now 3 new al-alloy composite materials were selected (al-1420, al-1450, al-2080)

After selecting the best design and converting that 3D-CAD file into STL file or saving file in STL form. That STL file is used for direct developing of prototyping model by using FDM process

## INTRODUCTION

A wheel hub is the central portion of a wheel through which the axle passes. The wheel hub is the main part of wheel and consists of bearings and axle. The axle is connected the wheel tug.

**Figure: 1.1 Wheel Hub**

## BASIC DEFINITIONS OF WHEEL HUB

**Axle:** An **axle** is a central shaft for a rotating wheel or gear

**Bearings:** A bearing is any of various machine elements that constrain the relative motion between two or more parts to only the desired type of motion.

**Wheel tug:** Wheel Tug is a fully integrated ground propulsion system for aircraft which puts a high torque electric motor into the

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hub of the nose wheel to allow for backwards movement without the use of pushback tugs and to allow for forward movement without using the aircraft's engines.

## PROBLEM DEFINITION

Wheel hub is the important component of wheel, it has to with withstand to the load acting over on it. When the wheel rotating the wheel hub has to bear the load acting on the wheel hub and the torque developed by wheel while takeoff or take. By this the high stress will be developed in the wheel hub, this caucusing to breakages of wheel hub. Due to this the wheel hub is to be with stand to load acting on it.

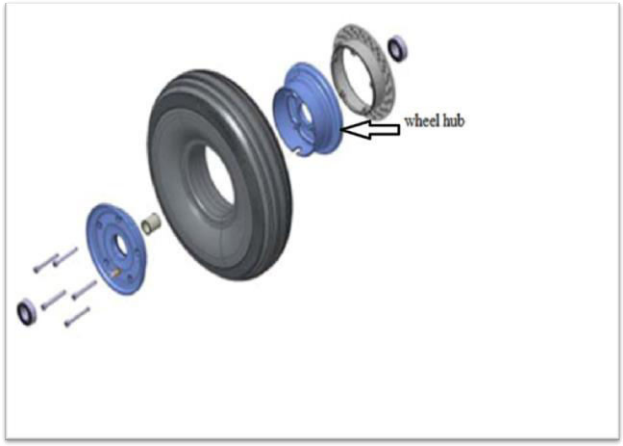


**Figure: 1.2 Position of Wheel Hub**

Coming to the problem, wheel hub is made up of al-alloy material, the load acting on the wheel hub, is load of the aircraft and the torque and factors which are influencing wheel hub Specification and Loads acting on wheel hub are shown below

Wheel hub outer diameter (max) =135mm
Wheel hub outer diameter of base (min) = 71mm
Wheel hub inner diameter (max) =69mm
Wheel hub inner diameter (min) =39.25mm
Wheel diameter = 765mm
Input Power = 1640 kW
Speed = 18800 rpm
Torque = 1100 N-m
Load Force = 18750 N

## METHODS OF REDUCING STRESS CONCENTRATION

To reduce the stresses which are developed in the wheel hub cover three methods had considered. They are:

- Design modification in existing model
- Material change in existing model
- Design modification and material change in existing model

Under design modification, where ever Maximum Stress is concentrated at that particular cross-section only design modification had considered. In Existing component Maximum Stress is concentrated at one particular at key hole and upper part, by modifying its thickness of hub at upper part and changing diameter of key hole gradually stress also reduce.

Under material change within the place of existing material new material had considered. This new material mechanical

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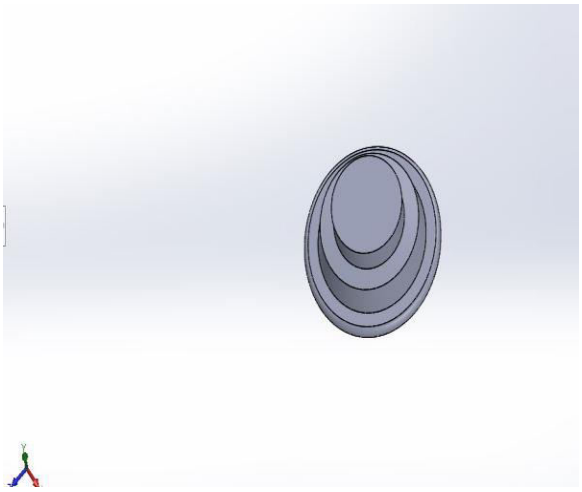
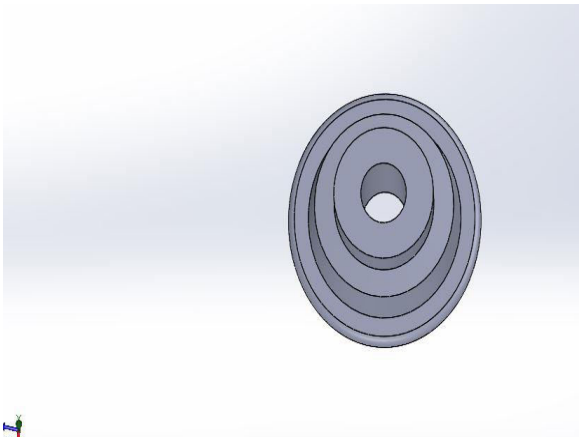
properties are very less compared to existing material mechanical properties. With this weight and cost of the component is reduced. In third method above two methods had considered simultaneously. By analyzing above three methods one method had considered which produce very less stress.



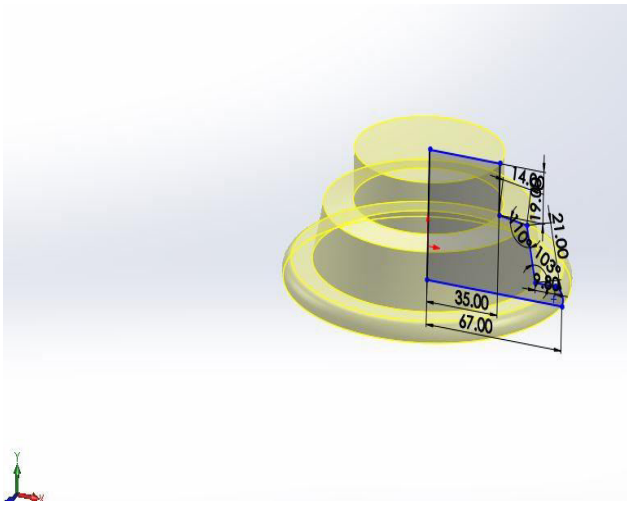
**OBJECTIVE OF THE WORK:**

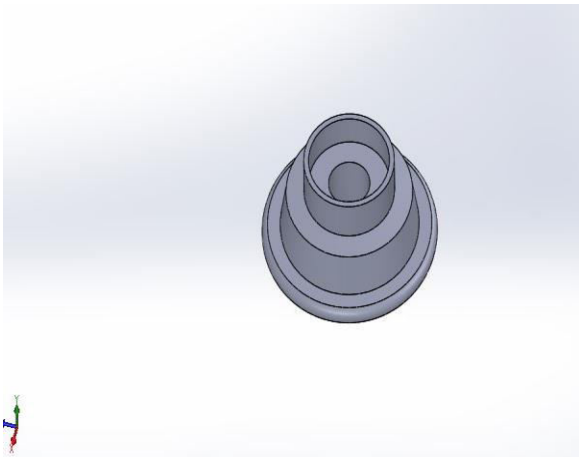
The objective of the project work is design and analysis of a aircraft wheel hub to with stand the loads acting on it.

- Model was created in SOLID WORKS
- Meshing and Analysis by using ANSYS WORKBENCH.
- Evaluation of stress, deformation, factor of safety under static analysis for Existing Wheel hub.



**Design process**



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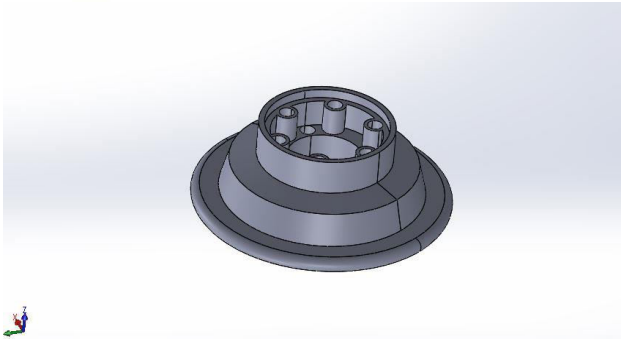
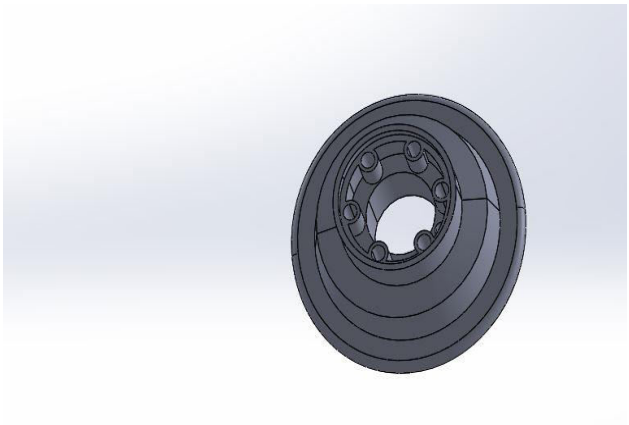
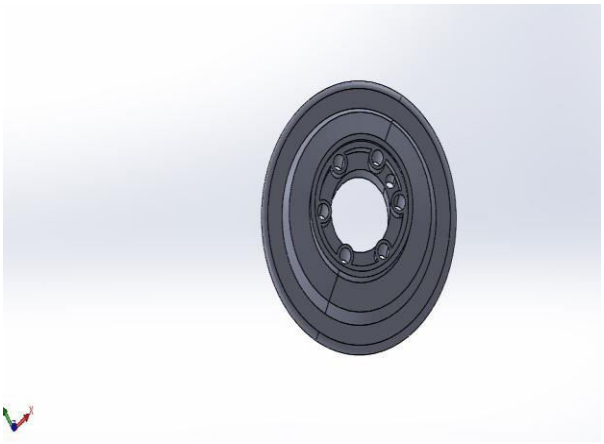


**(Wheel Hub Inner Diameter (39.25mm) Key Hole Diameter (7.8mm))**



**(Wheel Hub Inner Diameter (40.25mm) Key Hole Diameter (8.4mm))**



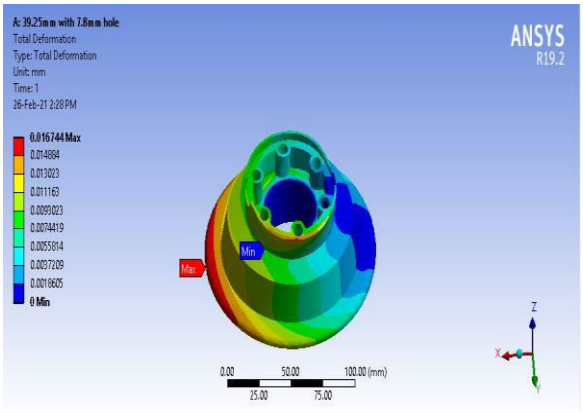
**(Wheel Hub Inner Diameter (41.175mm) Key Hole Diameter (7.6mm))**

**Ansys process**

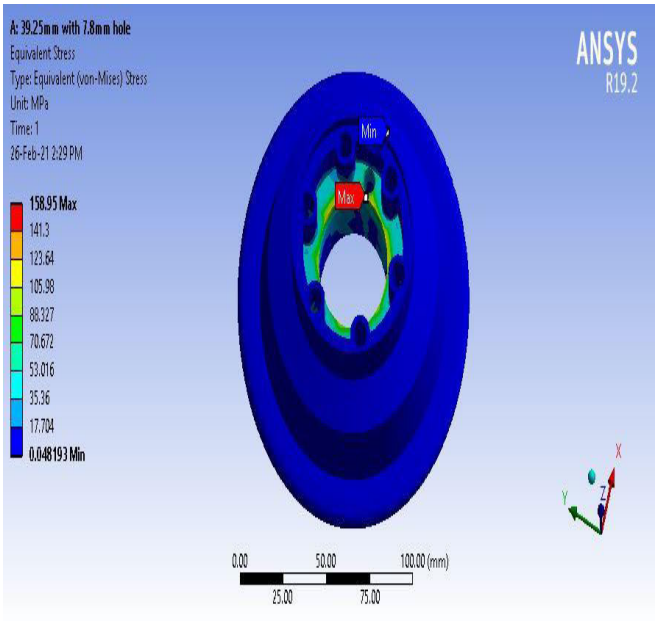
**Results**

**(Wheel Hub Inner Diameter (39.25mm) Key Hole Diameter (7.8mm))**
**AL-1420**

**Deformation**




**Stress**



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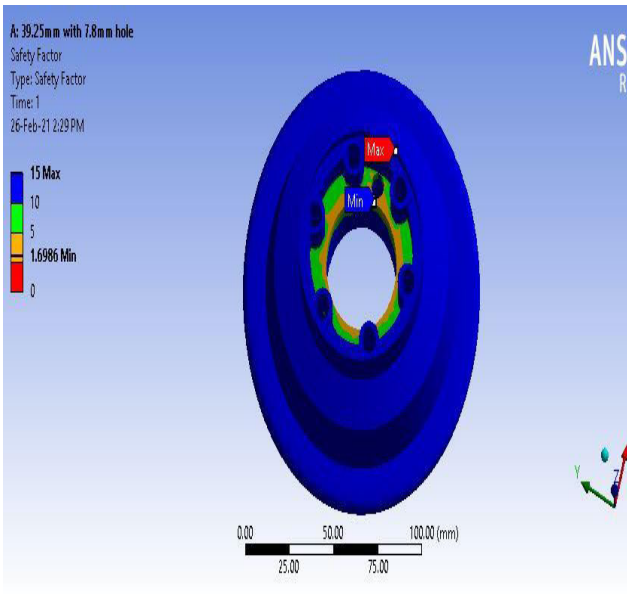
**Safety factor**

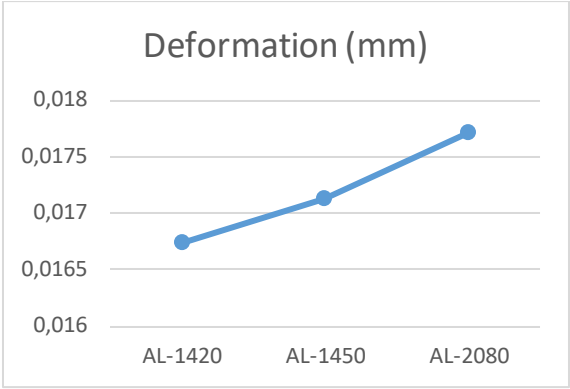


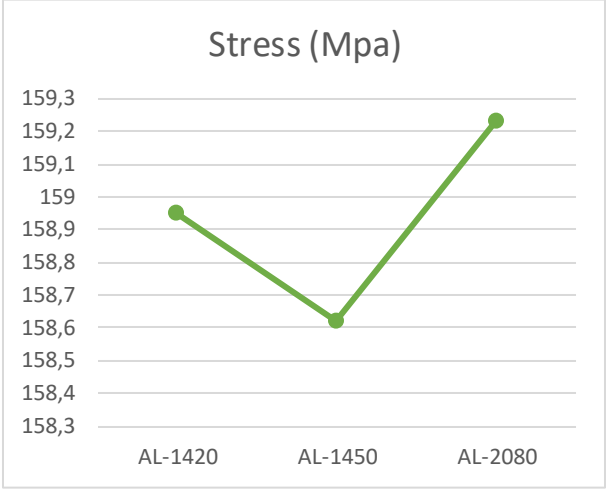

**Tables**

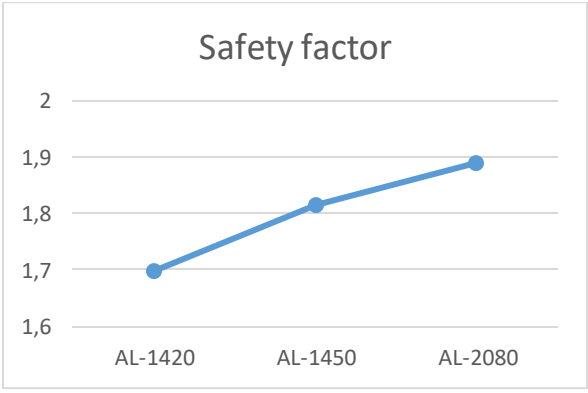
(Wheel Hub Inner Diameter (39.25mm) Key Hole Diameter (7.8mm))

| | AL-1420 | AL-1450 | AL-2080 |
|---|---|---|---|
| Deformation (mm) | 0.016744 | 0.017134 | 0.01772 |
| Stress (Mpa) | 158.95 | 158.62 | 159.23 |
| Safety factor | 1.6986 | 1.8157 | 1.8903 |

**Graphs**



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(Wheel Hub Inner Diameter (40.25mm) Key Hole Diameter (8.4mm))

| | AL-1420 | AL-1450 | AL-2080 |
|---|---|---|---|
| Deformation (mm) | 0.016151 | 0.016529 | 0.017089 |
| Stress (Mpa) | 135.59 | 134.92 | 136.17 |
| Safety factor | 1.9914 | 2.1346 | 2.2105 |

(Wheel Hub Inner Diameter (41.175mm) Key Hole Diameter (7.6mm))

| | AL-1420 | AL-1450 | AL-2080 |
|---|---|---|---|
| Deformation (mm) | 0.014995 | 0.015345 | 0.015867 |
| Stress (Mpa) | 137.94 | 137.68 | 138.16 |
| Safety factor | 1.9574 | 2.0919 | 2.1786 |

## CONCLUSION

The main constrain of this project is minimizes of stress. To reduce this stress three methods had considered they are

- Design modification in existing model
- Material change in existing model
- Design modification and material change in existing model

Among these three methods third method had given best results. In this method out of number of design modified model is D40.25 &D8.4mm model with material AL-2080 will had produced less stress 136.17Mpa and FOS 2.2 compared to other materials. This material satisfies two conditions they are less weight and less cost.

The final conclusion of this project is D40.25 &D8.4mm model with AL-2080 material will give very less stress, and have good safety factor, and also it has optimum dynamic analysis results

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