Design and Analysis of New Locking Mechanism For Fixing Wheels To An Automobile with minimum Human effort

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ABSTRACT

In this paper, the need for a new product or development of the existing product is always consistent in the modern day of developing science, engineering and technology. The enhancement of the product leads to greater profits and reputation. One such developing mechanism is an automobile wheel fixing mechanism. The existing method of fixing a wheel to an automobile axle is with the help of bolt and nuts. This requires more human effort and time taking either to fix or remove the wheel from the axle. The main aim of this project is to change the existing fixing mechanism with new mechanism by reducing human effort and time drastically. The material used is Aluminum alloy for alloy wheel and structural steel for the lock mechanism. Design is an important industrial activity which influences the quality of the product. Locking mechanism modelling is done in CATIA software later this is imported to ANSYS for analysis purpose. ANSYS software is used for simulating the different forces, pressures acting on the component and also for calculating and viewing the results. The following analyses such as equivalent stress, total deformation are carried out on new designed wheel and the results are compared with existing experimental values for validation. Once the validation processes is over and results are within the acceptable range, a prototype is produced.

Keyword: - *Design, Analysis, New locking mechanism, Equivalent stress, Total deformation*.

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1. INTRODUCTION

Today, automobiles play an unimaginable role in the social, economic and industrial growth of any country. Major role of automobiles is played by cars. Technological improvements in computers, smart phones, wireless communications and the cloud have converged to advance safety for connected consumers. In this advanced automobile field, there is no change in the existing nut and bolt wheel fixing mechanism since many years. This project is on a new wheel fixing mechanism which works on the principle of a worm gear. The scope of the project is to design and manufacture a new wheel fixing mechanism which replaces the existing mechanism in future. This new mechanism is put forth in order to decrease the inconveniences caused due to nut and bolt mechanism i.e. this new mechanism reduces human effort to remove the wheel in case of emergencies, reduces time to remove the wheel, reduces disengagement of wheel from its place during high speeds. The mechanism of this system is when the worm present is the mechanism is turned by an Ellen key, the locking and unlocking of the wheel from the rim of the wheel.

2. LITERATURE REVIEW

S Vikranth deepak et al. [1]: This paper discuss the comparision between the aluminum, magnesium, zinc alloy wheels. The wheel specifications are taken from existing model.The anlysis tests such as total life, damage factor, load factor, are caliculated. Then the results are compared and concluded by saying that out of these three alloys aluminum alloy is most suitable material for wheel manifacturing

N Satyanaryana et al. [2]: In this project a static and fatigue analysis of aluminum alloy wheel(A356.2) was caried out using FEA. 3D model is created and imported to ansys. PCD and hub portion is constrained then pressure is applied on the rim . We found out the total deformation.alternating stress,and shear strain. Also life , safty factor and damage of alloy wheel by using S-N curve.S-N curve is input for A356.2 material

P Meghashyam et al. [3]: In this paper the wheel rim is designed in CATIA and analyzed using the ANSYS software then made a comparision between the aluminum and forged wheel then performed the caliculations such as stress, bending moments,etc. In addition to this rim is subjected to the vibration analysis and apart of dynamic analysis and caliculated by sayin that forged steel is suggested to be the best material.

Sanjay chowdary et al. [4]: This paper presents the weght reduction of the aloy wheel. Aluminum wheel is replaced with the PEEK(polyether ether ketone) of four different specifications. Then analysis of total deformation and equavelent stress is carried out. the results obtained is that aluminum alloy is replaced with the peek 90 hmf 20 material.

3. PROBLEM WITH EXISTING WHEEL HUB ASSEMBLY

- Lot of human effort is required to fix the wheel
- Few cases of unlocking of wheel from the vehicle
- Time taken process
- High material is required

4. DESIGN OF NEW WHEEL FIXING MECHANISM

Due to few drawbacks in the existing wheel fixing mechanism, a new mechanism is put forth with consists of various parts like body, cover plate, gear box, worm gear, pin, nut and clamp. all these are assembled to form a mechanism. when the worm is turned with an allen key, the worm gear rotates and the clamps will be lifted up projecting the cylindrical surface outside the slots. the rim is also designed accordingly so that the whole system is fixed without slipping.The product was designed using solid works software. initially each part was designed separately and then assembled together. the whole products consists of different parts, namely

4.1 Body

The body is where the mechanism is fixed having grooves on the outer diameter. This outer body was designed to accommodate the other parts of our mechanism. The body was restricted to 20 cms which is the minimum diameter .
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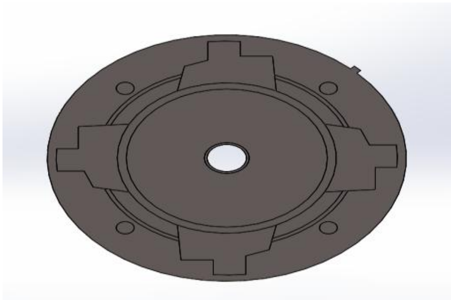
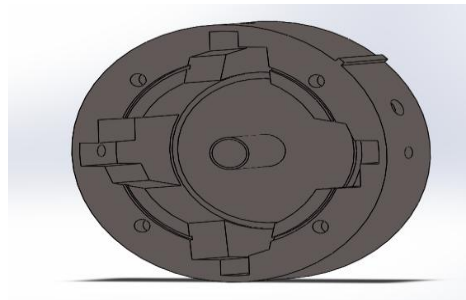


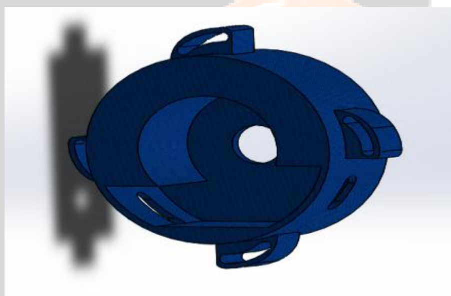
Front view of the body



Isometric view of the body

4.2 Gear box

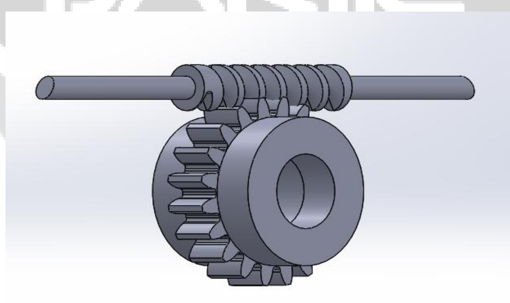
The gear box is the base for the new wheel fixing mechanism which we have designed. It is fixed on the shaft. In this gear box, a worm gear rests at the center of the box. The rack of the worm gear projects out from the rectangular slots of this gear box. The gear box consists of cam profiles which play a major role in this mechanism. The clamps are connected to the cam profile with a pin. The rotary motion of the worm gear is converted into translatory motion to the clamps



Gear box

4.3 Worm Gear

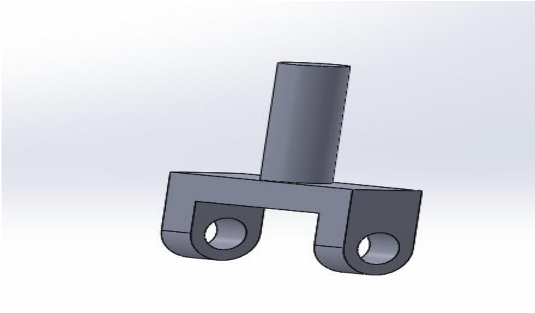
A worm gear (or worm drive) is a specific gear composition in which a screw (worm) meshes with a gear/wheel similar to a spur gear. The set-up allows the user to determine rotational speed and also allows for higher torque to be transmitted.The worm gear plays a major role in this new mechanism. The worm gear is rotated about 5 degrees to 10 degrees, to lock the mechanism into the rim**.**



Worm Gear

4.4 Clamp

A clamp is a drive used to join, grip, support, or compress mechanical or structural parts a band clamp (also known as a web clamp) is used and it is a type of clamp that allows the clamping of items where the surfaces to be clamped are not parallel to each other; where there are multiple surfaces involved; or where clamping pressure is required from multiple directions at once.Clamping pressure is applied either through a mechanical method such as a screw or ratchet mechanism that tightens the band, or through the elastic nature of the band material itself. Here the clamp is fixed in the groove provided in the body. The spokes are fixed to the clamp. The spokes travel up and down depending on the movement of the clamp along the groove



Clamp

4.5 Pin

Pins are used to preserve alignment and hold parts in position for temporary and permanent applications. Lock the pins with either cotter pins. Measure length from under the head.

Here, pin is used to hold the clamp in the groove of the body.

Dimensions of the pin:

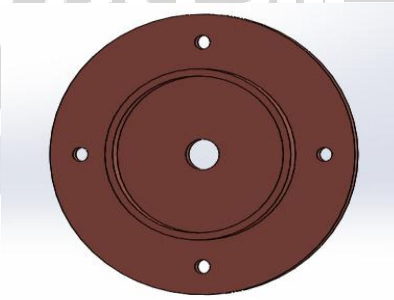
Diameter of pin=5.96 mm

Length of pin= 35 mm

Pin

4.6 Cover plate

This plate is placed on the body after inserting all the parts in to it. It is fixed to the body with the help of screws

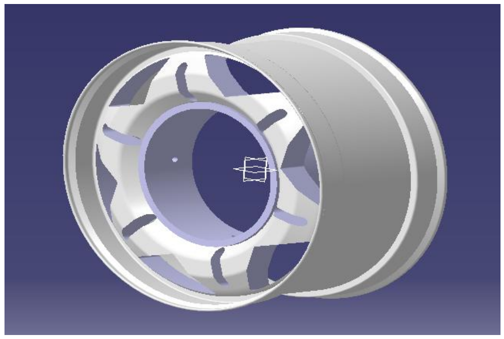


Cover plate

All these parts are assembled together. When they are assembled and fixed with screws, the mechanism cannot be visualized as it is placed inside the body and then covered with a cover plate.

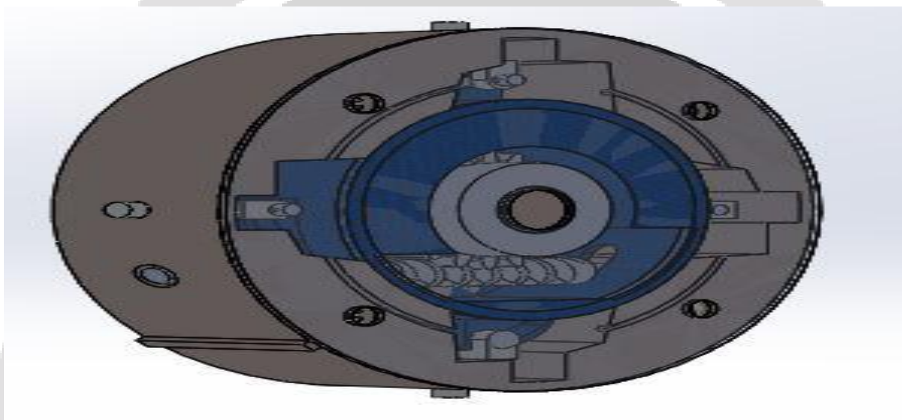
4.7 Rim

Rim is the most essential part of this assembly. Rim is used for the support of the tyre . Rim is designed in such a way that the inner mechanism of the assembled component is fixed in to the rim tightly



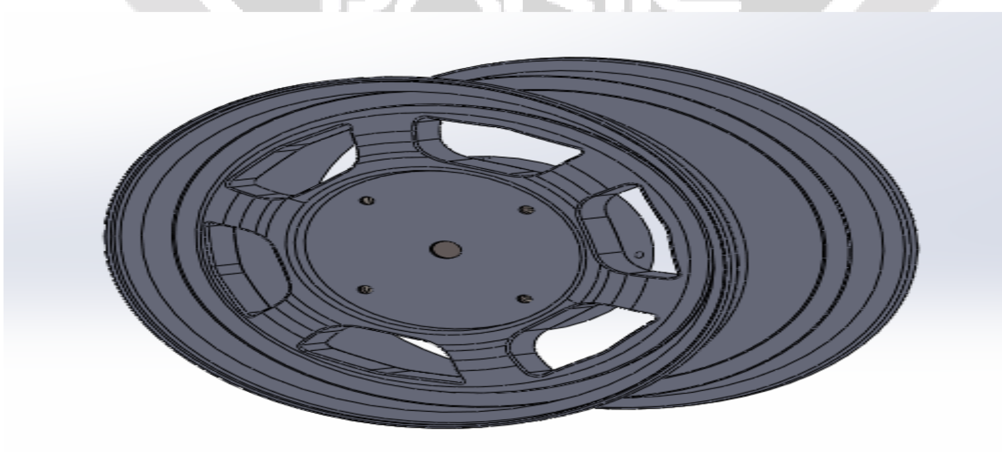
Rim

5. ASSEMBLY OF THE PARTS OF THE MECHANISM



Isometric View of Assembly

5.1 ASSEMBLY OF THE PARTS OR THE MECHANISM WITH RIM



Isometric View of Assembly with Rim

6. ANALYSIS OFASSEMBLY PART

For conducting the analysis on the assembly part ANSYS Software is used. Materials used are Aluminum Alloy is used for the Rim and structural Steel is used for the Locking mechanism.

6.1 Caliculation Part

Kerb weight of car : 860 kg

Factor of safty : 2

r_1=186mm

r_2=207mm

h_1=104mm

h_2=60.4mm

Input calculations:

Surface area = $2\Pi r_1 h_1 + 2\Pi r_2 h_2$

= 2*3.14*186*104 + 2*3.14*207*60.4

= 199579.09 mm^2

=0.199579 m^2

Applied weight = kerb weight *factor of safty

= 860*2

=1720 kg

Force applied on all 4 wheels

F=m*g

Where g=9.81 m/sec^2

F=1720*9.81

F=16873.2 N

Force applied on one wheel

F=4218.3 N

Pressure applied = force/area

P=4218.3/0.199579

P=21135.99 N/m^2

6.2 Material Properties

6.2.1 Aluminium alloy: This is used for Rim

Density	2685 kg/m^3
Modulus of Elasticity	72.4 GPa
Tensile Strength (Ultimate)	230 MPa
Tensile Strength (yield)	185 MPa
Shear Strength	120 MPa
Compressive strength	185 MPa
Poisson's ratio	0.33

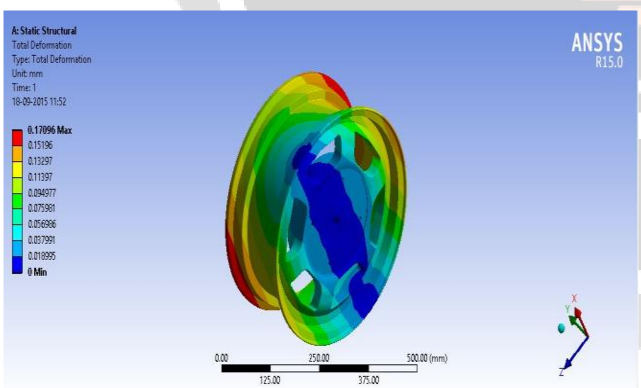
6.2.2 Structural steel: This is used for Locking Mechanism

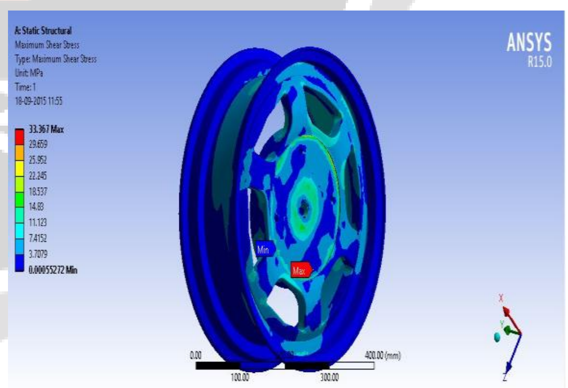
Density	7850 kg m^-3
Coefficient of Thermal Expansion	1.2e-005 C^-1
Young's Modulus	2.e+011Pa
Bulk Modulus	1.6667e+011Pa
Shear Moudulus	7.6923e+010Pa
Tensile Yield Strength	2.5e+008 Pa
Tensile Ultimate Strength	4.6e+008 Pa
Poisson's Ratio	0.3

6.3 Analysis of the Assembly Part

Analysis such as Total Deformation, shear stress are conducted on the assembly part by applying all the constraints and also applying various speeds on the assembly part such as 80,100,120 Rpm

6.3.1 Analysis of the assembly part at 80 rpm speed

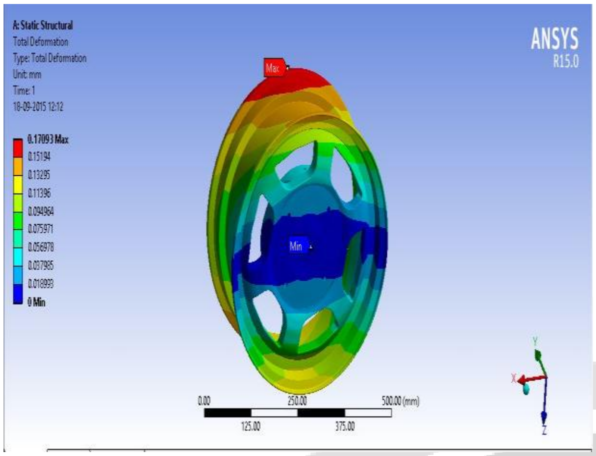


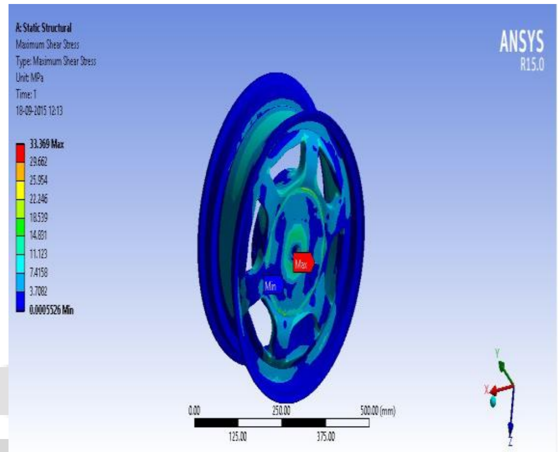


Total Deformation Max: 0.17096
Min: 0

Sheer stress Max:33.367
Min:0.00055272

6.3.2 Analysis of the assembly Part at 100 Rpm

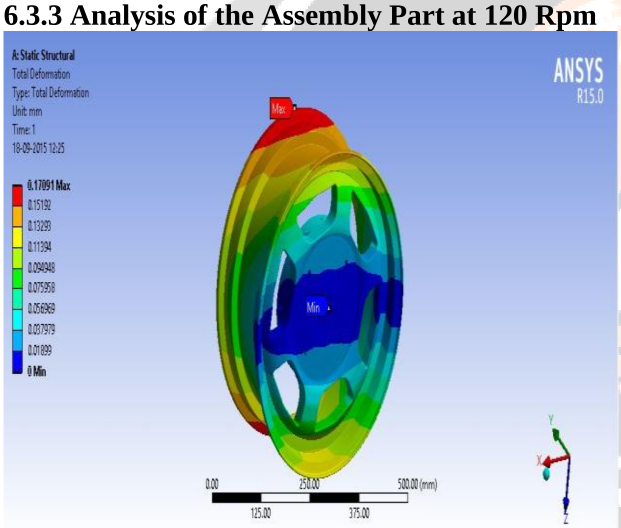


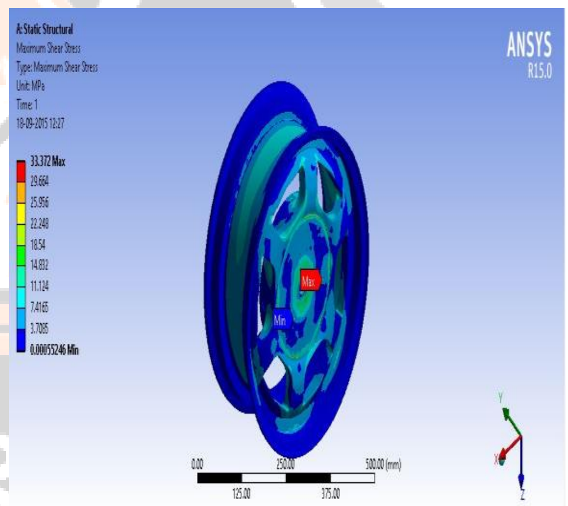


Total Deformation Max: 0.17093
Min: 0

Shear stress Max:33.369
Min:0.0005526

6.3.3 Analysis of the Assembly Part at 120 Rpm





Total Deformation Max:0.17091
Min:0

Shear stress Max:33.373
Min:0.00055246

7.CONCLUSIONS

After a thorough study of existing model and analyzing its backdrops, a thought for renewing the model in a way to decrease the human effort and also the time elapsed was developed.Further the model was clearly designed using SOLID WORKS 2015. Every part of this mechanism was keenly modeled and then carefully assembled virtually. The model is then analyzed in ANSYS 14.5 Work Bench.Various analyses are done on the model taking Structural Steel as material for wheel fixing mechanism and Alluminum alloy A356 for Rim. Considering the strength and cost restrictions structural steel and AL356 is preferred for the respective modeled designs. The main objective of the project that is to develop a wheel fixing mechanism with suitable Rim designed is achieved.

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