International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

Design of Hubless Wheel

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Abstract - *Designing existing parts of an automobile with new ideas is a significant trend, Eliminating hub & spokes from a wheel can reduce the weight & can make steering much smoother. This paper discusses the new mechanism for a hubless wheel. Deformation test, equivalent stress & strain test have been carried out. Considering the material as Structural steel Stress and strain performance can be obtained. In this study feasibility of roller bearing mechanism have been tested for commercial use. Different frequency of load has applied on the wheel to get the most feasible value for the design. The analysis predicts that this design can be used in bikes very effectively. This research predicts the practicality of the structural design, some Valued references & history of hubless design are provided for the design and development of the hubless wheel.*

Key Words: Hubless, Wheel, Design, Analysis, Stress, Bearing, Rim.

1. INTRODUCTION

The Centre less wheel or hubless wheel is a wheel which is not solid or we can say like its axle is hollow and The man behind its creation is "Franco Sbarro" and it was patented by Globe Holding of Geneva in 1989.

It is stopped to use as alternative wheel to simple or basic wheel just because of its numerous practical problems. Its manufacturing is very difficult and its expensive too as compared to basic wheels and it required a high stage of advance machining and because of its delineation the bearing and other valuable components are majorly exposed to the environment conditions. Since a normal axle and velocity joint can't be used which makes a drive system problematic.

Hubless wheels require components that work on higher stresses. Wheel's outer bearing will rotate slower than the ones on the orbit of the wheel for any speed. Which leads to make them better suited to slow movement devices. As a function, they might be useful for in wheel drive because the smart wheels for a few electric cars. They are also reported to help steering and braking as the kingpins can be vertical on the wheel, opposed to regular car style, where you would wish to offer them an angle therefore the wheel rotates on the contact spot. So perhaps you would want them on a high precision drive system.

1.1 LITERATURE REVIEW

1) Bradford had proposed that hubless rim for a wheel of a vehicle is disclosed. It consists of an indoor gear rim tooth ring. It also consists of lighting device disposed on annular rim body. Further, the hub-less rim comprising may include an indoor gear rim tooth ring disposed on the annular rim body.

2) It was proposed by Trivini that the construction of an improved hubless castor wheel specially for a furniture article consists of a circular element which was assist by a helping element mounted with the same furniture article. Helping element consists of a two partly casing which are delineation for trimming an upright which is joint with the furniture article.

3) Proposed by Donakowski, a hub-less caster assembly includes a caster body and a minimum of one wheel, the wheel comprising of a toroidal member having an impact race, and a complementary bearing race supported by the caster body. Bearing elements within the races support the wheel in free rotation. The caster body may comprise a hoop body having an axial opening, whereby the caster assembly features an outsized central aperture extending entirely therethrough. A centring ring could also be secured within the axial opening with the complementary bearing race formed therein. A hub cap with visual treatment could also be secured over the central aperture.

4) Wang proposed that the origination of the wheel structure with an interior rim with main interior circular face and main outer circular face that are settled centrifugally the main interior circular face is vacant and it help the steering system to join to the exterior rim which has secondary circular face which is also settled centrifugally and secondary exterior face to connect the ground.

5) Mothafar proposed that the hub-less wheel system consisting an interior ring and a range of interior rings holding brackets marked with in the mostly motionless rings. There are two bearings mounted on the ring which was mostly motionless and exterior rings are settled on the centre ring assembly.

6) Karpman proposed that a vehicle used for passenger applications consists of a middle frame, two wheel assemblies from which one wheel assembly should be a hubless wheel assembly and a foot support during a middle portion of a minimum of one wheel assembly.

7) This invention was proposed by Olsson which describes the drive system of an vehicle whish was energised by source of battery which consists of a wheel rim in different arrangement and a circular rotatory element arranged in a manner such that its perimeter is on the same axial with the perimeter of the rim.

8) This was proposed by Mopare aiming to design and build an innovative hubless wheel. In which there are three planetary rollers which can be energised by the means of two direct current motors. One from the three rollers is mounted on a shaft which is direct connected to the two direct current motors and other tow rollers are mounted on another two shafts which was connected to each other by the help of belt drives. This is how all the three rollers are driven by the help of motors and therefore the outer main wheel is also driven by motor. The values of speed, torque during working and the time taken by battery to discharge itself is first calculated theoretically afterwards compares with the values of the same calculated experimentally.

2. DESIGN CONSIDERATIONS & CALCULATION

Design of Hubless wheel depends on the application in mechanical vehicle. Hubless wheel is basically used in Light automobile vehicle (LAV), as it just being designed for bikes and cars.The Dimension view of Hubless wheel is as shown below

Table -1: Unit System

UNIT SYSTEM	UNIT
ANGLE	DEGREES
ROTATIONAL VELOCITY	RADIAN
TEMPERATURE	CELSIUS
STIFFNESS BEHAVIOUR	FLEXIBLE

2.1 Calculation

We have done simulation in Ansys 16.2 version software their workbench is very interesting to use as a new user.
In simulation we have to check their Total deformation, Equivalent Elastic Strain, Equivalent Stress of the hubless wheel.
We use some formulas for calculation

Stress = F/A=force/area of cross section

Strain = ΔL/l. = change in length/ original length

We fixed Inner rim, Outer rim is movable, however outer rim can take load up to 780N above which it is not feasible for Bikes as well as cars.
Static Analysis: The static analysis of the parts is done in Ansys 16.2 software. The outcomes are beneath:
Outer Rim: For the material is Structural Steel. The force applied was 780N in radial outwards direction.

3. SOLIDWORKS MODEL

Model is designed in 3D designing software solidworks. Different view of Model is Shown below:

Fig-1: Hubless wheel

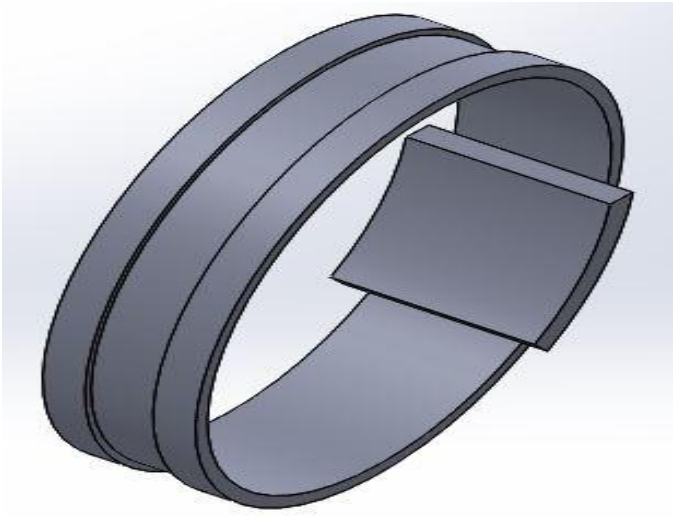

Fig-2: Inner Part of Rim

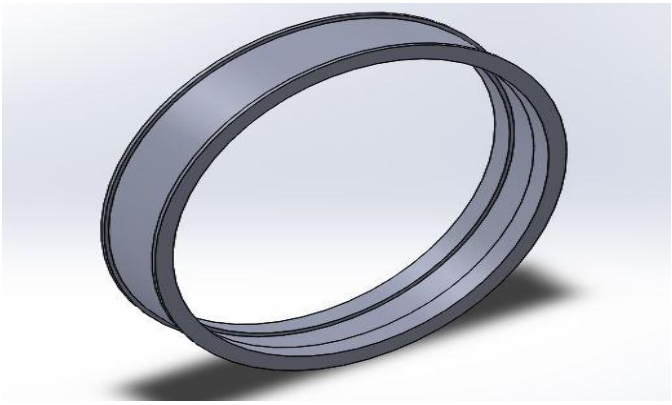

Fig-3: Outer Part of Rim

4. ANALYSIS OF HUBLESS WHEEL

This paper is presented to analyse the feasibility of a hubless wheel with roller bearing mechanism. Material used in this design is structural steel. We have used Ansys software for analysis. During analysis, we have applied a load of 780N on wheel & results of the analysis are written below:

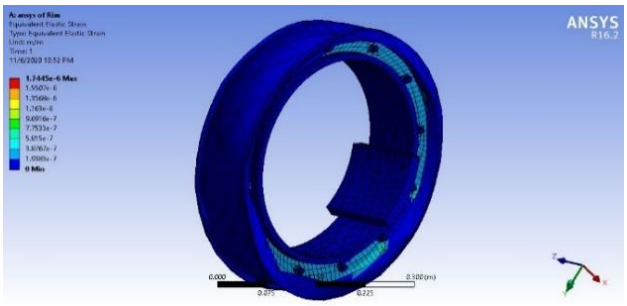

Fig-4: Equivalent Elastic Strain

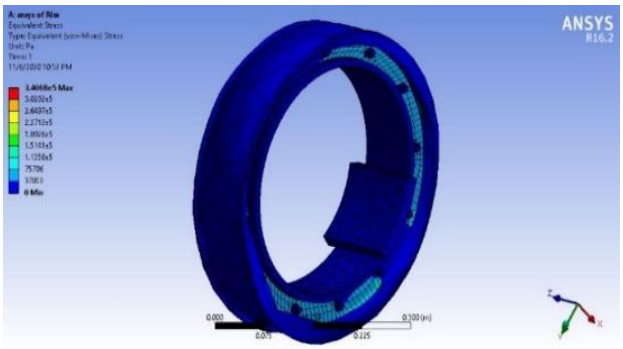

Fig-5: Equivalent Stress

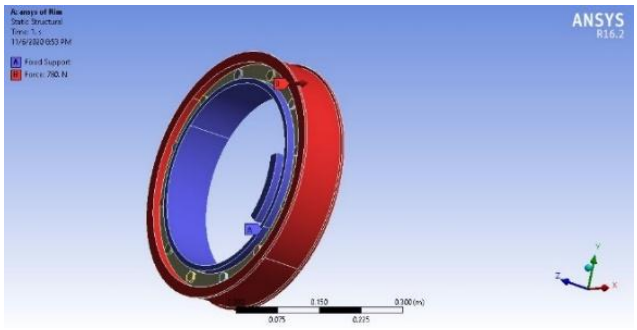

Fig-6: Static Structural

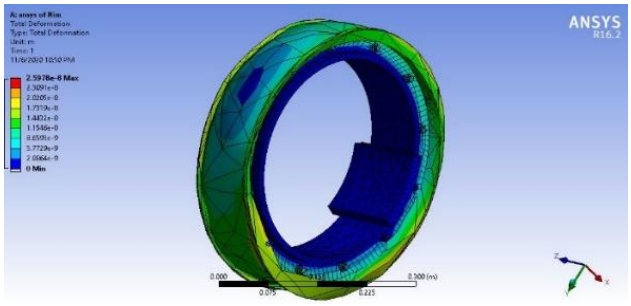

Fig-7: Total Deformation

Table-2: Results

Maximum Total Deformation	2.597 x 108 Pa
Maximum Equivalent Stress	3.406 x 105 N/m2
Maximum Equivalent Elastic Strain	1.744106

The hubless design actually Decrease the weight of the vehicle, it claims to form the vehicle more lighter and innovative in appearance as compared to the conventional model due to the removal of hub and spokes. Steering becomes more smother because of the removal of effects of deformation of stub axles and forks of the Vehicle. Center of gravity has brought much more near to the ground. Reduction in manufacturing cost.

5. CONCLUSIONS

- Hubless is future generation wheel which eliminates hub and spokes. In the current scenario, safety and accessibility is prime concern. Hubless wheel provide the solution of all them. Elimination of hub and spokes introduces safety in the device and ride experience also increase the better stability of the vehicle. In the presence of non complex component in the design. Hubless wheel more serviceable and accessible.

- Steering becomes more easier due to elimination of effect of deformation of strub axle and forks of motorbike.
- Vibration and jarring are reduced near 40-50%as compared to convention model.

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